Future Equity Patterns and Baby Boomer Retirements

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Future Equity Patterns and Baby Boomer Retirements

1.0 Introduction

Born during the two decades following World War II, the baby boom generation has had and will continue to have profound effects on financial markets and economies worldwide. During their younger years, the cohort demanded infrastructure for education and training. In their prime, this cohort placed high demand on assets such as homes and stocks. Today, with an aging population and the baby boomer generation nearing retirement age, many researchers and policymakers are wondering how their exit from the labor force and entry into retirement will influence the economy.

With the advancement of technology and a trend toward healthy lifestyles, people are living longer today and spending more of their lives in retirement. This means that retirees will require more funding to maintain their standards of living during retirement, and a huge burden will be placed on retirement income systems and health care systems. As the baby boomers save more for retirement, they drive up the demand for financial assets and raise their value. Once they enter into retirement, they will begin to rely on pensions and the decumulation of assets, possibly resulting in depressed asset prices. Some researchers suggest that asset prices may fall so rapidly that markets could experience an asset meltdown. This theory serves as the motivation for this research.

In May 2013 a Letter of Agreement was entered between the Society of Actuaries (SOA) and researchers at the University of Waterloo and the University of Kent with respect to this project titled "Future Equity Patterns and Baby Boomer Retirements."

The **First Stage** of the project involved a literature review to identify papers and models that pertain to this subject and to summarize and broadly classify the papers and models. This is a rich area for research of interest to actuaries and with implications for actuarial work. The literature review will be valuable to SOA members and others trying to understand and evaluate the opposing arguments regarding the potential for asset value depression due to demographic shifts. The first draft of the literature review was completed in August 2013, and it has been updated to August 2014 for this final report. It is attached as Appendix B. Sixty-one papers are included.

The literature review identifies whether the author expects that the retirement of the boomers will result in severe asset value reductions, referred to as "asset meltdown"(4 papers), moderate asset value reductions (33 papers), rejects the asset meltdown hypothesis (14 papers), is inconclusive (3 papers) or is only of slight relevance to this research (7 papers). Note that some of the papers rejecting the asset meltdown hypothesis also support the thesis that there will be moderate asset value reductions. One paper, Kedar-Levy (2006), No. 13 in the literature review, not only rejects the asset meltdown hypothesis but suggests the boomers' retirement might have a positive effect on equity prices. The literature review identifies whether a model

was used and, if so, provides information regarding the model. The review also identifies which papers, among the 61, are related.

There are considerably more papers written with respect to this topic than we anticipated at the proposal stage. The earliest paper identified dates to 1989, and papers continue to be written on this topic. The literature review is comprehensive and will facilitate understanding the research and difference in views and methodologies on this topic.

The **Second Stage** involved the selection and detailed analysis of two papers that support the hypothesis that demographic factors such as cohort size and asset sales associated with retirement can have an impact on asset prices. Although only four papers support the thesis that there will be an asset meltdown, the majority of papers argue that asset returns will be affected by demographics. The Second Stage had the following four main components:

1. We discussed with the project oversight group (POG) the models that relate to asset value depression and decided on two of these models to be the subject of further research. After discussion with the POG, we selected for further analysis, the papers:
   - The Effects of a Baby Boom on Stock Prices and Capital Accumulation in the Presence of Social Security (2003) by Andrew B. Abel (No. 31 in the literature review)
   - Boomer Retirement: Headwinds for U.S. Equity Markets? (2011) by Zheng Liu and Mark M. Spiegel (No. 45 in the literature review).
   The Abel paper uses an Overlapping Generations (OLG) model and is cited by a number of other papers in the literature. The Liu and Spiegel paper, published by the Federal Reserve Bank of St. Louis, is more recent, and uses a statistical analysis of demographic ratios. The two papers present different approaches to analyzing this subject.
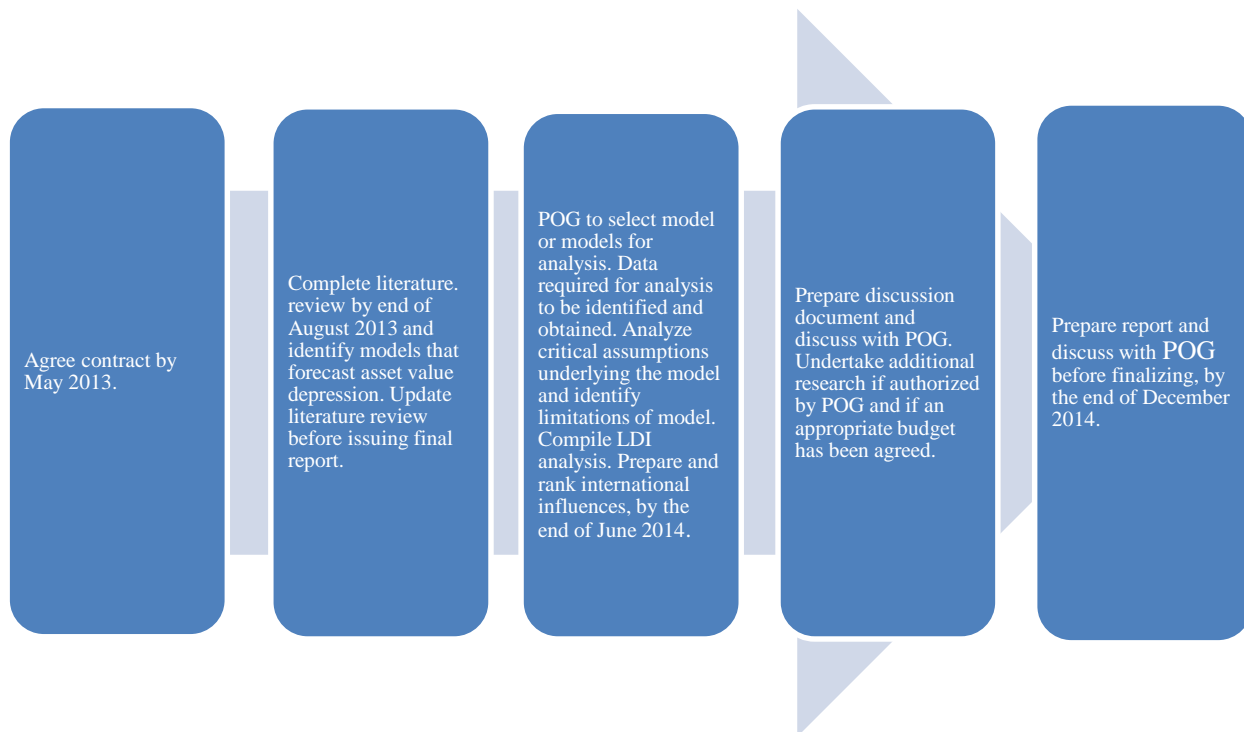2. Using available U.S. data, we investigated the critical underlying assumptions of the selected models to ensure that model users would understand the foundation on which the models are based and any limitations in the models' usefulness. See Section 3.
3. In Section 4 we examine data to determine whether liability-driven investment (LDI) strategies may be expected to impact equity prices and returns. We compiled data regarding equities held by defined-benefit pension plans in the United States and compared the magnitude of possible asset re-allocations, as a consequence of implemented LDI strategies, to traded equity volumes.
4. We prepared a list of international factors that may affect U.S. equity prices and grouped the list in order of importance (magnitude and likelihood of impact). See Section 4.

This research has been performed with respect to U.S. equities held by the U.S. population. Use of U.S. data was necessary in order to create a manageable project and is consistent with the objectives of the project. According to Towers Watson Global Pension Assets Study 2013, pension funds in the United States show a greater "home bias" than any other country, with approximately 70 percent of equity investments in domestic equity. Moreover, we believe that the majority of equities held by the U.S. population are U.S. equities. Furthermore,

many U.S. equities are shares in multinational companies whose share prices are affected by global factors. Consideration of international capital flows increases the complexity of the analysis. It is an area with great potential for further research.

In the **Third Stage** of the project, the results of the Second Stage were presented in a preliminary draft report that was reviewed by and discussed within the POG. This document incorporates the points raised in that discussion and represents part of the **Fourth Stage** of the project.

A schematic of this process follows.

| Agree contract by May 2013. | Complete literature. review by end of August 2013 and identify models that forecast asset value depression. Update literature review before issuing final report. | POG to select model or models for analysis. Data required for analysis to be identified and obtained. Analyze critical assumptions underlying the model and identify limitations of model. Compile LDI analysis. Prepare and rank international influences, by the end of June 2014. | Prepare discussion document and discuss with POG. Undertake additional research if authorized by POG and if an appropriate budget has been agreed. | Prepare report and discuss with POG before finalizing, by the end of December 2014. |

The author would also like to thank the Project Oversight Group who provided valuable guidance and input. The members of the Project Oversight Group were Tim Bischof, Dan Finn, Kim Gordon, Steve Marco, Dennis Radliff, Bob Reitano, and Greg Slone.

2.0 Introduction to the Papers

Two papers that support the asset meltdown hypothesis, and which use different approaches, were selected for further analysis. These papers are: "The Effects of a Baby Boom on Stock Prices and Capital Accumulation in the Presence of Social Security" by Andrew B. Abel (2003) (No. 31 in the literature review), and "Boomer Retirement: Headwinds for U.S. Equity Markets?" by Zheng Liu and Mark Spiegel (2011) (No. 45 in the literature review). The Abel paper uses a theoretical approach whereas the Liu and Spiegel paper is based on an empirical analysis of U.S. data. General differences between theoretical and empirical approaches are outlined in subsection 2.1. Subsections 2.2 and 2.3 discuss the papers briefly and outline key assumptions underpinning their results. A more detailed analysis is presented in Section 3.

2.1 Overview

Both Abel (2003) and Liu and Spiegel (2011) focus on aggregate demand for investment, which is linked to the price of capital. Demand for investment is driven, in part, by the value of future consumption, but also by the productivity of capital in the future. Some theoretical models, including Abel (2003), focus on aggregate savings and the transformation of savings into capital as a means to generate consumption in the future. As a result, they do not distinguish between different sectors of the economy or the different types and risk profiles of investments.

The empirical literature focuses on variables that provide a proxy for the relative value of assets, and on expected future cash flows. In equity markets, much of the research examines the price-to-earnings (P/E) ratio or the equity premium. Empirical studies, such as Liu and Spiegel (2011), test directly for links between the demographic structure and these quantities.

Theoretical models specify a function to describe population dynamics. These theoretical models can then be calibrated to predict the path of future asset prices based on predictable changes in the resulting demographic structure. By necessity, these models may abstract from other features of the economy, factors that may alter predictions altogether. For example, if an excess is anticipated by rational investors, these investors would adjust their investments, preventing an asset meltdown (see Bovbjerg and Scott (2006) or Schich (2008), Nos. 12 and 14 respectively in the literature review). The papers we are considering predict that asset prices will move with population shares of certain cohorts.

2.2 Theoretical Model in Abel

Abel (2003) establishes a plausible link between population dynamics and asset prices. The Abel paper has many assumptions underlying the behavior of agents and production in the model. As such, on first reading, it can be difficult to fully comprehend the derivation of the model's conclusions. The relevant modeling assumptions and derivations, with explanation, are given in Appendix A.

In this subsection, we provide an overview of his approach and methodology. Abel uses many simplifying assumptions in order to keep the model tractable. More realistic assumptions lead to non-analytical solutions, such that model predictions can only be made via simulation. In the following discussion in this subsection, references to sections relate to those of Appendix A.

Abel defines a rudimentary overlapping generations model for a population with two states—young and old—where young is the workforce and old is the pensioners group. At any point in time, these two groups co-exist. At the end of the period, the old die, and the young become old in the next period. A new supply of young at each time is assumed to follow a geometric random walk to introduce variability in the model. The choice of geometric random walk for population dynamics helps keep the algebra tractable. Given the uncertainty involved in trying to model fertility rates, it seems like a reasonable choice. Section 2.1 provides the notation.

Section 2.2 defines the aggregate capital stock in the economy.

Section 2.3 shows how labor, i.e., the young population, and capital combine to produce goods via a standard Cobb-Douglas production function (Equation 1).

Section 2.4 indicates the proportion of production (goods) which is consumed (consumption), relative to that which is set aside (saving) to use as capital in the future production period. Saving, along with existing capital stock, some of which might have depreciated, comprise the capital stock in the future period (Equation 2).

Given Abel's model of production, consumption, saving and the evolution of capital, Section 3 describes the rates at which goods and future capital are produced, e.g., wage is the rate at which labor is converted to goods. As expected, all the conversion rates are related and one of the most important consequences is Equation 3, which defines the price of capital as the reciprocal of the conversion rate of saving into future capital.

Abel incorporates a rudimentary central Social Security system, which could include either a very simple defined-benefit or a defined-contribution scheme. See Section 4.

Section 5 outlines the individual's objective. A young individual is assumed to pay tax to the Social Security system from his or her wages. A part of the post-tax wage is consumed and the rest saved privately. An old individual consumes everything he or she has, i.e., the Social Security benefits funded by tax and the private savings. The young determine how much to consume/save by maximizing their objective function, an expected logarithmic utility function (Equation 8), which is increasing in current and future consumption. The choice of logarithmic utility is standard in the literature and keeps the model tractable. Total consumption is the aggregate of individual consumption.

An expression for the evolution of the price of capital over time is given in Equation 15 of Section 6. Equation 15 indicates that a population increase such as a baby boom leads to high levels of goods production. This in turn leads to increased saving and investment compared to capital stock, which drives up the price of capital.

We limit our critical analysis of Abel (2003) to a theoretical discussion, in keeping with the structural framework of the paper. First, we note that multiple factors can influence equilibrium outcomes. However, several underlying assumptions must be clarified before the magnitude of these factors can be established. For instance, the timing of transfer of ownership of capital, and the associated impact on the counting of gross domestic product (GDP) from the capital transformation technology, are not very clear. Further, the relationship between the return on capital and individual consumption is not well described. Abel states that each individual has a negligible effect on aggregate consumption; however, this statement is somewhat misleading because in aggregate the decisions of individuals could have a substantial impact.

Abel makes several simplifying assumptions to keep the model tractable. However, some of these assumptions may have important implications for empirical prediction, in terms of a loss of flexibility in modeling attenuating effects on asset prices.

The first assumption that has implications on the return to capital is a log-linear production technology for capital conversion. This assumption, while common in the literature, may be an inaccurate representation of capital transformation and thus investment—factors that are critical in determining the price of capital in the model. This assumption also affects aggregate output, and thereby the value added from capital.

A second assumption that contributes to the large predicted drop in the price of capital is that population follows a geometric random walk, making the size of future generations unpredictable. The uncertainty generated by this assumption could imply that intergenerational pricing is much more sensitive to current shocks in population dynamics.

Finally, the model assumes full employment, i.e., inelastic supply of one unit of labor by the young, and zero labor supply by the older generation. However, labor supply and employment rate are important adjustment mechanisms in the economy. If income from capital drops and relative income from labor rises, we might expect increased labor supply. By assuming fixed labor supply, the model could force extra variability in the relative price of capital, resulting in a biased prediction of the magnitude of the drop in asset prices.

In order to draw accurate quantitative inferences from Abel's model, we believe that it is imperative to consider the implications of relaxing the above assumptions, and testing the sensitivity of the model's predictions to more realistic depictions of population structure, labor supply and production. Likewise, empirical results from the Liu and Spiegel paper are dependent on a set of very specific assumptions/techniques.

2.3 Liu and Spiegel Paper

The Liu and Spiegel paper takes a statistical approach, which is guided by the OLG model in Geanakoplos et al. (2004), No. 33 in the literature review. The innovation of Geanakoplos et al.'s model is to allow for deterministic booms and busts in population growth in place of Abel's stochastic growth rate. Liu and Spiegel's analysis focuses on the strong historical correlation between P/E ratios and the ratio of middle-aged (prime savers) to older (retired) cohorts of the population. Unfortunately, the time-series properties of the above ratios imply that there is a danger of detecting a spurious relationship unless all other explanatory factors are controlled for. See Section 3 for further analysis and discussion. Control variables should include known correlates of asset prices such as:

- Inflation expectations
- Liquidity (money supply) in the system
- Growth expectations
- Wealth distribution of equity owners (to determine their motive for selling when prices fall).

A first step in our analysis is to extend the time period and widen the scope of the regressions reported by Liu and Spiegel, with a view to evaluating the robustness of the reported relationship.

3.0 Analysis of Papers

In this section, we present various data and analyses to enable the reader to form an opinion on the models, the assumptions underlying the models, and to draw conclusions regarding the likelihood that the projected effects will occur.

3.1 Considerations with Respect to Abel Paper

In Abel's model, one channel in which demographic changes can impact prices is that capital formation increases with a baby boom, leading to increased cost of capital, which reduces subsequently when a population boom passes. This result suggests that we should observe a positive correlation between the P/E ratio and the ratio of gross fixed capital formation (GFCF) as a share of GDP (GFCF/GDP). We do observe this positive correlation in the U.S. data.

However, when we regress P/E on its own lag and on GFCF/GDP this results in a statistically insignificant parameter estimate, as shown in Table 1, suggesting it is not persistent and other factors may be affecting this relationship.

Table 1. Regression Results for Abel Paper

	GFCF/GDP	Lag P/E	Constant
Estimate	81.97965	0.369069	-3.87516
Std. error	56.52976	0.133135	10.32991
R^2	0.21446		

*Annual data (1961-2012). Sources: World Bank (http://data.worldbank.org/) and Robert Shiller (http://www.econ.yale.edu/~shiller/data.htm)

Figure 1. Examining the Relationship between Demographics, Investment and the Cost of Capital

*Annual data (1961-2012). Sources: World Bank (http://data.worldbank.org/) and Robert Shiller (http://www.econ.yale.edu/~shiller/data.htm)
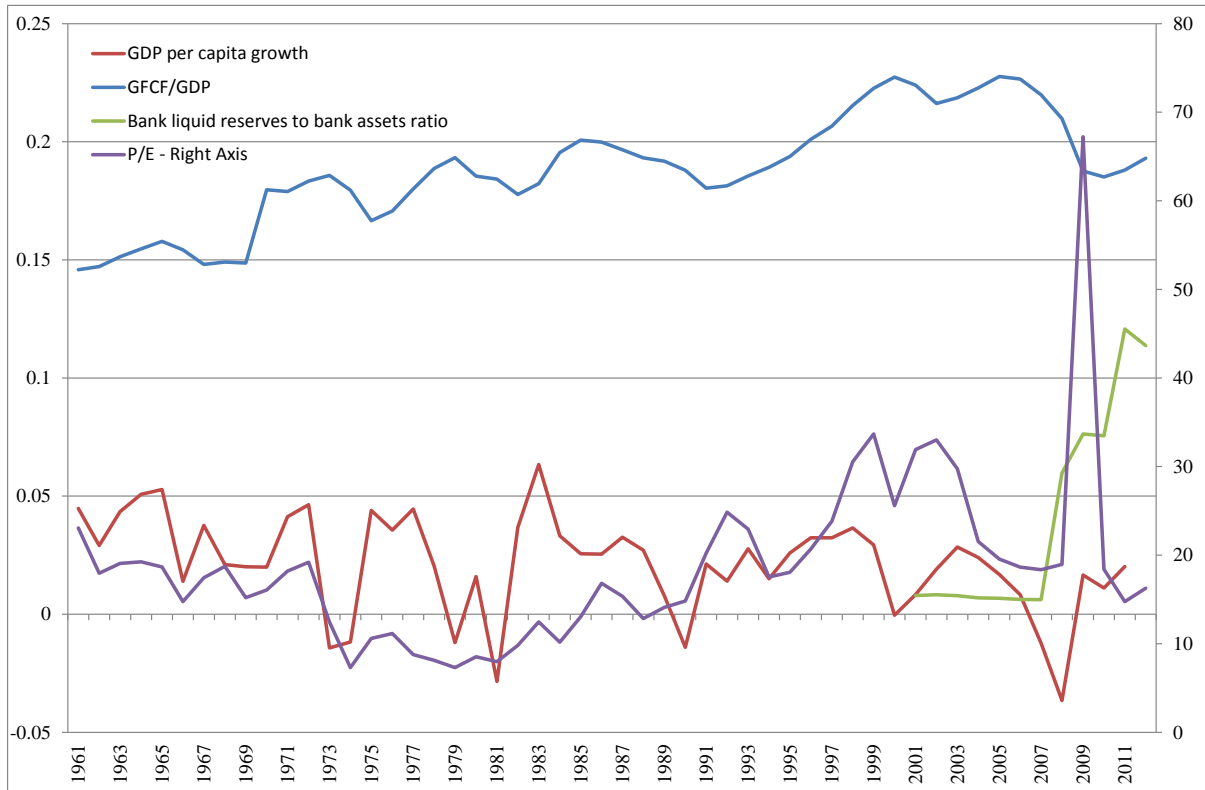
As can be seen in Figure 1, the proportion of capital formation (a proxy for investment) in total output (blue line)—a predictor of the price of capital in Abel's model—has a very different dynamic than the P/E ratio (purple line).

Other predictors of the P/E ratio and GFCF suggested by the events of recent years may include the liquid reserves of banks as a proportion of their assets (green line in Figure 1).

Based on this preliminary data analysis, it seems unlikely that Abel's assumption regarding the relationship between demographics and the price of capital is the only explanation for changes in the price of capital.

3.2 Considerations with Respect to Liu and Spiegel Paper

In analyzing the Liu and Spiegel (2011) paper we consider whether their results are robust or are affected by the time periods selected. We also consider alternative constructions of the ratios.

We construct the Middle-Aged/Young (M/Y) and Middle-Aged/Old (M/O) ratios using U.S. Census Bureau data from 1900 onwards, with the three relevant age groups being 25-34, 35-44, and 55-64, respectively. Below is the plot of these three ratios—please note that the P/E

ratio is plotted on the right axis. Also note that the P/E ratio is constructed in real terms as in Liu and Spiegel.

**Figure 2. Age-Group Ratios and the Price-Earnings Ratio for S&P 500**
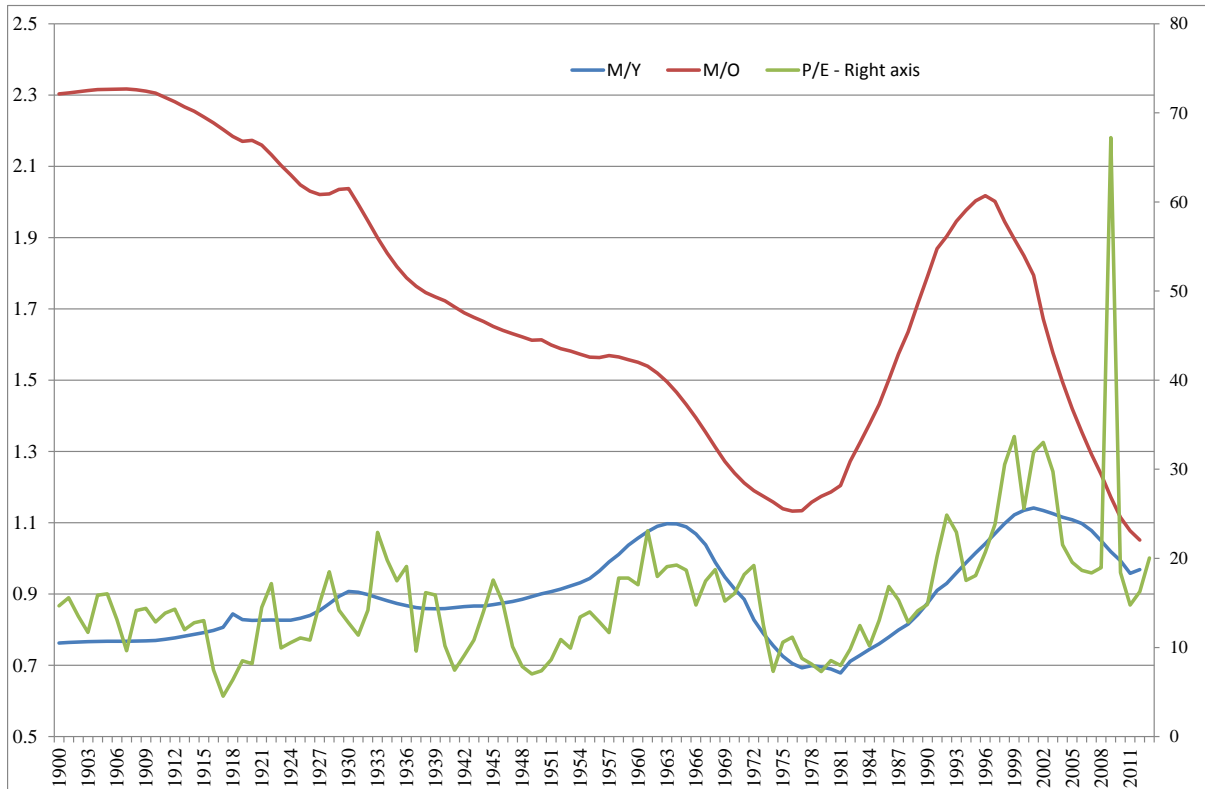
Liu and Spiegel used data from 1954 to 2010. When we use observations for this same time period, a regression of the P/E ratio on the M/O ratio results in a statistically significant coefficient estimate for the M/O ratio. In this sense, our analysis corresponds to Liu and Spiegel's finding. However, we can see in Figure 2 that the sample period in Liu and Spiegel may be driving their results. Indeed, we find that starting the sample in 1954 leads to a stronger relationship between P/E and M/O. However, the two years following their study are not consistent with their hypothesis. Furthermore as discussed below, when (for this 1954 to 2010 period), we include the lagged P/E ratio in the regression, the M/O ratio is no longer significant, suggesting that the findings in Liu and Spiegel may be driven by the high autocorrelation in the two ratios rather than by a causal link.

The age groups that we use are similar to, but not the same as, those used by Geanakoplos et al. (2004) or Liu and Spiegel (2011). Liu and Spiegel's ratio uses 40-49 years and 60-69 years as the M and O cohorts, respectively. Geanakoplos et al. use 20-29 years as the Y cohort. Our cohorts are shifted by five years, but they allow us to extend the data sample back to 1900. We argue that these alternative cohort ratios would be just as relevant if the relationships identified in the above papers are robust. Because the age groups are arbitrarily chosen (i.e., there is no precise definition of young, middle and old), we should find that a small shift in the definition of age groups would not alter the empirical relationships identified by Liu

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and Spiegel. (We could just show this by using the shifted age groups for their time period.) Besides, as our M/Y ratio is relatively more correlated with P/E, we do not believe we are biased against the arguments we are examining.

We check the autocorrelations of the series to ascertain if there is a risk of finding spurious regression results.

Figure 3. Autocorrelations up to 20 Lags of the Three Ratios
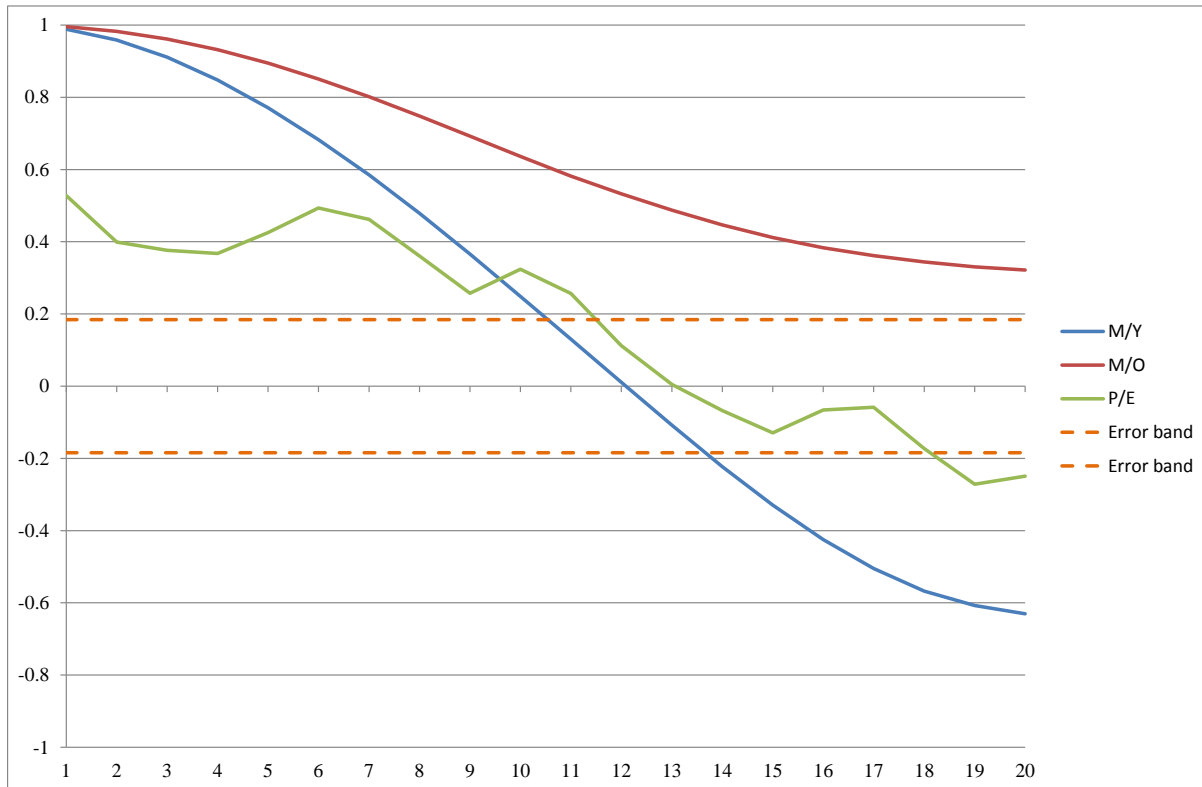
The two dashed lines represent the 95 percent error bands for the given sample size, beyond which autocorrelation measurements can be considered significant. The demographic ratios clearly display long-memory properties, so we need to be careful when interpreting regression results. Given these autocorrelations there is a risk of finding a spurious association based on a regression involving the ratios.

To check the implications of the autocorrelations in Figure 3 above, we regress P/E ratios on, respectively, the M/Y ratio and the M/O ratio, and plot the autocorrelation function (ACF) of the *errors* from the two models. In a robust, well-specified model, these residuals would have no autocorrelation; but, as shown in Figure 4, they do.

Figure 4. Autocorrelation of Residuals from Two Regressions, up to 20 Lags

1. P/E = a + b*M/Y + e
2. P/E = a + b*M/O + e
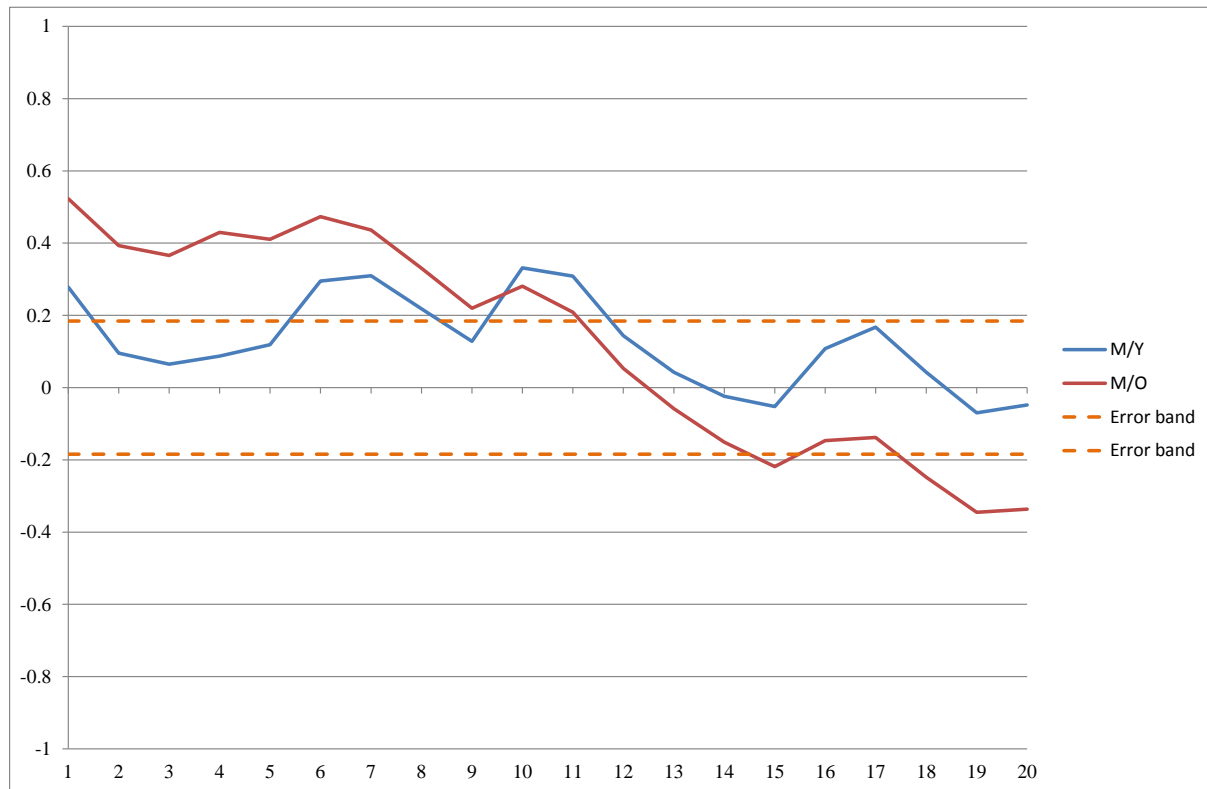
This result suggests that interpreting regressions of the P/E on demographic ratios is problematic. One way to address the issue of autocorrelation is to incorporate the lagged P/E ratio as a regressor. We ran the modified regressions and present the results in Table 2.

Table 2. Regression Results for Liu and Spiegel Paper

Dependent variable: P/E ratio

	I	II	III	IV
Constant	**-16.50**	**18.80**	**-12.07**	**8.23**
	4.20	*3.32*	*4.28*	*3.29*
M/Y	**35.86**		**25.98**	
	4.67		*5.48*	
M/O		-1.92		-0.49
		1.88		*1.63*
L(P/E)			**0.28**	**0.52**
			0.09	*0.08*
R-squared	0.35	0.01	0.40	0.28

Note: Statistically significant (at the 5 percent level) parameter estimates are in bold, with the standard error below the estimates. Annual data (1900-2012). Sources: U.S. Census Bureau and Robert Shiller (http://www.econ.yale.edu/~shiller/data.htm)

Although specification I has a high R^2, both specification I and II may be misspecified based on the ACF of residuals shown above in Figure 4. In order to correct for the possibility of a spurious association, we include lagged values of P/E as regressors in specifications III and IV.

We find that the M/O ratio (specifications II and IV) does not appear to have explanatory power for the P/E ratio, contrary to the findings in Liu and Spiegel.

However, once we control for the lagged value of P/E, the M/Y ratio appears to offer some explanatory power (specification III).

An alternative approach to verifying this relationship is to regress first differences of the P/E ratios ($P/E_t - P/E_{t-1}$) on first differences of the two ratios respectively. We ran these regressions; however, the parameter estimates were statistically insignificant at conventional levels and the R^2 were close to zero, so results are omitted for brevity.

Overall, we find very limited support for the underlying assumptions of the models presented in Liu and Spiegel, and in Abel.
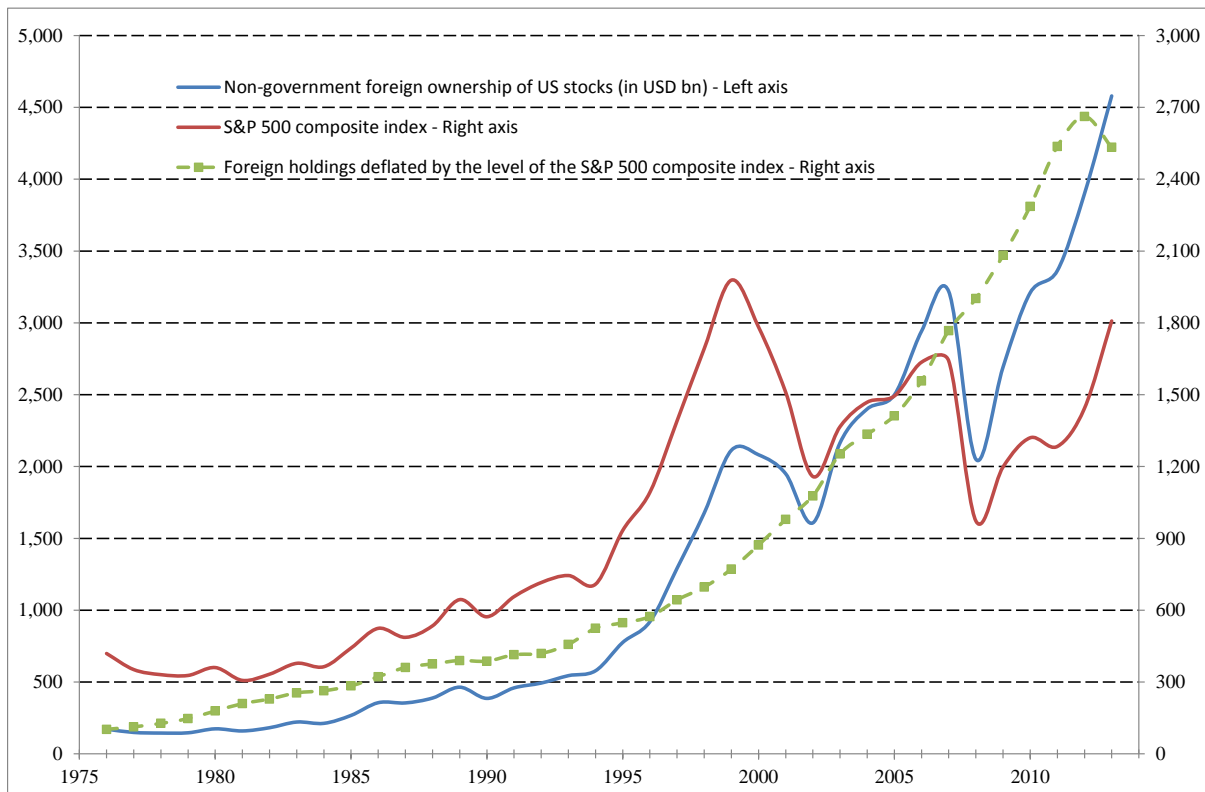
4.0 Other Considerations

There may be other factors that could lead to an asset meltdown that arise because of actions taken to adjust to the size of the baby boom cohort. For example, pension plans may implement LDI strategies recognizing the changing nature of their liability profile as baby boomers

approach retirement and retire. In this section we consider how other factors, such as sale of assets to support LDI strategies and holdings of U.S. equities by foreigners, impact asset prices.

4.1 Sales to Implement LDI Strategies

Figure 5 shows that foreign ownership of U.S. stocks has risen consistently (blue line) and that this is not an artifact of rising market values (the red line). The black line in Figure 6 shows that share of foreign ownership has increased to over 20 percent in 2011, from approximately 7 percent in 1991 and approximately 11 percent in 2001. The more broadly U.S. equities are held, the less the likelihood that sales of equities by pension plans to implement LDI strategies will impact asset prices.

Figure 5. Foreign Ownership of U.S. Stocks

Data is in December 2013 dollars.

Sources: U.S. Bureau of Economic Analysis (http://www.bea.gov/itable/index.cfm) and Robert Shiller (http://www.econ.yale.edu/~shiller/data.htm)

Figure 6. Share of Foreign Holdings in Total Market Capitalization Has Been Rising Steadily
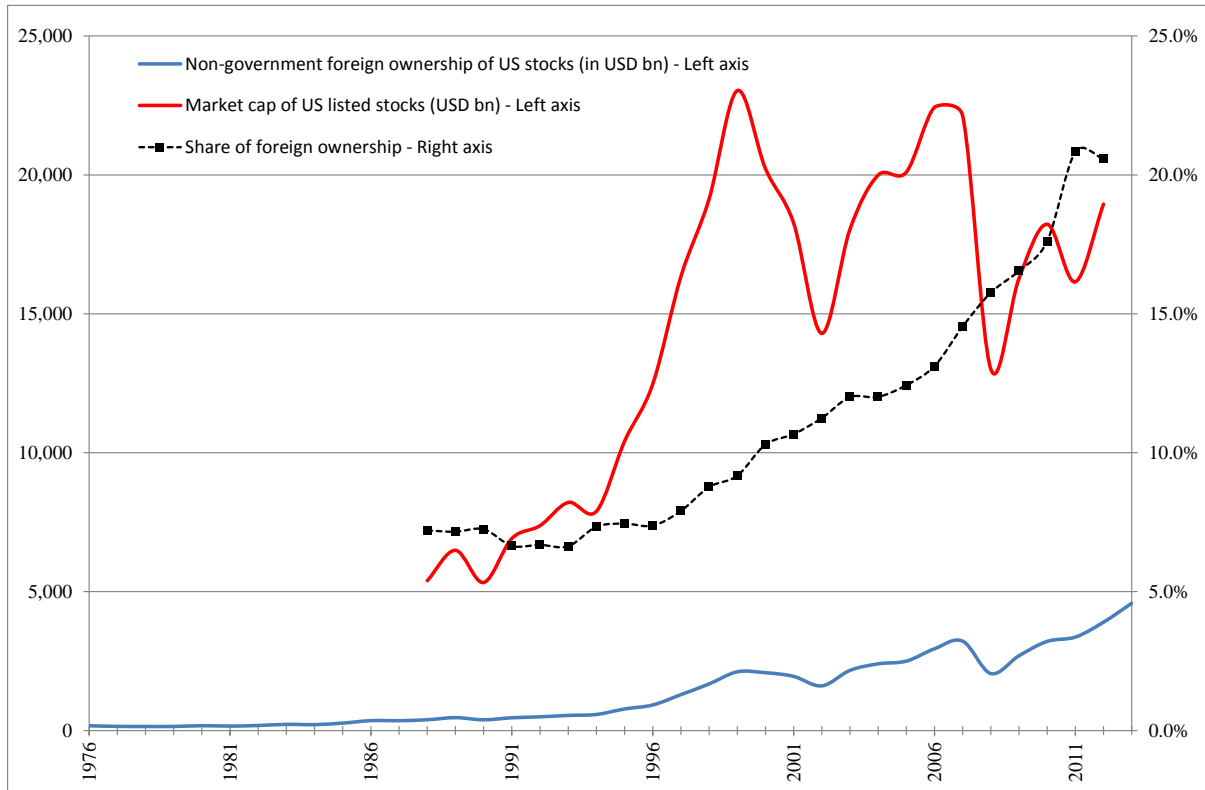
Data is in December 2013 dollars.

Sources: U.S. Bureau of Economic Analysis (http://www.bea.gov/itable/index.cfm);
Robert Shiller (http://www.econ.yale.edu/~shiller/data.htm); and
World Bank (http://data.worldbank.org/)

      Table 3 shows the asset allocation of U.S. pension arrangements in 2012, with comparative figures for the Netherlands, Japan and Germany. According to the OECD data, U.S. pension arrangements hold a larger allocation to equities than in any other OECD country. Also, the pension assets are significantly greater in the United States than in any other country.

Table 3. Global Pension Asset Allocation 2012

Country	Shares	Bills & Bonds	Cash & Deposits	Other	Total Pension Assets (billions USD)	As a Percentage of GDP
United States	48.9	20.9	1.0	29.2	16,851	108
Netherlands (1)	33.5	42.7	3.2	22.7	1,199	156
Japan (2)	9.7	36.3	5.1	48.9	3,721	62
Germany (3)	3.6	51.4	3.0	42.0	498	15

Source: OECD Global Pension Statistics; and Towers Watson Global Pension Assets Study 2013 (last two columns)

Notes: (1) The high value for "Other" is driven by investments of mutual funds.

(2) The high value for "Other" is driven mainly by accounts payable and receivable and outward investment in securities.

(3) The high value for "Other" is driven mainly by loans and other investments of mutual funds.

To estimate the impact of equity sales to implement LDI strategies, we assume that the asset allocation in the pension arrangements in the Netherlands, Japan and Germany reflects adoption of asset-liability management strategies. (Other explanations of the lower equity holdings in other countries compared to the United States include fewer defined-contribution plans in which members direct asset allocation, or greater proportion of pensioners to contributors implying a more conservative investment strategy.) Using this assumption U.S. plans might sell 15.4 percent of their equities or $2,595 billion to reach a position similar to the Netherlands or 45.3 percent of their equities or $7,634 billion to reach a position similar to Germany (which appears extreme). These are significant amounts of assets.

Table 4 shows the average daily volume for shares traded on U.S. exchanges for the last five years. These trading volumes will include asset sales and purchases by pension funds. If sales related to LDI strategies occurred regularly over this period of time, it is unlikely that they would have much impact on prices. For example, the $7,634 billion of equity sales to reach a position similar to Germany's asset allocation is equal to about 28 days of average trading volume. Hence, approximately a 5 percent increase in daily trading volume over a two-year period could effect such a massive asset re-allocation and would be unlikely, in of itself, to have much impact on asset prices.

Table 4. Daily Trading Volume U.S. Exchanges

Year	Number of Shares (billions)	Value (billions of USD)
2014 (1)	7	279
2013	6.2	n/a
2012	6.4	n/a
2011	7.8	n/a
2010	8.5	n/a
2009	9.8	220

Source: Bloomberg News

Note: (1) First 30 days of trading in 2014.

4.2 Potential Impact of International Investors

Moderating influences of the demographic impact on equity prices, such as international investment, are recognized by several papers in the literature. However, the effect of international investment is not quantitatively evaluated. Modeling international influences over a future time horizon is extremely complex, requiring several additional assumptions and often resulting in non-analytic solutions. It would be difficult to get data with sufficient granularity to conduct a thorough analysis, making the analysis very costly relative to the potential benefit. Accordingly this project has been limited to the preparation of a list of international influences that may affect U.S. equity prices, and the identification of whether such influences are likely to be positive or negative in the context of the asset meltdown hypothesis. The list follows.

Influences Positive to the Asset Meltdown Hypothesis

1. Foreign investors perceive that the boomer retirement will negatively impact corporate performance and sell shares.
2. Foreign investors decide non-U.S. equities are likely to provide better returns with comparable risk and sell shares.
3. Foreign governments restrict the holdings of U.S. equities causing foreigners to sell U.S. equities.
4. A change in U.S. foreign policy results in foreigners selling U.S. equities.

Influences Negative to the Asset Meltdown Hypothesis

1. Foreigners consider the long-term risk-adjusted return to be better for U.S. equities than other asset classes and purchase U.S. assets.
2. Foreign businesses use equity purchases as a way to gain greater control over U.S. companies.
3. Foreign investors, pension funds, sovereign wealth funds or governments (those with time horizons and investment objectives different from the boomers) perceive sufficient long-term value and purchase U.S. equities, keeping prices stable or higher.

4. A U.S. policy change increases the value of U.S. equities by foreign investors, e.g., U.S. immigration favors foreigners that invest substantial amounts in the United States or in U.S. equities.

4.3 Further Observations

In Section 4.2 we suggest several pathways by which international investment could mitigate severe asset price depreciation. We cast further doubt on the asset meltdown hypothesis by incorporating alternative explanations for the dynamics of P/E ratios. In Figure 7 we examine demographic ratios and P/E during periods of expansion and recession.

Figure 7. Demographic Ratios, P/E Ratio and NBER Recessions
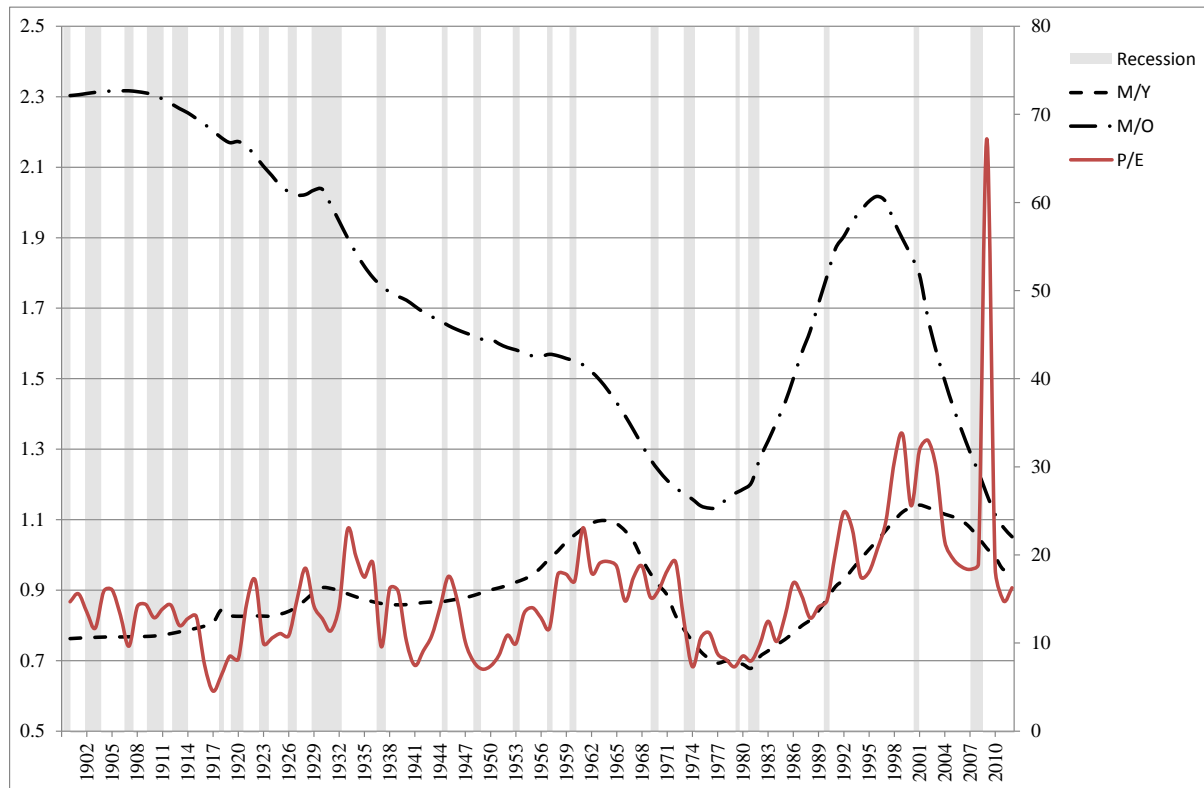
*Annual data (1961-2012). Sources: U.S. Census Bureau, NBER, and Robert Shiller (http://www.econ.yale.edu/~shiller/data.htm)

The gray bars represent periods of recession. We note that the relationship between demographic ratios and the P/E ratio is strongest during periods of relative economic stability (that is, in the absence of long recessions). Between 1982 and 2000, a relatively recession-free period (with a brief exception in 1990), there was an upward trend in all three ratios. Thus, it may be that the relationship between demographics and asset prices is incidental, since it is limited to a period when other explanations for increases in the price of capital are present.

Finally, while the relationship is sensitive to the choice of demographic ratios, the U.S. Census Bureau predicts relatively stable M/Y ratios and M/O ratios for the next 50 years, about a

25 percent change over the time period as shown in Figure 8. This finding casts further doubt on the validity of predictions of a stock market meltdown.

Figure 8. Demographic Ratio Forecasts
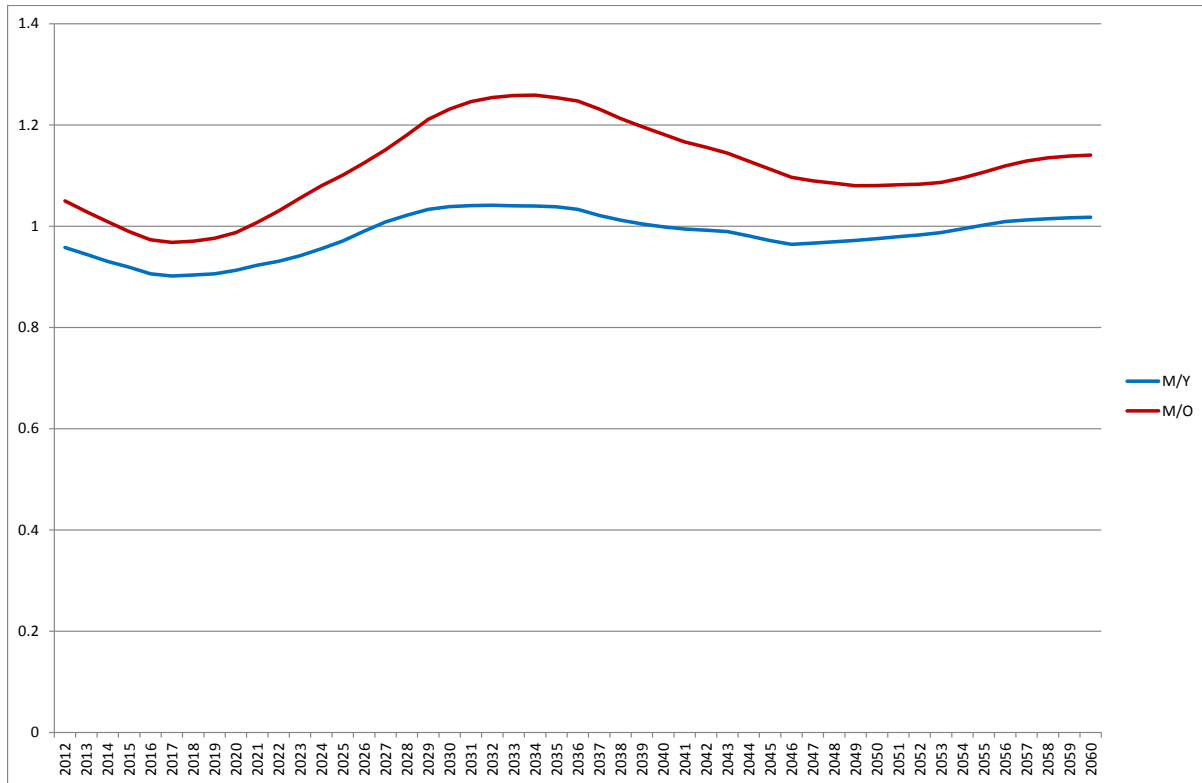
Source: U.S. Census Bureau

5.0 Conclusions and Areas for Future Research

In this project, we have provided a comprehensive literature review with respect to the hypothesis that the retirement of the baby boomers will have a severe impact on asset values. Only 4 papers suggest that the impact will be so severe as to constitute an asset meltdown; whereas 14 papers reject the asset meltdown hypothesis. Nonetheless, the majority of papers argue that the retirement of the boomers is likely to have a negative impact on asset values or returns. In addition to the 4 papers suggesting an asset meltdown, there are 33 papers suggesting that there will be at least a moderate impact on asset values, and a number of the papers rejecting an asset meltdown also support the view of a moderate impact on asset values.

The literature contains both theoretical and empirical analyses of the impact of demographics on asset prices. We have provided a detailed analysis of two papers; one by Abel (2003) that uses a theoretical model and one by Liu and Spiegel (2011) that uses an empirical model. We analyze historical data and find little support for the positions presented in those two papers. However, we are not able to incorporate all factors that might potentially mitigate (or exacerbate) an asset meltdown.

The oldest boomers are just beginning to retire, and it is unlikely that the boomer generation will be retired fully for at least another 20 years. During the early stages of retirement, it is unlikely that massive asset sales will be required. Hence, it is far too early to be able to observe an impact of boomers' retirement on asset values.

Moreover, even if there is a significant impact of the boomers' retirement on asset values, it may be difficult to discern. First, asset sales are likely to extend over a considerable time period. Second, sales may be timed to avoid a depressed price, which implies that the extent to which a bull market is depressed by boomers' asset sales is difficult to quantify. Third, asset prices and markets are affected by many factors, such as actions of central banks and governments, election campaigns, labor shifts and international players. Prices may also be affected by demographics, but it will be difficult to identify the contribution of each component. A much more complex model is required to incorporate all of these factors, some of which are moving in the same direction.

Analyzing major shifts in factors, such as demographics, that affect asset prices is an important area of research for actuaries. A considerable amount of actuarial work is very much concerned with the value of assets in the future and with population data. If, as is suggested by the majority of papers in the literature review, demographics can influence asset prices, and the sale of assets by the relatively large cohort of boomers is likely to have a negative impact on asset prices, then this is important to actuaries, their work, and their clients.

But to be valuable to actuaries more work needs to be done to attempt to model and quantify future cash flows. To fully investigate this issue requires a larger undertaking than was possible within the time frame and budget for this project. We recommend that future research be conducted as accurate analysis should prove beneficial to the actuarial profession.

5.1 Areas for Future Research

The greatest impact of the boomers' retirement on asset values is most likely to occur in the period 15 to 35 years hence. Accordingly there is a need for the development of a model that can make projections for this time frame. The model would need to be able to project population structure, consumption requirements, savings, asset holdings by class, and asset sales. It would need to establish a relationship between demographics and asset prices. Moreover, the model would need to consider the impact of international capital flows.

An asset meltdown signifies an extreme decline in asset values. Normally extreme declines are triggered by shocks to the system, which receives a significant response that is often an over-reaction, but which exacerbates the decline. The boomers' retirement is not a shock. It has been anticipated and will occur over an extended period. As such, there is time for boomers to consider and plan the timing of asset sales and for policymakers to take actions that may moderate the impact of the boomers' retirement, e.g., by raising the retirement age. Another area of research focuses on quantifying the impacts of policy alternatives to mitigate depressed asset prices from the boomers' retirement. Börsch-Supan (2006), No. 42 in the literature review, argues that policy can offset the effects of aging on asset values.

Finally, a productive venue for future research would be to explore the extent to which aging impacts different asset classes. The majority of papers in the literature deal with the impact of demographics on equity prices, (Some papers deal with the impact on house prices, e.g., the initial paper by Mankiw and Weil (1989) and more recently Takáts (2010), Nos. 1 and 43 respectively in the literature review). But we found no mention of an impact on bond or infrastructure returns. Both of these asset classes are important for financial institutions and pension plans, which are employers or clients of actuaries.

In conclusion, based on the literature reviewed, we suggest that the retirement of the boomers will have a moderate effect on asset prices. To quantify this effect and the timing of its occurrence requires the use of complex models whose results are sensitive to the underlying assumptions. Actuaries can contribute to and learn from the research in this area. We hope that this report will interest and encourage actuaries in this area to become involved in the analysis.

1   Background

Abel (2003) provides a theoretical set-up to study the plausible link between changes in population structure and stock prices. Based on certain underlying assumptions, the author shows that a baby boom increases the price of capital. But, being mean-reverting, the price of capital falls in the following period. The purpose of this review is to outline the main underlying assumptions of the model, and also to outline the derivations that are pertinent to this particular result, so that these can be critically assessed. Abel (2003) goes on to analyze social security issues that will not be discussed here.

The notations used in this note are broadly consistent with those used in Abel (2003), with minor modifications made for clarity of exposition.

2   Model Set-Up

2.1   Population Structure

The paper uses an overlapping generations model, in which an individual lives over two periods. In the first period, the individual is "young" and supplies one unit of labor to earn a wage, some of which is spent on consumption and the rest is saved privately or through a social security system. In the second period, the individual is "old" and consumes all available resources without contributing to labor. Notationally:

$N_{t,y} = N_{t-1,y} \exp(\epsilon_{N,t})$: Number of "young" individuals at time t follows a geometric random walk, where $\epsilon_{N,t}$ is i.i.d.

$N_{t,o} = N_{t-1,y}$: Number of "old" individuals at time t equals the number of "young" individuals at time $(t-1)$.

2.2   Capital Stock

The aggregate capital stock at time t is denoted by K_t.

2.3   Consumption Goods

Consumption goods at time t, Y_t, are produced in the economy as follows:

$$Y_t = A_t K_t^\alpha N_{t,y}^{1-\alpha}, \tag{1}$$

where, $0 < \alpha < 1$ and the total factor productivity $A_t = A_{t-1} \exp(\epsilon_{A,t})$ is a geometric random walk, where $\epsilon_{A,t}$ are i.i.d. and independent of $\epsilon_{N,t}$.

2.4 Evolution of Capital

A portion, C_t, of the consumption goods, Y_t, is consumed at time t. The remainder $I_t = Y_t - C_t$ is diverted to generate future capital, K_{t+1}, based on the following mechanism:

$$K_{t+1} = a I_t^\phi K_t^{1-\phi}, \tag{2}$$

where $a > 0$ and $0 \le \phi \le 1$.

Note that a log-linear specification is slightly unusual for modeling evolution of capital over time. However, taking logarithm of both sides, $(1-\phi)\log K_t$ can be interpreted as an approximation for depreciated initial capital and $\phi \log I_t$ as new investment.

3 Price of Capital and Return on Capital

3.1 Marginal Conversion Rates

Given the above set-up outlining the mechanism to convert labor and capital into consumption goods and future capital, the marginal rates of conversions are as follows:

$w_t = \frac{\partial Y_t}{\partial N_{t,y}} = (1-\alpha)\frac{Y_t}{N_{t,y}}$ is the rate of converting labor into consumption goods. In a competitive market, labor earns a wage rate of w_t per unit of labor.

$\nu_t^C = \frac{\partial Y_t}{\partial K_t} = \alpha\frac{Y_t}{K_t}$ is the rental earned by capital in producing consumption goods.

$\gamma_t^K = \frac{\partial K_{t+1}}{\partial K_t} = (1-\phi)\frac{K_{t+1}}{K_t}$ is the rental earned by capital in producing future capital.

$\gamma_t^I = \frac{\partial K_{t+1}}{\partial I_t} = \phi\frac{K_{t+1}}{I_t}$ is the rate of converting diverted capital goods, I_t, into future capital.

Note that the aggregate wage and aggregate rental of capital adds up to the total consumption goods, i.e., $N_{t,y}w_t + K_t\nu_t^C = Y_t$. And similarly, $K_t\gamma_t^K + I_t\gamma_t^I = K_{t+1}$.

3.2 Price of Capital

As defined above, γ_t^I is the rate of converting diverted consumption goods into future capital. So, conversely, the price of capital, q_t, is defined as the inverse of γ_t^I, i.e.:

$$q_t = \frac{1}{\gamma_t^I} = \frac{1}{\phi}\frac{I_t}{K_{t+1}} = \frac{1}{a\phi}\left(\frac{I_t}{K_t}\right)^{1-\phi} \qquad \text{(by Equation 2).} \tag{3}$$

So, the capital carried forward to time $(t+1)$, measured in terms of consumption goods, is

$$q_t K_{t+1} = \frac{1}{\phi}I_t. \tag{4}$$

And the rental earned by capital in producing future capital, in terms of consumption goods, can be denoted as:

$\nu_t^K = \gamma_t^K q_t.$

3.3 Return on Capital

If R_t is the rate of return earned on the capital K_t (which is $q_{t-1}K_t$ in terms of consumption goods), then it satisfies the following:

$$q_{t-1}K_tR_t = (\nu_t^C + \nu_t^K)K_t \Rightarrow R_t = \frac{\nu_t^C + \nu_t^K}{q_{t-1}}. \tag{5}$$

4 The Social Security System

The Social Security system is assumed to tax a "young" individual, at the rate of $\tau_t w_t$, while paying a retirement income of $R_{t+1}\theta_t w_t$ in the following period when these individuals are "old". Note that $\theta_t = \tau_t$ implies a defined-contribution scheme. If θ_t is a replacement rate, it implies a defined-benefit scheme, where $\theta_t w_t$ is the retirement benefit in present value terms. The social security system is assumed to hold a portion $K_t^S = \sigma_t K_t$ of the total capital stock, K_t.

5 Consumer Behavior

A "young" individual gets after-tax wage of $(1-\tau_t)w_t$, a portion of which, $c_{t,y}$, is consumed and the remainder, $q_t k_{t+1}^P$ (in terms of consumption goods), is saved privately to carry forward in the next period, so that:

$$c_{t,y} = (1-\tau_t)w_t - q_t k_{t+1}^P. \tag{6}$$

When "old", individuals consume all available resources derived from private savings and social security benefits, i.e.:

$$c_{t+1,o} = R_{t+1}\left[q_t k_{t+1}^P + \theta_t w_t\right] = R_{t+1}\left[(1-\tau_t+\theta_t)w_t - c_{t,y}\right]. \tag{7}$$

Individuals are assumed to have logarithmic utility function, i.e.:

$$U_t \equiv \ln c_{t,y} + \beta E_t\{\ln c_{t+1,o}\} = \ln c_{t,y} + \beta E_t\{\ln R_{t+1}\} + \beta \ln\left[(1-\tau_t+\theta_t)w_t - c_{t,y}\right], \tag{8}$$

where $0 < \beta < 1$ denotes time preference.

Maximizing U_t with respect to $c_{t,y}$, yields:

$$c_{t,y} = (1-\tau_t+\theta_t)\frac{w_t}{1+\beta}, \tag{9}$$

which when aggregated over the entire "young" cohort gives

$$C_{t,y} = N_{t,y}c_{t,y} = \frac{1}{1+\beta}(1-\tau_t+\theta_t)(1-\alpha)Y_t, \quad \text{as } N_{t,y}w_t = (1-\alpha)Y_t. \tag{10}$$

Also from Equation 6,

$$C_{t,y} = N_{t,y}c_{t,y} = (1-\tau_t)(1-\alpha)Y_t - q_t K_{t+1}^P, \tag{11}$$

where $K_{t+1}^P = N_{t,y}k_{t+1}^P$ is the aggregate private capital stock.

So from Equations 10 and 11, and the fact that $K_{t+1}^P = K_{t+1} - K_{t+1}^S = (1 - \sigma_{t+1})K_{t+1}$:

$$q_t K_{t+1} = \frac{1}{1 - \sigma_{t+1}} \frac{1 - \alpha}{1 + \beta} \left[(1 - \tau_t)\beta - \theta_t \right] Y_t = \frac{1}{\phi} \psi_t Y_t, \tag{12}$$

where

$$\psi_t = \frac{\phi}{1 - \sigma_{t+1}} \frac{1 - \alpha}{1 + \beta} \left[(1 - \tau_t)\beta - \theta_t \right]. \tag{13}$$

Comparing Equation 12 with Equation 4, we get:

$$\psi_t = \frac{I_t}{Y_t}, \tag{14}$$

i.e., ψ_t is the investment-output ratio.

6 Result

The above model set-up leads to the following expression for the evolution of the price of capital, q_t:

$$\ln q_t = [1 - (1 - \alpha)\phi] \ln q_{t-1} + (1 - \phi) \ln \frac{\psi_t}{\psi_{t-1}} - (1 - \alpha)\phi \ln \phi - (1 - \alpha) \ln a$$
$$+ (1 - \phi)[\epsilon_{A,t} + (1 - \alpha)\epsilon_{N,t}]. \tag{15}$$

The proof of the above result is given in the Appendix.

The implications of the result are:

If $0 < \phi < 1$, then

- q_t is an increasing function of the shocks $\epsilon_{A,t}$ and $\epsilon_{N,t}$.
- $\ln q_t$ is mean-reverting in response to the shocks $\epsilon_{A,t}$ and $\epsilon_{N,t}$.

Equation 15 can be interpreted as follows. A baby boom in period t, represented by a high value of $\epsilon_{N,t}$, leads to high levels of production of consumption goods, Y_t, compared to capital stock, K_t. This, in turn, leads to high levels of I_t (consumption goods invested to produce future capital) relative to K_t, driving up the price of capital q_t. However, the resulting high values of K_{t+1} reduce the price of capital in the following period implying mean-reversion.

References

ABEL, A.B. 2003. The Effects of a Baby Boom on Stock Prices and Capital Accumulation in the Presence of Social Security. *Econometrica*, **71:2**, 551–578.

4

Appendix

DERIVATION OF EQUATION 15

$$
\begin{aligned}
\ln q_t & = -\ln \phi + \ln I_t - \ln K_{t+1}, \qquad \text{by Equation 3} \\
& = -\ln \phi + \ln I_t - \ln a - \phi \ln I_t - (1-\phi) \ln K_t, \qquad \text{by Equation 2} \\
& = -\ln \phi - \ln a + (1-\phi) \ln I_t - (1-\phi) \ln K_t \\
& = -\ln \phi - \ln a + (1-\phi) \ln \psi_t + (1-\phi) \ln Y_t - (1-\phi) \ln K_t, \qquad \text{by Equation 14} \\
& = -\ln \phi - \ln a + (1-\phi) \ln \psi_t + (1-\phi) \ln A_t + \alpha(1-\phi) \ln K_t + (1-\alpha)(1-\phi) \ln N_{t,y} \\
& \quad -(1-\phi) \ln K_t, \qquad \text{by Equation 1} \\
& = -\ln \phi - \ln a + (1-\phi) \ln \psi_t - (1-\alpha)(1-\phi) \ln K_t + (1-\phi) \ln A_t + (1-\alpha)(1-\phi) \ln N_{t,y}.
\end{aligned}
$$

So,

$$
\ln q_t - \ln q_{t-1} = (1-\phi) \ln \frac{\psi_t}{\psi_{t-1}} - (1-\alpha)(1-\phi) \ln \frac{K_t}{K_{t-1}} + (1-\phi)[\epsilon_{A,t} + (1-\alpha)\epsilon_{N,t}]. \qquad (16)
$$

And,

$$
\begin{aligned}
\ln \frac{K_t}{K_{t-1}} & = \ln a + \phi \ln \frac{I_{t-1}}{K_{t-1}}, \qquad \text{by Equation 2} \\
& = \ln a + \frac{\phi}{1-\phi} \ln [a\phi q_{t-1}], \qquad \text{by Equation 3} \\
& = \frac{1}{1-\phi} \ln a + \frac{\phi}{1-\phi} \ln \phi + \frac{\phi}{1-\phi} \ln q_{t-1}.
\end{aligned}
$$

Using this expression in Equation 16 gives:

$$
\begin{aligned}
\ln q_t - \ln q_{t-1} & = (1-\phi) \ln \frac{\psi_t}{\psi_{t-1}} - (1-\alpha) \ln a - (1-\alpha)\phi \ln \phi - (1-\alpha)\phi \ln q_{t-1} \\
& \quad +(1-\phi)[\epsilon_{A,t} + (1-\alpha)\epsilon_{N,t}].
\end{aligned}
$$

Rearranging gives Equation 15.

Future Equity Patterns and Baby Boomer Retirements

Appendix B—Literature Review

Literature Review Summary

Over the past few decades, numerous studies have examined the mechanisms that tie demography to the financial asset markets. Common models used in these studies include the Overlapping Generations (OLG) model, the Life-Cycle model, and the Risk Aversion model. Abel (2003) used a classical OLG model and finds that baby boomers increase the price of capital during their working years, but the price of capital reverts to the mean in their retirement years. The assets examined include stocks, bonds and housing. Our literature review covers 61 English peer-reviewed journal articles, reports and newspaper articles from 1989 to 2014. A short summary of each is presented in the Summary Table below. For a more in-depth analysis, refer to the subsection at the end in which the papers are listed in chronological order.

The central theme is that a link between demography and asset prices does exist, although this effect is not significant enough to cause an "asset-price meltdown." It is acknowledged that the retirement of the baby boomer cohort will depress asset values, but the fall in asset prices is expected to be gradual and predictable (Poterba, 2001). Bakshi and Chen (1994) showed that a person's risk aversion is positively correlated with age. Individuals will become more risk averse and shift their preferences toward less risky assets as they age. As a result, baby boomers may shift their investment away from stocks and toward bonds. Liu and Spiegel (2011) used the M/O ratio (a ratio of the middle-age cohort to the old-age cohort) to predict price-to-earnings (P/E) ratio trends in the stock market and found that stock prices may be headed downward until 2021. However, even with a decline in stock prices, baby boomers will still be better off in terms of lifetime consumption compared to other generations (Brooks, 2002).

A recent study by Takáts (2010) suggests that demographic factors have a significant effect on the housing market. He projects that house prices will fall over the next 40 years but the effect is not substantial enough to cause a "meltdown" as originally proposed by Mankiw and Weil (1989). A report by Wallick, Shanahan and Tasopoulos (2013) of the Vanguard Group suggested several factors that contradict the "meltdown hypothesis." First, the boomer cohort spans over two decades so the chances of all the members retiring simultaneously and causing sudden and unexpected shocks to the financial market are slim. Second, equity ownership is global so capital will flow to countries with less aging, neutralizing the excess supply and scarce demand argument. Third, the wealthiest 10 percent of the baby boomer cohort owns over 88 percent of the stock holdings, further reducing the likelihood of massive stock decumulation.

Although there is considerable research in this field, there are numerous issues with the current set of studies. Calibration remains a major issue for the various models presented. Each model has its own set of assumptions and is difficult to generalize to other data sets. The financial markets (housing for example) may be difficult to compare across countries due to varying characteristics of demography and political climate in each country. The context of policies to counteract the effects of demographics will be very different for each country because of the differences in political atmosphere. It may be necessary to develop a model tailored for each environment. Very few countries have experience with rapidly aging populations, resulting in a lack of data or tools for analyses. Analyses are further impaired because demographic impacts are slow in nature and there are many other effects overlaid during the same period.

Summary Table

A total of 61 articles were obtained for the literature review. Four articles endorsed the "asset-price meltdown" hypothesis. An additional 33 articles supported the theory that aging has an effect on asset prices and returns. Fourteen articles directly rejected the asset meltdown hypothesis, but some of these express the view that there may be a moderate impact on asset prices. Few papers actually quantify the extent of the impact. The remainder of the articles did not directly mention it, or were inconclusive. Below is a table to summarize the findings. For a more detailed review of literature, see the summary of the papers at the end of this Appendix.

No.	Author (Year)	Title	Countries Examined	Result
Articles supporting the "Asset-Price Meltdown" hypothesis				
1	N. Gregory Mankiw and David N. Weil (1989)	The Baby Boom, the Baby Bust, and the Housing Market	U.S.	Increase in housing prices is attributable to the aging of the baby boom generation. Housing prices will fall substantially when the baby bust generation reaches house-buying years and the baby boom generation reaches retirement.
2	Robin Brooks (2000)	Life Cycle Portfolio Choice and Asset Market Effects of the Baby Boom	NA and EU	Demographic shocks have significant asset market effects. Expected returns on retirement savings of boomer cohort 20 percent lower.
3	Karen Damato (2012)	Bad News for Boomers		Population of senior citizens is rising more rapidly than the working age population in the United States. Future economic growth rate will slow down, and the returns on stocks and bonds will be close to zero.
4	Jong Man Kang (2013)	Retirement of Baby Boomers and Its Impact on the Financial Market	Korea	Author suggests that the wave of baby boomers entering retirement will have negative effects on savings, investment and growth potential of Korea's economy. Author supports the idea that financial asset prices will fall and financial markets may be hit hard.
Articles rejecting the "Asset-Price Meltdown" hypothesis				
5	Richard Green and Patrick H. Hendershott (1995)	Age, Housing Demand, and Real House Prices	U.S.	Results show that the demand for housing remains constant or increases slightly with age. This suggests that an aging population is not expected to lower real house prices.
6	James M. Poterba (2001)	Demographic Structure and Asset Returns	U.S., Canada, U.K.	Projections do not show a sharp decline in asset demand between 2020 and 2050. Data shows a weak relationship between demographics and asset returns.
7	Christian Helmenstein, Alexia Prskawetz and Yuri Yegorov (2002)	Wealth and Cohort Size: Stock Market Boom or Bust Ahead?	Germany	Various demographic and economic factors contribute to attenuate the expected stock market decline. A decline in stock market prices may even set in well before collective retirement.
8	Kyung-Mook Lim and David N. Weil (2003)	The Baby Boom and the Stock Market Boom	U.S.	Demographic change will cause a decline in asset prices, but this effect will be too small to justify the "meltdown" hypothesis.
9	Junning Cai (2004)	Baby Boom, Asset Market Meltdown and Liquidity Trap		Evidence does not support "meltdown" hypothesis. If meltdowns are about to occur, baby boomers' attempts to escape them may lead economy into a "liquidity trap."
10	Robin Brooks (2006)	Demographic Change and Asset Prices	NA and EU	Asset prices may continue to rise as population ages. There is no evidence of asset price declines when baby boomers retire.
11	Axel Börsch-Supan, Alexander Ludwig and Joachim Winter (2006)	Ageing, Pension Reform and Capital Flows: A Multi-Country Simulation Model	NA, EU, OECD	Aging results in decreased savings rates when baby boomers retire and decumulate their assets. Rate of return on capital is projected to decline in response to population aging.

No.	Author (Year)	Title	Countries Examined	Result
Articles rejecting the "Asset-Price Meltdown" hypothesis continued				
12	B.D. Bovbjerg and G.A. Scott (2006)	Baby Boom Generation: Retirement of Baby Boomers Is Unlikely to Precipitate Dramatic Decline in Market Returns, but Broader Risks Threaten Retirement Security	U.S.	Retiring baby boomers are unlikely to sell their financial assets in such a manner as to cause a sudden and sharp decline in asset prices. Demographics may only have a small effect on stock returns relative to the broader economy.
13	Haim Kedar-Levy (2006)	Can Baby-Boomers' Retirement Increase Stock Prices?	U.S.	Results suggest a modest positive effect of demographics on equity prices as baby boomers retire.
14	Sebastian Schich (2008)	Revisiting the Asset-Meltdown Hypothesis	OECD	There is some support for a link between demographics and financial asset prices. Forward-looking and efficient markets would price the developments (aging, retirement, etc.) well before they actually occur.
15	M. Santoro (2009)	Will the Demand for Assets Fall When the Baby Boomers Retire?		Dramatic decline in asset demand is unlikely.
16	Bradford Cornell (2012)	Demographics, GDP, and Future Stock Returns: The Implications of Some Basic Principles		Demographic changes will become less relevant as financial assets become more integrated internationally.
17	*The Economist* (2012)	Are Retiring Baby Boomers About to Crash the Stock Market?		It is unlikely that all retirees will sell shares en masse. The number of equity buyers perhaps won't fall. Global markets are more integrated, and younger countries can offset the older ones. Demand and supply are not the only factors that affect asset pricing.
18	Daniel W. Wallick, Julieann Shanahan and Christos Tasopoulos (2013)	Baby Boomers and Equity Returns: Will a Boom in Retirees Lead to a Bust in Equity Returns?	U.S.	There is no evidence of a negative effect of retirement on stock returns.
Articles supporting the asset price effect of aging				
19	Patrick H. Hendershott (1991)	Are Real House Prices Likely to Decline by 47 Percent?	U.S.	Future housing prices are likely to decline by 10 to 15 percent for baby boomers.
20	Gurdip S. Bakshi and Zhiwu Chen (1994)	Baby Boom, Population Aging, and Capital Markets	U.S.	A rise in average age predicts a rise in risk premiums. Similarly, a rise in average age raises the demand for financial investments and lowers the demand for housing. Furthermore, an aging population means increasing average risk aversion.
21	Sylvester J. Schieber and John B. Shoven (1994)	The Consequences of Population Aging on Private Fund Saving and Asset Markets	U.S.	The pension system will no longer be a source of national saving by 2030 and this may depress asset prices, especially for long-term assets.
22	Peter S. Yoo (1994)	Age Distributions and Returns of Financial Assets	U.S.	There is a significant negative relationship between the proportion of population aged 45-54 and asset returns.
23	Diane J. Macunovich (1997)	Discussion: Social Security: How Social and Secure Should It Be?	U.S.	Results suggest a close correspondence between demographic effects (uncertainty and risk exposure) and the financial market.
24	Peter S. Yoo (1997)	Population Growth and Asset Prices	U.S.	Demographic variables play a role in the determination of low-frequency movements in the prices of assets through individuals' saving decisions. Asset prices respond to demographic changes even with perfect foresight.
25	Robin Brooks (1998)	Asset Market and Savings Effects of Demographic Transitions	NA and EU	Empirical evidence suggests that savings and investment rates are negatively correlated with the relative size of middle-aged cohorts.
26	John Y. Campbell (2001)	A Comment on James M. Poterba's "Demographic Structure and Asset Returns"		There will be modest effects of demographics on future risky asset demands, but difficult to distinguish from other factors that influence asset markets.
27	Robert L. Brown, Robin Damm and Ishmael Sharara (2001)	A Macroeconomic Indicator of Age at Retirement	Canada	There is only a slight mention that if baby boomers decide to liquidate their assets upon entering retirement, asset prices will become depressed.
28	Monika Bütler and Philipp Harms (2001)	Old Folks and Spoiled Brats: Why the Baby Boomers' Saving Crisis Need Not Be That Bad		The passage of a large generation (baby boom cohort) creates substantial swings in wages and capital returns, specifically a stock market boom during the baby boomers' working years and a subsequent dramatic decline in returns.

No.	Author (Year)	Title	Countries Examined	Result
Articles supporting the asset price effect of aging continued				
29	Robin Brooks (2002)	Asset-Market Effects of the Baby Boom and Social-Security Reform	U.S.	Baby boomers will likely experience poor asset returns in retirement.
30	Garry Young (2002)	The Implications of an Ageing Population for the UK Economy	U.K.	Baby boomers will increase stock returns while in labor force and reduce stock returns in retirement. But the impact of demographic change on asset prices is small.
31	Andrew B. Abel (2003)	The Effects of a Baby Boom on Stock Prices and Capital Accumulation in the Presence of Social Security	U.S.	The price of capital displays mean reversion, so an increase in price is followed by a decrease in price in the following period. Although a baby boom will drive up asset prices, the baby boomers' subsequent entry into retirement will drive down asset prices.
32	E. Philip Davis and Christine Li (2003)	Demographics and Financial Asset Prices in the Major Industrial Economies	OECD	An increase in the fraction of middle-aged people (age 40-64) boosts real asset prices, and a decline in this cohort will reduce real asset prices.
33	John Geanakoplos, Michael Magill and Martine Quinzii (2004)	Demography and the Long-Run Predictability of the Stock Market	U.S.	A large middle-aged cohort seeking to save for retirement will push up prices of securities, and prices will be depressed in periods when the middle-aged cohort is small (e.g., retirement).
34	Amit Goyal (2004)	Demographics, Stock Market Flows, and Stock Returns	U.S.	Outflows are positively correlated with changes in the fraction of old people. Over the next 50 years, outflows are not expected to rise to levels that cause concern even with the retirement of baby boomers. Stock returns also decrease if old-age population rises.
35	A. Jamal and S. Quayes (2004)	Demographic Structure and Stock Prices	U.S. and U.K.	A decline in the proportion of the earning cohort (age group 45-64) is expected to cause a downward pressure on the demand for financial assets.
36	James Poterba (2004)	The Impact of Population Aging on Financial Markets	U.S.	Asset holdings rise sharply when households are in their 30s and 40s. Projected data do not show a decline in asset demand between 2020 and 2050. There is a weak correlation between asset returns on stocks/bonds/bills and the U.S. population age structure.
37	Andrew Ang and Angela Maddaloni (2005)	Do Demographic Changes Affect Risk Premiums? Evidence from International Data	OECD	Demographic variables significantly predict excess returns internationally. Faster growth in the fraction of retirees greatly decreases risk premiums.
38	Robert F. Martin (2005)	The Baby Boom: Predictability in Housing Prices and Interest Rates	U.S., U.K., Japan	Changes in the working age population (driven by the baby boom) are the primary forces underlying the evolution of real house prices.
39	Aaron Bernstein (2006)	A Boomer Bust?		Aging population is a critical issue facing the developed world. If there aren't enough workers earning income, then there aren't enough buyers of all the stocks and bonds being sold, and this will lead to a decline in prices.
40	*The Economist* (2006)	Baby Boom and Bust: Will Share Prices Crash as Baby-Boomers Sell Their Assets to Pay for Retirement?		Sale of assets by baby boomers as they retire will drive down the prices as there are too few people in the younger generations that followed the boomers to buy up all of the assets at current prices. But increased life expectancies and technological innovation are allowing people to work longer and retire later so this issue may be mitigated.
41	Wilson Huynh, Girijasankar Mallik and Samanthala Hettihewa (2006)	The Impact of Macroeconomic Variables, Demographic Structure and Compulsory Superannuation on Share Prices: The Case of Australia	Australia	Findings suggest that asset prices will decline as baby boomers enter retirement.
42	Axel Börsch-Supan (2006)	Demographic Change, Saving and Asset Prices: Theory and Evidence	NA, EU, OECD, World	Aging significantly affects asset prices and returns but policies can offset these effects.
43	Előd Takáts (2010)	Aging and Asset Prices	OECD	Aging negatively affects asset prices, especially housing prices.
44	Alan Guoming Huang, Eric N. Hughson and J. Chris Leach (2011)	Generational Asset Pricing, Equity Puzzles, and Cyclicality	U.S.	The model suggests that if baby boomers are more risk-tolerant than their offspring, there will be a drop in asset prices when baby boomers sell to the next generation.
45	Zheng Liu and Mark M. Spiegel (2011)	Boomer Retirement: Headwinds for U.S. Equity Markets?	U.S.	Aging has a negative effect on U.S. equity values.

No.	Author (Year)	Title	Countries Examined	Result
Articles supporting the asset price effect of aging continued				
46	Michael Baxter (2012)	Bull and Bear: The Great Baby Boomer House Sale Approaches		By 2017, more than a quarter of a million retirees will consider downsizing and 59,347 will look into equity release. If baby boomers were to downsize the house en masse, house prices would fall and they would find that they have less money than they were expecting.
47	Cheolbeom Park and Dong Heon Kim (2012)	Demographic Structure and Financial Markets in Korea	Korea	Results suggest that real interest rate will continue to rise until 2020 as retirees continue to exhibit dissaving behavior.
48	Amlan Roy, Sonali Punhani and Liyan Shi (2012)	How Demographics Affect Asset Prices	U.S., U.K., Japan, France, Germany	Results suggest a relationship between demographic variables and stocks, bonds and house prices across the five countries. The magnitude of these effects is unclear.
49	Yumi Saita, Chihiro Shimizu and Tsutomu Watanabe (2013)	Aging and Real Estate Prices: Evidence from Japanese and US Regional Data	Japan and U.S.	Results suggest real estate prices are negatively correlated with the old age dependency ratio. Aging continues to exert downward pressure on asset prices.
50	Barrie McKenna (2014)	Aging Population Will Put Brakes on Economic Growth: BMO	Canada	Aging population will slow economic growth in Canada. McKenna references Porter's (2014) article suggesting that interest rates will continue to rise and returns on financial assets will drop over the next few decades.
51	Douglas Porter (2014)	Long-Term Outlook: Destiny Dictated by Demography?	Canada	Interest rate is expected to rise with an aging population along with a reduction in asset returns.
Inconclusive				
52	*hsdent.com* (2009)	The Dent Method: Economic Forecasting Based on Changes in Demographic Trends. What Is It? Why Use It?		This paper provides a method to forecast demographic trends.
53	John W. Schoen, Sr. (2011)	Baby Boomers May Be Bad News for Stock Market		This paper presents two viewpoints: (1) Data projections do not show a sharp decline in asset prices from 2020 to 2050. (2) Those in their 40s are buyers and those in their 60s are sellers. The ratio between these age groups should have an impact on stock prices, and these prices will start dropping by 2021.
54	Ronald D. Lee (2014)	Macroeconomic Consequences of Population Aging in the United States: Overview of a National Academy Report	U.S.	Population aging may raise private asset holdings, but it also raises public debt so the net effect is unclear. Aging is slow and predictable so it won't cause any sudden changes in asset values. There may be a small decline in rates of return by 1 percent in the next few decades.
Not very relevant				
55	R. Dugger, R. McNally and R. Medley (1999)	The American Stock Market as a Financial Risk		Baby boomers' savings is an important variable affecting the U.S. economy. Baby boomers need to save more in order to get a satisfactory retirement income.
56	John Heaton and Deborah Lucas (2000)	Stock Prices and Fundamentals	U.S.	Changes in participation that have occurred from 1990 to 2000 are unlikely to have an effect on stock returns. Increased portfolio diversification is likely to have had a large impact.
57	John Y. Campbell and Robert J. Shiller (2001)	Valuation Ratios and the Long-Run Stock Market Outlook: An Update		P/E ratios and dividend-price ratios do poorly in forecasting dividend growth, earnings growth, or future productivity growth. The ratios appear to be useful primarily in projecting future stock price changes.
58	Barbara A. Butrica, Howard M. Iams and Karen E. Smith (2003)	It's All Relative: Understanding the Retirement Prospects of Baby-Boomers	U.S.	Baby boomers will be better off than current retirees in absolute terms but will be worse off in relative terms.
59	Annamaria Lusardi and Jason Beeler (2006)	Savings Between Cohorts: The Role of Planning	U.S.	Early baby boomers (age 51-56 in 2004) accumulated more wealth than the previous cohort (age 51-56 in 1992), but they benefited from a large increase in house prices.
60	Annamaria Lusardi and Olivia Mitchell (2007)	Baby Boomer Retirement Security: The Roles of Planning, Financial Literacy, and Housing Wealth	U.S.	Early baby boomers (age 51-56 in 2004) rely more on housing equity than their predecessors (age 51-56 in 1992), but their total net worth levels have changed very little.
61	David Rosnick and Dean Baker (2009)	The Wealth of the Baby Boom Cohorts after the Collapse of the Housing Bubble	U.S.	Analysis shows that loss of wealth due to collapse of housing bubble and stock market plunge will make baby boomers more dependent on Social Security and Medicare than prior generations.

Papers in Chronological Order

1989

Mankiw, N.G., and Weil, D.N. 1989. The Baby Boom, The Baby Bust, and the Housing Market. *Regional Science and Urban Economics, 19*(2), 235-258.

<u>Support</u>: Yes.

<u>Model Description</u>:
In Section 3, a regression model is defined to examine the link between age and housing demand. Using the cross-sectional results obtained in Section 3, and time series on the age composition of the population, the authors examine how baby boom and bust generations affect the demand of housing in Section 4. In Section 6, an inter-temporal model of the housing market, a variation of Poterba (1984), is used to examine the impact of changing housing demand.

<u>Assumptions</u>:
The approach used in the paper is to assume that the age structure of housing demand is constant over time. Model assumes that any correlation of age with income and other household characteristics does not pose a problem. In an inter-temporal model, it is assumed that the flow of housing services is proportional to the stock of housing. The operating cost of owning a home is some constant times the value of the house.

<u>Data Source</u>:
Cross-sectional data are from the census for years 1970 and 1980. Residential capital data are from Fixed Reproducible Tangible Wealth. The data of yields on long-term Treasury bonds are from International Financial Statistics; from 1953 onward, these are 20-year constant maturities.

<u>Projection Period</u>:
The rates of growth of housing demand and prices are both projected to 2007.

<u>Summary</u>:
This paper examines the impact of major demographic changes on the housing market in the United States. The analysis of both cross-sectional and time-series data leads to three conclusions: 1) Large demographic changes of the sort induce large (and mostly predictable) changes in the demand for housing. 2) These fluctuations in demand appear to have substantial effect on the price of housing. 3) Recent (at the time of the paper) demographic patterns imply that housing demand will grow slowly over the next 20 years. The results in the paper indicate that the increase in housing prices is largely attributable to the baby boom generation, while the estimates suggest that real housing prices will fall substantially when the baby bust generation will be in its housing-buying years and baby boomers are in their retirement.

1991

Hendershott, P.H. 1991. Are Real House Prices Likely to Decline by 47 Percent? *Regional Science and Urban Economics,* 553-563.

<u>Support</u>: Yes, but moderate; severe for housing. Effect not as large as 47 percent.

<u>Model Description</u>:
The author adopts a simple regression model used by Mankiw and Weil (1989) to adding a term to include the level and change in real after-tax interest rate.

Data Source:
The same data set as Mankiw and Weil (1989) is used.

Projection Period:
Housing prices are projected to 2007.

Summary:
In this paper, the author restudies the Mankiw and Weil (1989) model and points out its flaw in using the wrong fitting data. To correct it, an expanded model is used and it predicts the decline in the housing prices would be 10 to 15 percent, not 47 percent.

Comments:
This paper projects the future housing prices for the baby boomers, rather than the future equity patterns.

1994

Bakshi, G.S., and Chen, Z. 1994. Baby Boom, Population Aging, and Capital Markets. *The Journal of Business, 67*(2), 165-202.

Support: Yes, but moderate.

Model Description:
Model setup is given in Section III, where a multi-period discrete-time model is first constructed. To analyze the equilibrium asset price process, a continuous-time model is adapted, discussed in Section III C.

Data Source:
Annual economic data for the period 1900-1990 is used, and the details of notations and their uses are given in Section IV from Page 181 to 183. To construct the life expectancy variable, Current Population Reports (Bureau of the Census) are used.

Assumptions:
Economic assumption: Assume the existence of a representative investor, who has an age given by the average of the population. This assumption simplifies the theoretical discussion. Statistical assumptions are given in Section III B on Page 177, such as number of traded securities, utility function u(.) is twice continuously differentiable, strictly increasing and concave in consumption, and in the form of power utility. The relative risk aversion of the agent is an increasing function of the average age.

Projection Period:
The method of forecasting regression and results is given in Section VII. This is an empirical study; the estimated risk premiums from 1900 to 1990 show that a change in the average age predicts a change in the risk premium, and a greater jump in age implies a larger risk premium.

Summary:
This article tests how demographic changes affect capital markets. The life-cycle investment hypothesis states that at an early stage an investor allocates more wealth in housing and then switches to financial assets at a later stage. Consequently, the stock market should rise but the housing market should decline with the average age, a prediction supported in the post-1945 period. The second hypothesis that an investor's risk aversion increases with age is tested by estimating the resulting Euler equation and supported in the post-1945 period. A rise in average age is found to predict a rise in risk premium.

Comments:
This article does not specifically predict whether there will be a decline in the asset prices when boomers retire, rather that there will be a rise in the risk premium as the average age increases.

Schieber, S.J., and Shoven, J.B. 1994. The Consequences of Population Aging on Private Pension

Fund Saving and Asset Markets. *National Bureau of Economic Research Working Paper No. 4665.*

<u>Support</u>: Yes, but moderate.

<u>Model Description</u>:
In Section I, how the baby boom generation affects the social security funding and the employer-sponsored retirement plan funding is discussed extensively. Although there is no exact form of the model, the authors provide a brief outline of the underlying methods, assumptions and inputs that are used to develop the estimates of pension system of U.S. in Section II. Projection is done in Section III, giving the result that the pension system will cease being a source of national saving after 2020.

<u>Assumptions</u>:
The assumptions in the paper are actuarial assumptions used mainly in the valuation of pension plans, such as the interest rates, the starting salaries, the rate of returns on different categories of assets, and the age and proportion of retirement.

<u>Data Source</u>:
Data sources include: Department of Labor's (DOL) Form 5500 pension reporting forms, Current Population Survey (CPS) March 1992, the 1991 Survey of Income and Program Participation (SIPP), and the Employee Benefit Research Institute's Quarterly Pension Investment Report (QPIR)

<u>Projection Period</u>:
The current dollar figures for the combined defined-benefit and defined-contribution private pension plans are projected to 2065. Real saving of private pensions relative to total private payroll is also forecasted to 2065.

<u>Summary</u>:
This paper examines the impact of the aging demographic structure of the United States on its funded private pension system. The major result is that the national saving generated by the private pension system can be expected to decline from current levels, gradually for about a decade, and then far more steeply. In addition the impact of the reduced saving of the pension system on asset prices is briefly discussed as follows: "The period of time when the pension system begins to be a net seller is more likely in the early part of the third decade of the 21st century under conservative assumptions. This could depress asset prices. If it occurs, it would likely affect all long term assets."

Yoo, P.S. 1994. Age Distributions and Returns of Financial Assets. *Federal Reserve Bank of St. Louis Working Paper No. 1994-002A.*

<u>Support</u>: Yes, but moderate.

<u>Model Description</u>:
A multi-period OLG version of the Lucas (1978) asset pricing model, where agents maximize their lifetime utility subject to an age-dependent path of endowments, is provided in Section II.A. Section II.B describes the procedure of simulation work and the results, which suggest a population's age structure affects a much wider class of assets than housing. The model used here makes no predictions about any differences in the response of various assets to changes in the demographic composition of the population. In empirical study part of Section III, a regression model defined as equation (4) to find the cross-sectional estimates is adopted. To estimate the reduce form relationship between age distribution and asset returns, again a regression model in (5) is used. Lastly, Appendix A outlines the model with investment in productive capital, where asset returns are equal to the rate of capital.

<u>Assumptions</u>:
The simulation in Section II.B assumes that the start and the end of the baby boom are unexpected shocks to the population growth rate. In Appendix A, a simple Cobb-Douglas production function with labor augmenting productivity growth for the economy is assumed. Implicitly, a closed economy is assumed.

<u>Data Source</u>:
Data of 1983 Survey of Consumer Finances are used to determine which age group has the largest increment to wealth. To test the aggregate wealth-age relationship, the author uses estimates of aggregate household wealth for the years 1946 to 1988 from the Federal Reserve's Balance Sheets for the U.S. Economy: 1949 to 1990. Stocks, Bills, Bonds, and Inflation: Yearbook 1991 published by Ibbotson and Associates

contains data on real annual total returns of the U.S. securities. These data are used to test if the empirical evidence matches the model's prediction about the relationship between the age structure of the population and asset returns.

Projection Period:
The simulated results are compared with the empirical estimates on age distribution and total returns of financial assets from 1926 to 1988.

Summary:
This paper explores the relationship between age distribution and asset returns implied by an OLG model. The model predicts that as more individuals reach the age when the increment to their wealth reaches its maximum, asset returns fall. In accordance with the model, time series estimates of the relationship between asset returns and the age distribution find a large, statistically significant, negative correlation between the fraction of the population aged 45 to 54 and the returns of several types of assets.

1995

Green, R., and Hendershott, P.H. 1995. Age, Housing Demand, and Real House Prices. *Regional Science and Urban Economics, 26*(5), 465-480.

Support: No.

Model Description:
A model relating the demand for housing characteristics to demographic factors as in Rosen's (1974) is set up in Section 2. To solve the targeted equation, a translog function defined as Christensen et al.'s (1975) is adopted. Hence a linear regression model is constructed for estimation, which is mainly done in Section 3 with full derivation and explanation.

Assumptions:
A statistical assumption that f(Z) is homogeneous of degree one justified with two reasons is given on Page 468. In projection part, the author assumes that the 1990 growth rate is equal to 3.8 percent of the 1989 rate.

Data Source:
Although the paper says that all data come from the public use micro-data series in 1980 census year, it does not include the exact sources of data.

Projection Period:
Both total and partial age derivatives are projected to 2030 (actual data from 1950 to 1990, and middle series census forecast from 2000 to 2030).

Summary:
In this paper, the authors use 1980 census data to measure the impact of the age structure, education and income on the willingness of households to pay for a constant-quality house. They compute total and partial derivatives for the effect of age on housing demand. The total derivatives look similar to the Mankiw and Weil (1989) age -demand results. But the partial derivatives suggest that holding all else constant, the demand for housing tends to be flat or rising slightly with age, implying that the aging of population should not be expected to lower real house prices.

1997

Macunovich, D.J. 1997. Discussion: Social Security: How Social and Secure Should It Be? *Federal*

Reserve Bank of Boston.

<u>Support</u>: Yes, aging demographics have an impact on asset values.

<u>Model Description</u>:
In Appendix on Page 73, the author mentions that "five different models have been estimated here, using population variables as regressors." However, the models are NOT presented in the paper. Please see Appendix for details.

<u>Data Source</u>:
Data sources are explicitly provided in Appendix: Data Sources part on Page 73, including: Current Population Report, Statistical Abstract of the United States, Historical Statistics of the United States, Vital Statistics: Natality, NCHS Monthly Vital Statistics Report.

<u>Projection Period</u>:
On Page 67, for Figure 1, 2, 3: A model based on data through 1985 has been used to predict values for the years 1986 to 1994. On Page 71, for Figure 7 and 8, values for 1976-1994 are predicted using 1934-76 and 1900-76 age structure variables, respectively.

<u>Summary</u>:
This is a discussion paper for "Social Security: How Social and Secure Should It Be?" written by Sass and Triest in 1997, in which the authors review how demographics will produce a worsening old-age dependency problem and how this will result in a fiscal crisis. Two basic reform proposals—whether social security should be moved toward a prefunded basis, and whether social security should maintain its defined-benefit structure or move toward a defined-contribution format are examined. In discussion part, Macunovich firstly summarizes all the "basics" of Sass and Triest (1997), and then attempts to buttress the argument regarding uncertainty and risk exposure caused by an aging population. Using a regression model, she estimates the following quantities: annual growth rates of real gross domestic product (GDP), annual personal saving rate, annual change in the consumer price index (CPI), annual percent change in the Dow Jones industrial average, and the number of births in the United States. The results suggest a close correspondence between financial market and those demographic effects. Hence Macunovich proposes to take more account of past effects of the changing age structure in the future.

Yoo, P.S. 1997. Population Growth and Asset Prices. *Federal Reserve Bank of St. Louis Working Paper No. 1997-016A.*

<u>Support</u>: Yes, but moderate.

<u>Model Description</u>:
A simple model defined in Section II.A is firstly constructed. The pricing equation with budget constraint is also presented there. In Section II.B, an age-dependent demand for an asset by solving a 55-period OLG model is derived, in which an agent receives an age-dependent endowment of a non-storable consumption good during the first 45 periods of her life. Section III examines the impact of relaxing the assumptions about static expectations (to perfect foresight) and fixed supply of assets.

<u>Assumptions</u>:
In a simple model described in Section II.A, an agent's demand for an asset is assumed not to respond to expectations of future prices, i.e., a static expectation. Supply of capital is fixed and agents' supply labor is inelastic. A closed economy is assumed. It is assumed that asset prices return to their steady state growth rate within a finite horizon.

<u>Data Source</u>:
This paper is simulation-based research. The model parameters are specified at Table 1 on Page 9.

<u>Projection Period</u>:
Asset prices and age distributions on two models are projected to 2035.

<u>Summary</u>:
This paper explores the theoretical relationship between the population growth rate and asset prices implied by an OLG model. The model suggests four conclusions: 1) It shows that changes in a population's age distribution affect asset prices. 2) Such changes generate low-frequency movements in asset prices (i.e., slow moving). 3) The treatment of expectations matters; a small response of individuals to changes

in asset prices has large implications for the path of asset prices. 4) Incorporating a supply of assets by interpreting an asset as a claim on physical capital diminishes the magnitude of the relationship but does not change the sign or timing of the relationship between age distribution and asset prices.

1998

Brooks, R. 1998. Asset Market and Savings Effects of Demographic Transitions. *Yale University*.

Support: Yes, demographics affect asset values.

Model Description:
Note: This is a Ph.D. dissertation paper written by Brooks in 1998. His other paper, Brooks (2000) is an excerpt from this dissertation. Hence the Model Specifications in this paper would be similar to those on Row 1. Please refer to Brooks (2000) on Row 2 for details.

Summary:
In this dissertation paper, an OLG model consisting of a risky equity and a safe bond as consumption-saving decision is used to explore asset market effects of demographic changes. Using the model to simulate a baby boom-baby bust yields two major effects: 1) As aggregate saving fluctuates with changes in the age distribution, real returns on stocks and bonds move in the same direction, driven by changes in the real rate of interest. 2) The equity premium changes over the demographic shift. An empirical investigation supports the qualitative predictions of the model. This dissertation also explores the impact of demographic transitions on national savings, investment, and international capital flows. Empirical evidence suggests that savings and investment rates are negatively correlated with the relative size of middle-aged cohorts.

1999

Dugger, R., McNally, R., and Medley, R. 1999. The American Stock Market as a Financial Risk. *Council on Foreign Relations Press.*

Support: Not very relevant to topic.

Summary:
Baby boomers' savings is one of the variables that affect the U.S. economy. It suggests that the baby boomers need to save more in order to get a satisfactory retirement income.

2000

Brooks, R. 2000. Life Cycle Portfolio Choice and Asset Market Effects of the Baby Boom. *International Monetary Fund mimeograph.*

Support: Yes.

Model Description:
A Diamond-style OLG model in which agents live for four periods (Childhood, Young working-age, Old working-age, Retirement) and make a portfolio decision over risky equity and safe bonds is constructed in Section II. The age distribution and the utility function with the constraints are given explicitly. The model has two sources of aggregate uncertainty: a technology shock to production, and stochastic population growth. The model is solved numerically using the parameterized expectations approach as demonstrated in Section IV.

Assumptions:

The model ignores market imperfections such as transaction costs or borrowing constraints. The model represents a closed economy. There are no bequests. The model ignores the effects of an important asset, housing, on holding of financial assets over the life cycle.

Data Source:

The model parameterization is given in Section III. The age distribution data to generate Figure 1 and 2 were provided by the statistical agencies in respective countries. Please see footnote 17. The simulated baby boom and bust data is described in footnote 18.

Projection Period:

Youth dependency ratios in various countries are forecasted to 2125. The annualized cohort growth rate, the annualized equity and bond returns, the equity premium, and the ratio of old to young workers are all projected to year 2210.

International Interaction:

This paper considers the similar pattern of baby boom and bust for 14 developed nations as presented in Figures 1 and 2 on Page 16. They show that the baby boom and bust is a common feature across the developed world—with one exception as in Japan.

Summary:

This paper explores life cycle portfolio choice in a Diamond-style model with OLG, in which agents make a portfolio decision over risky equity and safe bonds. It generates portfolio behavior whereby optimizing agents shift from stocks to bonds as they age. It finds that the portfolio shift from stock to bonds is unchanged for realistic levels of the payroll tax. The paper uses the model to simulate the general equilibrium effects of a baby boom and bust on asset returns. It finds evidence of significant asset market effects, with the expected return on retirement savings of boomer cohorts up to 20 percent below returns to earlier generations.

Heaton, J., and Lucas, D.J. 2000. Stock Prices and Fundamentals, in B.S. Bernanke, and J. Rotemberg (ed.), *NBER Macroeconomics Annual 1999,* Vol. 14, MIT Press/NBER, Cambridge, Massachusetts, 213-242.

Support: Not very relevant to topic.

Model Description:

In Section 3, a simple discounted-cash-flow model is used, giving some possible explanations for the stock price increase. In Section 4, an OLG model is set up to examine the influence of participation rates, extent of diversification, background income risk, and preferences on stock prices.

Data Source:

Data from the Survey of Consumer Finances to document changes in stock-holding patterns and reported attitudes toward risk from 1989 to 1995 are used. Data from the U.S. Treasury, S&P 500 index and NYSE 1997 Fact Book are used as well.

Summary:

In this paper, the authors look at a number of potential fundamentals-based explanations for the recent (at the time of the paper) stock price run-up. In particular, they look at how participation patterns have changed, and at how they are expected to affect required returns in a stochastic equilibrium model. To quantify the potential impact of these changes, the authors calibrate an OLG model that allows for considerable heterogeneity in the cross-section of non-market income risk, preferences, diversification and participation. It concludes that the changes in participation that have occurred from 1990 to 2000 are unlikely to be a major part of the explanation. However, increased portfolio diversification is likely to have had a large impact.

Comments:

The OLG model in Section 4 is different from the classical Diamond (1964) one.

2001

Brown, R.L., Damm, R., and Sharara, I. 2001. A Macroeconomic Indicator of Age at Retirement. *North American Actuarial Journal, 5*(2), 1-10.

Support: Yes, demographics affect asset values.

Model Description:
Only one paragraph is relevant to our project. Please see it on Page 6.

Summary:
This paper explores the relationship between the Wealth Transfer Index (WTI) and retirement age. It explains why a relationship between WTI and retirement age must exist. Three linear regression models are fitted using Canadian historical median retirement data. It concludes that there is a positive correlation between the WTI and average retirement age. A practical application of the WTI model suggests that the baby boom cohort may experience a rise in the normal retirement age in the period 2017-2034.

Comments:
This paper briefly and qualitatively discusses the effect of population aging on the asset prices due to baby boom. However, it is not very relevant to our project.

Bütler, M., and Harms, P. 2001. Old Folks and Spoiled Brats: Why the Baby Boomers' Saving Crisis Need Not Be That Bad. *Center for Economic Research, Tilburg University, Discussion Paper No. 2001-42.*

Support: Yes, but meltdown dampened by the responses of parents and children of boomers.

Model Description:
A three-generation (parents, baby boomer and children) OLG model is introduced in Section 2, giving assumptions made in the model. The supply side of the economy consists of two sectors on consumption goods and capital goods, respectively. There exist bonds and physical capital that provides rents on the asset market. The results of numerical simulation and other implications are presented in Section 4.

Assumptions:
Model assumes: 1) There is a closed economy. 2) Agents have perfect foresight and leave no bequests. 3) Economy produces a consumption good and physical capital. 4) Agents can transfer income across periods by buying bonds or capital. 5) Labor supply is endogenous. 6) No social security exists. 7) Preferences are additively separable and the instantaneous utility function displays a constant inter-temporal elasticity of substitution.

Data Source:
Table 1 on Page 14 summarizes the parameters used for the different simulations as depicted in Figures 1-4.

Summary:
A three-generation OLG model with endogenous labor supply and a convex capital adjustment cost technology is presented to study the impact of anticipated demographic changes on factor prices, savings, and the welfare of different generations. The paper shows that the passage of a large generation (baby boom cohort) creates substantial swings in wages and capital returns—in particular a stock-market boom during the baby boomers' working years and a subsequent dramatic decline in returns. However, the economic impact of the baby boom generation is dampened by the responses of both the parents and children of baby boomers. The inter-temporal substitution effects are especially pronounced if labor supply is endogenous and if agents work for at least two periods

Campbell, J.Y. 2001. A Comment on James M. Poterba's "Demographic Structure and Asset Returns." *The Review of Economics and Statistics, 83*(4), 585-588.

<u>Support</u>: Yes, but moderate.

<u>Model Description</u>:
A simple benchmark model is constructed, consisting of a safe asset and a risky asset. See Page 2 for details.

<u>Assumptions</u>:
Assume that investors can borrow against the future labor income. The investor is assumed to have constant relative risk aversion.

<u>Summary</u>:
The author reviews some literature and gives his support to Poterba's idea that demographic effects on future risky asset demands are likely to be modest, and hard to disentangle from the many other forces that influence asset markets. He also provides some alternative approaches to consider the share of risky assets in total asset demand. A simple benchmark model is illustrated with pro and con comments.

Campbell, J.Y., and Shiller, R.J. 2001. Valuation Ratios and the Long-Run Stock Market Outlook: An Update. *National Bureau of Economic Research Working Paper No. 8221.*

<u>Support</u>: Not very relevant to topic.

<u>Model Description</u>:
This paper is irrelevant to our project, although a very brief discussion regarding the relationship between the baby boom generation, and the market participation and the demand for stock is mentioned in Section II on Page 16.

<u>Data Source</u>:
The data used to evaluate the dividend-price ratio are explained in footnote 5: The data in this paper use the January Standard and Poor Composite stock price for each year since 1872, while earnings and dividends are for the entire previous year. Data before 1926 are based on Cowles (1939). The price index used to deflate nominal values to real values is the producer price index.

<u>Summary</u>:
In the paper the use of P/E ratios and dividend-price ratios as forecasting variables for the stock market is examined using aggregate annual U.S. data from 1871 to 2000, and aggregate quarterly data for 12 countries since 1970. However, the authors conclude that the ratios do poorly in forecasting dividend growth, earnings growth, or future productivity growth. Rather, the ratios appear to be useful primarily in projecting future stock price changes.

Poterba, J.M. 2001. Demographic Structure and Asset Returns. *The Review of Economics and Statistics, 83*(4), 565-584.

<u>Support</u>: Yes, but not a meltdown. There exists a moderate positive relationship between age distribution and asset prices.

<u>Assumptions</u>:
The assumptions are the same as those in Poterba (2004): 1) Fixed savings rate for workers. 2) There is a durable capital good that does not depreciate and that is in fixed supply. 3) Closed economy without international capital flows. 4) Other economic effects of population aging are omitted.

<u>Summary</u>:
This paper investigates the association between population age structure and the returns on stocks and bonds. It shows that whereas age-wealth profiles rise sharply when households are in their 30s and 40s, they decline much more gradually when households are in their retirement years. When data are used to generate "projected asset demands" based on the projected future age structure of the U.S. population, they do not exhibit a sharp decline in asset demand between 2020 and 2050. The results suggest caution in projecting large future changes in asset values on the basis of shifting demographics.

Comments:
This paper is widely cited and provides a good reference and model to our topic. Although it shows that the asset prices will decline, it is mainly used to object to the "meltdown" argument.

2002

Brooks, R. 2002. Asset-Market Effects of the Baby Boom and Social-Security Reform. *American Economic Review, 92*(2), 402-406.

Support: Yes, but moderate.

Model Description:
The model used here is the same as the one in Brooks (2000). The difference lies in the method of solving. This model is solved numerically following Mareet and Singleton (1999).

Assumptions:
The same as Brooks (2000).

Data Source:
The population data are from the U.S. Bureau of the Census (1975) and updated from its website. How to perform the simulation is given in footnotes 2 and 3 in detail.

Projection Period:
Returns on stocks and bonds are projected to decline by 92 and 82 basis points below their 2000 levels in 2020.

Summary:
This paper explores the quantitative impact of the baby boom on stock and bond returns. It augments a real business-cycle model with OLG and a portfolio decision over risky capital and safe bonds. The model has two exogenous sources of uncertainty (technology shocks and population growth) and used to simulate the asset-market effects of recent changes in the U.S. population structures. The results suggest that, while the baby boomers will likely earn returns on retirement saving about 100 basis points below current returns, they will nonetheless be better off in terms of lifetime consumption than their parents or children. This is because asset returns move in baby boomers' favor during their working lives, and because they have relatively few children, which boosts their consumption and ability to save early on. Together, these effects outweigh the impact of poor asset returns in retirement.

Helmenstein, C., Prskawetz, A., and Yegorov, Y. 2002. Wealth and Cohort Size: Stock Market Boom or Bust Ahead? *Max Planck Institute for Demographic Research Working Paper No. 2002-051.*

Support: Yes, but not a meltdown.

Model Description:
This paper considers the impact of population aging on the financial markets when wealth is unevenly distributed. Starting from presenting the stylized facts about heterogeneity in cohort size and wealth in Section 2, the authors analyze the individual path of wealth accumulation, indicating the differences between high-wealth individuals and low-wealth individuals in Section 3. Allowing for heterogeneity of cohort size, a full-fledged model with analytically tractable asset market equilibrium conditions is studied in Section 6, where the assets are made up with safe bonds and stocks. Calibration and simulation results are presented in Section 8.

Assumptions:
Wealth is assumed to accrue from bequests and savings, which are accumulated as a fraction of wage income. The population is divided into different generations, each of which has equal amount of wealth but is composed of low- and high-wealth individuals. High-wealth individuals

receive a bequest at age 20, hold their wealth in stocks, consume only labor income, and work their entire lives. Low-wealth individuals are assumed to start their independent financial life at age 20 and have a constant rate of savings between 20 and 60, then retire at 60 and completely dissave till 80.

Data Source:

For empirical studies, on Table 1: Source: Income and Expenditure Survey (Federal Statistical Office, 1998). For calibration and simulation part, parameter values are given in Table 2 and Table 3.

Summary:

A theoretical model that incorporates the concept of a wealth distribution is considered and analytically solved to investigate the relationship between cohort size, population aging and capital dynamics. To do so: 1) A benchmark model with constant cohort size is firstly constructed wherein the relative price of stocks and bonds turns out to be constant over time. 2) Allowing for heterogeneous cohort size (baby boom) the authors replicate the standard result that stock prices increase when the baby boomers enter the labor force and decline during retirement, provided that wealth is distributed uniformly across all cohorts of high-wealth individuals. 3) Introducing wealth heterogeneity across cohorts of high-wealth agents, a well-defined but wide variety of resulting stock market regimes is derived. The negative stock market impact of population aging may be offset or even be reversed. Therefore, the results do NOT lend support to a "meltdown" hypothesis as the baby boomers retire. Instead, various factors, inter alia bequest heterogeneity and asset allocation preferences, contribute to attenuate the expected stock market decline.

Young, G. 2002. The Implications of an Ageing Population for the UK Economy. *Bank of England Working Paper No. 159.*

Support: Yes, but moderate.

Model Description:

In Section 3, an OLG model, where two separate ways of consumption behavior (optimizing behavior and rule-of-thumb behavior) are considered, is used to evaluate the implications of a changing demographic structure. Three types of demographic shocks are considered: a baby boom, increase in longevity, and a reduction in fertility. The results of each case are given on Page 28. Section 4 considers the impact of demographic change on asset prices and rates of return. It focuses on the historical volatility of asset prices and draws the conclusion that while the effects of demographic change on asset prices are likely to be small, the historical volatility is significant.

Assumptions:

Agents will save for old age, but some may die before old age, with their savings being bequeathed to the next generation. 2) Agents supply labor exogenously in varying amounts and degrees of effectiveness over their lifetime. Agents can hold assets that pay a rate of return, and receive bequests. Agents live up to five periods and consume a decreasing amount of their wage income in each period.

Data Source:

Chart 1: Source of data: Government Actuary's Department (UK). Table A: Office for National Statistics, Economic Trends Annual Supplement.

Projection Period:

Demographic trends and living standards are projected to 2068.

Summary:

This paper discusses the impact of demographic change on the U.K. economy, looking at effects on GDP growth and GDP per head, saving and capital investment, interest rates, asset prices, and the distribution of national income. It also considers the risks associated with demographic change. The paper analyzes those effects in an OLG model where people are reliant on their own saving for retirement income and considers three different types of demographic shocks: a baby boom, an increase in longevity, and a decline in fertility. It finds that while the impact of demographic change on asset prices is small, the historical volatility of asset prices and rates of return is significant. A key finding is that even under relatively cautious assumptions about the technological progress and capital accumulation, aggregate living standards are set to double over the next 50 years. Model suggests that baby boomers will increase stock returns while in the labor force and reduce stock returns in retirement.

2003

Abel, A.B. 2003. The Effects of a Baby Boom on Stock Prices and Capital Accumulation in the Presence of Social Security. *Econometrica, 71*(2), 551-578.

Support: Yes, but moderate.

Model Description:
A neo-classical Diamond (1965) OLG model with production and capital accumulation modified to include a random birth rate and a convex adjustment cost technology is set up with detailed definitions in Section 1, where agents live for two periods: working when young, but not when old. A social security system included in the model is given in Section 2. The main results, the equilibrium values of the capital-to-labor ratio and the price of capital are provided in Section 4. Section 8 examines the DC social security system.

Assumptions:
To solve the equilibrium values, four statistical assumptions and the reasons of giving these assumptions are discussed at the beginning of Section 4: 1) The production function for consumption goods is Cobb-Douglas. 2) The capital adjustment technology is log-linear. 3) Consumers have logarithmic preferences. 4) A young consumer in period t knows the present value of the social security benefits. 5) A closed economy is assumed.

Data Source:
This paper is mathematical with detailed derivation. There is no data used to predict the future.

Projection Period:
No projection is made in the paper. Instead, the main result reveals that the price of capital displays mean reversion, so that the increase in the price of capital is followed by a fall in the price in the following period.

Summary:
This paper develops an OLG model in which a baby boom is modeled as a high realization of a random birth rate, and the price of capital is determined endogenously by a convex cost of adjustment. It shows that a baby boom will increase the price of capital. Specifically, when baby boomers are in the labor force earning wage income, national saving and investment are high. In the presence of convex adjustment costs, a high rate of investment can be achieved only by driving up the supply price of capital. However, the price of capital displays mean reversion, so that this increase in the price of capital is followed by a fall in the price of capital in the following year, which supports the idea that the asset price will decline as the baby boomers retire.

Comments:
This is one of the most cited papers to support the argument.

Butrica, B.A., Iams, H.M., and Smith, K.E. 2003. It's All Relative: Understanding the Retirement Prospects of Baby-Boomers. *Center for Retirement Research at Boston College Working Paper No. 2003-21.*

Support: Not very relevant to topic.

Model Description:
The authors use the Social Security Administration's Modeling of Income in the Near Term (MINT) data system to project the retirement income to compare the economic well-being of retirees in the baby boom generation with current retirees. Although the methodology of the model is given with the full description, how the MINT system is set up is not given in this paper. The methodology part is presented in Section IV.

Data Source:
1) MINT starts with data from the 1990 to 1993 U.S. Census Bureau's Survey of Income and Program Participation (SIPP) matched to the Social Security Administration's (SSA) earnings and benefit records through 1999.

Projection Period:

1) MINT projects retirement income from the base SIPP year through 2032 for individuals born between 1926 and 1965.

Summary:

The aim of this paper is to compare baby boomer retirees with previous generations on their overall level, distribution, and composition of family income and on the adequacy of this income in maintaining their economic well-being in retirement. To this end, the authors use projections of retirement income from the Social Security Administration's MINT data system. The paper finds that baby boomers will be better off than current retirees in absolute terms, measured by real per capita income and poverty rates; but in relative terms, they will be worse off than the current retirees.

Comments:

This paper is not very relevant to our project, however, the MINT system might be borrowed for use as it can "project housing equity and non-pension, non-housing wealth (i.e., vehicle, other real estate, farm and business equity, stock, mutual fund, and bond values, checking, saving, money market, and certificate of deposit account balances, less unsecured debt)."

Davis, E.P., and Li, C. 2003. Demographics and Financial Asset Prices in the Major Industrial Economies. Mimeo, Brunel University, West London.

Support: Yes, but moderate.

Model Description:

Section 3 tests empirically the relation between demographics and financial asset prices. In particular, a Gordon's (1962) growth model is used to consider equity price determination. A basic regression model including various variables is given in Equation (6). With respect to bonds, the expectations theory of the term structure is adopted, and again a similar regression model to examine the relationship between demographics and bond is defined in Equation (7).

Data Source:

Main data source to exhibit age distributions is from UN (1998). Data from 1950 to 1999 are used to examine the effect on equity, and data from 1960 to 1999 are used for estimating the effect of bonds. See Appendix for data definitions and sources.

Projection Period:

The projection is done in Section 3.7. The asset prices are projected up to 2025.

International Interaction:

Seven OECD countries—United States, U.K., Germany, France, Italy, Spain and Japan—are considered. The paper adopts an international as well as U.S. focus. The international results are of particular interest given their robustness and the logic of international financial integration.

Summary:

This paper examines the potential links of changes in age distribution of seven countries—United States, U.K., Germany, France, Italy, Spain and Japan—to real stock prices and real bond yields. The results indicate a significant link between panel, international and U.S. demographics on the one hand, and real stock prices and real bond yields on the other. The paper shows that an increase in the fraction of middle-aged people (aged 40-64) tends to boost real asset prices. A corollary is that a decline in this cohort in coming decades will tend to weaken them. The estimated results covering the over-65 cohort in the United States suggest a more severe downturn is possible, thus underlining the potential market risks associated with sole reliance on fully funded pension schemes.

Comments:

Section 2 of the paper provides a very good theoretical background and literature review.

Lim, K.M., and Weil, D.N. 2003. The Baby Boom and the Stock Market Boom. *Scandinavian Journal of Economics, 105*, 1-19.

Support: Yes, but moderate. There is a decline, but no asset meltdown.

Model Description:

A macro-demographic model of linked dynasties is a variation of Abel and Blanchard (1983). The detailed description is given in Section 4.

Assumptions:

Model assumes that production and investment are carried out by identically competitive firms that maximize the present discounted values of their cash flows. Firms making investments face installation costs that are a positive function of the ratio of investment to capital. Labor supply is exogenous.

Data Source:

In the paper, the support ratio defined in Section 3 is essential. Data used to generate various figures are borrowed from CPSS (a paper by Cutler, Poterba, Sheiner and Summers, 1990).

Projection Period:

Support ratio and labor force growth rate is projected to 2050 using data (estimates) from CPSS.

Summary:

This paper attempts to parameterize the model and to use data on actual demographic change as an input. It shows that the case for a large demographic effect on stock prices is fairly weak. The model predicts that there will indeed be a decline in asset prices in response to demographic change over the period 2010-2030, but the magnitude of the decline will be far too small to justify the term "meltdown."

2004

Cai, J. 2004. Baby Boom, Asset Market Meltdown and Liquidity Trap. *Working Paper from EconWPA.*

Support: Yes, but no meltdown.

Model Description:

A two-period OLG model is set up in Section II, where it models risk-averse investment behaviors as an investment impediment.

Data Source:

No data and source of data can be traced. Instead this paper is quite mathematical, with lots of derivation, propositions and corollaries.

Summary:

The analysis in the paper shows that the meltdown hypothesis is fundamentally flawed; and baby-boom-driven asset markets may not necessarily collapse. However, in the case where meltdowns are about to happen, forward-looking boomers' attempts to escape them will be futile, and may lead the economy into a "liquidity trap."

Geanakoplos, J., Magill, M., and Quinzii, M. 2004. Demography and the Long-Run Predictability of the Stock Market. *Brookings Papers on Economic Activity, Economic Studies Program, The Brookings Institution, 35*(1), 241-326.

Support: Yes, but moderate.

Model Description:

An OLG model consisting of three periods (Young, Middle and Retirement) is set up in Section I from Page 248. Some important factors affecting the asset returns, such as wages and dividends, are analyzed in Section I. Other factors affecting demographic structures such as family, bequests and social security are discussed in Section II from Page 257.

Assumptions:
Population assumption: Large cohorts are deterministically followed by small cohorts in a recurring cycle. Preference for saving is relatively insensitive to interest rates. Take a model in which a fixed quantity of land produces a fixed output per period as reference point. A closed economy is assumed.

Data Source:
Various sources of data are used in the paper. They are clearly stated at the bottom of each figure.

Projection Period:
The middle-aged-to-young-adult (MY) ratio is projected from 2001 to 2050. The paper compares the results of the model with the stylized facts on the bond and equity markets for the period 1910-2002.

International Interaction:
Section V also briefly presents some evidence on equity markets and demography for Germany, France, the U.K. and Japan from Page 297. The paper concludes with some cautionary remarks on the use of the model for predicting the future course of prices in an era of globalization of equity markets.

Summary:
The authors construct an OLG endowment economy, which they use to simulate the effects of changes in the U.S. age distribution on stock prices, and the equity premium. It finds that a large middle-aged cohort seeking to save for retirement will push up the prices of securities, and prices will be depressed in periods when the middle-aged cohort is small. It also shows stock prices will be proportional to the size of the middle-aged cohort. The model yields several predictions: 1) P/E ratios should be proportional to the MY ratio. 2) Real rates of return on equity and bonds should be an increasing function of the change in the MY ratio. 3) The equity premium should co-vary with the YM ratio (the reciprocal of the MY ratio), even though the young are more risk-tolerant than the middle-aged.

Comments:
This paper is quite lengthy, detailed in analyses, and useful. There are a couple of discussion papers at the end of this article.

Goyal, A. 2004. Demographics, Stock Market Flows, and Stock Returns. *Journal of Financial and Quantitative Analysis, 39*(1), 115-142.

Support: Yes, but not a meltdown.

Model Description:
An OLG model is constructed, where population consists of four generations: Infants, Youngs, Middles and Olds. In Section II.A, there is a partial equilibrium analysis—the return distribution is specified exogenously. Section II.B endogenizes the price of the risky asset in the economy. Section II C presents the exact dynamics of wealth transfer. Different from previous studies, a power utility function, rather than log utility is maximized. *SEE DETAILS IN SECTION II*.

Assumptions:
In the model setup, it is assume there is no growth in total population and the total population is normalized to one. The fraction of people belonging to the different generations changes over time. In Section II B, assume that the firm issues shares to optimize profits over the next period only. *SEE DETAILS IN SECTION II*.

Data Source:
The asset data used is obtained from S&P. The notations used are specified in the first paragraph of Section III on Page 122. The population data are collected from two sources: Historical Statistics of the United States, Colonial Times to 1970: A Statistical Abstract. See it at the end of paragraph on Page 124. *SEE DETAILS IN SECTION III.*

Projection Period:

On Page 125, population structure is projected to 2050. The main empirical results are presented in Section IV. The forecast of outflows is described in detail in Section IV C from Page 130 to 132. *SEE DETAILS IN SECTION IV.*

International Interaction:

International capital flows are analyzed in Section IV E from Page 133 to 135, where model and statistics are presented. *SEE DETAILS IN SECTION IV E.*

Summary:

This paper attempts to model the investments in the stock market in an OLG model with wealth effects in which each generation has more than two periods to live. It finds support for the traditional lifecycle models—the outflows from the stock market are positively correlated with the changes in the fraction of old people (65 and over) and negatively correlated with the changes in the fraction of middle-aged people (45-64). The population structure adds to the predictive power of regressions involving the investment/savings rate for the U.S. economy. Finally, international demographic changes have some power in explaining international capital flows.

Jamal, A.M.M., and Quayes, S. 2004. Demographic Structure and Stock Prices. *Economics Letters, 84*(2), 211-215.

Support: Yes, but moderate.

Model Description:

A simple supply and demand for financial assets model is constructed in Section II, where the demand and supply are the functions of price of assets.

Data Source:

Annual data from 1950 to 2000 are used to estimate parameters of the equations specified in Section 2. The financial data are obtained from the Economic Report of the President. Population ratio for the 45-65 age group is obtained from the Statistical Abstract of the United States. The S&P 500 volume data is collected from *Economagic.com*. For the U.K., data sources are given in Section 3 on Page 213.

Projection Period:

The projected value of asset decline, measured as P/D ratio, in 2030 due to a change in population structure is rather implied from the estimates derived from the model.

International Interaction:

The case of the U.K. is considered, which also provides evidence that its stock prices are affected by demographic changes.

Summary:

This paper analyzes the relationship between the population age structure and the activities in the stock market. The results indicate that the rise in the proportion of the earning cohort has had a positive influence on the stock prices. The projected decline in the proportion of this age group (45-64) is expected to cause a downward pressure on the demand for financial assets. A study of the U.K. also provided evidence that its stock prices are affected by demographic changes.

Poterba, J. 2004. The Impact of Population Aging on Financial Markets. *National Bureau of Economic Research Working Paper No. 10851.*

Support: Yes, but moderate. There is a positive effect on asset prices, but only to a moderate degree.

Model Description:

The model used in the paper is the same as the ones in Poterba (2001). Please read it on Row 6 of this summary report. Section 5 presents new empirical results on the relationship between various measures of demographic structure and asset returns and the level of asset prices. The specific formulae are given at the bottom of each table at the end of the paper.

Assumptions:

The assumptions are the same as the ones in Poterba (2001), and are discussed in Section 2.1: 1) Fixed saving rate for workers. 2) There is a durable capital good that does not depreciate and that is in fixed supply. 3) Closed economy without international capital flows. 4) Other economic effects of population aging are omitted.

Data Source:

Data sources and dates are given at the bottom of each table.

Projection Period:

Tables 8 and 9 predict various asset statistics up to 2040.

International Interaction:

In Section 1, a few countries have been mentioned on their projected age dependency ratio.

Summary:

This paper explores the importance of changing demographic structure for asset returns, asset prices, and the composition of household balance sheets in the United States. First it describes current age-specific patterns of asset holding in the United States, and finds that asset holdings rise sharply when households are in their 30s and 40s. The projected data do NOT show a sharp decline in asset demand between 2020 and 2050. Second, the paper considers the historical association between population age structure and real returns on T bills, long-term government bonds and corporate stock. The evidence suggests only MODEST effect of a changing demographic mix. There is a stronger historical correlation between asset levels, measured by P/E ratio, and summary measures of the populations.

Comments:

Although this paper does not support the argument, it provides very good literature review and comparisons on this topic, including the analyses on models' assumptions.

2005

Ang, A., and Maddaloni, A. 2005. Do Demographic Changes Affect Risk Premiums? Evidence from International Data. *Journal of Business, University of Chicago Press, 78*(1), 341-380.

Support: Yes, but moderate.

Model Description:

A regression model investigating the relationship between expected returns and demographic variables is constructed in Section 2.2. The empirical results representing the United States and other countries are given with explanations in Section 4. In Section 5, the relationship between demography, social security, and the relative degree of financial market development is examined, partly explaining why the U.S. risk premium predictability by demographic variables is different from the experiences of other countries.

Data Source:

Two data sets (G5's and 15 countries') are used for empirical studies. The general description of data is presented in Section 3. At the end of the paper, data sources and detailed description in G5 countries are respectively given at Appendix A. In particular, data from 1900 to 2001 for the United States, France, Germany and U.K. are used. Data from 1920 to 2001 is used for Japan.

Projection Period:

This is an empirical study. No projection is made.

International Interaction:

Long data samples for the five developed countries (France, Germany, Japan, U.K. and United States) are constructed. A cross-sectional sample of 15 countries (Australia, Austria, Belgium, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, Spain, Sweden, Switzerland, the U.K. and the United States) is constructed. Pool the G5 and 15 countries sample to jointly estimate the predictability coefficients.

Summary:

The authors examine the link between equity risk premiums and demographic changes using a very long sample over the 20th century for the United States, Japan, U.K., Germany and France, and a shorter sample covering the last third of the 20th century for 15 countries. The paper finds that demographic variables significantly predict excess returns internationally. Pooling international data, it finds that, on average, faster growth in the fraction of retired persons greatly decreases risk premiums. This international analysis backs up the predictions of Abel (2003), who suggests that as the baby boom generation enters retirement, and leaves the middle-age peak-saving years, future realized excess returns on equity will be low. This demographic predictability of risk premiums is strongest in countries with well-developed social security systems and lesser-developed financial markets.

Comments:

This paper has an international perspective, and provides good summary on previous literature studies using international data. See details in section 1 on page 3.

Martin, R.F. 2005. The Baby Boom: Predictability in Housing Prices and Interest Rates. *International Finance Discussion Papers Working Paper No. 2005-847.*

Support: Yes, demographic impact on house prices.

Model Description:

A simple Lucas model is constructed in Section 3.3, and two key asset pricing equations are derived. The paper is mathematical and statistical with extensive theoretical analysis in Section 4 and simulation in Section 5.

Data Source:

In Section 10 at the end of paper, the author gives a comprehensive description of data use and sources. For example: Annual data from the Bureau of the Census on the age structure of the population from 1940 through 2005 is used for the United States. House price data from 1970 to 2005 is taken from the OFHEO house price index. Real house data for Japan are from the OECD and are available from 1970 to 2005. Population projections for Japan are also taken from U.N. data. House price data for the U.K. are from the Office of the Deputy Prime Minister. House price data for Ireland are from the Office of National Statistics.

Projection Period:

For United States: The simulated house prices and long-/short-term real interest rates are projected to 2050. For Japan: The simulated house prices are projected to 2010. For U.K.: The simulated house prices are projected to 2050. For Ireland: The simulated house prices are projected to 2050.

International Interaction:

This paper uses international data from Japan, U.K. and Ireland to test the model "out-of-sample." It shows that those data are well-suited for an "out-of-sample" test because the existence, timing and intensity of baby booms vary across countries.

Summary:

This paper explores the baby boom's impact on U.S. house prices and interest rates in the post-war 20th century and beyond. Using a simple Lucas asset pricing model, the author quantitatively accounts for the increase in real house prices, the path of real interest rates, and the timing of low-frequency fluctuations in real house prices. The model predicts that the primary forces underlying the evolution of real house prices are the systematic and predicable changes in the working age population driven by the baby boom. The model is calibrated to U.S. data and tested on international data.

2006

Bernstein, A. 2006. A Boomer Bust? *Businessweek.*

<u>Support</u>: Yes, but probably not a meltdown.

<u>Summary</u>:
Jeremy Siegel, Wharton finance professor, made the following speech at the annual conference held by the Milken Institute in Los Angeles: 1. Aging population is the most critical issue facing the developed world. 2. If there are not enough workers earning income, then there aren't enough buyers of all the stocks and bonds that are going be sold. 3. The age Americans spend in retirement will shrink from 14.4 years to 9.2 by mid-century. 4. Productivity is one possibility to fix the problem.

<u>Comments</u>:
It seems that this article is incomplete and the arguments are alike to the next one.

Börsch-Supan, A. 2006. Demographic Change, Saving and Asset Prices: Theory and Evidence. *Mannheim Research Institute.*

<u>Support</u>: Yes, but moderate.

<u>Model Description</u>:
A multi-country OLG model is used to compute the time paths of saving, capital flows and returns to productive capital as demographic change proceeds. Details, including a mathematical description of the model, are not shown in the paper. Rather, they can be found in Börsch-Supan et al. (forthcoming). International capital movements are modeled in Section 4.3, and calibration is done in detailed explanation in Section 4.5.

<u>Data Source</u>:
Most of the data used are the same as those in Börsch-Supan et al. (forthcoming). At the bottom of each figure, the source of data has been mentioned. Pay-as-you-go (PAYG) pension systems are calibrated with data on replacement rates taken from Palacios and Pallarès-Miralles (2000), and employees' social security contributions are taken from the OECD (2001). Population data for 1950-2050 are from UN Population Division (2001). One example of use of data can be found in footnote 6.

<u>Projection Period</u>:
Most of projections on the interested items are made up to 2070.

<u>International Interaction</u>:
Seven world regions (United States, Canada, Germany, France, Italy, EU and OECD countries) are considered in respect of demographic changes, saving patterns and capital flows.

<u>Summary</u>:
This author feeds a computational multi-country OLG general equilibrium model with detailed long-term demographic projections for seven world regions and computes the time paths of saving, capital flows and returns to productive capital as demographic change proceeds. The simulated results indicate that capital flows from fast-aging regions to the rest of the world will initially be substantial but that trends are reversed when households decumulate savings. It also shows that, because of international diversification, the dynamics of capital accumulation and rates of return in open-economy models are different from what would be predicted by closed economy.

Börsch-Supan, A., Ludwig, A., and Winter, J. 2006. Ageing, Pension Reform, and Capital Flows: A Multi-Country Simulation Model. *Econometrica, 73*(292), 625-658.

<u>Support</u>: Yes, but moderate. The rate of return is projected to decline in response to population aging, and no devastating "asset meltdown" is foreseen.

Model Description:

In Section II, a dynamic model with respect to the demographic projection, stylized pension systems and overlapping-generations that allows them to analyze the effects of population aging and of a shift from a PAYG system to a funded pension system is constructed. The model is fully explained and solved with detailed derivation. The model is calibrated to fit the UN projections in Section III. This paper is very statistical, containing calibration, simulation and sensitivity tests.

Assumptions:

In the paper, more than 10 economic and statistical assumptions are made. Key assumptions: Model assumes countries and regions are modeled symmetrically as open economies; demographic changes capture survival rates, immigration and fertility rates; variable labor supply in some scenarios; and bequests are accidental.

Projection Period:

There are four periods: a phase-in period, a calibration period, a projection period and a phase-out period. Please read *Numerical Implementation* part for details on Page 636. The projections run from 2002 to 2100.

International Interaction:

Seven world regions in the benchmark scenario are considered, including France, Germany, Italy, the remainder of the EU, North America (the United States and Canada), the remaining OECD countries, and all other countries in the world. This paper is famous for its international perspective.

Summary:

This paper presents a quantitative analysis of the capital and labor market effects, and in particular of international capital flows induced by differential aging processes across countries and by pension reform. The authors develop a stylized multi-country OLG model and project macroeconomic aggregates such as international capital flows over a 70-year horizon, using long-term demographic projections for different sets of countries and regions. The simulations predict substantial capital flows arising from population aging. Aging results in changes to saving rates when the baby boomers decumulate their assets. International capital flows follow this trend. However, capital exports from the rapidly aging countries will decrease, and by around 2020 such countries are projected to become capital-importing countries. While the rate of return on capital is projected to decline in response to the population aging, no devastating "asset meltdown" is foreseen.

Bovbjerg, B.D., and Scott, G.A. 2006. Baby Boom Generation: Retirement of Baby Boomers Is Unlikely to Precipitate Dramatic Decline in Market Returns, but Broader Risks Threaten Retirement Security. *U.S. Government Accountability Office.*

<u>Support</u>: Yes, but moderate. There is a small effect, but it is unlikely to cause a dramatic decline on asset returns.

Model Description:

In Appendix IV, an econometric model to determine the effects of changes in demographic, macroeconomic and financial variables on stock market returns from 1948 to 2004 is developed. A regression equation specified on Page 59 is estimated. Model specification, limitations and estimation are given in detail in this part. The model itself and results obtained are comparable to those in Geanakoplos, Magill and Quinzii (2004).

Assumptions:

Assume that all assets listed in mutual fund shares are held in stocks to show the maximum amount of assets that could be held as stock. In calculating annuity equivalents, the authors assume an interest rate of 5.5 percent, single life benefits beginning at age 65, no joint survivor benefits, and level payments.

Data Source:

Data sources include: GAO analysis of Survey of Consumer Finances 2004, and S&P 500 index from 1948 to 2004. Please see Data and Sample Selection part on Page 58 for details. The Health and Retirement Study (HRS) from 1994 to 2004.

Summary:

This summary report produced by the U.S. Government Accountability Office is made to report to congressional committees in 2006. The analysis of national survey and other data suggests that retiring boomers are not likely to sell financial assets in such a way as to cause a sharp and sudden decline in financial asset prices. The statistical analysis of the paper shows that macroeconomic and financial factors, such as dividends and industrial production, explained much more of the variation in stock returns from 1948 to 2004 than did shifts in the U.S. population's age structure, suggesting that demographics may have a small effect on stock returns relative to the broader economy. Lastly, the paper indicates that the retirement security of boomers and others will likely depend more on individual savings and returns on such savings.

Brooks, R. 2006. Demographic Change and Asset Prices. *Demography and Financial Markets.*

Support: No.

Model Description:
A regression model following Davis and Li (2003) is specified in Section 5, which is different from Brooks (2000) and Brooks (2002).

Assumptions:
Some statistical assumptions are made in order for the regression cross-section model to be valid. Please find them in Section 5.

Data Source:
This paper constructs a new data set that contains a long time-series on stock and bond prices, as well as age distributions, across advanced countries. Most of the data start between 1900 and 1925. Sources include: *globalfinancialdata.com* and UN Population Division (2005). *Details of data description are given in Section 4 on Pages 241-243.*

Projection Period:
Population projections and old-age dependency ratios are made up to 2050.

International Interaction:
This paper shows that the relationship between middle-aged cohorts and high real stock and bonds does NOT hold for the following countries: Australia, Canada, New Zealand, the U.K. and the United States.

Summary:
This paper investigates the question of "Baby Boom Meltdown Hypothesis," using a new data set that covers stock and bond prices, as well as age distributions, for a large cross-section of developed countries from the early 1900s. It finds little evidence to suggest that asset prices will suffer abrupt declines when the baby boomers retire. Evidence suggests that real financial asset prices may continue to rise as the population ages, consistent with survey evidence that households continue to accumulate financial wealth well into old age and do little to run down their savings in retirement.

Comments:
The model used in this paper is different from what is used in the other two papers of the author. The model itself is compared with some other important models used by other researchers. Please read the comparison on page 245.

Huynh, W., Mallik, G., and Hettihewa, S. 2006. The Impact of Macroeconomic Variables, Demographic Structure and Compulsory Superannuation on Share Prices: The Case of Australia. *Journal of International Business Studies, 37*, 687-698.

Support: Yes, but moderate.

Model Description:
Model is set up on Page 690 with two co-integration relations held. The methodology and main results are shown on Pages 691 and 692-695, respectively.

Data Source:

The required time series data on share prices index are taken from the DX Data Series (OECD Main Economic Indicators Database, 2001). The time series on demography are taken from the Australian Bureau of Statistics. Please see it on Page 691.

Projection Period:

The period under consideration is from 1967 to 1987 and 1988 to 2002.

International Interaction:

Although the paper considers the case of Australia, this issue is not confined to Australia (quoted from paper). It can be borrowed for use in other countries that experience a similar situation.

Summary:

In this paper, the authors use a value-at-risk (VAR) model to test the long-run relationship between stock prices, real GDP, interest rates, inflation, and the population of the baby-boomers for annual data, and to test the long-run relationship between stock prices, real GDP, interest rates, inflation and superannuation funds in Australia using a VAR model. The authors find that the population in the 40-64 age group and the superannuation fund positively and significantly affect share prices separately in the long run. The findings of this paper are consistent with the view that asset prices will decline as the baby boom cohort reaches retirement age.

Comments:

This paper is short and helpful. The data used is for Australia, but it is also applicable to the developed nations. it supports the idea and provides good literature review and discussion in this topic.

Kedar-Levy, H. 2006. Can Baby-Boomers' Retirement Increase Stock Prices? *The Quarterly Review of Economics and Finance, 46*(2), 284-299.

Support: No meltdown, positive effect of equity prices.

Model Description:

A model setup is given in Section 2, outlining the optimal portfolio rules and the aggregate trend and contrarian strategies. In Section 3, the model is solved and equilibrium prices are derived. Demographic effects are fully analyzed with a calibrated estimate of the United States through 2050.

Assumptions:

There are a few assumptions made as follows: 1) Aggregate investors' consumption is independent of demographic changes. 2) A fixed supply of equities is assumed. 3) Assume that the ratio of labor market participation to total population is perfectly negatively correlated. 4) Assume that 7.79 percent mean log return on the S&P composite between 1950 and 2004 is the long-term return until 2050. Ignore consumption and wealth effect in the model.

Data Source:

Under each figure, detailed data descriptions and sources are provided. Sources include: UN, World Population Prospects (2004); the 50-year (1950-2004) average rate of return of the S&P 500 and its variance parameters; Shiller's website data.

Projection Period:

Log S&P 500 is projected to 2050.

Summary:

The goal of this paper is to demonstrate a *positive* aging effect on equilibrium equity prices of investors with Hyperbolic Absolute Risk Aversion (HARA) utilities and Decreasing Relative Risk Aversion (DRRA) preferences. It shows that the contrarian strategy is optimal for high risk-averse investors with CRRA (Constant Relative Risk Aversion) preferences, and the trend strategy is optimal for investors with DRRA preferences under a HARA utility function. The author calibrates the model to post-war U.S. data and solves for the model-implied mean price process, and then projects the calibrated model until 2050, obtaining the results consistent with the empirical findings of Poterba (2001, 2004), who estimates moderate positive demographic effects on equity prices as the U.S. baby boomers retire.

Lusardi, A., and Beeler, J. 2006. Savings Between Cohorts: The Role of Planning. *University of Michigan Retirement Research Center Working Paper No. 2006-122.*

Support: Not very relevant to topic.

Data Source:
Source of data: from Health and Retirement Study (HRS) in 2004 and 1992; method of data collection: detailed in Section 2.

Summary:
It compares the saving behavior of two cohorts: the early baby boomers (EBBs, age 51-56 in 2004) and the HRS cohort (age 51-56 in 1992, i.e., an earlier cohort). It finds that EBBs have accumulated more wealth than the previous cohort but they benefited from a large increase in house prices. For both the EBB and the HRS cohort, lack of planning is tantamount to lack of saving irrespective of the many changes in the economy between 1992 and 2004.

The Economist. 2006. *Baby Boom and Bust: Will Share Prices Crash as Baby-Boomers Sell Their Assets to Pay for Retirement?*

Support: Yes, but moderate.

Summary:
Two different views are presented by Jeremy Siegel and Michael Milken. Siegel is pessimistic: 1) The sale of assets holding by the baby boomers when they retire will lead to a sharp fall in prices, because there are too few people in the smaller generations that followed the boomers to buy all of those assets at today's prices. 2) His hope is that the shortfall of buyers of assets in the rich world will be made up for by a surge in demand from the developing world. 3) However, the growing protectionism in the rich world will both slow the rate of growth in the developing world and prevent its demand for shares being met. Milken is hugely optimistic, mainly because: 1) Many boomers will live far longer than is expected today, hence people will want to keep working, not retire. 2) Working for longer will become easier thanks to tech innovation, and hence there may be not enough assets to buy.

2007

Lusardi, A., and Mitchell, O. 2007. Baby Boomer Retirement Security: The Roles of Planning, Financial Literacy, and Housing Wealth. *Journal of Monetary Economics, 54*(1), 205-224.

Support: Not very relevant to topic.

Data Source:
Source of data: from Health and Retirement Study (HRS) in 2004 and 1992; method of data collection: detailed in Section 2.

Summary:
The authors compare wealth holdings across two cohorts of the Health and Retirement Study: the early baby boomers in 2004, and individuals in the same age group in 1992. Levels and patterns of total net worth have changed relatively little over time, though boomers rely more on housing equity than their predecessors. Most important, planners in both cohorts arrive close to retirement with much higher wealth levels and display higher financial literacy than non-planners. Instrumental variables estimates show that planning behavior can explain the differences in savings and why some people arrive close to retirement with very little or no wealth.

Comments:
This paper is written by the same author as the previous one and is similar to the previous one.

2008

Schich, S. 2008. Revisiting the Asset-Meltdown Hypothesis. *OECD Journal: Financial Market Trends, 2008*(2), 1-14.

Support: Yes, asset meltdown highly unlikely.

Data Source:
Data sources are given at the bottom of each figure. For example: Figure 1: OECD estimates based on United Nations, World Population Prospects and Thomson Financial Datastream and IMF; Figure 2: Stanovsky (2004); Figure 3: Global Financial Stability Report (September 2004).

International Interaction:
Estimated personal saving rates by age in seven developed countries have been drawn in Figure 3, although not much discussion has been taken.

Summary:
This report from OECD revisits the "Asset Meltdown Hypothesis" caused by baby boomers' retirement. It shows that there is some support for a link between demographics and financial asset prices, although the link may not be strong. It agrees, to some extent, with Poterba (2001, 2004), stating that forward-looking and efficient markets would price the developments (aging, baby boomers' retirements, etc.) well before they actually occur. Thus, any rapid demographically induced financial asset meltdown appears to be highly UNLIKELY. However, the situation for non-financial assets may be different. Therefore, such downward outcome cannot be completely ruled out.

Comments:
This is a literature review paper without much mathematics.

2009

Rosnick, D., and Baker, D. 2009. The Wealth of the Baby Boom Cohorts after the Collapse of the Housing Bubble. *Center for Economic and Policy Research.*

Support: Not very relevant to topic.

Summary:
This paper makes projections of wealth for the baby boom cohorts in 2009 using data from the 2004 Survey of Consumer Finance (SCF). The projections show: 1) The median household with a person between 45 and 54 saw its net worth fall by more than 45 percent between 2004 and 2009. 2) The situation for early baby boomers is worse. 3) As a result of the plunge in house prices, many boomers have little or no equity in their homes. Finally, the projections show that the renters within each wealth quintile in 2004 will have more wealth in 2009 than homeowners in all three scenarios. This analysis indicates that the loss of wealth due to the collapse of the housing bubble and the plunge in the stock market will make the baby boomers far more dependent on Social Security and Medicare than prior generations.

Comments:
This paper is not much relevant to our topic. No model is traced and no references can be found.

Santoro, M. 2009. Will the Demand for Assets Fall When the Baby Boomers Retire? *U.S. Congressional Budget Office.*

Support: No.

Summary:

This is a summary report produced by the U.S. Congressional Budget Office (CBO) to examine whether "the asset meltdown hypothesis" of the baby boomers is valid. An evaluation of the evidence indicates that such a dramatic decline in asset demand is unlikely. Factors that may explain the evidence are summarized on Page 1.

Comments:

This paper gives the direct links of the reference papers at its References section. Those reference papers can be easily traced.

The Dent Method: Economic Forecasting Based on Changes in Demographic Trends. What is it? Why Use It? *hsdent.com*. 2009.

Support: Inconclusive.

Summary:

This paper gives a method to forecast the demographic trends. It studies: predictable spending patterns at different ages and stages of life; who spends what in the economy and its demographic impact; birth index and immigration; the spending wave; and inflation indicator. The conclusion of each point is summarized at the end of each sub-heading with bold and inclined scripts.

2010

Takáts, E. 2010. Aging and Asset Prices. *Bank for International Settlements Working Paper No. 318.*

Support: Yes, but moderate.

Model Description:

A small OLG model is set up in Section 2.1, where agents live for two periods (Young and Old). On one hand, an agent wants to maximize his utility subject to the income constraint at Young and Old ages. On the other hand, the agent trades a single asset priced at p with part of his income. Using the first order condition, the asset price evolution in terms of economic and demographic factors can be determined, as shown in Section 2.1. An extension model is given in Section 2.2, in which constant elasticity of inter-temporal substitution, housing utility and social security are taken into account.

Data Source:

The empirical analysis uses real housing price data compiled by the Bank for International Settlements (BIS) from national data. The database covers 22 advanced economies between 1970 and 2009. Historical and projected demographic data, such as old age dependency ratio and population size, are taken from the UN Population Database (2008). The IMF WEO and IFS database is used for real GDP per capita data.

Projection Period:

The UN (2008) population projections are used together with the model coefficients to estimate the demographic impact on house prices up until 2050.

International Interaction:

Twenty-two countries have been considered, including: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United States, and the U.K. A similar pattern has been identified.

Summary:

The paper investigates how aging will affect asset prices. A small model is used to show that economic and demographic factors drive asset prices, and in particular house prices. It finds that aging will affect asset prices significantly negatively, but an asset price meltdown is unlikely. The impact of aging is identified using house price data from 22 advanced economies between 1970 and 2009.

Comments:
In the paper, the case of financial asset is NOT directly derived; rather it is implied by considering the equilibrium situation of financial market. i.e.: "Given that financial assets are priced in equilibrium with the housing market, the headwinds estimated on real housing prices are likely to affect the returns on financial assets as well." The asset price implications are discussed in Section 4.2 in detail.

2011

Huang, A.G., Hughson, E.N., and Leach, J.C. 2011. Generational Asset Pricing, Equity Puzzles, and Cyclicality. *Working Paper.*

Support: Yes, under certain assumptions regarding risk tolerance.

Model Description:
In the paper, two-generational asset pricing models respectively specified in Section 2 and 3 are presented. Section 2 considers a deterministic four-generation example, where all generations are assumed to have log utility with numerical implementation. Section 3 extends the model to an infinite horizon with stochastic preferences and wages. The model in the paper is most related to Constantinides et al. (2002), Geanakoplos et al. (2004), and Liu and Spiegel (2011). The comparison is made explicitly in Section 1 on Page 4. Note we have Geanakoplos et al. (2004) and Liu and Spiegel (2011) as references in this Literature Review Summary. See Rows 33 and 45 for details.

Assumptions:
Following Constantinides et al. (2002), the authors characterize structural differences between life stages by assuming: 1) young adults consume and cannot buy or sell securities; 2) the middle-aged trade riskless and risky securities to maximize the utility of consumption in their remaining lives; 3) the old liquidate their securities holdings, consume everything possible, and die.

Summary:
Long-term cycles in financial markets suggest that investor risk aversion is time-varying. In this paper, the authors consider a model with stochastic generational variation in preferences to examine the potential role cohort preferences play in asset pricing cycles and puzzles. The structure leads directly to pricing kernel dominance by succeeding generations of a strict subset of consumers-investors: wage earners investing to transfer wealth to their retirement years. The results show that the volatility of the stochastic discount factor (SDF) governing asset prices does not translate into the volatility of an aggregate consumption-based empirical SDF. Rather the pricing kernel reflects an investing generation's consumption growth from mid-life to retirement. Furthermore, the model produces a high market Sharpe ratio, a reasonable P/E ratio, and negative long-term price-excess return on correlation. *"If the baby boomers are much more risk-tolerant than their offspring, the model suggests that there should be a sizeable decline in asset prices when baby boomers net-sell to the next generation."*

Liu, Z., and Spiegel, M.M. 2011. Boomer Retirement: Headwinds for U.S. Equity Markets? *FRBSF Economic Letter*.

Support: Yes, aging has a negative effect on asset values.

Model Description:
No exact formulae are presented in the context, but the model used here is similar to that in Geanakoplos et al. (2004).

Data Source:
Data sources on Figure 1: Bloomberg (P/E) and Haver Analytics (M/O). Data sources on Figure 2: Bloomberg and Census Bureau.

Projection Period:
The future P/E ratios are projected to 2030.

<u>International Interaction</u>:
International influences are considered and discussed briefly at the end of paper.

<u>Summary</u>:
The paper considers a statistical model in which the equity P/E ratio depends on a measure of age distribution. The authors construct the P/E ratio based on the year-end level of the Standard & Poor's 500 index adjusted for inflation and average inflation-adjusted earnings over the past 12 months, and they measure age distribution using the M/O ratio, a ratio of the middle-age cohort, age 40-49, to the old-age cohort, age 60-69.They also project the future P/E ratios to 2030, which shows a bearish pathway on stock market.

<u>Comments</u>:
This is an important paper supporting the argument. Although the exact formulae (in the model) are not presented in the context, the model used is similar to that in Geanakoplos et al. (2004).

Schoen Sr., J.W. 2011. Baby Boomers May Be Bad News for Stock Market. *NBCNews.com*

<u>Support</u>: Inconclusive.

<u>Summary</u>:
This article summarizes two opposite viewpoints: 1. MIT economist James Poterba tackled the question and concluded that the data "do not show a sharp decline in asset demand between 2020 and 2050. This finding calls into question the 'asset market meltdown' view." 2. On the other hand, San Francisco Fed economists Zheng Liu and Mark Spiegel compared the stock market's P/E ratio with the ratio of "middle-aged" people to "old-aged" people. The theory is that if those in their 40s are typically buyers and those in their 60s are sellers, the ratio of those two age groups should have an impact on stock prices. From historical data and their projection, the trend is that P/E ratio and the ratio of 40s to 60s will likely continue until 2021, when the stock prices will be 13 percent lower than they were in 2010.

2012

Baxter, M. 2012. Bull and Bear: The Great Baby Boomer House Sale Approaches. *The Share Centre Blog.*

<u>Support</u>: Yes, if boomers downsize en masse.

<u>Summary</u>:
According to the Equity Release Council, the report says that "by 2017, more than a quarter of a million (257,168) retirees will consider downsizing and 59,347 will look into equity release." If baby boomers were to downsize the house en masse, house prices would fall, and baby boomers would find that they have less money than they were expecting.

Cornell, B. 2012. Demographics, GDP, and Future Stock Returns: The Implications of Some Basic Principles. *The Journal of Portfolio Management, 38*(4), 96-99.

<u>Support</u>: No.

<u>Model Description</u>:
Basic formulae in economics are used to illustrate the ideas/NO EXACT MODELS.

Summary:

The paper discusses five basic economic principles that are related to GDP and stock returns due to demographic changes. It shows that demographic changes are UNLIKELY to have a negative impact on stock prices in future years. The main impact of demography is primarily on the current level of stock prices. In addition, as the markets for goods and services, and particularly financial assets, become more integrated internationally in future years, the demographics of individual countries will become less relevant.

Damato, K. 2012. Bad News for Boomers. *The Wall Street Journal*.

Support: Yes.

Summary:

Robert D. Arnott, a manager of two Pimco mutual funds, received an interview from the *WSJ*. He supported the argument and made the following comments: 1) In 2012, for the first time in U.S. history, the population of senior citizens rises faster than the working-age population. 2) Over the coming decades, he anticipated a considerably slower economic growth rate, and hence a close-to-zero real after-tax return on stocks and bonds. 3) He referred to the Japanese situation of 20 years ago and to the U.S. current situation and made some comparisons. 4) It's naive if people of the United States expect 8 or 10 percent return a year from stocks now and onwards. 5) He suggested a diverse investment in emerging economies, such as BRICs.

Comments:

In summary, his idea is simply: Save more aggressively; invest in economies that aren't afflicted by the 3-D hurricane of deficit, debt and demography; and diversify into markets that can serve us well in a reflationary world.

Park, C., and Kim, D.H. 2012. Demographic Structure and Financial Markets in Korea. *Korea and the World Economy, 13*(2), 307-328.

Support: Yes, aging affects real interest rate.

Model Description:

A non-parametric life-cycle model is used in this study (see Section 2). Previous studies utilized a linear regression approach but the authors suggest that misspecification is a problem. This current approach is more robust in two ways: (1) No functional form is imposed. (2) The model relates the variation in asset price to variation of the full age distribution instead of choosing a specific age range a priori.

Assumptions:

The age response function (which reflects the impact of demographic distribution on asset price) is smooth enough to be approximated by a series of polynomials, trigonometric functions, or a mixture of both (see Section 2).

Data Source:

Korean stock market data is obtained from Datastream (includes price index, dividend yield, P/E ratio). Age distribution data is obtained from Korea Statistical Information Services. (See Section 3 for a detailed mathematical description of data strategies.)

Projection Period:

Demographic trends are projected to 2050. The price/dividend ratio, P/E ratio and real interest rate are projected to 2020 (see Section 4.2).

Summary:

The paper explores the association between demographic structure and asset prices in Korea using the life-cycle model. The authors use a non-parametric model that has the advantage of not having a functional form a priori (avoids misspecification). Their results and projections suggest that the relationship between stock price and population structure is inconsistent with the standard life-cycle model (results were inconclusive here). However, their results do suggest that real interest rates will continue to rise until 2020, which is consistent with the life-cycle model. Retirees will exhibit dissaving behavior and as the proportion of retirees in the population increases, so will interest rates.

Roy, A., Punhani, S., and Shi, L. 2012. How Demographics Affect Asset Prices. *Global Demographics and Pensions Research, Credit Suisse.*

<u>Support</u>: Yes, but moderate.

Model Description:

The authors use regression analyses (life-cycle model) and examine the asset channels affected by demographic variables (i.e., stocks, bonds and house prices). However, the actual regression models are not specified.

Assumptions:

The authors use a baseline assumption that 51 percent of U.S. households in 2009 are at risk of being unable to maintain their pre-retirement standard of living in retirement.

Data Source:

Sources are listed under each respective figure and table. They include UN, Credit Suisse, Japan Ministry of Health, Germany Federal Statistical Office, U.S. Consumer Expenditure Survey, U.S. Survey of Consumer Finance, Center for Retirement Research, The National Association of U.S. Investment Companies, OECD.

Projection Period:

Demographic trends, P/E ratio, M/O ratio, bond yield, Yuppie/Nerd ratio and real housing prices are projected to 2020/2025.

International Interaction:

The paper considers the trend for United States, U.K., Japan, France and Germany.

Summary:

The report analyzes the connections between demographic variables and asset prices. The authors individually examine the effects of demographics on stocks, bonds and house prices, and extend the study across five countries (United States, U.K., Japan, France and Germany). First, they find that supply-demand dynamics for assets change over the life-cycle as individuals borrow when young, accumulate assets when middle-aged, and decumulate assets when old; and this affects asset prices. Second, they find strong relationships between long-term stock/bond yields and demographics. Third, different countries exhibit different demographic and institutional features, and, as a result, countries differ in terms of asset allocation and prices. Fourth, the authors project P/E ratios and bond yields up to 2025 for five countries. Finally, the authors find a link between demographics and house prices and suggest that the typical age ranges used in the past will not work for the future.

The Economist. 2012. *Are Retiring Baby Boomers About to Crash the Stock Market?*

<u>Support</u>: No.

Summary:

The author challenges the argument based on the following reasons: 1) It is unlikely that each cohort of retiring baby boomers will sell shares en masse. 2) The number of equity buyers perhaps won't fall. 3) Global markets are also more integrated and it's the global population of investors that matters. 4) The supply and demand story is not the only thing that determines asset pricing. 5) The supply and demand story also ignores the risk.

2013

Kang, J.M. 2013. Retirement of Baby Boomers and Its Impact on the Financial Market. *KIF Weekly Financial Brief, 13*(20).

<u>Support</u>: Yes.

Data Source:
The author uses various U.S. and Korean statistics from various sources (Korean Insurance Research Institute (KIRI), Korean Household Financial and Welfare Survey, Ministry of Health and Welfare, Census, etc.).

Summary:
The author examines the effects of demographics on Korea's financial markets using empirical evidence from the United States and Korea. It is suggested that the wave of baby boomers entering retirement will have negative effects on savings, investment, and growth potential of Korea's economy. The author supports the idea that financial asset prices will fall and financial markets will be hit hard. To mitigate this problem, the author has suggested several policies: 1) Promote reverse mortgage schemes. 2) Reform securities industries. 3) Open up the stock market further to be more global. 4) Diversify business activities of securities firms. 5) Maintain strong social safety nets.

Saita, Y., Shimizu, C., and Watanabe, T. 2013. Aging and Real Estate Prices: Evidence from Japanese and U.S. Regional Data. *Tokyo Center for Economic Research Paper No. E-68.*

Support: Yes, but moderate.

Model Description:
An OLG model based on Samuelson (1958) and Diamond (1965) and modified by Takáts (2012), and Nishimura and Takáts (2012) is used. (The regression equation is in Section 2.1.)

Assumptions:
Population projections are based on the assumption of medium fertility unless specified to be low-variant or high-variant projection. Low-variant projection uses the assumption of low-fertility and high-mortality rates. High-variant projection uses the assumption of high-fertility and low-mortality rates.

Data Source:
Regional price data is constructed for Japan and the United States. The authors use state-by-state housing price indexes from the Office of Federal Housing Finance Agency (FHFA) to construct the U.S. data. Land price data from Ministry of Land, Infrastructure, Transport, and Tourism are used to construct Japanese data (see Section 2.2).

Projection Period:
Land prices, effects of migration on demographic impacts, and contributions of demographic changes are projected to 2040 (see Figures 6a-b, A1-A2).

International Interaction:
The trend is compared between Japan and the United States.

Summary:
The paper explores the link between real estate prices and aging, specifically for Japan and the United States. Using the OLG model, the authors find that real estate prices are negatively correlated with the old age dependency ratio and positively correlated with total population in the region. The factor of aging had a greater impact on Japanese real estate prices. Projections show a decline in real estate prices of 2.4 percent per year from 2012 to 2040, suggesting that aging will continue to exert a downward pressure on asset prices.

Wallick, D.W., Shanahan, J., and Tasopoulos, C. 2013. Baby Boomers and Equity Returns: Will a Boom in Retirees Lead to a Bust in Equity Returns? *Vanguard Research, The Vanguard Group, Inc.*

Support: No.

Model Description:

The authors mention that quantitative methods were used and graphs were derived from various methods of calculation but exact models and math were not specified.

Data Source:

U.S. Census Bureau, Survey of Consumer Finances, World Bank, U.S. Bureau of Economic Analysis, Moody's Analytics, International Monetary Fund, MSCI, FTSE. (See graphs and charts for specific sources.)

Projection Period:

1) Demographic trends are projected to 2025. 2) Labor-force growth in the United States is projected to 2050.

International Interaction:

Labor force growth is projected for the United States, India, Brazil, China, Europe, Russia and Japan.

Summary:

The authors compiled a report examining the link between an aging population and returns on equity for the United States. They specifically looked at the effects of baby boomers' entry into retirement on equity returns. They find no evidence of a negative effect of retirement on stock returns. Three factors for this evidence are mentioned: 1) Baby boomer generation is spread over two decades so the chances of en masse actions are slim. 2) The amount of equity owned by baby boomers is similar to that of previous generations so the impacts will be similar to past data. 3) Equity ownership is concentrated in the baby boomer cohort with the wealthiest 10 percent owning over 88 percent of the stock holdings. Furthermore, globalization will add an additional cushion to the effects of boomers' retirements on stock prices.

2014

Lee, R.D. 2014. Macroeconomic Consequences of Population Aging in the United States: Overview of a National Academy Report. *American Economic Review, 104*(5): 234-239.

Support: Inconclusive.

Summary:

This paper is a review of a National Academy Report on the macroeconomic consequences of population aging in the United States. Only one section is directly relevant to the topic (Page 6). The author suggests that population aging may raise private asset holdings but it also raises public debt (from pensions, health care, etc.) and so the net effect is unclear. Even if population aging does affect the demand of assets, it shouldn't cause any sudden shifts in asset values or returns due to the slow and predictable nature of aging. The author predicts that there may be a small decline in rates of return by less than 1 percent in the next few decades.

McKenna, B. 2014. Aging Population Will Put Brakes on Economic Growth: BMO. *The Globe and Mail*.

Support: Yes, returns on assets affected.

Summary:

The article talks about the slowing of economic growth in Canada by an aging population. It is in reference to the report by Douglas Porter listed below. Only the last two paragraphs are relevant to the topic. McKenna mentions that interest rates will continue to rise and returns on financial assets will be lower over the next decade.

Porter, D. 2014. Long-Term Outlook: Destiny Dictated by Demography? *Bank of Montreal, Capital Markets*.

<u>Support</u>: Yes, aging reduces asset returns.

<u>Data Source</u>:
Statistics Canada and IMF.

<u>Projection Period</u>:
Canadian economic growth projected to 2030. Employment rate projected to 2020. Real GDP and financial market returns projected to 2025.

<u>International Interaction</u>:
A comparison of the share of global real GDP is made for 12 countries (see Table 2).

<u>Summary</u>:
Most of this article examines the various economic factors of aging (such as growth rates and unemployment rates). Table 3 is directly relevant to the topic. Interest rates are expected to rise with an aging population along with a reduction in asset returns.