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Life Cycle Investment Behavior, Demographics, and Asset Prices

by

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B.A. Economics, Yale University (1989)

M.A. Economics, Yale University (1992)

Submitted to the Department of Economics
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

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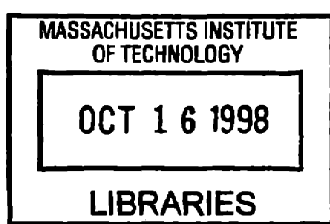
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Abstract

This thesis investigates the relationship between demographics and asset prices. More specifically it examines the effect of changes in the age distribution of the U.S. population on housing, stock, and bond prices over the post World War II period in the U.S. This is done in two steps. First, survey data on household asset holdings is used to construct age profiles of household demand for housing, stocks, bonds, and debt. These asset demand profiles are combined with data on the age distribution of the U.S. population to construct time series measures of aggregate demographic demand for housing, financial assets net of debt, and stocks in excess of bonds, which are then used to analyze the effects of demographically driven changes in aggregate asset demand on equilibrium asset prices over the period from 1946 through 1997. The results of this exercise suggest several interesting findings.

With respect to the microeconomic issue of life cycle investment behavior, one finds that the scale and composition of household asset demand changes dramatically over the course of the economic life cycle. Young households, that is, households with heads under age 40, tend to draw credit out of financial markets, primarily by issuing mortgage contracts for the purchase of houses. The extent of this and other borrowing done by young households tends to exceed any gross contributions they make to financial markets through transactions accounts, mutual funds, retirement plans, etc., making them net negative investors in financial assets on average. In contrast, households with heads between ages 40 and 60, tend to provide substantial amounts of credit to financial markets. Much of this saving is, at least nominally, retirement saving, held in personal retirement accounts and employer provided pensions. Households with heads over age 60 tend, like younger households, to drain credit from financial markets. However, unlike young households, older households draw credit out of financial markets not by borrowing, rather, by using previously accumulated assets to fund consumption during retirement.

Due to large shifts in the age distribution of the U.S. population since 1946, these life cycle investment patterns appear to have had significant macroeconomic consequences. Tests of the correlation between the constructed demographic demand variables and corresponding asset price series, suggest a statistically significant link between demographic changes in the U.S. population and observed long run movements in housing, stock, and bond prices. This is true even after controlling for the effects of other factors such as fluctuations in real GDP (in the case of housing and bond prices) and dividends (in the case of stock prices). Estimated elasticities of real housing prices with respect to the demographic demand for housing suggest that demographic factors can account for approximately 59% of the observed annual increase in real housing prices between 1966 and 1986. Similarly, demographically driven changes in the demand for financial assets can account for approxi-

mately 77% of the observed annual increase in real stock prices between 1986 and 1997 and can account for at least 81% of the observed annual increase in real bond prices.

As for the future, current Census Bureau population projections suggest that annual growth in demographic housing demand will provide a positive stimulus of about 0.35% per year to real housing price appreciation between 1997 and 2007, down from about 0.98% per year for the period between 1986 to 1997, and 1.02% per year for the period between 1966 and 1986. Growth in the demographic demand for financial assets is expected to provide a positive stimulus to real stock and bond price appreciation of about 8.76% per year between 1997 and 2007, up from about 6.62% per year for the period between 1986 and 1997, and -1.34% per year for the period between 1966 and 1986.

Thesis Supervisor: Jerry A. Hausman

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There are many people to whom I will always be indebted for the friendship, guidance, and knowledge that they have given me.

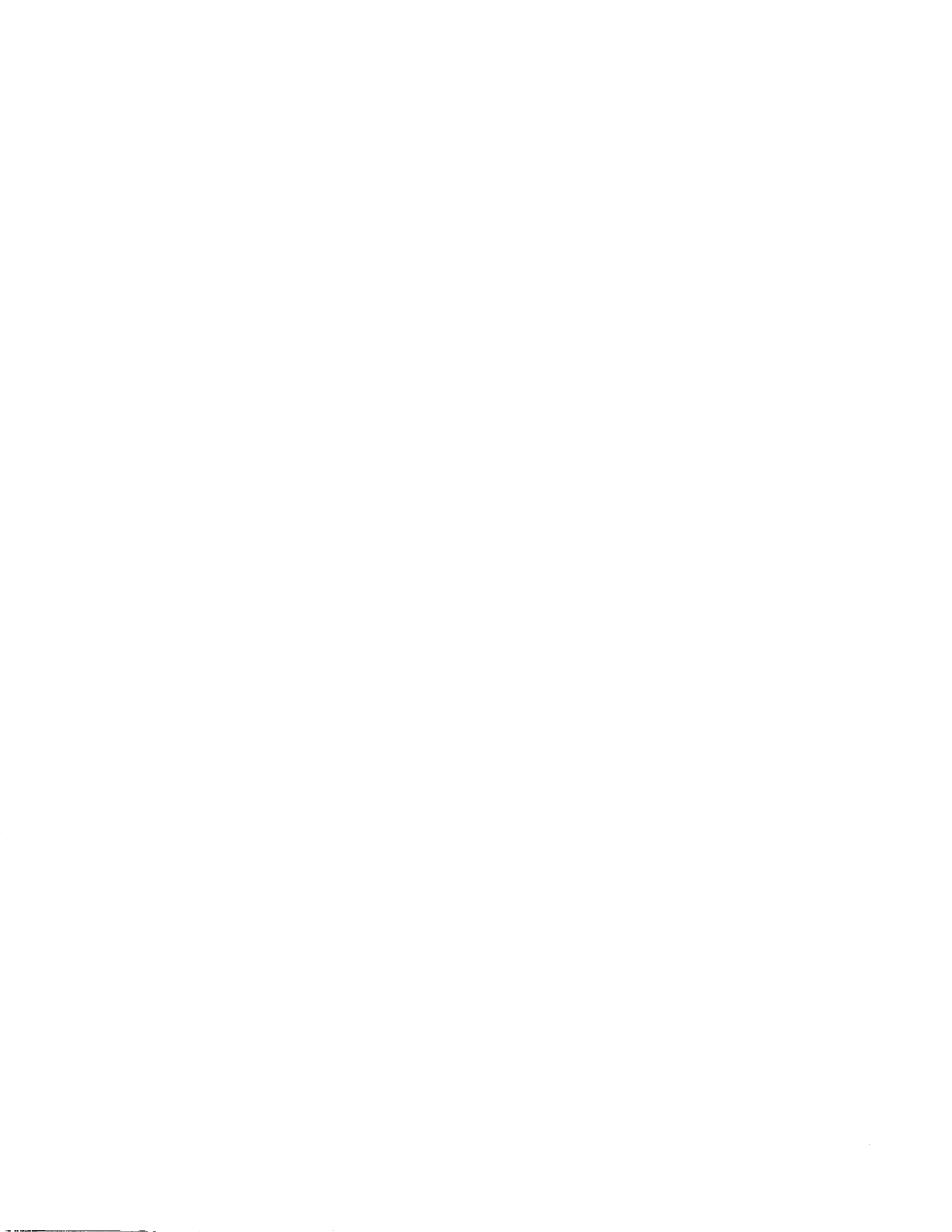
While at Yale University I benefitted from the instruction of many professors. I am particularly grateful for having had the opportunity to learn from David Pearce, Truman Beweley, Donald Andrews, David Pollard, Peter Jones, and Richard Beals. I would also like to thank my first year study group partners Robert Chase, Mark Foley, and Ryan Schneider for their intellect, good humor, and companionship; and my intramural basketball teammates and fellow students, Dan Ackerberg, Joe Boyer, Jeff Desimone, and Mark Foley. Together, we demonstrated the ability of heart to win out over height (and talent) on the basketball court.

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I would have never made it to graduate school if it had not been for my family. A person could not ask for more giving and caring parents than those with which I have been blessed, and my older siblings Lisa, Jimmy, and Paul have always been ready and willing to help out their little brother. In addition to being good friends they have, in many ways, been a second, and much appreciated, set of parents.

I finish by thanking the person to whom I am most indebted, my wife Christina. The life of a graduate student's spouse is infinitely worse than that of the graduate student. While the graduate student toils away in a self imposed exile from society, the graduate student's spouse is left waiting, wondering when life will return to normal. During my extended tenure as a graduate student, I have come to learn how remarkably patient and giving an individual my wife is. She has been a constant source of support and inspiration, always willing to provide a shoulder to lean on, a pep talk, or a kick in the butt, when needed. I have no doubt that there have been many a night and weekend when she wished that her husband had been born a hare instead of a tortoise, and I am certain that she will be relieved to know that this tortoise has finally finished.



Contents

1	Introduction	11
2	Some Facts about the Baby Boom	23
3	Literature Review	27
4	Asset Holdings and Investment over the Life Cycle	37
4.1	Data Description and Overview of Household Asset Holdings	38
4.1.1	The Data Set	38
4.1.2	The Household Balance Sheet	39
4.1.3	Reasons for Saving	43
4.2	Estimating Cross Sectional Age Profiles of Asset Holdings	46
4.3	Estimating Life Cycle Profiles of Asset Holdings	59
4.3.1	Estimation Procedure and Regression Results	59
4.3.2	Cohort Adjustments and Profile Construction	64
4.3.3	Life Cycle Asset Holdings: Baby Boomer	65
4.3.4	Life Cycle Asset Holdings: Parent of Baby Boomer	70
4.3.5	Life Cycle Asset Holdings: Child of Baby Boomer	82
5	Demographics and Asset Prices in the U.S.	89
5.1	Calculating Demographic Asset Demand	89
5.2	Demographics and Asset Prices: Empirical Evidence	91
5.2.1	Real Housing Price Appreciation and the Demographic Demand for Housing	93
5.2.2	Real Stock Price Appreciation and the Demographic Demand for Financial Assets	101
5.2.3	Real Bond Price Appreciation and the Demographic Demand for Financial Assets	108
5.2.4	Excess Stock Price Appreciation and the Excess Demographic Demand for Stocks	115
5.3	Demographics and Long-Run Asset Price Cycles	120
6	Conclusion	127

Chapter 1

Introduction

This thesis examines the relation between demographics and asset prices. More specifically, it examines the relation between changes in the age distribution of the U.S. population and observed housing, stock, and bond prices over the post World War II period in the U.S. The motivation for the study stems from the observation that the dramatic rise in real housing prices during the 1970s and much of the 1980s, and the similarly dramatic rise in real stock prices since the late 1980s both roughly coincide with the entrance of the baby boom generation into stages of life typically associated with high demand for those assets.

For example, between 1966 and 1986, a period during which the first cohort of baby boomers aged from 20 to 40, real housing price appreciation averaged about 1.73% per year, compared to just 0.67% per year over the twenty years preceding 1966, and 0.53% over the eleven years between 1986 and 1997. Conversely, real stock price appreciation, as measured by changes in the average annual S&P 500 stock price index, averaged -0.64% over the twenty year period during which the first cohort of baby boomers aged from 20 to 40, compared to 5.54% over the twenty years prior to their entrance into the adult population and 8.54% over the eleven years since they turned 40. As for bonds, detrended real bond price appreciation was -0.34% per year between 1966 and 1986, compared to 3.12% per year between 1946 and 1966, and 5.64% per year between 1986 and 1997.¹

Figure 1.1 provides a visual display of the apparent link between demographics and asset prices. The top panel plots a real price index for single family homes against the

¹Trend real bond price appreciation between 1946 and 1997 was about -7.10% per year after accounting for growth in real income and demographic demand for financial assets. Chapter 5 describes in detail the real bond price index used in the analysis of this thesis.

number of people ages 29–31; the middle panel plots the real S&P 500 stock price index against the ratio of people ages 49–51 to those ages 29–31 and 69–71; and the bottom panel plots the detrended real bond price index against the ratio of people ages 49–51 to those ages 29–31 and 69–71. The choice of demographic variables is somewhat ad hoc but is intended to reflect the ideas that young families make up the vast majority of first time home buyers and tend to have large quantities of debt relative to financial asset holdings, that the retirement saving of middle-aged individuals leads them to invest heavily in financial assets, and that retirement itself leads older individuals to draw down on their previously accumulated wealth. The choice of ages 30, 50, and 70 as being representative of young, middle-aged and old is based on a division of the adult life cycle into the three stages: 20-39, 40-59, and 60 and over.

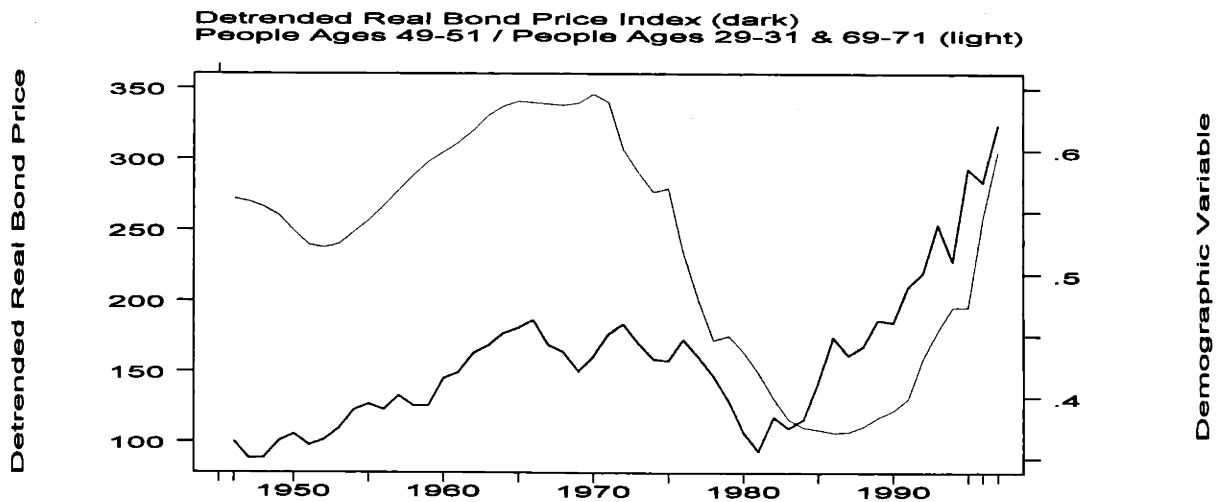
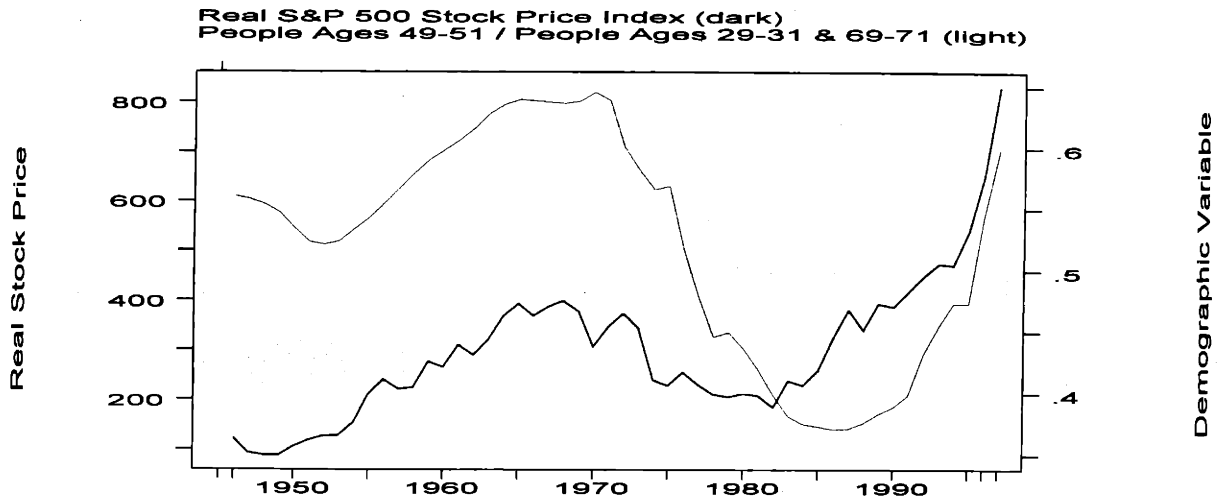
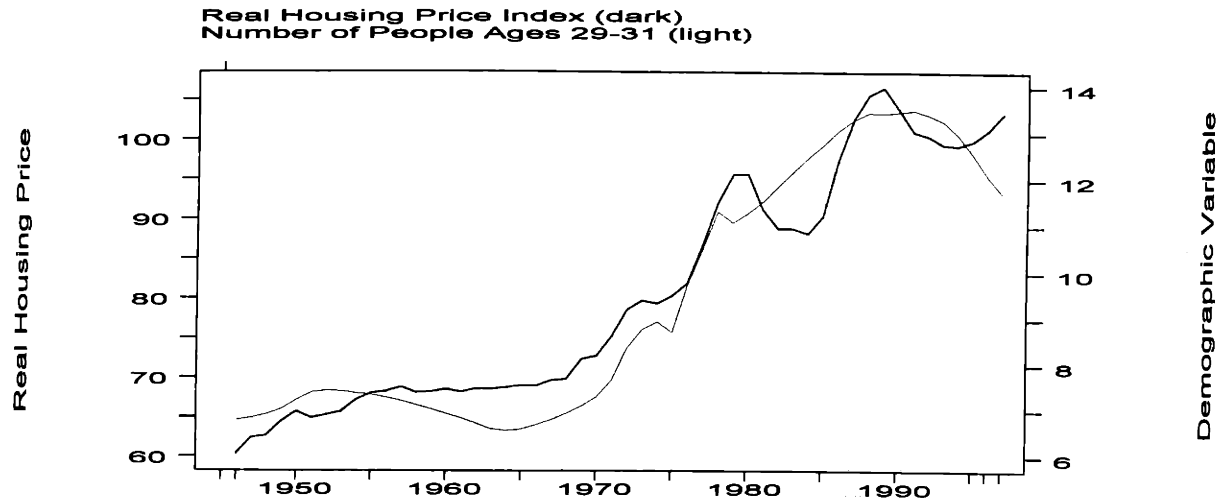
Looking at the graphs, one can see that the demographic demand variables fit the long run cycles in real housing, stock, and bond prices surprisingly well. According to these graphs, it appears that the entrance of the baby boom generation into young adulthood beginning in the late 1960s, and the resulting increase in housing demand and borrowing, caused real housing prices to rise and caused real stock and bond prices to fall. Similarly, it appears that the retirement saving of middle-aged baby boomers is now causing real stock and bond prices to rise. This interpretation of the data has received much attention in the financial press in recent years.² Despite the media attention received, there has been relatively little academic research done on the subject of demographics and asset prices.

A complete review of the existing academic literature on demographics and asset prices is contained in Chapter 3. The seminal papers in this area, however, are those by Mankiw and Weil (1989), which examines the relation between demographics and housing prices; and Bakshi and Chen (1994), which examines the relation between demographics and stock and bond returns. Both papers find evidence in support of the basic hypothesis that demographic changes in the population affect equilibrium asset prices. Subsequent authors, however, have questioned the robustness of these results.

The purpose of this thesis is to present a comprehensive empirical analysis of the relation between demographics and asset prices; one which will provide some insight into whether the graphs presented in Figure 1.1 display intriguing but spurious correlations, or are indicative of a more fundamental economic relationship between the demographic makeup of

²See, for example, Colvin (1997).

Figure 1.1



an economy and the equilibria obtained in its asset markets. With this goal in mind, the empirical analysis of later chapters is divided into two complementary parts.

The first part of the analysis uses survey data on household asset holdings to verify the microeconomic story underlying the apparent connection between demographics and asset prices. Embedded in the hypothesis that demographic changes in the population affect asset prices is a set of assumptions about the economic life cycle of the typical household. As alluded to in the initial discussion, what creates the apparent link is an economic life cycle in which individuals borrow money to finance the purchase of a house when young, pay down their mortgage debt and save for retirement when middle-aged, and draw down on their previously accumulated savings to fund consumption when old and no longer in the work force. We can think of such a household as transferring income from the middle stage of its life to either end. The transfer to the early stage being achieved through mortgage financing of the home purchase and the transfer to the latter stage being achieved through retirement saving.

To see how life cycle behavior such as this could yield the graphs displayed in Figure 1.1, notice that the concentration of first time home purchases among young households implies that a population bubble, such as the baby boom, should have its largest impact on housing demand, and hence on housing prices, as the members of the bubble generation pass through the early stages of the economic life cycle, that is, as they pass through the home buying years. As for the connection between demographics and financial markets, it is essential to realize that the important aspect of the described life cycle behavior in terms of interest rate and stock price determination is the transfer of income between various stages of life. In this regard, the retirement consumption of the old and the mortgage financed home purchases of the young are equivalent actions, since both tighten aggregate credit constraints by drawing credit out of financial markets. Thus, the actions of both the young and the old tend to put upward pressure on interest rates and, by increasing the discount rate used to value expected future dividend/earnings streams, downward pressure on stock prices.³ In contrast, the retirement saving of the middle-aged loosens aggregate credit constraints by supplying credit to financial markets, and so puts downward pressure on interest rates and

³In terms of interest rate and stock price determination, it doesn't matter that the young household invests the money it borrows rather than consume it as long as the investment is not back into financial assets.

upward pressure on stock prices.

Worded differently, the retirement consumption of the old and the mortgage financed home purchases of the young reduce the net demand for financial assets, putting downward pressure on financial asset prices (i.e. stock and bond prices).⁴ Equivalently, their actions put upward pressure on the rates of return required on financial assets (e.g. interest rates and required rates of return on stocks). The retirement saving of the middle-aged, in contrast, increases the net demand for financial assets. This puts upward pressure on financial asset prices and, hence, downward pressure on the rates of return required on financial assets.

Given the importance of this description about the economic life cycle in giving economic content to the graphs displayed in Figure 1.1, it seems that a logical first step in assessing the significance of those graphs would be to verify that the hypothesized life cycle behavior put forth as an explanation for them is, in fact, representative of the typical household. This is done in Chapter 4 of the thesis by using survey data on household holdings of housing, stocks, bonds and debt to estimate age profiles of household asset demand. If the estimated profiles are inconsistent with the hypothesized life cycle, then either we would have to develop an alternative explanation for the observed correlations between the demographic and asset price series or else conclude that these correlations are, in fact, spurious. Even if the estimated profiles are consistent with the microeconomic story, however, we must still show that demographic fluctuations over the past 50 years have been sufficient to give the observed life cycle investment patterns macroeconomic significance.

Essentially what we need to show is that movements in asset prices are correlated with changes in demand for those assets brought about by changes in the demographic structure of the population. Fortunately, the estimated profiles used to examine life cycle investment behavior can also be used to test the macroeconomic significance of that behavior. By combining the estimated asset demand profiles with time series data on the U.S. population, we can construct time series estimates of aggregate demand for housing, financial assets net of debt, and stocks in excess of bonds. Fluctuations in these demand variables can be interpreted as measuring changes in asset demand brought about by changes in the size and composition of the U.S. population. Further, since fluctuations in these demand vari-

⁴The young reduce net demand for financial assets by increasing the supply of financial assets through the issuance of mortgage claims (bonds).

ables are entirely driven by demographic changes, they are exogenous from the perspective of asset price movements. Tests of the correlation between these variables and the corresponding asset price series, therefore, can actually be interpreted as tests of the *effect* of demographically driven changes in asset demand on equilibrium asset prices.⁵ Moreover, the estimated relationships between these variables and corresponding asset price series can be used both to assess the historical importance of demographic factors in bringing about past movements in asset prices and, given projections of future population changes, to predict the direction and magnitude of future changes in demographic asset demand and the likely impact on future asset prices. This is done as the second part of the empirical analysis and is presented in Chapter 5.

Before proceeding with a complete outline of the thesis it would probably be best to address some issues that might give one pause in interpreting the results, presented in later chapters, as evidence of a causal link between demographics and asset prices. Most of the issues addressed in the next few paragraphs have been raised in the course of discussions I have had with other economists. So, to the extent that they will enter the minds of other readers, it is probably a good idea to try and lay them to rest now.

One thing that economists might find troubling, is the apparent need for the housing demanded by young households to be satisfied by mortgage financed purchases, if, as suggested, the behavior of young households is to have financial market implications. What if young households rented homes instead of buying them, and as a result did not amass any mortgage debt; would this imply that the increase in housing demand created by young households would have no impact on stock and bond prices? I believe that the answer to this question is no. The increased demand for housing generated by young households would require the conversion of financial wealth into physical wealth and, hence, would tighten aggregate credit constraints, irrespective of which individuals in society formally request the withdrawal of credit from financial markets. That is, the direction (and most likely the magnitude) of the effect on stock and bond prices resulting from an increase in aggregate housing demand, should be the same whether individual households issue mortgages to finance the purchase of the homes themselves or deep pocketed investors draw funds on some of their accounts to build the homes and rent them to young families. What is important, or at least aesthetically appealing, about the link between the quantity of housing demanded

⁵ Assuming, of course, that other potential determinants of asset prices have been controlled for.

by individual households and their desire to own that housing, is that it makes the link between the microeconomic behavior and its macroeconomic consequence more direct and, as a result, more easily modeled.

Another misgiving one might have with respect to the housing side of the story is the possibility of constant returns to scale production in housing, for this would seem to imply that changes in aggregate housing demand could have no impact on real housing prices. The most obvious response to this worry would be to point out that the use of land as an input to the production of real estate (i.e. house plus lot), and the importance of location to the value of land, prevents real estate production from being constant returns to scale, even if housing production is. Another possible response would be just to state that if housing production is constant returns to scale, then we won't observe any correlation between demographic housing demand and real housing prices. Thus, if we do, we have evidence supporting both the claim of a link between demographics and asset prices and decreasing returns to scale production in the housing sector.

The problem with this second response, as I see it, is that constant returns to scale in housing production, in and of itself, is not enough to break the link between housing demand and housing prices in a general equilibrium setting. If housing production shares scarce inputs, such as labor, with industries that are themselves characterized by decreasing returns to scale production, then, in order for the housing sector to attract enough of those inputs into housing production to satisfy a large increase in housing demand, it will have to bid up their real wages in step with the decreasing returns to scale industry that these inputs are being bribed out of. If this happens, however, then the only way for the constant returns to scale housing sector to maintain zero economic profits is to increase real housing prices in proportion to the wage increase. Thus, even if housing production is constant returns to scale, increased housing demand could cause real housing prices to increase.

Moreover, it is not even necessary that the housing sector share the scarce resource with another sector. If this resource is scarce enough relative to the increase in housing demand, then it would eventually become an input whose supply is fixed, making production constant returns to scale in theory, but decreasing returns to scale in practice. To relate this to our demographic story, observe that several of the more important inputs into the production of housing are skilled laborers such as carpenters, plumbers, and electricians. If the skill possessed by these individuals is acquired over many years, then the entrance of a

large generation, such as the baby boomers, into young adulthood, creates a large demand for housing, and a potentially large supply of unskilled labor, but a dearth of the skilled labor required to build the homes that they want. Thus, once again the resulting increase in housing demand could generate a substantial, and sustained, increase in real housing prices.

Moving on to issues surrounding the financial market side of the story, I can think of three major questions that a skeptical reader might raise: (1) Is this theory consistent with rational expectations? (2) Are the implications of this theory robust to the assumption of integrated international financial markets? and (3) Couldn't intergenerational transfers eliminate the hypothesized life cycle investment/borrowing patterns?

I will try to address each question in turn, beginning with the issue of rational expectations. What makes accepting the idea of a link between demographics and asset prices most difficult, is the fact that the accuracy with which one can forecast demographic changes in the adult population, even far into the future, belies the unquestionable difficulty of forecasting asset returns, whether they be returns on stocks, bonds, or even housing. It would seem, therefore, that any observable relationship between demographics and asset prices would allow rational agents to use readily available demographic data to exploit arbitrage opportunities.

Any reservations one may have about short run arbitrage, should be allayed by thinking of any link between demographics and asset prices as providing information about the time varying drift parameters on risky asset returns. Since, over short time intervals, the drift on a risky asset is dominated by its volatility, it would be difficult, if not impossible, to use demographic information for short term gain. Indeed, as will be seen in the frequency analysis presented in Chapter 5, the correlation between the demographic demand for financial assets and real stock price appreciation is not even statistically significant at horizons under two years, and so could not yield any short run arbitrage opportunities.

But what about longer time periods, like two to five years, or even a decade? It would seem that if demographics impact long run stock prices in the way suggested by the middle panel of Figure 1.1, then an investor could time the withdrawal of his/her funds from the stock market a year or two ahead of when the baby boomers are expected to start retiring, avoiding otherwise certain capital losses. Where, however, would the investor put his/her money after withdrawing it from the stock market? As can be seen in the bottom panel of

Figure 1.1 the long run cycles in bond prices seem to mirror those of stock prices. Thus, one should not expect to earn any handsome returns by shifting the money into bonds.

Indeed, equilibrium in asset markets would require that the saving activity of the baby boom generation drive down required returns on all forms of retirement saving. Moreover, this would have to happen in such a way that the relative returns on the various assets produce an equilibrium in which people are not only satisfied with the direction and size of any intertemporal income transfers in which they are engaged, but are also satisfied with the allocation of their portfolios across different assets. Thus, the assumption of rational expectations does not rule out demographically driven movements in asset prices, rather, it places restrictions on the timing and magnitude of any price movements. In particular, equilibrium asset prices would have to reflect individual preferences for intertemporal wealth transfer, individual (possibly time varying) risk aversion, the arrival process of demographic information, and the cost of acting on that information.

Another concern one might have about the strength of any relationship between demographics and financial asset prices, even if one accepts the stated life cycle hypothesis as valid, is that integrated international financial markets could break any link between the financial asset prices within a given country and the demographic structure of that country's own population. There are several reasons to believe that the relationship between prices in U.S. financial markets and the demographic structure of the U.S. is robust to such considerations. First, and most obvious, the results presented in Chapter 5 suggest the existence of a strong historical relationship between demographics and financial asset prices in the U.S.

Even if one accepts the historical relationship as true, however, why should (s)he expect it to persist into the future, especially given the rapid pace of international financial integration and innovation? One reason is the size and importance of the U.S. economy relative to the world economy. The U.S. is not a small open economy whose domestic interest rate is given exogenously by world financial markets. Much to the contrary, because it has the largest economy in the world, the economic and financial activity that takes place inside the U.S. plays an important role in the determination of international asset prices. It is more likely, therefore, that demographically driven changes in U.S. financial markets would break the link between demographics and financial asset prices in another country than for the reverse to happen. Further, since the relative importance of the U.S. economy in the

world economy is unlikely to be diminished greatly in the years to come, there is reason to believe that any observed link between the demographic structure of the U.S. population and financial markets in the U.S. will persist into the future.

Another reason to expect any such link to persist is that, despite the seemingly rapid pace of international financial market integration and innovation, investors display a rather strong home country bias in the allocation of their portfolios. Calculations by French and Poterba (1991) for example, found that the domestic ownership shares of the world's five largest stock markets were 79% or above, and, in the case of the U.S., Japan, and the U.K., 92% or above.⁶ Moreover, they calculated that, as of 1989, 93.8% of the equity portfolio of U.S. investors was invested in U.S. equity markets. Since it is probably safe to assume that international diversification has increased rather than decreased over the post World War II period, it would seem reasonable to state that historically more than 90% of equities traded on U.S. equity markets are owned by U.S. investors, and more than 90% of the equities owned by U.S. investors are traded on U.S. equity markets. Although this could change in the future, recent data from the Flow of Funds Accounts published by the Federal Reserve Board show that foreign ownership of U.S. equities was still below 7% in December of 1997.

Finally, one might wonder if intergenerational transfers could undo any link between demographics and asset prices. Specifically, part of the life cycle story told above seems to rely on the desire of individuals to transfer income from middle age to youth for the purchase of a home. It would seem, however, that bequests could potentially smooth out the life cycle path of income enough to make such intertemporal transfers insignificant, or even unnecessary.

Although the issue of bequests and life cycle asset demand will be taken up again later, it is worth noting that in each of the three survey samples analyzed in Chapter 4, fewer than 25% of households reported having ever received a substantial inheritance, trust or transfer. Of those that had, the median value, in constant 1995 dollars, of all inheritances, trusts, and transfers ever received, was approximately \$17,000 per spouse.⁷ This represents about 60% of the median annual income per spouse for these same households. Clearly then, for most households, intergenerational transfers are of minor importance relative to

⁶The exact shares calculated by the authors were 92.2% for the U.S., 95.7% for Japan, 92% for the U.K., 79% for Germany, and 89.4% for France.

⁷The per spouse unit of measure means that the total amount of inheritances received was divided by two in cases where the head of the household was married or living with a partner.

the life cycle path of other income, such as wage income, in determining the life cycle paths of financial and nonfinancial asset demand.

Also, to the extent that intergenerational transfers are important for some households, the fact that they tend to be received during middle age suggests that such transfers are more likely to amplify the effects of a hump shaped income path, rather than dampen them.⁸ Lastly, recalling our earlier discussion about the lack of a difference between deep pocketed investors paying for the houses and the young households mortgage financing the housing purchase themselves, one can think of the bequeathing generation as the deep pocketed investor. Thus, the affect on aggregate credit constraints of any investment in housing by young households should be the same whether it is mortgage or bequest financed since, in both cases, the conversion of financial wealth into physical wealth draws credit out of financial markets.

We now proceed with an outline of the thesis. Chapter 2 presents some facts about the baby boom and attempts to provide some perspective on the demographic significance of this event. Chapter 3 reviews the existing literature on demographics and asset prices. Chapters 4 and 5 present the results of the two part analysis outlined earlier. Chapter 4 focuses on obtaining an understanding of how household asset demand evolves over the life cycle. As stated earlier in the introduction, the purpose of this chapter is to determine whether or not household asset demand displays any sort of life cycle pattern, and if so, to verify whether or not the observed patterns are consistent with the type of behavior thought to generate a link between demographics and asset prices. This is done by using survey data on household asset holdings to estimate age profiles of asset demand. Also contained in Chapter 4 is an examination of the effects of changes in lifetime income and family size on life cycle asset demand. The results of this part of the analysis are used to compare the life cycle investment behavior of a typical baby boomer to that of his/her parents and children. The estimated age profiles from Chapter 4 are used in Chapter 5 to construct approximate measures of demographically driven aggregate asset demand. These demand variables are used for three things. First, and most important, they are used to test for

⁸Among individuals who had received at least one major inheritance, trust, or transfer in their lifetime, the average age of receipt for the largest one was 41. Among those who had received at least two such gifts, the average age of receipt for the second largest one was 42. Forty two was also the average age of receipt for the third largest gift among those who had received at least three substantial inheritances, trusts, or transfers in their lifetime.

an economic link between demographics asset prices. Second, the estimated relationships between the demand variables and corresponding asset price series are used to estimate the percentage of observed asset price cycles since World War II that can be attributed to demographic factors. Lastly, the estimated relationships between the demand variables and corresponding asset price series are used, along with Census Bureau population projections, to forecast future changes in demographic asset demand and any implied changes in future asset prices. Chapter 6, contains a brief summary of the main results and some concluding remarks.

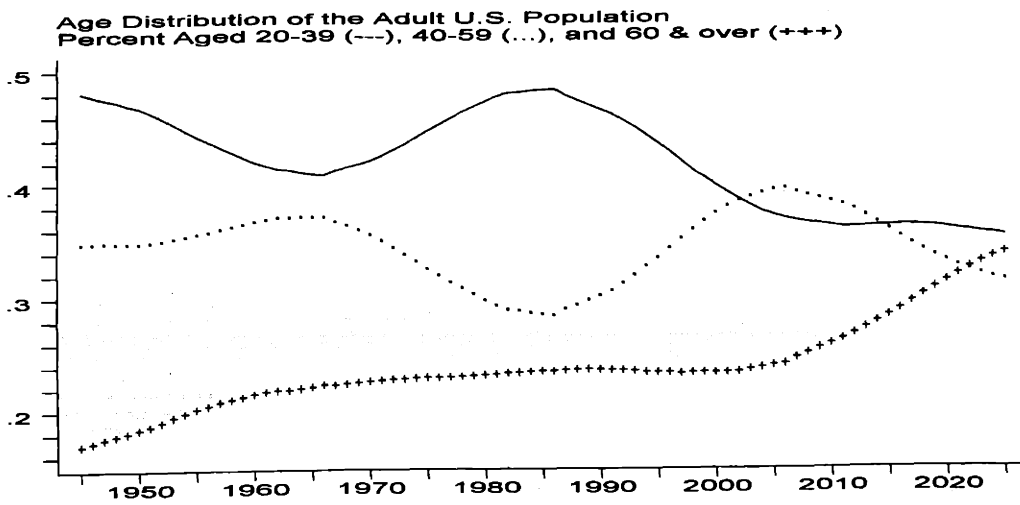
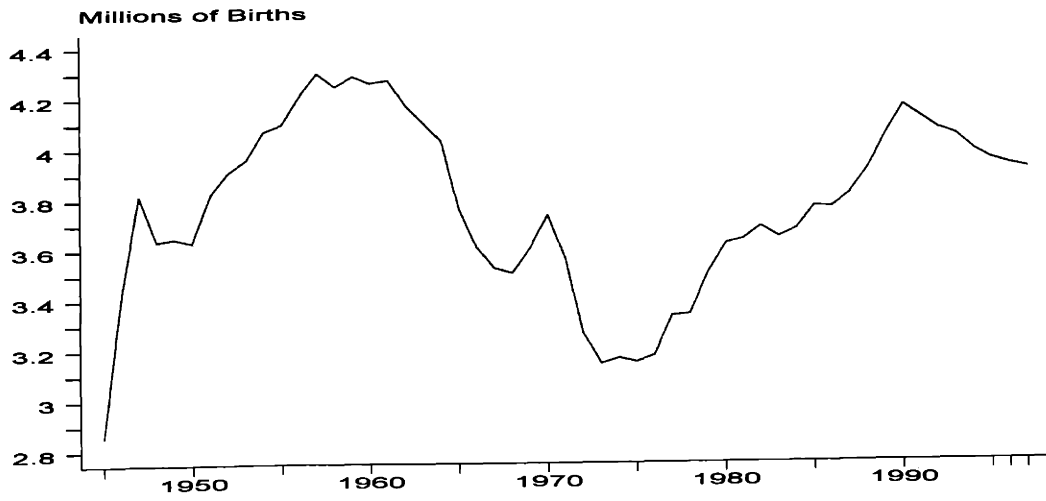
Chapter 2

Some Facts about the Baby Boom

The three panels of Figure 2.1 give one a sense of just how large the baby boom generation actually is. The top panel of the figure plots births per 1000 women age 15-44. As one can see, birth rates were extraordinarily high during the baby boom. In 1945, the year just preceding the baby boom, there were approximately 86 births per 1000 women age 15-44. The following year this figure increased by 18.6% to 102 and by the peak year of 1957 there were 123 births per 1000 women age 15-44, a birth rate 43% higher than in 1945. The birth rate recorded in 1957 is also 87% higher than in 1976, the year that marked the trough of the baby bust in terms of birth rates. There were approximately 66 births per 1000 women age 15-44 in 1976, and fewer than 71 in each year since then.

The next panel plots total births in the U.S. since 1945. Unlike the previous graph, this one displays what appear to be two baby booms. The first peak in the graph corresponds to the post World War II birth rate boom displayed in the top panel. As in the case of birth rates, the peak year is 1957. In that year there were 4.3 million births in the U.S., 51% more than in the year preceding the baby boom, and 36% more than in 1976. The other large peak in this graph lags that of the baby boom by 33 years, occurring in 1990. The 4.2 million births recorded in 1990 are part of what is often referred to as the baby boomlet. This bubble in births is the result of the original baby boomers reproducing themselves, and so doesn't show up as a significant change in birth rates. If current birth rates persist, then we can expect to observe alternating large and small generations long into the future. Thus, to the extent that life cycle behavior creates a link between demographics and asset prices, the baby boom's effect on asset markets may persist well after the passing of the

Figure 2.1



original baby boom generation.

The bottom panel of Figure 2.1 shows the effect of the baby boom generation on the age distribution of the adult population of the U.S. This graph plots the number of individuals age 20–39, 40–59, and 60 and over as a proportion of the population age 20 and over. We can think of the population age 20 and over as the adult population.¹ The years prior to 1966 are characterized by a more or less steady aging of the adult population, due in part to increases in the life expectancy of the old.² The percentage of adults age 20–39, for example, fell from approximately 48% in 1946 to 41% in 1966, while the percentage of adults age 40–59 increased from 35% to 37% and the percentage of adults age 60 and over increased from 17% to 22%.³

In 1966, the first cohort of baby boomers turned 20, drastically altering previous demographic trends. By 1986, the percentage of adults age 20–39 had risen back to its 1946 level, whereas the percentage of adults age 40–59 had fallen approximately 9 percentage points to 28%. The percentage of adults age 60 and over continued to grow but at a significantly slower rate, reaching just over 23% by 1986. In the eleven years since the first cohort of baby boomers turned 40 the percentage of adults age 40–59 has increased from 28% to 35% while the percentage of adults age 20–39 has fallen from 48% to 42%. The percentage of adults age 60 and over has remained roughly constant over the last 11 years.

According to Census Bureau population forecasts, current demographic trends will continue until 2006, when the first cohort of baby boomers turns 60. By 2003, the number of adults age 40–59 is expected to exceed the number of adults age 20–39 for the first time since 1900, and will continue to do so until some time around 2015. Starting in 2006 the percentage of adults age 60 and over is expected to increase rapidly, from 24% in that year to 34% by 2025, at which time the number of adults age 60 and over will almost equal the number of adults age 20–49. Further, starting in 2023 the number of adults age 60 and over is expected to exceed the number of adults age 40–59 for the first time since 1900.

These statistics should leave no doubt that the baby boom has had a dramatic impact on

¹One could also use age 18 (high school graduation) or age 22 (college graduation) as the demarcation for adulthood.

²The life expectancy of someone age 65, for example, increased from about 13 years in 1946 to 15 years in 1966 and to 18 years in 1996.

³Moreover, this trend extended back at least to 1900. In that year the percentage of adults age 20–39 was 58%, the percentage of adults age 40–59 was 31%, and the percentage adults age 60 and over was just under 12%.

the demographic landscape of the United States, and will continue to do so for many years into the future. Understanding how much of an effect it has had and possibly will have on asset markets requires that we acquire more information about how the typical household's interactions with asset markets evolves over the life cycle. If middle-aged households do tend to be the biggest providers of financial assets to the economy, then the substantial increase in the percentage of middle-aged adults over the past 11 years is a potentially significant factor in explaining the dramatic rise in stock and bond prices over that same period. Further, the retirement of these individuals and the entrance of their offspring into young adulthood in the years to come could have significant effects in the opposite direction.

Chapter 3

Literature Review

One of the first papers to investigate the relation between demographics and asset prices was that of Mankiw and Weil (1989), which examined the relation between demographics and real housing prices.¹ The authors estimated an age specific housing demand function by using 1970 Census data to regress the value of a household's residence (imputed value when not owned) on the number of household members of each age from 0 (less than a year old) to 99. The estimated coefficients from this regression were combined with information on the age distribution of the U.S. population to construct a time series measure of aggregate housing demand. Specifically, the authors calculated aggregate demographic demand for housing in year t as

$$H_t = \sum_{a=0}^{99} \alpha_a N_{a,t}$$

where α_a denotes the estimated demand coefficient for age a from the cross sectional housing demand regression, and where $N_{a,t}$ denotes the number of people age a in year t . The log of H_t was then included on the right hand side of a real housing price regression for which the other explanatory variables were a constant, time trend, log real GNP and the user cost of housing.² Having obtained a statistically significant positive coefficient on H_t , the authors concluded that real housing prices are affected by demographically driven changes

¹McFadden (1992) extends the Mankiw-Weil analysis to include tenure choice and an analysis of the welfare effects of changes in housing prices on different birth cohorts.

²The authors calculated the user cost of housing as $(1 - \tau)i - \pi$, setting the marginal tax rate, τ , equal to 0.3 in every year, using the nominal yield on long term treasury bonds to represent the nominal interest rate, i , and calculating expected inflation, π , as the average rate of inflation over the previous two years.

in the aggregate demand for housing. Further, based on Census Bureau projections of future changes in the U.S. population, the authors predicted that real housing prices would fall to levels lower than observed at any time in recent history.³

This conclusion, however, does not appear to result from any anticipated decline in the level of demographic demand for housing, as measured by Mankiw and Weil. The estimated growth rates of housing demand that the authors present in Figure 4 of their paper, anticipated diminishing, but positive growth in aggregate housing demand over the forecast period. The lowest value of annual growth in housing demand forecast by Mankiw and Weil for the twenty years after 1987 was about 0.5%, and this implied demand driven real housing price appreciation of about 2.6% per year, down from about 6% per year in 1987.⁴ Similarly, trend growth in real GNP of about 3% per year would have implied additional increases of about 0.7% per year in real housing prices.⁵ It appears, therefore, that what drives the Mankiw–Weil forecast of decreases in the *level* of real housing prices is the estimated trend growth rate of -8.1% per year from their regression.

Without further information about the source or likely persistence of this negative trend, however, it may have been more appropriate for the authors to restrict their conclusions to the partial effect of changes in demographic demand on real housing prices. If they had done this, then the authors would have predicted demographically driven reductions in the growth rate of real housing prices over the forecast period rather than reductions in the level of real housing prices.⁶

This is an important point to make for two reasons. First, the Mankiw-Weil prediction of declining real housing prices inspired several authors to produce research suggesting that demographics will not cause real housing prices to fall, and in some cases, suggesting that demographics have no effect on real housing prices. These articles will be discussed below.

More importantly, the authors' forecast error may have resulted from the use of an incorrect measure of aggregate housing demand in their regressions. Observe that since the left hand side variable in the Mankiw-Weil cross sectional regression is the total value of a household's primary residence, the aggregate housing demand variable, H_t , used in their

³Their forecast was for the twenty year period beginning in 1987, the last year in their sample.

⁴These estimates were calculated using housing demand growth rates read off of Figure 4, and the estimated coefficient on log housing demand, which was 5.29.

⁵The estimated coefficient on log real GNP was 0.234.

⁶Real housing prices, as measured by the index used in this thesis, did fall during five of the ten years, between 1987 and 1997, but were, nonetheless, almost 1% higher in 1997 than in 1987.

regressions, is best thought of as a measure of the aggregate stock of housing demanded in year t , or equivalently, the gross demand for housing in year t . The problem with this measure of demand is that it ignores the effect on housing prices of the existing supply of houses. Since the *flow* demand for housing in year t , $H_t - H_{t-1}$, provides a measure of housing demand above and beyond that which can be satisfied by the existing supply of housing, it may be a more appropriate right hand side variable to use in reduced form regressions such as those run by Mankiw and Weil.

To illustrate this point, consider the following, simple model of housing market price determination

$$\begin{aligned} H_t^d &= H_t \\ H_t^s &= H_{t-1}^s + A(P_t^h)^\eta \end{aligned}$$

where H_t is the Mankiw-Weil measure of the aggregate stock of housing demanded in year t , P_t^h is the real price of housing in year t , and A and η are nonnegative parameters which govern the price responsiveness of housing supply. Adding the equilibrium condition that supply equal demand in every period would then yield the following relationship between real housing prices and the demographic demand for housing

$$\ln(P_t^h) = -\frac{1}{\eta}\ln(A) + \frac{1}{\eta}\ln(H_t - H_{t-1}).$$

Even if we allow for depreciation of the housing stock, and relax the assumption that housing demand is unresponsive to changes in real housing prices, the basic point of the above model, that flow rather than gross demand for housing is the more appropriate right hand side variable, still stands.⁷ It is possible, therefore, that the large negative coefficient on the time trend in the Mankiw-Weil regression is due, in large part, to the use of gross, rather than flow, housing demand on the right hand side of the regression.

The aggregate asset demand variables used in the regression analyses presented in Chapter 5 of this thesis, are all measures of flow, rather than gross, demand. Moreover, the gross demand variables from which they are derived, unlike those calculated by Mankiw and Weil, incorporate the effects of trend growth in real income and differing family sizes on the asset

⁷One possible justification for ignoring the price responsiveness of housing demand is that we wish to isolate the equilibrium effect on real housing prices of that portion of housing demand which is driven by demographic changes in the population.

demand of different cohorts. Interestingly, when this is done, there appears to be no secular trend in real housing prices and no prediction of future drops in the level of real housing prices. Nonetheless, the main conclusion of the Mankiw-Weil analysis, that real housing prices are affected by demographic changes in the population, is overwhelmingly supported by the evidence presented in Chapter 5.

I will now attempt to relate the above discussion to the results presented in several papers with conclusions of varying degrees of opposition to those of Mankiw-Weil.

A brief response to the Mankiw-Weil paper written by Engelhardt and Poterba (1991), presented evidence that not only raised doubts about the Mankiw-Weil forecast of falling housing prices, but also called into question their finding of a statistically significant positive correlation between demographics and real housing prices. Specifically, Engelhardt and Poterba reproduced the Mankiw-Weil analysis for Canada, which experienced a baby boom similar to the one in the U.S., and found there to be no statistically significant positive correlation between demographics and real housing prices. Moreover, in three of the four regression specifications examined by these authors, the estimated coefficient on housing demand was negative. They therefore suggested caution in interpreting the Mankiw-Weil results and any forecasts based on them.

Given the above discussion on the appropriateness of the demand variable used in the Mankiw-Weil study, it is difficult to assess the extent to which the Engelhardt and Poterba results contradict those obtained by Mankiw and Weil. In this regard, it is interesting to note that none of the three Canadian regressions in the Engelhardt-Poterba paper for which the estimated coefficient on housing demand was negative, contained an income variable on the right hand side. In the one regression which did control for income effects on real housing prices, the estimated coefficient on the housing demand variable was statistically insignificant, but positive, and the time trend in this regression, unlike in the other three, was negative.⁸

Something else that makes the results in both papers difficult to interpret is that the housing price indexes that they use do not measure the market price of housing, which is what we are interested in; rather, they measure the cost of residential construction. Even

⁸This regression included on the right hand side a constant, time trend, the log of housing demand, the log of real GNP, and the user cost of housing (calculated differently than in the Mankiw-Weil paper), and so is equivalent to the Mankiw-Weil specification discussed above.

though the cost of inputs to housing production affect the market price of housing, there are noticeable differences between housing price indexes based on market prices and those based on construction costs. As will be discussed in Chapter 5 below, the housing price index used in this thesis is constructed to track changes in the market price of housing as closely as possible.

Several other responses to the Mankiw–Weil paper, despite casting doubt on the authors' forecast of future drops in the level of real housing prices, present evidence which supports the more general hypothesis of a relation between demographics and real housing prices. The main criticism of the Mankiw–Weil analysis made in these papers, is that the fall in real housing prices predicted by Mankiw and Weil disappears if one takes a little more care in calculating aggregate housing demand.

One example is a paper on housing markets by DiPasquale and Wheaton (1994). These authors estimate separate supply and demand equations for housing and then use the estimated coefficients from these equations to examine the likely impact of changes in the U.S. population on future housing prices and construction. The primary conclusion reached by these authors with regard to the effect of demographics on real housing prices, is that, due to shifts in the supply of housing, demographic changes in the U.S. population will not cause real housing prices to fall, but will slow the growth of real housing prices in future years.

This is the same conclusion reached by Green and Hendershott (1996) who use a hedonic pricing model of household demand for various housing characteristics to construct age profiles of demand for a constant quality house and, from these profiles, measures of aggregate housing demand. The total and partial age derivatives calculated by Green and Hendershott are similar to the cross sectional and life cycle profiles of housing demand constructed in Chapter 4 of this thesis and so the adjustment to the Mankiw–Weil housing demand variables obtained by using the partial, as opposed to total, demand derivatives in their paper, is similar to the that obtained, in this thesis, by incorporating trend growth in lifetime income into the construction of aggregate housing demand variables.

With regard to financial markets, the seminal paper on demographics and asset prices is that of Bhakshi and Chen (1994). These authors consider two primary hypotheses regarding the relation between demographics and asset prices. The first is what they refer to as the life cycle investment hypothesis, which is similar to the microeconomic story laid out in

the introduction to this thesis and analyzed in Chapter 4. Specifically, Bhakshi and Chen's life cycle investment hypothesis states that household demand for housing is decreasing in age, and household demand for financial assets is increasing in age. The authors conduct no formal test of this hypothesis, however. Rather, they present as evidence of its validity, a set of graphs of real housing and stock prices against the average age of the adult population.

The more serious empirical work done in the Bhakshi–Chen paper is devoted to examination of what the authors refer to as the life cycle risk aversion hypothesis. The idea behind this hypothesis is that people become more risk averse with age, implying that the risk premium on equities should be positively correlated with the average age of the population.⁹ The vehicle for testing the life cycle risk aversion hypothesis put forth by the authors is the standard representative agent consumption CAPM, with constant relative risk aversion utility. The authors relax the assumption of constant relative risk aversion by replacing the coefficient of relative risk aversion, γ , in the representative agent's utility function, with $\gamma(a) = \gamma_0 + \lambda A_t$, where A_t is the average age of the population. Standard Euler equation estimation methods are then used to test whether or not $\lambda > 0$.

GMM estimation of λ , based on the conditional Euler equation in their representative agent model yields a statistically significant positive coefficient of λ , as predicted by the life cycle risk aversion hypothesis. The authors also find that, consistent with the life cycle risk aversion hypothesis, changes in the average age of the population are positively correlated with future excess returns on stocks over treasury bills. Thus, even though the unconditional Euler equation for the Bhakshi–Chen model is rejected by the Hansen–Jaganathan variance bounds test, the authors conclude that the majority of their evidence suggests that financial markets are affected by demographic fluctuations.

Poterba (1997) also studies the relation between demographic variables and the returns on financial assets in the U.S., and, contrary to the findings of Bhakshi and Chen (1994), finds little evidence for the existence of any relation between demographics and the returns on financial assets. As will be seen in the analysis presented in Chapter 5 of this thesis, I find a rather strong relation between demographics and asset prices. To see why my results differ from those of Poterba (1997), observe that the primary set of return regressions run

⁹Even though this hypothesis does not exclude the possibility of non risk aversion based reasons for life cycle portfolio preferences, as implied by the life cycle investment hypothesis, the two are treated separately by Bhakshi and Chen.

by Poterba were of the form

$$R_{i,t} = \alpha + \beta DEMOG_t + \epsilon_{i,t}$$

where $R_{i,t}$ denotes the return on financial asset i for year t , and $DEMOG_t$ is one of six demographic variables employed in his analysis.¹⁰

There are three reasons that I can think of why Poterba's regressions failed to show a statistically significant relationship between demographics and financial asset returns. First, the demographic variables used in Poterba's analysis are, in general, analogous to the level of the financial asset demand variable used in this thesis. Thus, his regressions test the correlation between financial asset returns and the level of demographic demand for financial assets. The regression results presented in Chapter 5 of this thesis, however, suggest that asset price levels are correlated with the level of demographic asset demand, and that asset price appreciation, and hence asset returns, are correlated with the growth rate of demographic asset demand.

Another reason why Poterba's return regressions show little evidence of a relation between demographics and asset returns is that they effectively measure high frequency correlations between the two. As will be seen in Chapter 5 of this thesis, however, the relationship between demographics and asset prices is less strong at high frequencies than at lower frequencies. Finally, a majority of Poterba's demographic variables (e.g. average and median age of the population, percent of population over age 55, etc.) assume a monotonic relationship between financial asset demand and age. This assumption, however, contradicts the evidence presented in Chapter 4 of this thesis, which suggests that life cycle investment demand for financial assets net of debt is highest among middle-aged individuals.

With regard to the first and last points, it is interesting to note that the the strongest relation between demographics and returns in Poterba's paper is found in a regression of the treasury bill yield on the percent of the population age 40–64. The coefficient on the demographic variable in this regression is negative and statistically significant in each of the two sample periods considered by the author. Given the above discussion, this could be

¹⁰The three return series considered by Poterba are the yield on three month treasury bills, the return on long term corporate bonds, and the return on the S&P 500 stock price index. The demographic variables used as regressors included the average age of the population, the average age of persons over age 19, the median age of the population, the percent of the population age 40–64, the percent of the population age 40–74, and the percent of the population age 55 and over.

interpreted as evidence of a statistically significant positive correlation between the price of treasury bills and the demographic demand for financial assets.

Other empirical papers on the relation between demographics and asset prices include those by Erb, Harvey, and Viskanta (1997); Craine (1983); and Scheiber and Shoven (1994). The paper by Erb, Harvey, and Viskanta examines the relation between demographics and stock returns in an international investment context. They treat information about the demography of a country as revealing information about the riskiness of equity returns in that country. To test this hypothesis they examine the ability of demographic information to predict long-horizon returns, and find that returns are positively correlated with demographic measures of country specific equity market risk.

Craine (1983) examines the extent to which the relatively high returns to housing and low returns to stocks observed during the 1970s can be explained by increases in the rate of household formation versus the combined effects of accelerating inflation and a non-indexed tax system. To test the competing theories he regresses the returns on stocks and housing, in excess of treasury bills, on measures of expected inflation and expected household formation, and finds weak evidence that both inflation and household formation affected the returns to stocks and housing during the 1970s.

Scheiber and Shoven (1994) examine the likely effects that the aging of the baby boom generation will have on the resources of the private pension system in the U.S. Their results suggest that private funds will cease being a source of national saving sometime around 2030, leading them to conjecture that the implied reduction in national savings rates will raise interest rates and depress the prices of long term assets such as stocks, bonds, land, and real estate.

Manchester (1989) examines the effect of a one time birth boom on housing prices and interest rates within a three period overlapping generations model, assuming both static and rational expectations.¹¹ She finds that the aging of the boom generation affects the path of housing prices and interest rates in both cases but that the timing and magnitude of the price movements differs, depending on whether individuals have static or rational expectations. In particular, she finds that equilibrium interest rates begin adjusting to the

¹¹In the static expectations case, individuals never realize that a large generation has been born, while in the rational expectations case, individuals become aware of the impending population bulge one full generation prior to the boom generation's birth.

boom generation earlier in the rational expectations case than in the static expectations case, and finds that the magnitude of housing price changes is smaller in the rational expectations case than in the static expectations case.

Finally, Barsky and DeLong (1989, 1992) offer a nondemographic explanation for observed long run cycles in stock prices over the twentieth century. These authors present evidence suggesting that observed long run changes in stock prices are consistent with changes in investor expectations of future dividend streams, assuming that investors form their expectations of future dividend growth from long moving averages of past dividend growth. As will be seen in the stock price regressions presented in Chapter 5 of this thesis, changes in the demographic demand for financial assets can account for a large portion of long run swings in stock prices even after accounting for changes in dividend growth. Moreover, in contrast to the model put forth by Barsky and DeLong, which can only account for stock price movements, changes in demographic asset demand can account for long run movements in bond and housing prices as well.

Chapter 4

Asset Holdings and Investment over the Life Cycle

The purpose of this chapter, as stated in the introduction, is to investigate the microeconomic foundations of a link between demographics and asset prices. In particular, we wish to verify whether or not the asset holdings of the typical U.S. household are consistent with an economic life cycle in which individuals borrow money to finance the purchase of a house when young, pay down their mortgage debt and save for retirement when middle-aged, and draw down on their previously accumulated savings to fund consumption when old and no longer in the work force. This is accomplished by using data from the 1989, 1992 and 1995 Surveys of Consumer Finances (SCFs) to estimate age profiles of asset holdings for housing, debt, stocks, and bonds, and to check to see if the estimated profiles are in accordance with the hypothesized life cycle.¹ The layout of the chapter is as follows.

We begin with a brief description of the dataset used and an overview of household asset holdings in Section 4.1. Section 4.2 discusses estimation of cross sectional age profiles of household asset demand and presents estimated profiles for housing, debt, stocks, and bonds, as well as various net asset and portfolio share variables calculated from them. The profiles presented in this section can be thought of as as snapshots of asset holdings for households with heads of varying ages at a given point in time. The last section in this chapter extends the age profile estimation procedure to generate life cycle profiles

¹The Survey of Consumer Finances is conducted every three years and published by the Federal Reserve Board.

of household asset demand, that is, age profiles that represent the life cycle of a single household. This section also contains an analysis of the effects on life cycle asset demand of changes in lifetime income and family size. In particular, we examine how the life cycle asset demand of the typical baby boomer differs from that of his parents and children. In addition to providing some insight into the effects of family size and lifetime resources on life cycle asset demand, the incorporation of income and family size considerations into the life cycle estimation procedure will allow us, in Chapter 5, to produce estimates of demographic asset demand that (1) incorporate the effects of trend changes in lifetime income on the life cycle asset demand of successive generations, and (2) incorporate the effects of the baby boom generation on the life cycle asset demand of the generation that produced it.

4.1 Data Description and Overview of Household Asset Holdings

4.1.1 The Data Set

The dataset used in the analysis of this chapter is taken from the 1989, 1992, and 1995 SCFs. The combined sample contained 11,348 cases to start, where each case represents a single household in a single survey year. Cases were then dropped if the household head was younger than 20 or older than 80 (437 cases), if the primary residence was part of a ranch or farm (405 of the remaining cases), if the head of the household was female (2,186 of the remaining cases)², if the household had positive financial assets but no assets held in checking, saving, money market, or call accounts, and no CDs (234 of the remaining cases), or if the household had zero or negative reported total income in the year preceding the survey (34 of the remaining cases)³. This brought the sample down to 8,052 remaining cases. Finally, in order to minimize the number of extreme outliers in terms of asset holdings, households with holdings of financial assets, nonfinancial assets, debt, net worth or net financial assets in the top 1% of their survey sample were dropped. Households were also

²The SCF classifies the household head as the male in a mixed sex couple and the older individual in a same sex couple. Thus, dropping female headed households essentially drops single women, including single mothers, from the sample.

³Total income includes income from any sources, and includes, for example, public assistance, alimony or child support, and retirement benefits. The 34 cases that reported zero or negative income tended to have losses from businesses and/or investments that offset or exceeded their reported wage and other income.

dropped if they had calculated net worth in the bottom 1% of their survey sample.⁴ In total, this resulted in an additional 247 cases being dropped, bringing the final sample down to 7,805 cases.

All dollar figures in the 1989 and 1992 SCFs were inflated to 1995 dollars using the Consumer Price Index for all urban consumers, for all items less shelter.⁵ Also, all household level asset and income figures were converted into per spouse quantities. What this means is that if the head of the household was married or living with a partner, then all household income and asset values were divided by 2, otherwise they were left unchanged. This was done so that estimated age profiles will reflect changes in economic behavior rather than just the addition or subtraction of a spouse or partner to the household. Children were not included in the normalization because they are treated in the analysis not as part of the decision making head unit, but as factors affecting the decisions made by the parents. The estimated age profiles, therefore, reflect the effects of typical family formation behavior. Finally, because the SCF oversamples wealthy individuals, the sample data includes a set of population weights for use in statistical analyses. The statistics and regression results reported below, are calculated using these weights. In the case of regression results, standard errors of estimated coefficients are calculated using White's robust method of variance estimation to correct for any heteroskedasticity created by the population weights.

4.1.2 The Household Balance Sheet

Table 4.1 presents summary statistics on household assets and debt for the 7,805 cases in the final dataset. The top panel of the table contains information on total financial and nonfinancial assets, debt, net worth and net financial assets. Net financial assets are defined as the difference between total financial assets and total debt and act as a measure of the extent to which a household is a supplier or user of credit in financial markets.

There are several things to notice about the data in the top panel of the table. First, there is a rather large disparity between the mean and median values of the various balance sheet statistics, implying distributions with fat upper tails and/or many zero observations. Since more than 90% of households hold some financial and/or nonfinancial assets, the

⁴In all cases this implied a very large negative value for networth.

⁵The reason for excluding shelter from the price index is to give the constant dollar figures the interpretation of being relative to a numeraire, nonhousing, consumption good.

Table 4.1: Balance Sheet Summary Statistics

	Survey Year			Survey Year		
	1989	1992	1995	1989	1992	1995
Overall Balance Sheet	Mean per Spouse (1995 \$)			Median per Spouse (1995 \$)		
Financial assets	71,760	70,067	83,459	18,065	18,867	19,318
Nonfinancial assets	121,033	106,262	108,746	47,036	46,106	51,300
Debt	34,840	31,563	32,066	8,554	8,929	11,925
Net assets	157,953	144,766	160,139	55,454	50,814	51,175
Net financial assets	36,920	38,504	51,392	2,200	2,121	1,200
	Probability >0			Average Share of Total Assets		
Financial assets	93.5	93.7	94.7	35.6	36.8	36.0
Nonfinancial assets	95.2	95.6	96.0	64.4	63.2	64.0
Financial Assets	Probability >0			Average Share of Financial Assets		
Short term liquid assets ¹	93.5	93.7	94.7	35.2	35.2	31.9
Other directly held bonds	6.3	5.0	3.7	1.2	1.2	0.7
Stocks held in company where work/have worked	12.3	10.1	10.0	2.3	1.6	1.8
Other directly held stocks	14.9	14.8	14.8	2.3	2.8	2.3
Mutual funds excluding retirement accounts	8.5	11.9	14.9	1.3	2.0	3.6
Personal retirement accounts ²	40.8	42.1	49.8	12.7	14.2	18.7
Employer provided pensions	53.1	52.0	48.5	32.0	31.9	29.1
Universal life insurance	42.2	39.1	35.7	8.6	7.9	8.1
Trusts, annuities, & other managed assets	4.5	4.4	4.0	1.4	1.0	1.1
Miscellaneous other financial assets ³	13.8	10.5	10.7	3.1	2.1	2.7
Stocks, directly & indirectly held ⁴	73.8	74.5	75.4	26.1	29.0	32.5
Bonds, directly & indirectly held ⁴	93.5	93.7	94.7	70.0	67.9	63.7
Nonfinancial Assets	Probability >0			Ave. Share of Nonfinancial Assets		
Vehicles	92.7	93.5	91.4	27.4	30.0	30.3
Primary residences	72.3	68.9	72.0	55.7	53.9	55.2
Other real estate	24.9	23.2	21.6	9.6	9.0	7.9
Businesses	13.2	13.9	13.9	5.2	5.2	4.9
Miscellaneous other nonfinancial assets ⁵	13.4	9.3	10.4	2.1	1.8	1.7
	Average Share of Total Assets			Ave. Share of Nonfinancial Assets		
Primary residence shares of homeowners	50.1	50.8	49.9	73.3	74.8	73.7
Debt by use⁶	Probability >0			Average Share of Debt		
Vehicles	42.8	37.4	40.4	20.6	16.6	17.7
Primary Residences	50.1	48.0	49.5	45.3	45.7	47.2
Other Real Estate	10.0	10.4	9.1	5.9	5.6	5.1
Businesses	4.3	5.1	3.6	2.3	2.4	2.0
Education	9.1	12.4	13.7	3.5	5.5	5.7
Credit Card Balances	46.7	47.8	53.0	12.2	13.2	13.3
Miscellaneous other debt	27.1	28.2	24.9	10.2	11.1	9.1
Residential debt of homeowners	69.1	69.2	68.6	59.8	62.9	62.4
Residential debt of homeowners with such debt	-	-	-	73.2	76.3	78.4
Income	Mean per Spouse (1995 \$)			Median per Spouse (1995 \$)		
Value of inheritances/trusts/transfers received	36,410	36,135	35,042	24,361	23,375	24,000
	21,164	16,278	16,061	0	0	0

Note: 1989 and 1992 values are inflated to 1995 dollars using the CPI-U for all items less shelter. (1) Checking, saving, money market, and call account balances, and directly held CDs. (2) IRAs, KEOGHs, 401ks, 403Bs, SRAs, and thrift/savings accounts. (3) Loans to friends/relatives/others, cash not elsewhere classified, future proceeds from lawsuits/estates, deferred compensation, futures contracts, royalties, non public stock, and future lottery prizes. (4) Information on holdings of stocks/bonds in mutual funds, personal retirement accounts and trusts/annuities/omas is provided in the various surveys. Employer provided pensions are split 50-50 between stocks and bonds and life insurance split 10-90 based on historical balance sheet data in the flow of funds accounts published by the Federal Reserve Board. (5) Precious metals, jewelry, antique or classic cars, antiques/furniture, art objects, coin/stamp collections, china, furs, musical instruments, oriental rugs, other collections (baseball cards, records, wine, etc.), computers, equipment/tools, etc. (6) Any debt outstanding, excluding credit card balances, used for the purchase, repair, or improvement of the listed asset.

latter is not likely to be the case for the aggregated asset figures presented in this panel. For most subcategories of assets, however, there are both households with extremely large holdings and a substantial number of households with no holdings at all. These features of the data will be incorporated into the age profile estimation procedures introduced in the next two sections.

Another striking feature of the aggregated asset data is the extent to which nonfinancial assets dominate the typical household portfolio, a portfolio that, as seen below, includes all non social security forms of financial wealth, including employer provided pension wealth. In each of the three survey samples, the average share of nonfinancial assets in total household assets is more than 63%, implying of course, that the average share of financial assets is less than 37% of total assets in each of the three survey samples.

The second panel in the table displays information on the components of total financial assets. Household financial assets include short term liquid assets, defined as the total value of CDs plus the value of all checking, saving, money market, and call account balances; other directly held bonds, a category which includes corporate bonds, U.S. treasury securities and mortgage backed bonds; stocks held through an employee stock option program (ESOP) and other directly held stocks; non retirement account mutual fund balances; personal retirement accounts, which includes IRAs, KEOGHs, 401ks, 403Bs, SRAs, and thrift/savings accounts; the present value of employer provided pensions (see the appendix to this chapter for a detailed description of the calculation of employer provided pension wealth); the cash value of universal life insurance policies; the account balances of any trusts, annuities, or other managed financial accounts other than mutual fund or personal retirement accounts; and other miscellaneous financial assets (see footnote 5 at the bottom of the table for a description of this category).

There are several things worth noting about the composition of household financial assets. To begin, observe that, after short term liquid assets, the most commonly held financial assets are personal retirement accounts and employer provided pensions. About 1/2 of all households have some employer provided pension wealth and more than 40% have personal retirement accounts. In addition to being widely held, total retirement account wealth (i.e. personal retirement accounts plus employer provided pensions) constitutes the largest source of financial wealth, with the next largest source being short term liquid assets (primarily transaction accounts). The average share of total financial assets held

in retirement funds, both personal and employer provided, was more than 44% in each of the three survey samples. Further, the share of retirement wealth in total financial assets increased in each survey year, rising from 44.7% for the 1989 sample to 47.8% for the 1995 sample.

It is interesting to note that the distribution of total retirement wealth has shifted away from employer provided pension accounts and toward personal retirement accounts over the course of the six years spanned by the three survey samples. The percentage of households who reported having personal retirement accounts rose from 40.8% to 49.8% between 1989 and 1995, while the percentage of households who reported having employer provided pensions fell from 53.1% to 48.5% over the same six year period. Moreover, the average share of personal retirement account balances in total financial wealth increased from 12.7% to 18.7% between 1989 and 1995, whereas the average share of employer provided pensions fell from 32.0% to 29.1%. Another commonly held form of financial assets are universal life insurance policies, although the percentage of households who report having these accounts appears to be falling over time. Somewhat surprising is the observation that, in each of the three samples, less than 15% of households held mutual fund accounts outside of a personal retirement account, with assets held in these accounts making up less than 4% of total financial assets. Even more surprising is that non retirement account mutual fund holdings accounted for a smaller share of financial assets than stocks held directly or through employee stock option programs.

The last two lines in the financial asset panel of Table 4.1 display information on all direct and indirect holdings of stocks and bonds.⁶ What is interesting to note about this data is that, even though fewer than 15% of households hold stocks either directly or through ESOPs, more than 70% of households hold stocks in some form.⁷ Given these numbers, it would appear that the typical household maintains a rather conservative financial asset portfolio. This, however, ignores the fact that many households have debt outstanding that largely offsets their other bond holdings. As will be seen in the age profiles presented

⁶Indirect holdings of stocks and bonds held in non retirement account mutual funds, personal retirement accounts, and trust/annuity/oma accounts were calculated directly from questions asked survey participants about the allocation (between stocks, bonds, and other assets) of these accounts. Financial asset holdings in employer provided pensions were split 50-50 between stocks and bonds, and universal life insurance policies 10-90, based on historical balance sheet data for pension funds and life insurance companies published as part of the Federal Reserve Board's Flow of Funds Accounts.

⁷The two categories don't sum to 100% due to the miscellaneous financial assets category and also because some households reported having investment accounts held in assets other than stocks and bonds.

in the next two sections, the net bond holdings of many households, especially younger households, are indicative of a much more aggressive portfolio strategy than the data on gross bond holdings suggest.

Looking at the next panel in Table 4.1, one can see that housing is by far the most important source of nonfinancial asset holdings for most households. Overall homeownership rates were more than 68% in all three survey samples, and the average share of primary residences in nonfinancial assets was more than 53%. For the more than 68% of households who owned homes, primary residences made up more than 73% of total nonfinancial assets, and about 50% of total assets. The next largest source of nonfinancial asset holdings was vehicles, with average shares of more than 27% in all three samples. Other real estate and businesses were relatively unimportant parts of the nonfinancial asset portfolios of most households. Less than 25% of households owned vacation property or commercial real estate and less than 14% owned or were partners in private businesses. Moreover, these two categories combined made up less than 15% of nonfinancial assets for the average household.

The data on uses of household debt suggests that, in addition to being a significant part of the nonfinancial and total asset portfolios of most households, primary residences are a major source of household debt. In each of the three samples, the average share of debt used for the purchase, repair, or improvement of one's home was around 45%, was 60% for homeowners, and was 75% for homeowners with some residential debt.

Finally, as can be seen in the last line of the table, intergenerational transfers are a relatively minor source of income for most households. The mean value per spouse of all inheritances, trusts, and transfers ever received are less than 1/2 of mean annual income per spouse in two of the three survey samples and, as can be seen from the median values, less than 50% of all households have ever received a substantial inheritance or transfer.

4.1.3 Reasons for Saving

Figure 4.1 provides some information on how the motivations for household saving change over the course of the life cycle. The panels in this figure plot histograms of individual responses to the question of why they save. Reasons for saving were grouped into seven categories, (0) can't/don't save; (1) buffer stock/precautionary saving; (2) purchase/repair/improvement of one's house or purchase of appliances/consumer durables; (3) education (either for oneself or a family member); (4) retirement/old age; (5) bequests; and

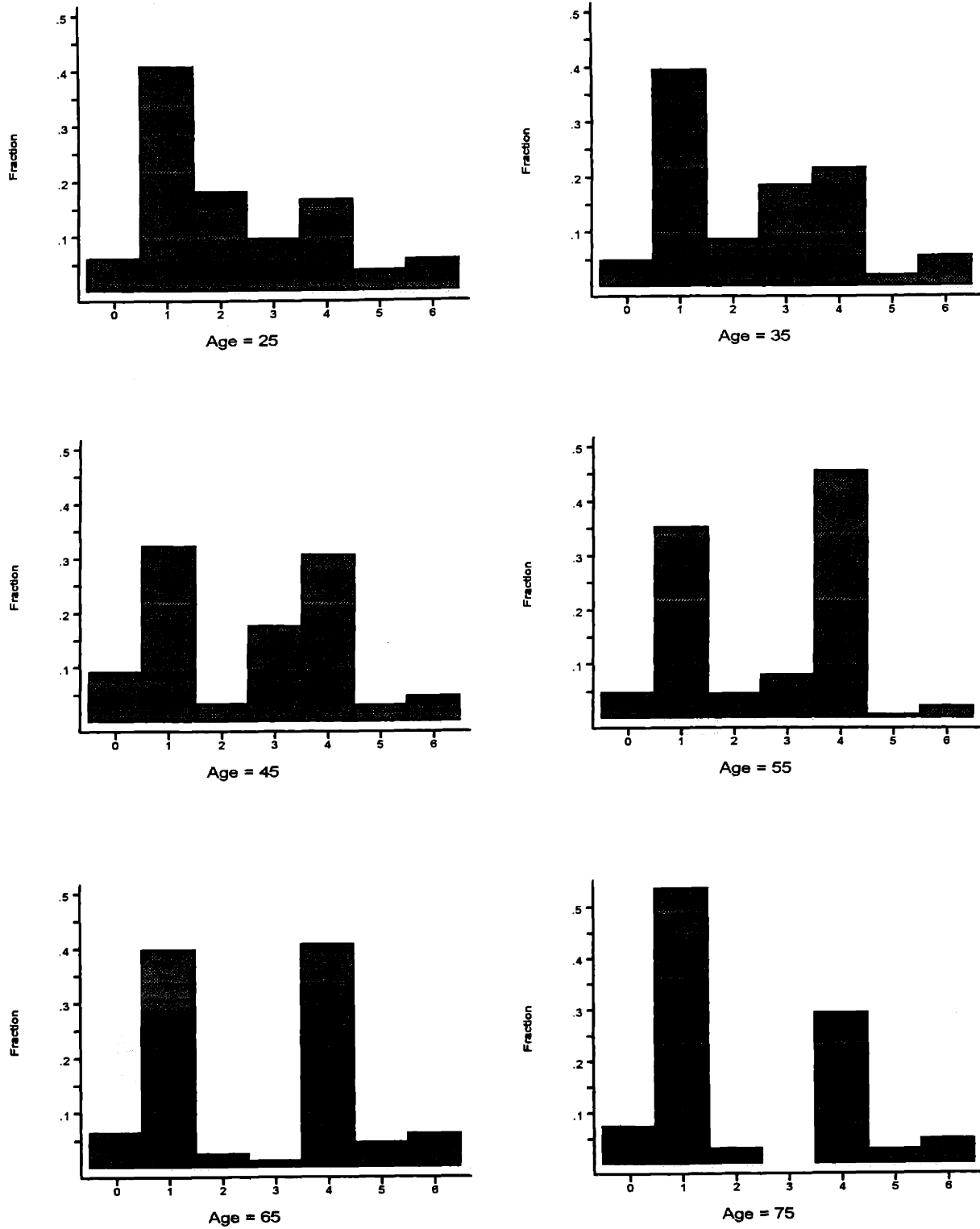
(6) other, a broad category which includes things such as the purchase of a car, vacation home, vacation, etc.

Probably the most striking feature of the histograms displayed in Figure 4.1, is the importance of precautionary saving motives, especially among young and old households. More than 30% of households in each of the listed age groups list precautionary motives as their primary reason for saving, and more than 40% of households with heads age 25 or 75 list precautionary motives as their primary reason for saving. Also of interest are the age profiles of saving for the purchase of a home and retirement saving. For households with heads age 25, saving for the purchase/repair/improvement of a home or purchase of appliances/consumer durables is the most commonly listed reason for saving after buffer stock saving. Notice, however, that far fewer households with heads age 35 or older appear to be saving for these reasons. For these households, retirement is the most commonly listed reason for saving after buffer stock saving, and for households with heads between ages 55 and 65, retirement saving is a more commonly listed reason for saving than even buffer stock saving. More than 45% of households with heads age 55 list retirement as the primary reason for saving, compared to just 16% of households with heads age 25.⁸ It appears, therefore, that most of the 60% to 70% of households who own homes, purchase and furnish them while young, and don't begin saving in earnest for retirement until later on.

Two other interesting features of the histograms are the infrequency of saving for bequests, even among older households, and the relative importance of saving for education among young households. Less than 5% of households in each of the listed age groups list bequests as their primary reason for saving, while between 15% and 20% of households with heads ages 35 or 45 list education as their primary reason for saving. Since it is unlikely that many 35 or 45 year olds are saving for their own education, this suggests that many individuals begin saving for their childrens' college education while these children are still quite young. Moreover, given the apparent lack of saving for bequests, payment of college tuition may be the largest source of intergenerational transfer from parent to child in many families.

⁸Many of the roughly 30% of households with heads age 75 who list retirement/old age as their primary reason for saving are probably interpreting the question differently than other households, and may represent precautionary saving motivated by uncertainty about how many years of life they have remaining.

Figure 2.1



0 = Can't/don't save, 1 = Buffer stock saving, 2 = Purchase/repair/improvement of home or purchase of appliances/consumer durables, 3 = Own/spouse's/children's/grandchildren's education, 4 = Retirement, old age, general consumption smoothing, 5 = Bequests, 6 = Other

Overall, the data in Table 4.1 and Figure 4.1 are consistent with the life cycle described in the introduction. Primary residences and residential debt are significant components of the typical household asset portfolio; acquisition of residences appears to be concentrated among young households; at least half of all financial assets held by households are, at least nominally, for the purpose of funding retirement consumption; and retirement saving is most common among middle-aged households. The summary data, however, do not provide either a complete or clear picture of how household asset demand evolves over the life cycle. The age profiles presented in the next section attempt to do this.

4.2 Estimating Cross Sectional Age Profiles of Asset Holdings

In this section we estimate cross sectional age profiles for per spouse holdings of housing, debt, stocks, and bonds. As mentioned earlier, these age profiles can be thought of as providing a snapshot of asset holdings for individuals of different ages, taken at a given point in time. Since each of the variables for which we would like to estimate an age profile has large upper tails and discrete probability mass at zero, the estimation procedure employed is chosen to accommodate such distributional features. Each asset type is modeled as a mixed distribution random variable with positive probability of taking on the value zero and lognormal distribution conditional on being greater than zero. The discrete probability mass at zero allows for a core of households with none of the specified asset, while the assumption of conditional lognormality allows for the possibility of fat upper tails in the distribution of asset holdings among those households with nonzero holdings. To be more concrete about the parametric specification assumed, let $A_{i,t}^j$ denote household i 's per spouse holdings of asset j in year t . Then the distribution of $A_{i,t}^j$ is assumed to be

$$P(A_{i,t}^j > 0) = \Phi(x'_{i,t}\alpha_j)$$

$$\ln(A_{i,t}^j) \sim N(x'_{i,t}\beta_j, \sigma_j^2) \mid x_{i,t}, A_{i,t}^j > 0$$

where $\Phi(\cdot)$ denotes the cumulative normal CDF and where x contains dummy variables for the 1989 and 1992 SCFs and either a full set of dummy variables for the age of the household head, or a constant and the household head's age and age squared. The advantage of the dummy variable specification is that it places no restrictions on the shape of the estimated

profiles, while the advantage of the smooth age specification is that it makes it more difficult for extreme outliers to effect the estimated asset holdings for the age group in which they fall.⁹

The coefficient vectors α_j and β_j for each specification and asset type, are estimated independently, the α_j s from a set of probit regressions over all households, and the β_j s from a set of OLS regressions over households with positive holdings of the specified asset type. The estimated coefficient vectors are then used to calculate age profiles of *typical* household asset holdings based on three different measures of central tendency. The first two measures are the usual, mean and median. The third, which we shall refer to, henceforth, as the 'average', is a hybrid of the first two. The 'average' for a random variable X is defined as the probability that X is nonzero times the median of X conditional on being nonzero. Notice, that since the mean of X is equal to the probability that X is nonzero times the mean of X conditional on being nonzero, the only difference between the mean and 'average' is that the latter replaces a conditional mean with a conditional median. The reason for introducing this third measure of central tendency is that the combination of many zero values and fat upper tails in the various asset class distributions, prevents either the mean or median from providing a satisfactory measure of typical household behavior.

The problem with the mean as a measure of typical behavior is that it can give too much weight to households in the upper tail of the distribution, while the median can give too much weight to the set of households with zero holdings. To see this, consider a population of households in which 51% of households hold no stocks, 48% hold \$10,000 of stock each, and 1% hold \$50 million of stock each. According to the mean of this distribution, typical household stock holdings are \$504,800, while according to the median, typical household stock holdings are \$0. Neither measure seems to give sufficient weight to the 48% of households whose stock holdings are positive, but not very large. The 'average', which implies typical household stock holdings of \$4,900, does. The exact formulas for the mean, median, and 'average' corresponding to the parametric specification given above are,

⁹The reason of course is that, in the smooth age specification, the estimated asset holdings for a given age are determined by the holdings of individuals of all ages. Thus, the dummy variable specification allows extreme outliers to greatly effect the estimated asset holdings for the age group in which they fall but, at the same time, contains the effect to that one age group. The smooth age specification reduces the effect of extreme outliers on the estimated asset holdings for the age group in which they fall, but does so by distributing the effect over all ages.

$$\begin{aligned}
A_j^m(a) &= \Phi(x(a)'\alpha_j)e^{x(a)'\beta_j + \frac{1}{2}\sigma_j^2} \\
A_j^d(a) &= \begin{cases} 0 & \text{if } \Phi(x(a)'\alpha_j) \leq \frac{1}{2} \\ e^{x(a)'\beta_j + \sigma_j \Phi((\Phi(x(a)'\alpha_j) - \frac{1}{2})/\Phi(x(a)'\alpha_j))^{-1}} & \text{if } \Phi(x(a)'\alpha_j) > \frac{1}{2} \end{cases} \\
A_j^v(a) &= \Phi(x(a)'\alpha_j)e^{x(a)'\beta_j}
\end{aligned}$$

where $A_j^m(a)$, $A_j^d(a)$, and $A_j^v(a)$ denote mean, median, and ‘average’ holdings of asset j for households with heads age a , and where $x(a)$ is defined such that it sets the 1989 and 1992 SCF dummy variables to zero and, in the case of the age dummy specification, sets all the age dummies to zero except that for age a which is set to one. In the case of the smooth age specification, $x(a)$ is defined to set the household head’s age to a .

Table 4.2 contains regression output from the smooth age specification for each asset type. It also contains output from regressions for income, a marriage indicator, and the number of children living at home among households headed by a married couple. These regressions will be used later on in the estimation of life cycle profiles of asset demand. Since total income is positive for all households in the sample, it is modeled as being continuously lognormally distributed. Similarly, the probability of being married is modeled using a probit specification. The number of children living at home is modeled according to the mixture specification outlined above. Because the number of children can take on only integer values, the assumed parametric specification is not strictly appropriate. Nonetheless, it yields reasonable estimates of the mean and ‘average’ cross sectional age profiles for this variable, which can take on noninteger values. Given estimates of the probability of being married and of the mean, median, and ‘average’ number of children living at home if married, we estimate the mean, median and ‘average’ number of family members living at home as $1 + P^m(a)(1 + K^h(a))$ where $P^m(a)$ denotes the probability that someone age a is married and where $K^h(a)$ denotes either the mean, median, or ‘average’ number of children living at home conditional on being married. To accommodate the fact that the median size of family living at home is, in general, integer valued, the above formula is rounded to the nearest integer to produce our final estimate of the median size of family living at home.

Examination of the estimated age coefficients in the probit and OLS regression output in Table 4.2 shows that the cross sectional age profiles for income, marriage, number of children living at home, and the various asset holdings variables all display a statistically significant

Table 4.2: Regressions for Cross Sectional Age Profiles of Asset Demand

	Income	Marriage	Children		Housing	
	OLS	Probit	Probit	OLS	Probit	OLS
age of household head	0.108 (0.005)	0.095 (0.009)	0.122 (0.014)	0.051 (0.006)	0.141 (0.009)	0.075 (0.008)
age of household head squared	-0.001 (0.000)	-0.001 (0.000)	-0.002 (0.000)	-0.001 (0.000)	-0.001 (0.000)	-0.001 (0.000)
1989 SCF dummy variable	0.0499 (0.0284)	0.0936 (0.0532)	0.1966 (0.0590)	0.0464 (0.0248)	0.0422 (0.0540)	0.0005 (0.0368)
1992 SCF dummy variable	0.011 (0.026)	0.016 (0.046)	0.059 (0.053)	0.012 (0.023)	-0.087 (0.046)	-0.012 (0.032)
constant	7.671 (0.118)	-1.701 (0.206)	-1.476 (0.321)	-0.421 (0.128)	-3.145 (0.205)	8.959 (0.204)
NOBS	7805	7805	6318	3446	7805	6151
R ²	0.087	0.036	0.211	0.066	0.115	0.032
	Debt		Stocks		Bonds	
	Probit	OLS	Probit	OLS	Probit	OLS
age of household head	0.100 (0.010)	0.220 (0.014)	0.128 (0.009)	0.343 (0.018)	0.041 (0.013)	0.258 (0.013)
age of household head squared	-0.0013 (0.0001)	-0.0024 (0.0002)	-0.0012 (0.0001)	-0.0030 (0.0002)	-0.0003 (0.0001)	-0.0021 (0.0001)
1989 SCF dummy variable	-0.0354 (0.0571)	-0.1658 (0.0714)	-0.0184 (0.0531)	-0.3145 (0.0837)	-0.0910 (0.0786)	0.2757 (0.0717)
1992 SCF dummy variable	-0.085 (0.051)	-0.157 (0.060)	-0.016 (0.047)	-0.300 (0.075)	-0.080 (0.068)	0.091 (0.066)
constant	-0.650 (0.243)	5.017 (0.308)	-2.408 (0.203)	0.349 (0.421)	0.492 (0.293)	2.027 (0.295)
NOBS	7805	6310	7805	6332	7805	7497
R ²	0.126	0.086	0.053	0.166	0.018	0.187

humped shape.¹⁰ This is also apparent in the panels of Figures 4.2a–4.2c, which plot the cross sectional age profiles of mean, median, and ‘average’ income, size of family living at home, housing, debt, stocks, and bonds, all calculated using the estimated coefficients from the dummy variable and smooth age specifications described above. Since the 1989 and 1992 SCF dummy variables are set to zero in the calculation of the age profiles, one can treat 1995 as being the appropriate year of reference.

Looking at the three sets of age profiles, one sees that, in all three cases, the smooth age specification fits the data quite well. Except for some extreme values between ages 55 and 65 for stock holdings, the unsmoothed age profiles calculated from the dummy variable specification form a fairly tight cluster of points around the smooth profiles. One can also see that, ignoring the numbers on the vertical axes, the qualitative features of the mean, median, and ‘average’ age profiles are very similar. In each, the hump shaped age profile for income achieves its maximum for households with heads between ages 45 and 50, while the size of family living at home is highest for households with heads between ages 40 and 45. The age profiles for owner occupied housing are all increasing in age for households with heads below age 55 and decreasing thereafter, although slowly enough that holdings of housing are still relatively high for households with heads age 80. The negative slope after age 55 probably reflects both income driven cohort effects and family size driven life cycle effects.

The profile for total debt peaks at around age 45 and decreases fairly rapidly toward zero thereafter. Comparison of the debt profile with those for stocks, bonds, and housing, suggests that, to the extent that the debt accumulated by young households is being used for investment, it is being used for investment in housing. This conclusion follows from the observation that, while the age profile for housing is fairly steep and upward sloping for households with heads as young as 25, the stock and bond profiles are generally flat and near zero for households with heads under age 35. Figure 4.2d, which breaks household debt out into its residential and nonresidential components, provides additional support for this view of household behavior.¹¹ One can easily see that, in each of the three profiles displayed in Figure 4.2d, and especially in the median and ‘average’ profiles, most of the

¹⁰ Emboldened entries signify that the estimated coefficient was significant at the 5% level or below.

¹¹ The profiles in Figure 4.2d were produced by using the mixed distribution specification to estimate probit and conditional OLS regressions for residential and nonresidential debt.

Figure 4.2a

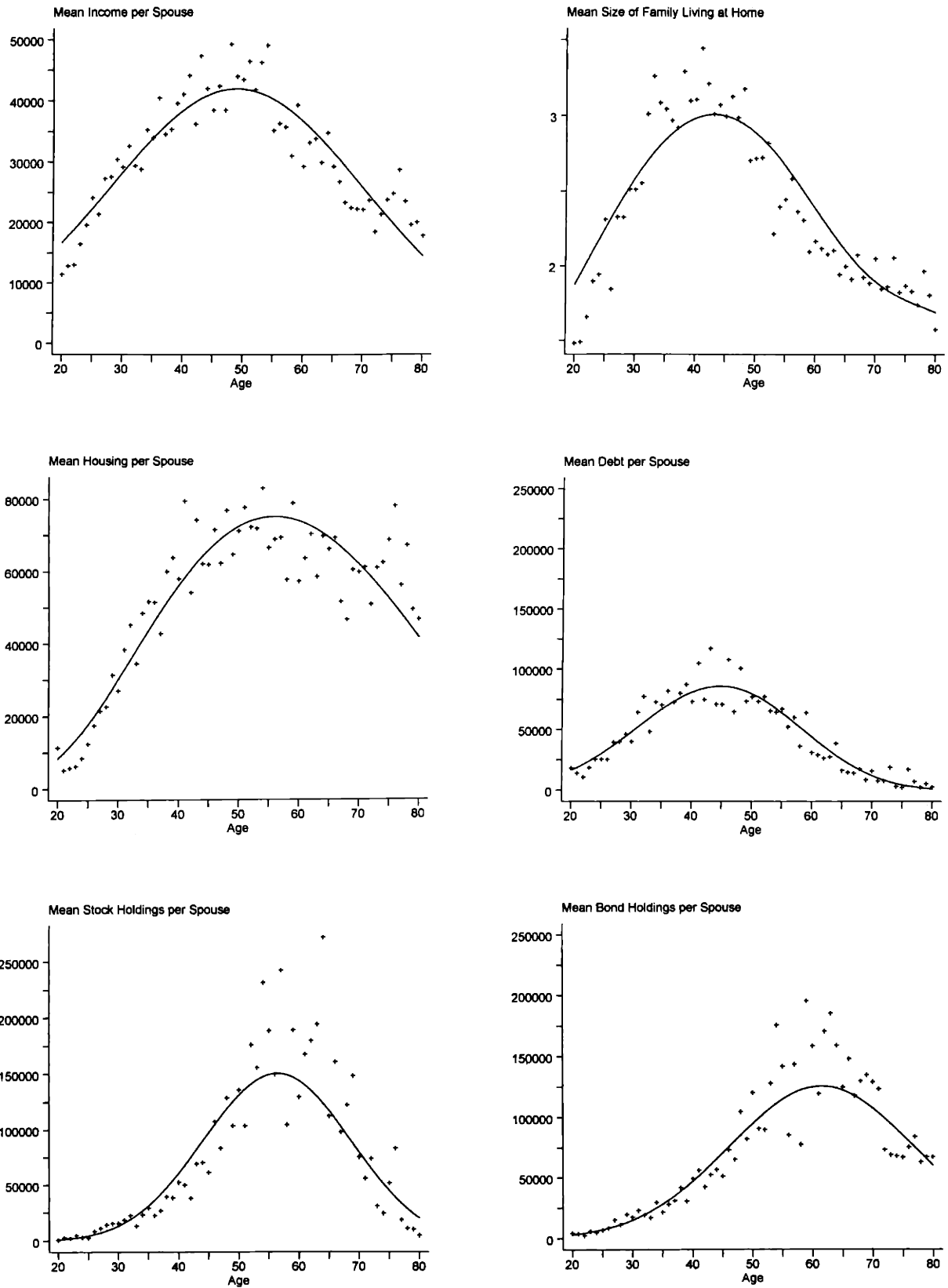


Figure 4.2b

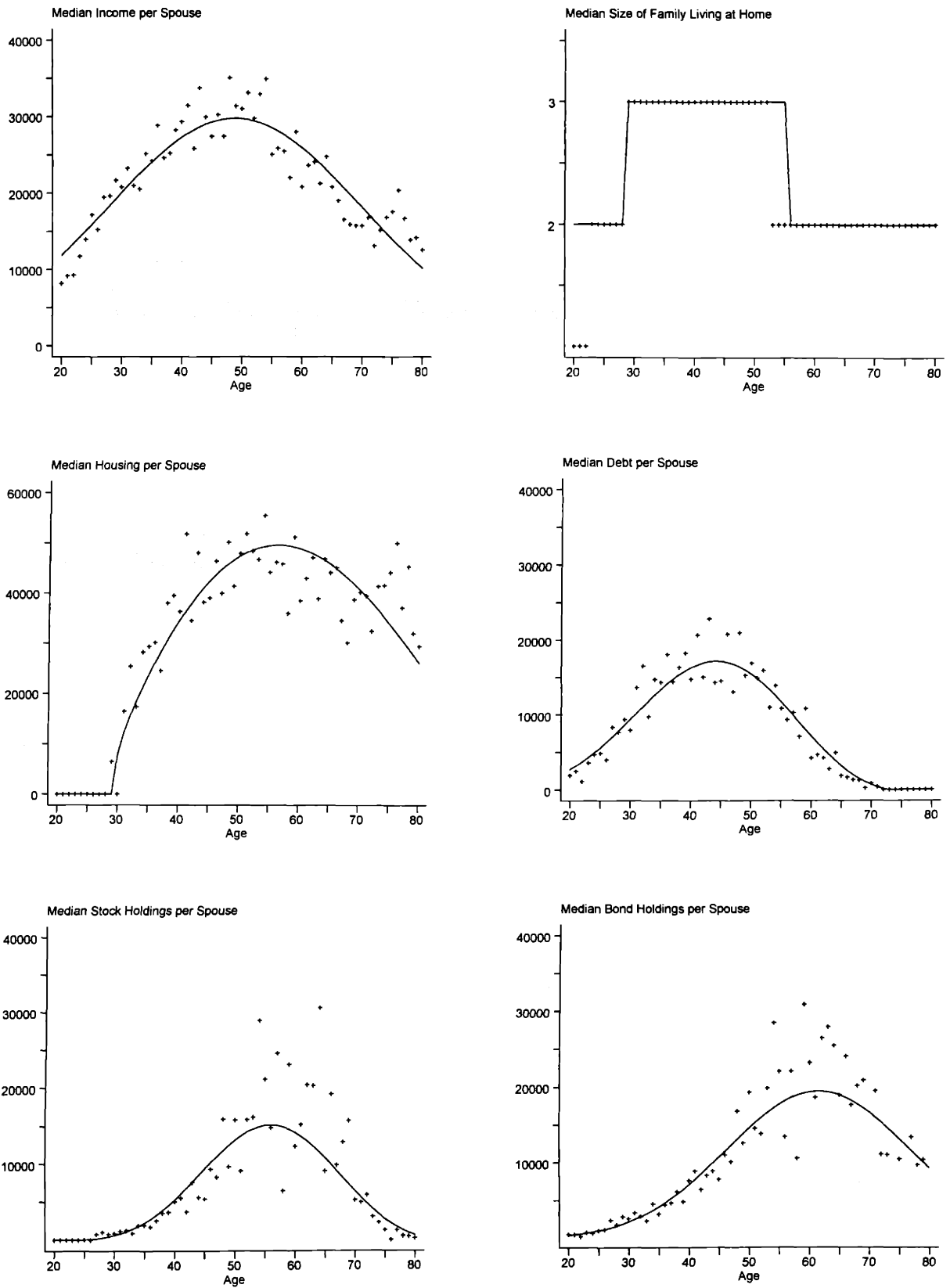


Figure 4.2c

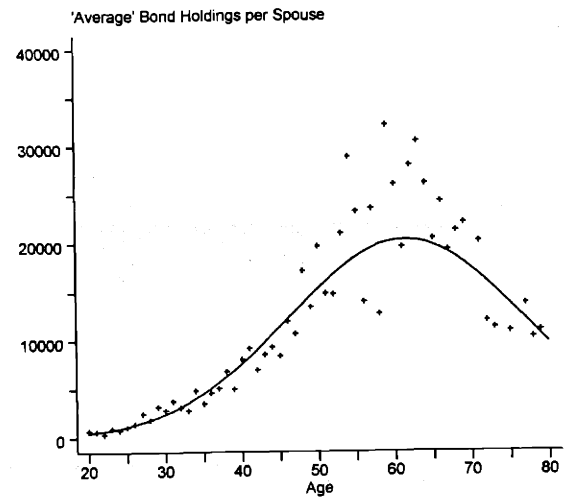
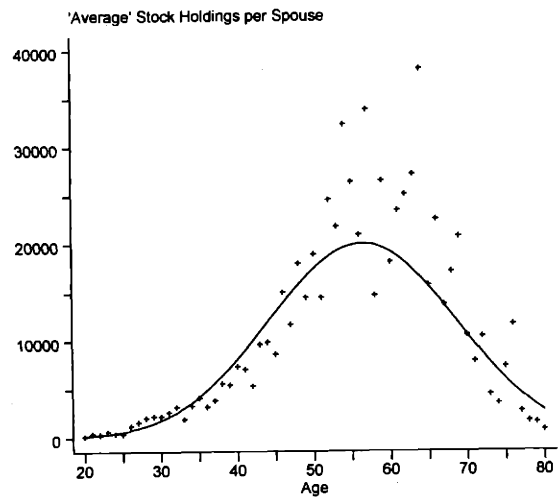
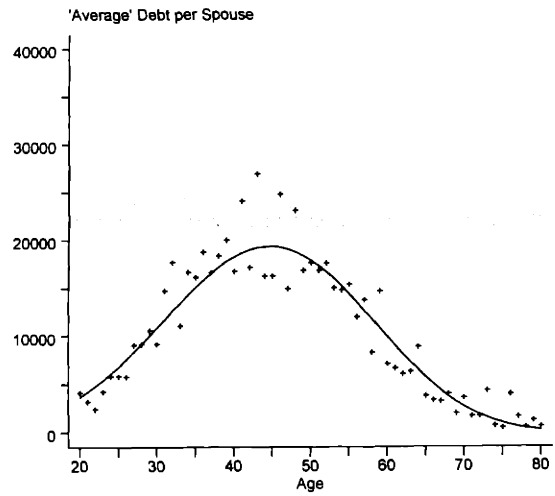
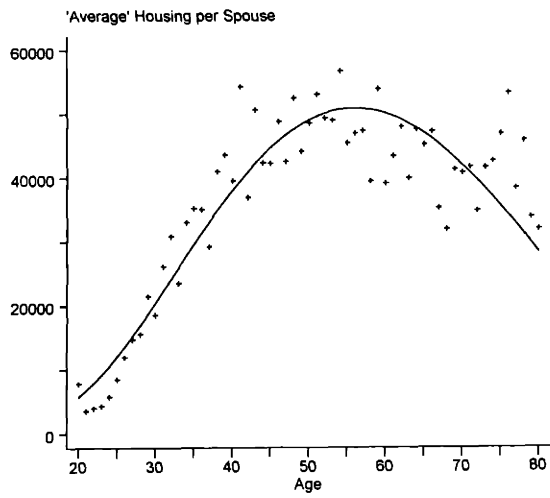
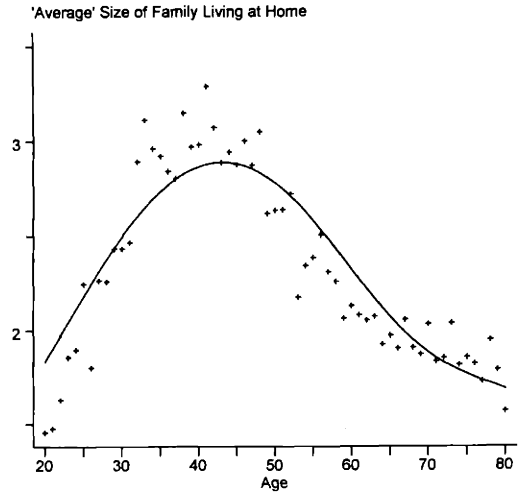
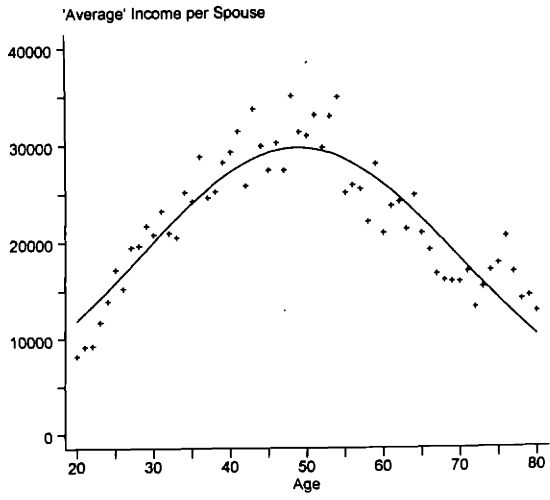


Figure 4.2d

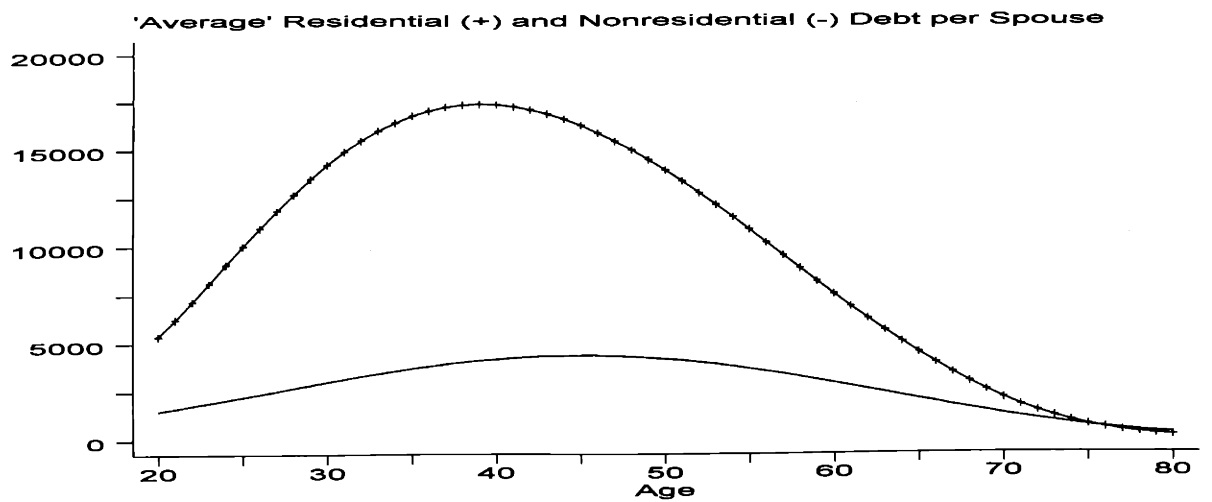
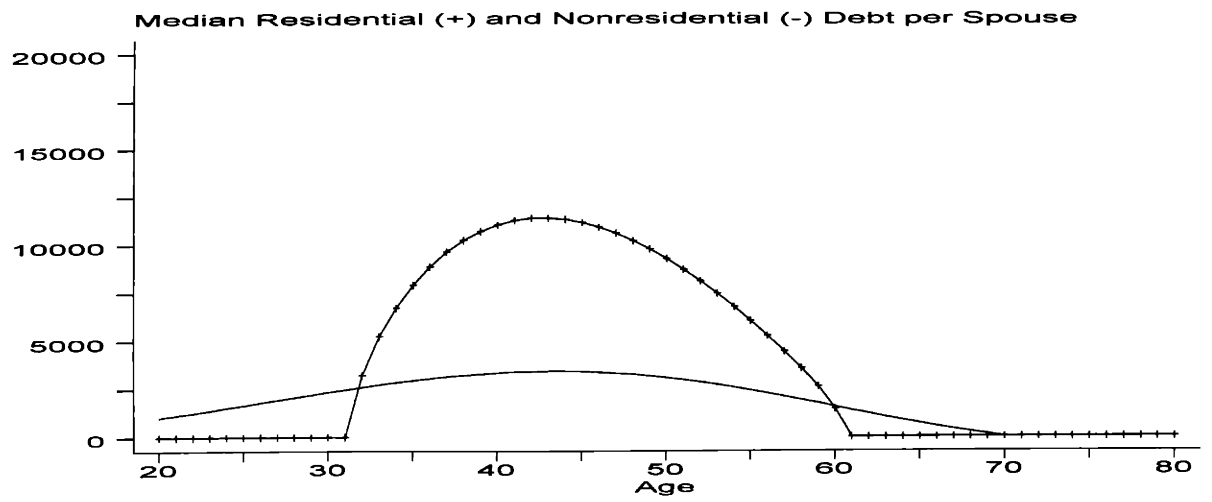
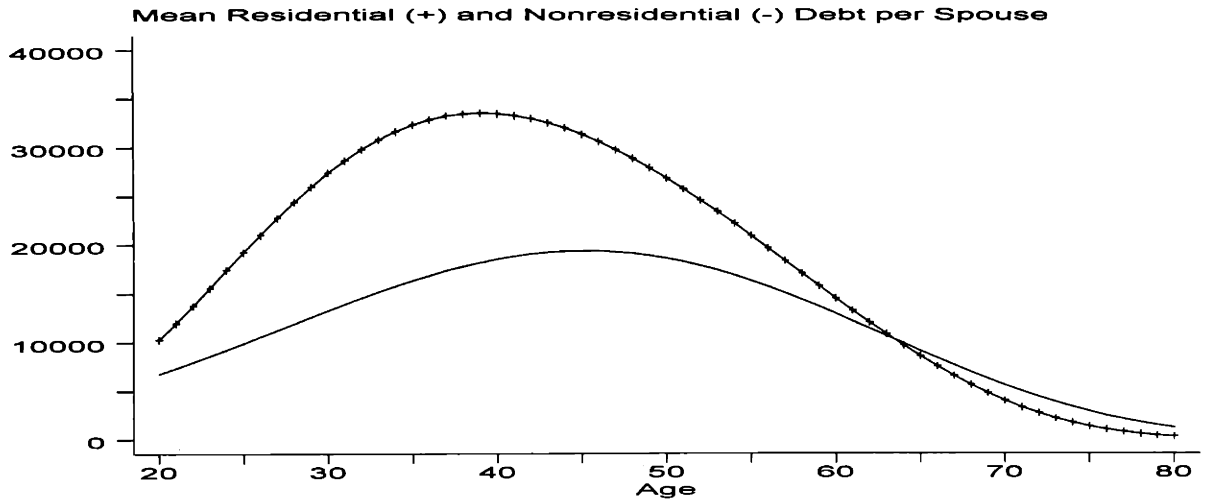


Figure 4.2e

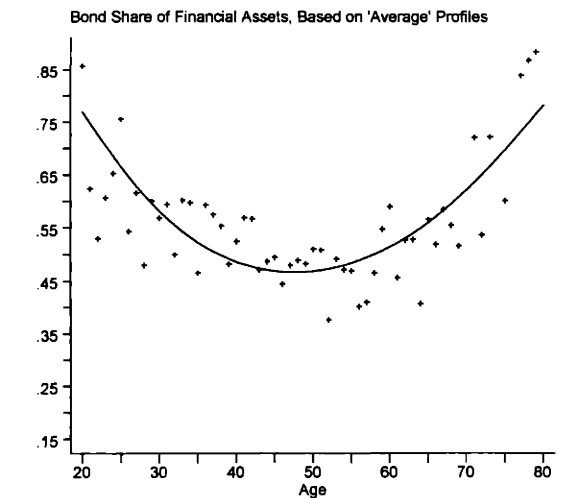
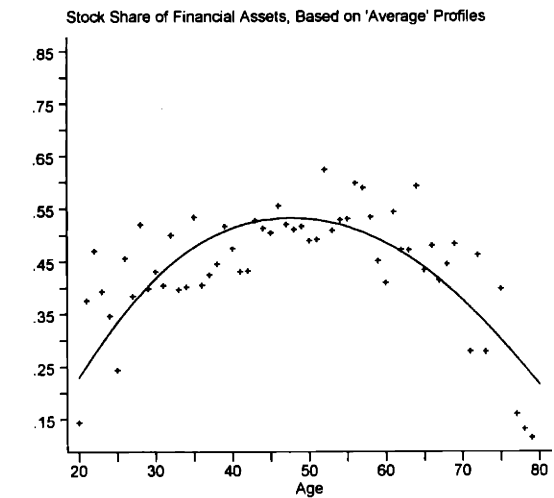
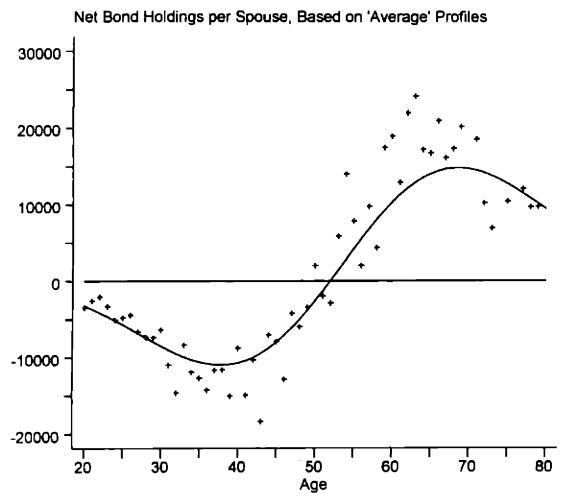
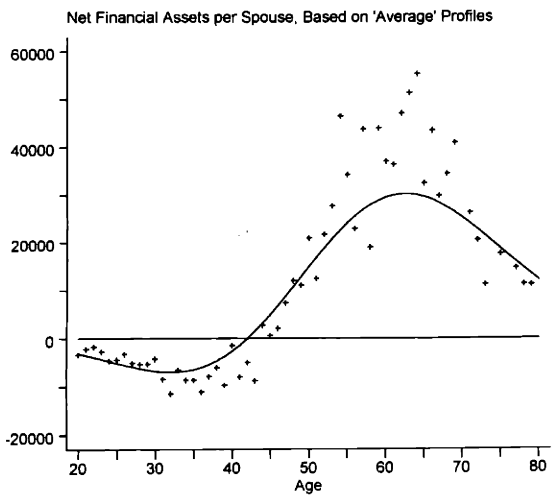
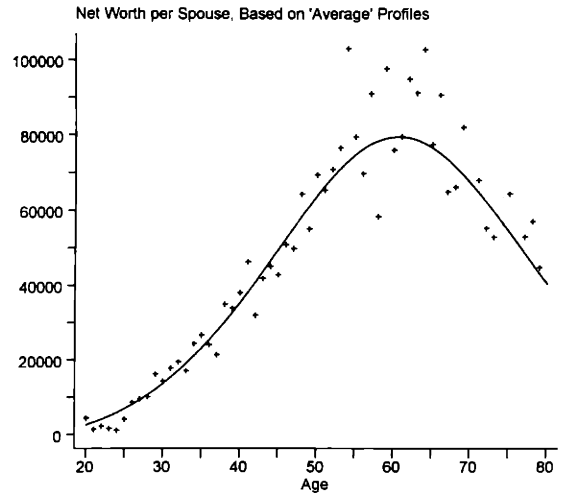
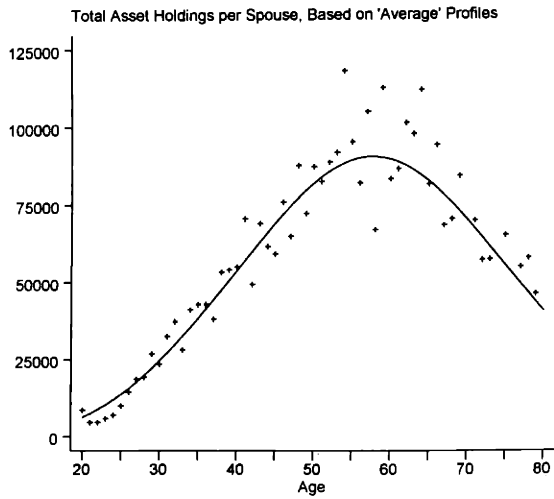
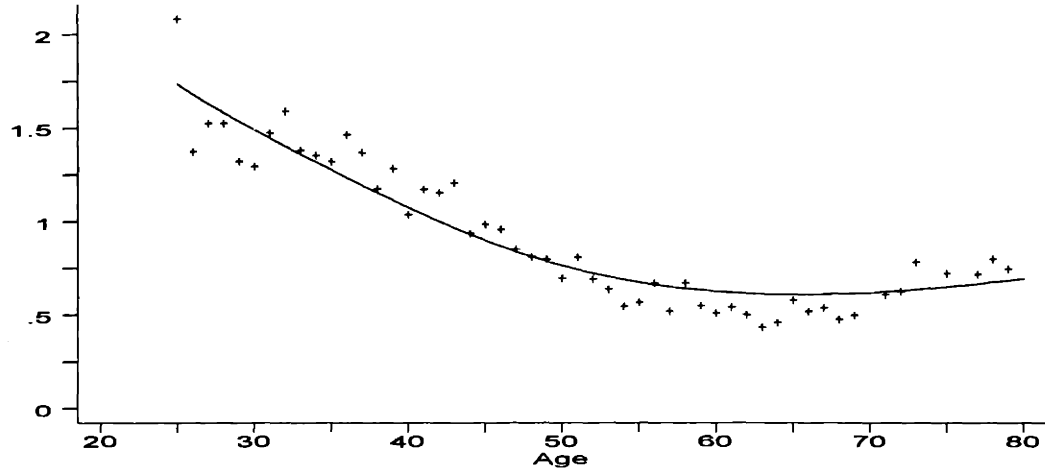
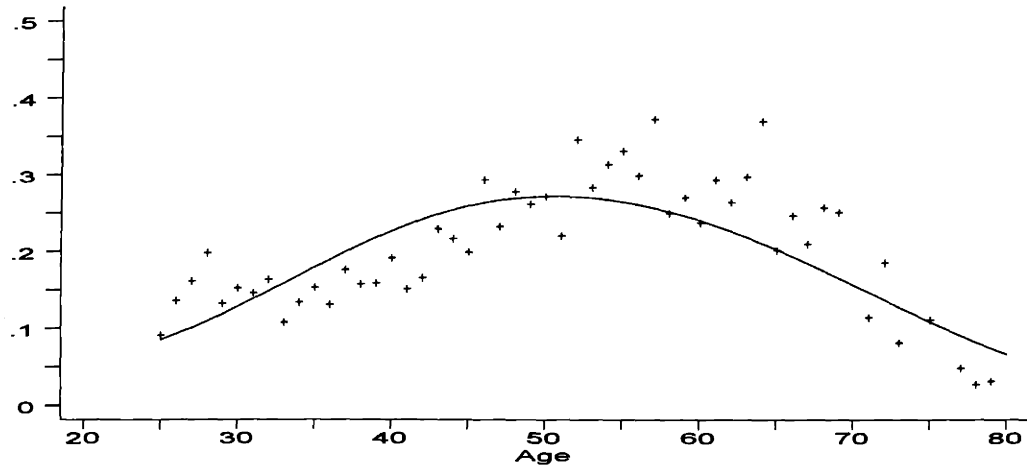


Figure 4.2f

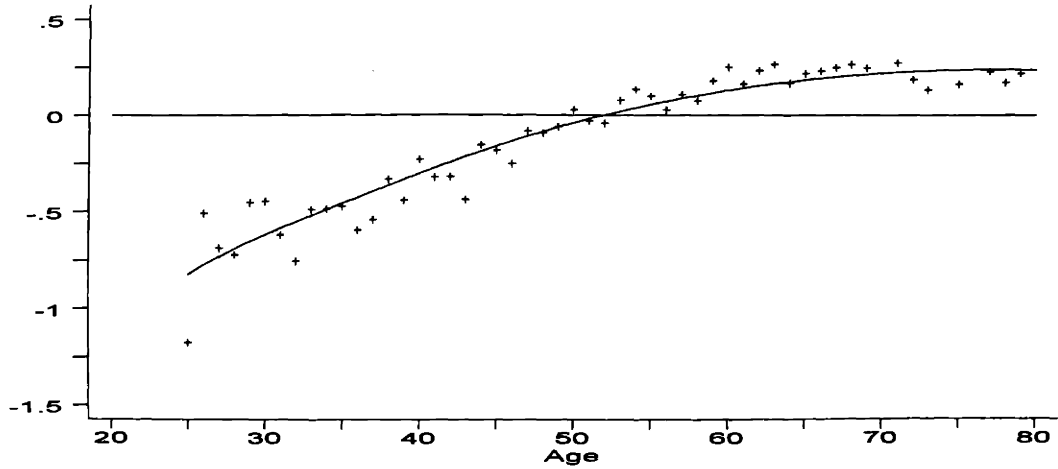
Housing Share of Net Worth, Based on 'Average' Profiles



Stock Share of Net Worth, Based on 'Average' Profiles



Net Bond Share of Net Worth, Based on 'Average' Profiles



hump in total debt is from residential debt, that is, debt used for the purchase, repair, or improvement of one's primary residence.

Looking once again at the profiles for stocks and bonds at the bottom of Figures 4.2a–4.2c, one can see that they are similar for households with heads below age 55, but that stock holdings drop off much more rapidly than bond holdings among older households. Given the rapid drop off in household debt after age 45, the difference would be even more dramatic if one were to compare the stock profile to one for net bond holdings. One possible explanation for the apparent shift in portfolio allocation is that it is a cohort effect, driven by individuals whose risk aversion was permanently ratcheted up as a result of living through the Great Depression. It could also be due to life cycle effects, however. In particular, if we think of the predictable portion of a household's income flow as a form of bond holdings, then the divergence in the stock and bond profiles for older households may reflect a desire on the part of retiring individuals to rebalance their portfolios in response to a reduction in income. As we will see in the life cycle profiles presented in the next section, it appears that a large part of the portfolio shift is due to life cycle, rather than cohort effects.

Since the qualitative features of the mean, median, and 'average' profiles are very similar, and since, as discussed above, the 'average' acts as a middle ground between the mean and median, we will restrict our attention to examination of the 'average' profiles throughout the rest of this chapter, and will use them to construct the demographic demand variables used in the analysis of Chapter 5. This will keep repetition to a minimum without affecting the qualitative results of the analysis.

Figures 4.2e and 4.2f display cross sectional age profiles for several net asset and portfolio share categories, calculated from the 'average' profiles for housing, debt, stocks, and bonds. The top two panels of Figure 4.2e display profiles for total assets and net worth per spouse, the middle two panels display profiles for net financial assets and net bonds, and the bottom two panels display profiles for the stock and bond shares of total financial assets. The definition of total financial assets used in Figures 4.2e, 4.2f and in the next section on life cycle asset demand is the sum of stocks and bonds, while total assets are defined as total financial assets plus housing. Although the total financial and nonfinancial assets of a household consist of more than its holdings of stocks, bonds, and housing, the profiles calculated using the above definitions are, in fact, representative of those based on more

inclusive definitions of financial and nonfinancial assets.¹²

There are several things worth noting about the graphs in Figure 4.2e. To begin, observe that although 'average' net worth is positive and increasing with age for households below age 60, net financial assets are actually negative for households below age 43, and flat or becoming more negative for households with heads below age 32. Similarly, net bond holdings are negative for households with heads below age 52 and become more negative with age for households with heads below age 38. Thus, as hypothesized, young households tend to be net borrowers in financial markets. Also of interest are the portfolio share profiles at the bottom of Figure 4.2e. The age profile for the stock share of financial assets has a hump shape and is highest for households with heads near age 50. According to the estimated smooth profiles, stocks make up between about 22% of total financial assets for households with heads age 20 or 80, compared to approximately 53% for households with heads age 50. The possible cohort and life cycle based explanations for the differences in financial asset allocation among middle-aged and older households were discussed above. As for the difference between middle-aged and young households, one would be hard pressed to find a cohort based explanation. Younger households tend to be more educated than their older counterparts, have higher expected lifetime earnings, and, except for the almost forgotten market crash of 1987, have yet to experience a severe stock market downturn. One must therefore search for a reasonable life cycle explanation for the apparently more risk averse behavior of younger households. In fact, looking at net rather than total bond holdings, reveals that the large amounts of debt issued by young households, makes their overall stock position look much more aggressive than in the bottom panels of Figure 4.2e.

Figure 4.2f displays cross sectional age profiles of housing, stock and net bond shares of net worth.¹³ Skipping to the middle and bottom panels, one can see that contrary to the impression given by the graphs at the bottom of Figure 4.2e, the financial asset positions taken by young households are rather aggressive. The 9% of household net worth held in stocks by households with heads age 25 is 91 percentage points higher than the -82% share of

¹²Recall from Table 4.1 that the average direct and indirect holdings of stocks and bonds account for more than 96% of total household financial assets in each of the three survey samples. Also, recall that the average share of housing in nonfinancial assets was approximately 55% when the average was taken over all households, and 74% when taken over the 68% or more of households that actually owned homes, with the remainder in each case largely accounted for by household holdings of vehicles.

¹³These graphs are displayed for households with heads age 25 and older because 'average' net worth is very close to zero for households with heads below age 25.

net bonds. Households with heads age 50, hold about 27% of their net worth in stocks, but unlike younger households, they hold almost enough in bonds to offset their debt. Indeed if one were to use the difference between the stock and net bond shares of net worth as a measure of the excess weight placed on stocks over bonds in the overall household portfolio, it would be monotonically decreasing in age, starting at a high of 91% for households with heads age 25 and reaching a low of about -17% for households with heads age 80.

Returning to the top panel of Figure 4.2f, we see that the share of housing in net worth is highest for young households, reaching almost $1\frac{3}{4}$ times net worth for households with heads age 25. From there it declines steadily with age until reaching a low of about 61% for households with heads age 65, and then increases with age, reaching about 70% for households with heads age 80. The extremely high housing share for 25 year olds reflects the fact that young households have very little wealth aside from their home, and that this asset is highly leveraged. Also, the fact that the housing share of net worth declines more or less steadily with age reflects the fact that as households age, their investment in financial assets exceeds their investment in housing.

Taken as a whole, the profiles displayed in Figures 4.2a-4.2f are highly supportive of the life cycle story put forth in the introduction. Moreover, the fact that these are cross sectional age profiles suggests that the underlying life cycle investment patterns are not severely distorted or smoothed by cohort effects. The age profiles presented in the next section, examine more closely, the life cycle investment behavior of individual households, and how this life cycle behavior varies across cohorts.

4.3 Estimating Life Cycle Profiles of Asset Holdings

4.3.1 Estimation Procedure and Regression Results

In order to obtain estimates of life cycle, as opposed to cross sectional, profiles of asset demand we need to remove any cohort effects from the estimated cross sectional profiles. This is done by making the assumption that any differences in life cycle asset demand across cohorts are due to differences in lifetime resources and family size, and then augmenting the set of regressors in our original model to control for these factors. The specific income and family size variables added to the set of regressors are the log of the previous year's total income per spouse, the log of total family size (including adult children living outside

the home), and the percentage of family members living at home. The inclusion of both total family size and the percentage of family members living at home among the regressors is designed to capture both the temporary and permanent effects of children on life cycle asset holdings.¹⁴

The income variable is intended to capture differences across households and across cohorts in lifetime resources. We would therefore like a measure of permanent income, where, in this context, permanent income is that portion of current income that is most representative of the full path of past and expected future income. Because reported income includes both permanent and transitory components, its use introduces a measurement error problem into the estimation procedure. In an attempt to eliminate, or at least minimize, this measurement error, the sample used in the estimation of the life cycle profiles is restricted to the 3,613 cases from the 1992 and 1995 SCFs who classified their previous year's reported income as normal, as opposed to being above or below normal, and who at the time of the survey had neither head nor spouse who was unemployed, working part-time involuntarily, or in bad health.¹⁵ The reason for the last set of restrictions is to eliminate any households whose long run income status may have deteriorated over the course of the survey year. Since we have no way of identifying households whose long run income status improved over the course of the survey year, they remain in the sample. It is assumed, however, that any measurement error created by this inclusion is negligible relative to that which has been eliminated by the above stated exclusions.

The regressions also include a dummy variable for individuals who expect the economy to perform worse over the five years following the survey year than over the five years preceding the survey year. This variable is included in the regressions in the hope of separating out expectational sources of asset holding from life cycle sources. Further, since the meaning of the dummy variable is likely to depend on the state of the economy at the time of the survey, the coefficient on this dummy variable is allowed to take on different values for each of the two survey years. The regression also includes measures of transfers received and expected. The variable for past transfers received is the log of one plus the total per spouse value of all inheritances, trusts, or transfers ever received, inflated to 1995 dollars using

¹⁴Adult children living outside the household are no longer an economic burden to their parents but are likely to have imposed permanent effects on their parents' life cycle asset holdings.

¹⁵The 1989 SCF did not include a question asking whether or not the household's reported income was representative of a typical year.

the CPI for all items less shelter, and the variable for transfers expected is the log of one plus the total per spouse value of all expected future inheritances. Since individuals are not asked when they expect to receive future inheritances, this second variable could not be deflated to 1995 dollars.

The regression results are presented in Table 4.3. As in Table 4.2, emboldened entries signify that the estimated coefficient was statistically significant at the 5% level or below. Overall, the sign and statistical significance of the estimated coefficients on age, income and family size are what one would tend to expect, and are consistent with the type of life cycle behavior we were trying to verify.

The estimated coefficients for age and age squared suggest that the humped shape of the cross sectional profiles will likely also be present in the life cycle profiles. It is interesting to note, however, that the negative coefficients on age squared in the housing regressions are near zero and statistically insignificant. The age coefficients in the probit regression for bonds are also statistically insignificant, but this is not surprising, given that almost all households in the sample hold some bonds. Moving down a row, one sees that the coefficients on log income are all positive and all statistically significant at the 5% level. Higher income increases the probability of owning a house, stocks, or bonds, and conditional on ownership, increases the quantity owned. Higher income also implies a higher probability of having debt and a higher level of debt conditional on having some debt. This probably reflects the fact that, having controlled for the effects of age on income, high levels of current income imply high levels of future income that can be borrowed against to fund current consumption and/or investment.

Looking at the coefficients on total family size, and focusing for the moment on the housing regression, we see that, as expected, total family size is positively correlated with the probability of home ownership. Notice, however, that family size is negatively correlated with the quantity of housing owned, conditional on homeownership. Even though the negative coefficient in the OLS regression is not statistically different from zero, the fact that it is negative at all is quite interesting since one would expect the quantity of housing demanded to be increasing in family size. One possible explanation for the negative coefficient on total family size is that an increase in total family size has two offsetting effects on housing demand. Holding household demand for other goods constant, an increase in family size should tend to increase household demand for housing. However, an increase in

Table 4.3: Regressions for Life Cycle Age Profiles of Asset Demand

	Housing		Debt		Stocks		Bonds	
	Probit	OLS	Probit	OLS	Probit	OLS	Probit	OLS
age of household head	0.061 (0.016)	0.028 (0.010)	0.047 (0.016)	0.094 (0.020)	0.075 (0.016)	0.247 (0.023)	-0.033 (0.031)	0.141 (0.016)
age of household head squared	0.000 (0.000)	0.000 (0.000)	-0.001 (0.000)	-0.001 (0.000)	-0.001 (0.000)	-0.002 (0.000)	0.001 (0.000)	-0.001 (0.000)
log(income per spouse)	0.402 (0.054)	0.600 (0.023)	0.192 (0.047)	0.948 (0.050)	0.613 (0.058)	1.103 (0.060)	0.666 (0.108)	1.153 (0.049)
log(family size)	0.792 (0.070)	-0.007 (0.046)	0.609 (0.081)	0.367 (0.080)	0.254 (0.077)	-0.307 (0.100)	0.232 (0.151)	-0.167 (0.075)
% family living at home	1.345 (0.174)	0.304 (0.092)	0.680 (0.187)	0.740 (0.176)	0.620 (0.180)	-0.555 (0.240)	0.603 (0.356)	0.118 (0.177)
log(1+inheritances received)	0.012 (0.008)	0.001 (0.004)	-0.012 (0.008)	0.003 (0.009)	0.038 (0.010)	0.026 (0.010)	0.072 (0.040)	0.044 (0.007)
log(1+inheritances expected)	-0.008 (0.009)	0.012 (0.004)	0.019 (0.011)	-0.007 (0.010)	0.010 (0.011)	0.004 (0.011)	0.080 (0.036)	0.005 (0.008)
expect economy to perform worse over next 5 years: 1992 SCF	0.105 (0.120)	0.051 (0.058)	0.095 (0.131)	0.125 (0.139)	-0.132 (0.117)	-0.149 (0.165)	-0.281 (0.193)	-0.024 (0.112)
expect economy to perform worse over next 5 years: 1995 SCF	-0.060 (0.107)	-0.008 (0.053)	-0.200 (0.118)	-0.014 (0.121)	-0.150 (0.108)	-0.294 (0.167)	0.036 (0.206)	-0.240 (0.119)
1992 SCF dummy variable	-0.130 (0.070)	-0.048 (0.038)	-0.116 (0.074)	-0.209 (0.075)	-0.016 (0.075)	-0.310 (0.091)	-0.036 (0.144)	0.034 (0.073)
constant	-7.477 (0.585)	3.442 (0.356)	-2.547 (0.530)	-2.805 (0.572)	-8.035 (0.613)	-7.926 (0.715)	-5.150 (0.970)	-6.890 (0.568)
NOBS	3613	2944	3613	2922	3613	3093	3613	3547
R ²	0.195	0.375	0.184	0.265	0.154	0.320	0.191	0.410

family size will also tend to increase the demand for other goods beside housing, reducing the amount of lifetime resources available for housing. One could interpret the first effect as a positive substitution effect, and the latter as a negative income effect. The negative, but statistically insignificant coefficient on family size, therefore, suggests that the income effect of an increase in total family size weakly dominates the substitution effect.

The effects of total family size on household debt, stock and bond holdings are somewhat less mysterious. Increases in family size are positively correlated with both the probability of having some debt outstanding and the quantity of debt outstanding, conditional on having debt. Also, conditional on holding stocks or bonds, the quantity held is negatively correlated with total family size. These results are what we would expect. Somewhat less intuitive, is the finding that total family size is positively correlated with the probability of holding stocks and bonds. Notice, however, that the size of the estimated coefficients in these regressions are less than half of what is obtained in the probit regression for debt, and, in the case of bond holdings, the estimated coefficient on family size is statistically insignificant.

Looking at the estimated coefficients for the percentage of family living at home, we see that household holdings of housing and debt are positively correlated with the percentage of family living at home, and that, conditional on being positive, household holdings of stock are negatively correlated with the percentage of family living at home. Bond holdings display no statistically significant correlation with the percentage of family living at home. Once again, given that our definition of bond holdings includes transaction accounts, this last finding is to be expected.

The estimated coefficients on past and expected future inheritances are generally what one would expect, but, in many cases, the effects of these sources of income on asset holdings are statistically insignificant. For example, the value of past inheritances is positively correlated with the probability of owning a home, stocks, or bonds and negatively correlated with the probability of having debt outstanding, but, only in the case of stock holdings, is the effect statistically significant. Similarly, conditional on owning a home, stocks, or bonds, household holdings of these assets are positively correlated with past inheritances, but the correlation is statistically significant only for stock and bond holdings. Expected future inheritances do not appear to have any significant effect on household asset holdings.

4.3.2 Cohort Adjustments and Profile Construction

The 'average' life cycle asset holdings profiles presented below, were calculated for individuals age 50, 75, and 25 in 1995. The profiles for the 50 year old, born in 1945, are intended to be representative of the typical baby boomer, while those age 75 and 25 in 1995 are intended to be representative of the typical parent and child of a baby boomer, respectively. The profiles for these individuals were constructed as follows.

Life cycle income profiles were calculated by adjusting the estimated cross sectional income profile for trend increases in real income. Specifically, the difference in log income at age a between someone born in year b and someone born in year b_0 was set equal to $\gamma(b - b_0)$, where γ denotes the average annual cohort effect for income. Since average annual growth in log real GDP per adult (i.e. per person age 20 or older) over the post World War II period is about 1.5%, γ was set equal to 0.015.

Life cycle profiles of the 'average' number of family members living at home for the typical baby boomer and child of a baby boomer were set equal to the cross sectional profiles obtained by reestimating the regressions for marriage and number of children living at home using only the 1995 SCF sample. The justification for doing this is that, given the stability in birth rates following the baby boom, the cross sectional profile for size of family *living at home* estimated from the 1995 SCF sample, is likely to be representative of the life cycle profiles for generations following the one which produced the baby boom. Life cycle profiles of the 'average' number of family members living at home for the typical parent of a baby boomer were calculated assuming that, at every age, married couples from this generation have twice as many children living at home as married couples from later generations.¹⁶ Total family size was defined to equal the size of family living at home up until the age at which the latter reaches its maximum, and then set equal to the maximum size of family living at home thereafter. Percent of family living at home was then calculated as the ratio of the size of family living at home to total family size.

'average' life cycle profiles of housing, debt, stock, and bond holdings were calculated from the regressions in Table 4.2, using the life cycle income and family profiles just described, and setting past and future expected inheritances to zero. The inheritance variables were set to zero because of the imprecision with which the coefficients on them were esti-

¹⁶This is consistent with the observation that birth rates during the baby boom were about double what they have been since.

mated, and also because most of the summary data suggests that inheritances are of minor importance for most households relative to the effects of other income.¹⁷

4.3.3 Life Cycle Asset Holdings: Baby Boomer

Figures 4.3a through 4.3c display the estimated life cycle profiles for someone age 50 in 1995. The profiles look very similar to the cross sectional age profiles presented in Figures 4.2c,d, and e. Notice, however, that because of the cohort adjustment to income, the life cycle income profile in Figure 4.3a rises more rapidly at young ages, peaks later, and falls less rapidly at older ages than the cross sectional profile depicted in Figure 4.2c. These differences are reflected to varying degrees in the asset and debt profiles as well, most noticeably in the housing and bond holdings profiles.

Looking at the life cycle housing profile in Figure 4.3a, for example, one can see that 'average' housing increases rapidly between ages 20 and 40, reaches a peak around age 60, and then declines slowly but still remains relatively high. The decline in housing after age 60 could represent disinvestment achieved by downgrading from a larger to smaller home or apartment as one's children grow up and leave the house, but could also reflect a reduction in maintenance and home improvement expenditures. Life cycle profiles of homeownership, displayed in Figure 4.6d, suggest that reductions in maintenance and home improvement expenditures are the more likely source of disinvestment in housing by older households.

Moving on, one sees that the life cycle debt profile follows essentially the same path as the profile for size of family living at home. The size of family living at home increases steadily until age 43, and then declines rapidly toward zero thereafter, while the life cycle profile for debt increases steadily until age 46, and then falls rapidly back toward zero.

Household stock holdings are quite low for most of the first twenty years of adulthood, remaining below \$3,000 per spouse, up through age 35. Between ages 35 and 60, however, per spouse stock holdings increase more than 600%, rising from about \$2,800 at age 35 to almost \$21,000 by age 60. The divestment from stocks after age 60 is also quite rapid, with

¹⁷Fewer than 23% of all households in the overall sample report having ever received a substantial inheritance, trust, or transfer. Among households with heads age 49, 50, or 51 in 1995, fewer than 26% reported having ever received a substantial inheritance, trust or transfer, and among those who had, the median per spouse amount received over their entire lives, in constant 1995 dollars, was about \$20,000. Similarly, among households with heads age 74, 75, or 76 in 1995, fewer than 34% reported having ever received a substantial inheritance, trust, or transfer, and, among those who had, the median per spouse amount received over their entire lives, in constant 1995 dollars, was about \$26,000.

Figure 4.3a

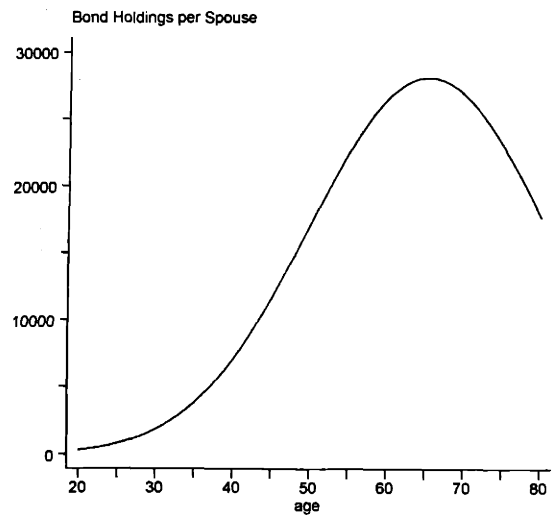
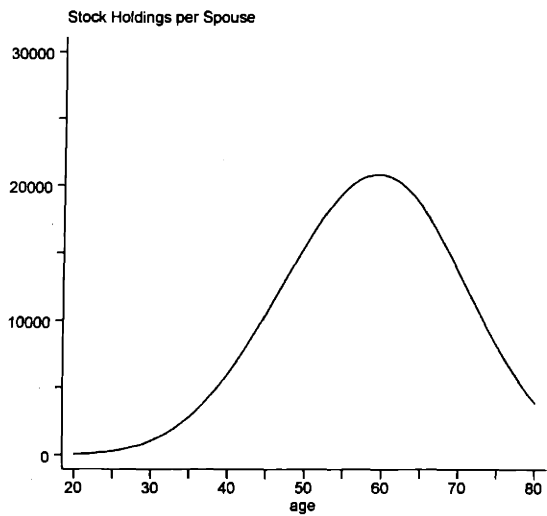
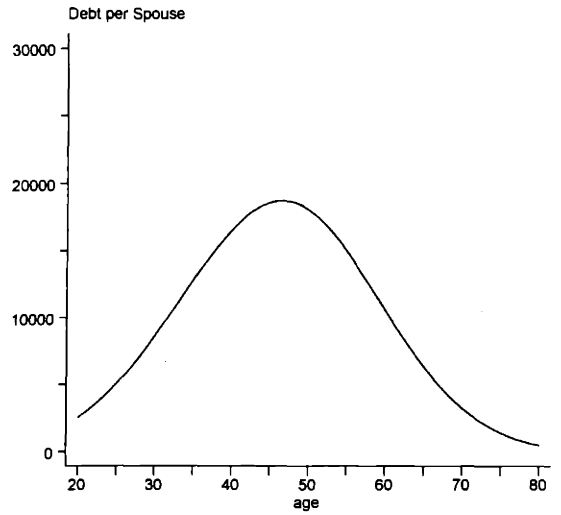
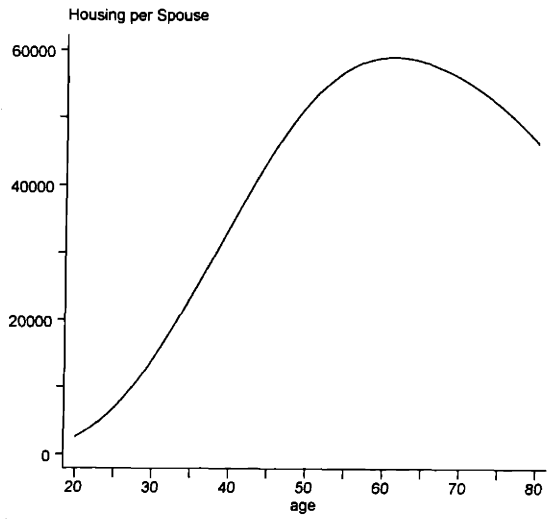
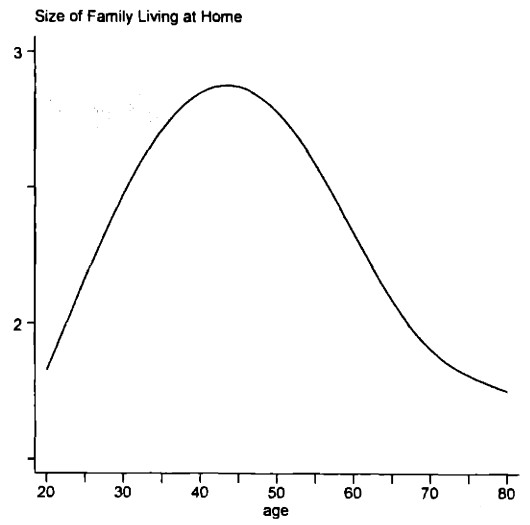
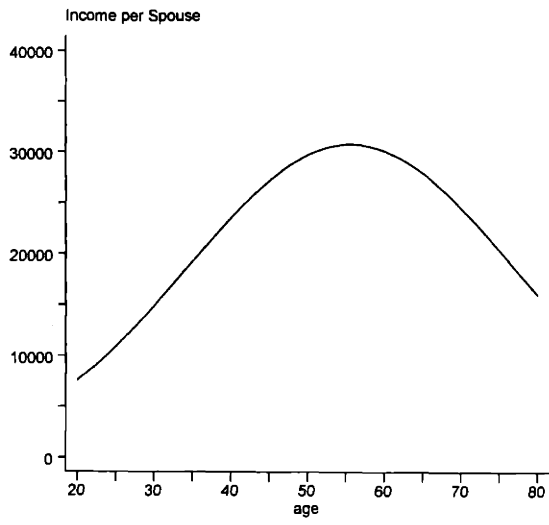


Figure 4.3b

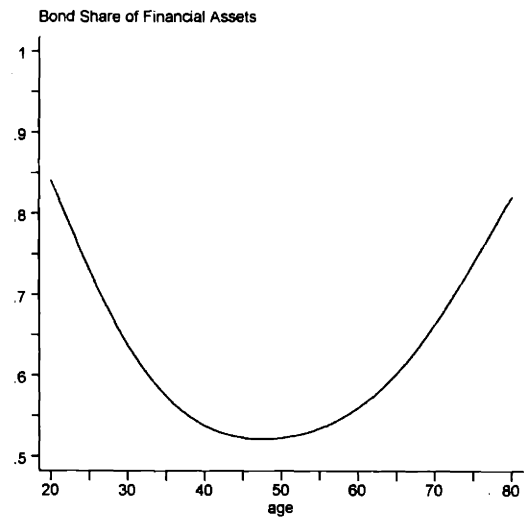
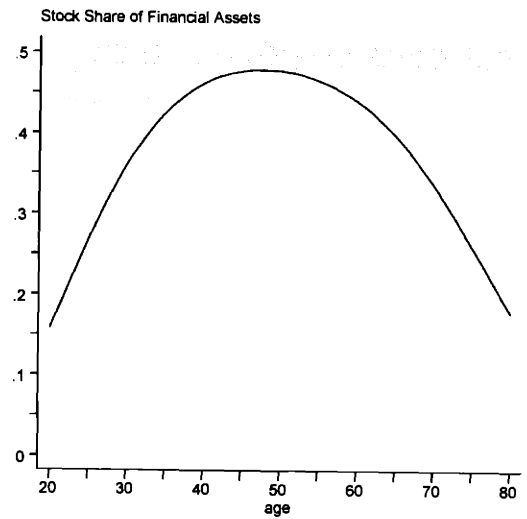
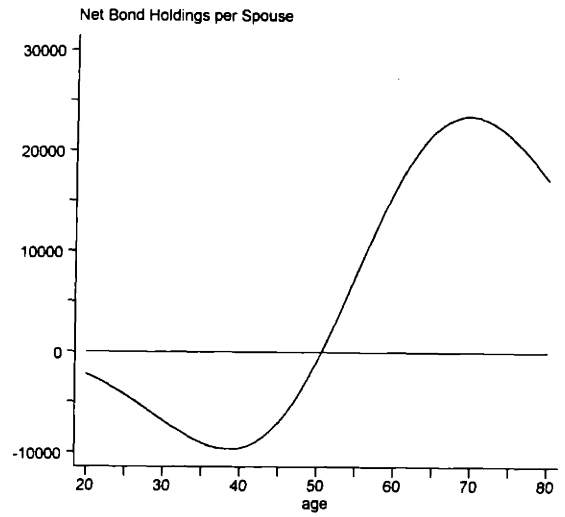
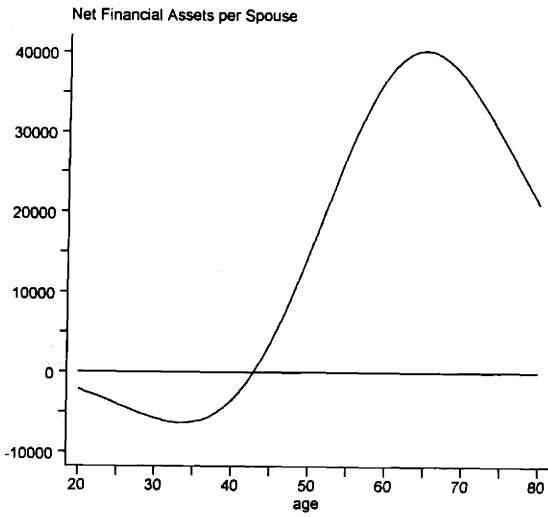
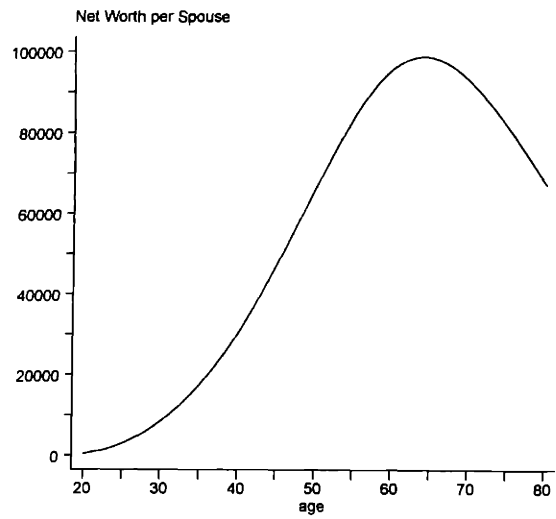
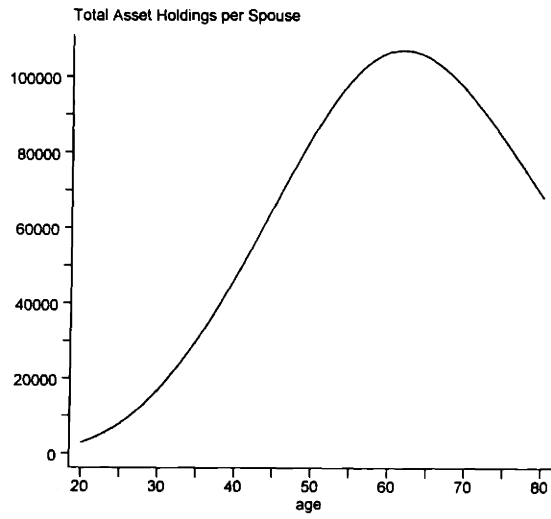
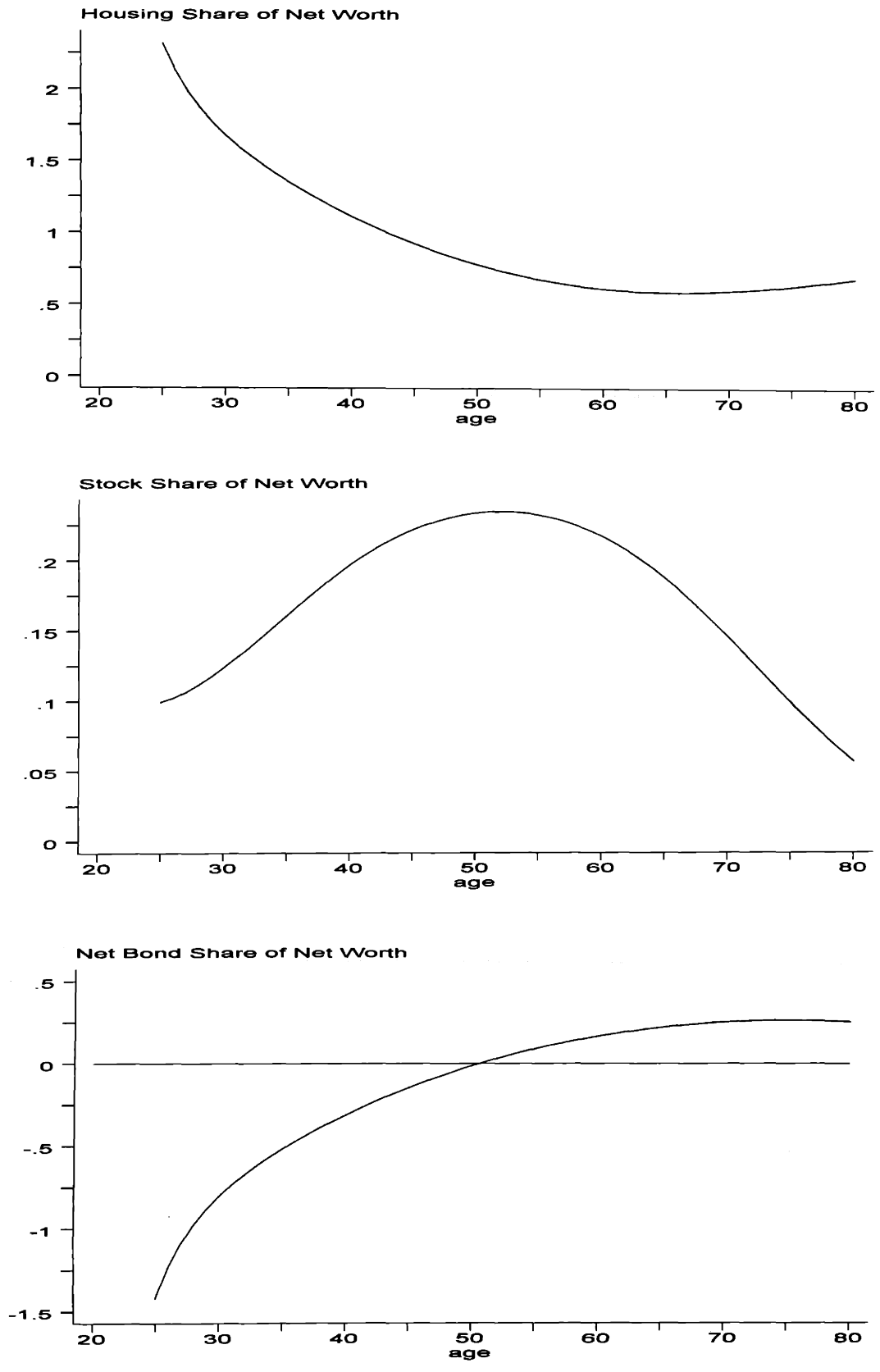


Figure 4.3c



per spouse stock holdings dropping to below \$3,900 by age 80. Investment in bonds mimics that for stocks early on in life, but doesn't cease until age 65, five years after the age at which the typical baby boomer has begun divesting from his stock holdings. Moreover, the decline in bond holdings after age 65 is much less rapid than in the case of stocks, with per spouse bond holdings remaining above \$17,000 at age 80.

Looking at Figure 4.3 b we see that total per spouse holdings of financial and nonfinancial assets increase rapidly until age 62, declining with age thereafter, as older households use previously accumulated wealth to fund consumption during retirement. This same basic pattern remains even after subtracting off debt, since much of the debt amassed by young households is invested in housing. It is not until we look at household holdings of net financial assets, that we see the extent to which young households drain credit out of financial markets. Net financial asset holdings per spouse for the typical baby boomer remain negative until age 42. Moreover, they tend to become more negative each year until age 34, suggesting that households below age 35 are net borrowers of financial assets. Net household investment in financial assets becomes positive after age 35 and remains positive throughout the rest of the working life. The result is that net holdings of financial assets increase from less than -\$6,000 per spouse at age 35 to more than \$40,000 per spouse by age 65. Net bond holdings display a similar profile, bottoming out around age 40, and remaining negative until after age 50.

Looking at the life cycle profiles for the allocation of financial assets between stocks and bonds, and for the allocation of net worth between housing, stocks, and net bonds, one sees that they are very similar to the cross sectional profiles displayed in Figures 4.2e and 4.2f. The share of total financial assets held in stocks increases from about 16% at age 20, to a maximum of about 48% by age 48, and then drops back down to approximately 18% by age 80. The share of net worth held in stocks follows a similar pattern, rising from about 10% at age 25 to a maximum of over 23% at age 52, and then dropping back to about 6% by age 80. Household holdings of bonds in excess of debt increase steadily throughout most of life, rising from about -1.4 times net worth at age 25 to slightly more than 26% of net worth by age 75, and declining only slightly thereafter. Holdings of housing, in contrast, decrease steadily throughout most of life, falling from about 2.3 times net worth at age 25 to just under 60% of net worth by age 66, and then rising slightly after age 66. The increase in the housing share of net worth after age 66, suggests that retired households draw down on

their accumulated housing wealth less rapidly than their accumulated financial wealth.

4.3.4 Life Cycle Asset Holdings: Parent of Baby Boomer

Figures 4.4, 4.5 and 4.6 display life cycle profiles for someone age 75 in 1995. Since this individual is likely to have both lower income and more children than the typical baby boomer, the effects of each are examined separately in Figures 4.4 and 4.5, and then the combined effects are examined in Figure 4.6.

Figures 4.4a-4.4c, isolate the effects on life cycle asset holdings of having more children. Given the same lifetime income as the typical baby boomer, an individual with twice as many children would tend to acquire more housing, issue more debt, and invest less in financial assets than the typical baby boomer. Notice, however, that the housing profile of this individual in Figure 4.4a, actually falls below that of the typical baby boomer after age 57, suggesting that having more children increases the extent to which one uses housing wealth to fund consumption during retirement. This makes intuitive sense given that having more children leads one to acquire less financial wealth over the course of his working life than does the typical baby boomer.¹⁸

Looking at the graphs in Figure 4.4b we see that having more children doesn't significantly affect total household asset holdings or net worth until later in life, but has a noticeable effect on net financial asset holdings and net bond holdings at every age. Net financial assets per spouse are lower at every age, and don't become positive until 3 years after the age at which the typical baby boomer becomes a net supplier of financial assets. The same is true for net bond holdings. Notice, however, that the distribution of total financial assets between stocks and bonds is not much affected by the increase in family size. In order to see the full extent to which having more children effects life cycle portfolio allocation, we need to look at the distribution of net worth, displayed in Figure 4.4c. We can see in Figure 4.4c that having more children causes wealth to be reallocated, more or less equally, from stocks and bonds, into housing, with the effect being most pronounced at younger ages (i.e. during the asset accumulation stages of life).

Figures 4.5a-4.5c isolate the effects on life cycle asset holdings of having less income.

¹⁸One way in which this individual could consume more of his housing wealth than the typical baby boomer is by shifting resources away from the maintenance and/or improvement of his home toward consumption of nonhousing goods and services.

Figure 4.4a

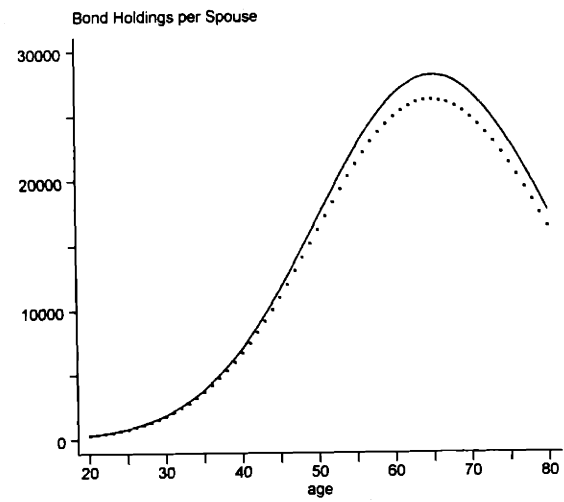
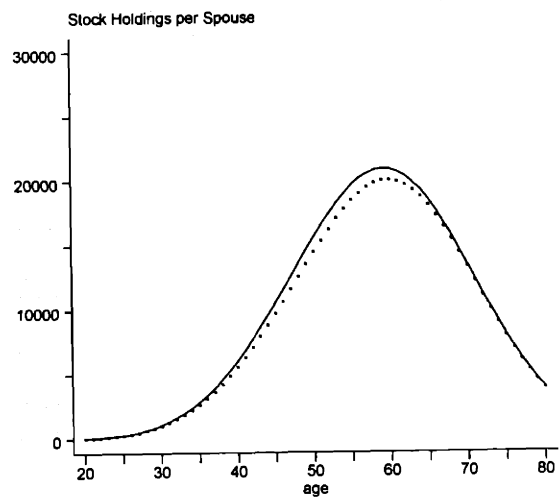
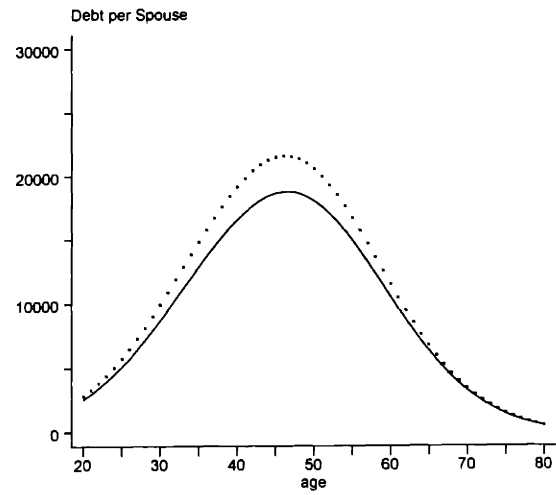
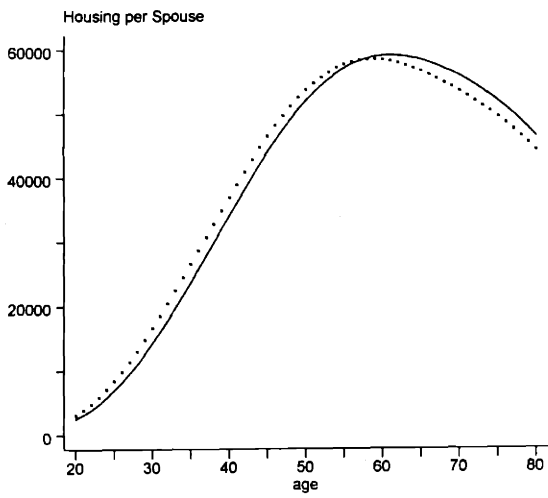
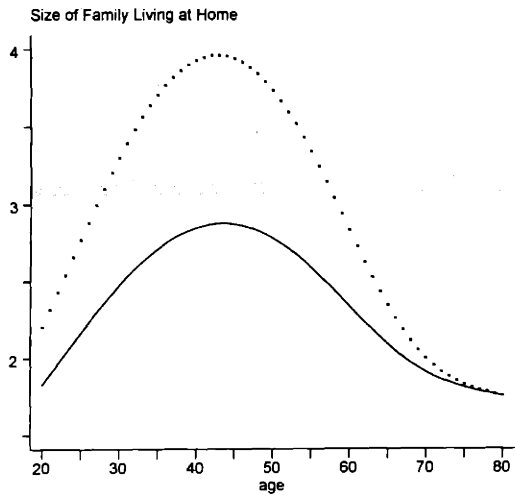
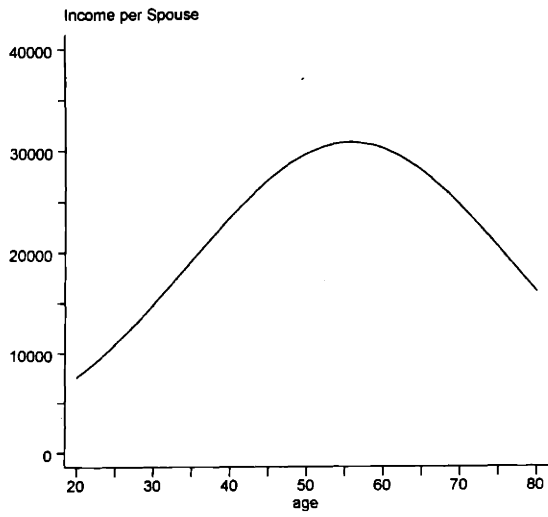


Figure 4.4b

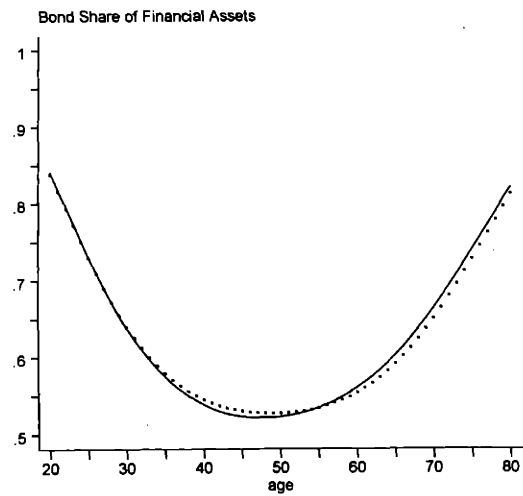
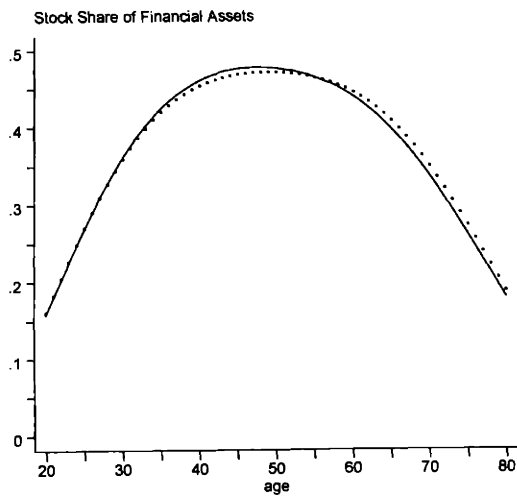
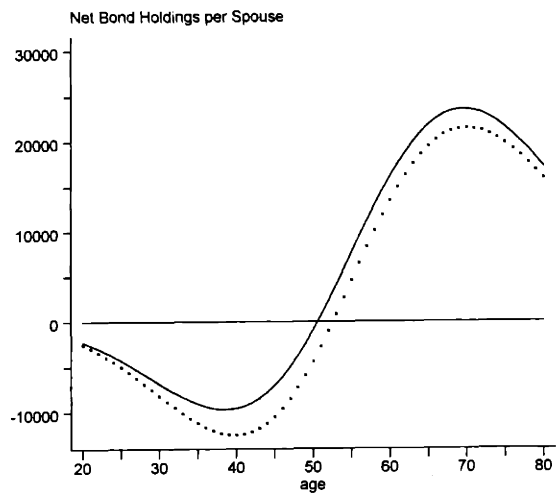
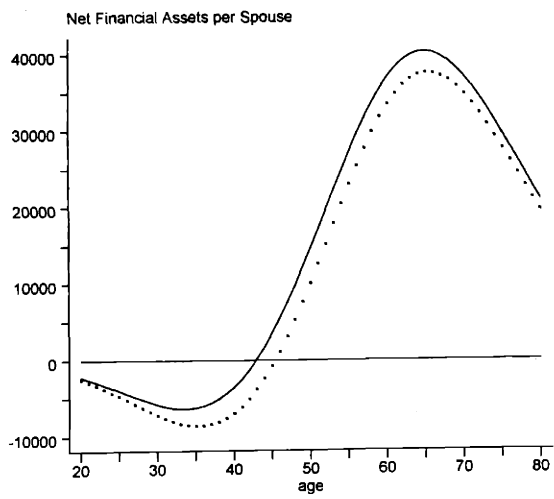
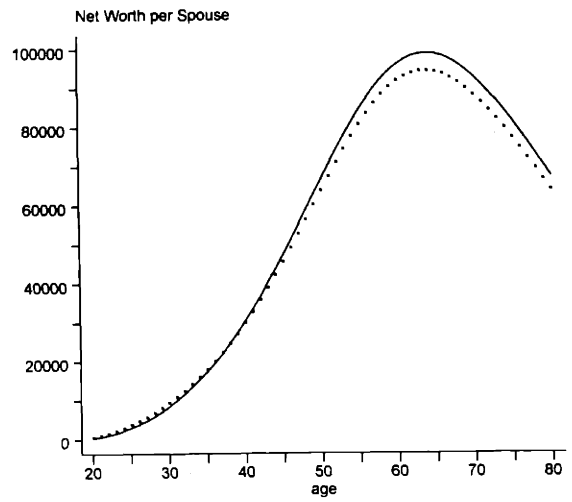
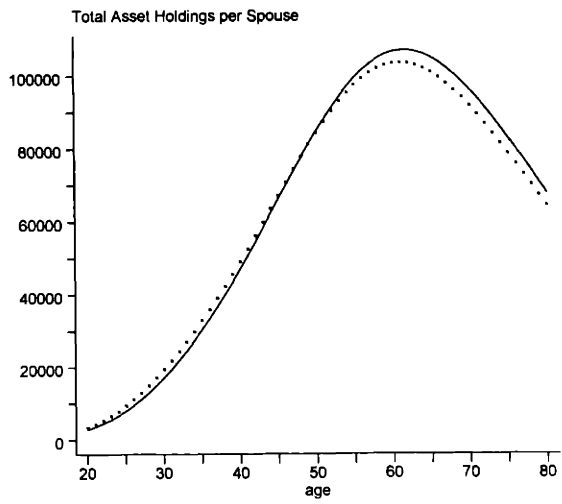


Figure 4.4c

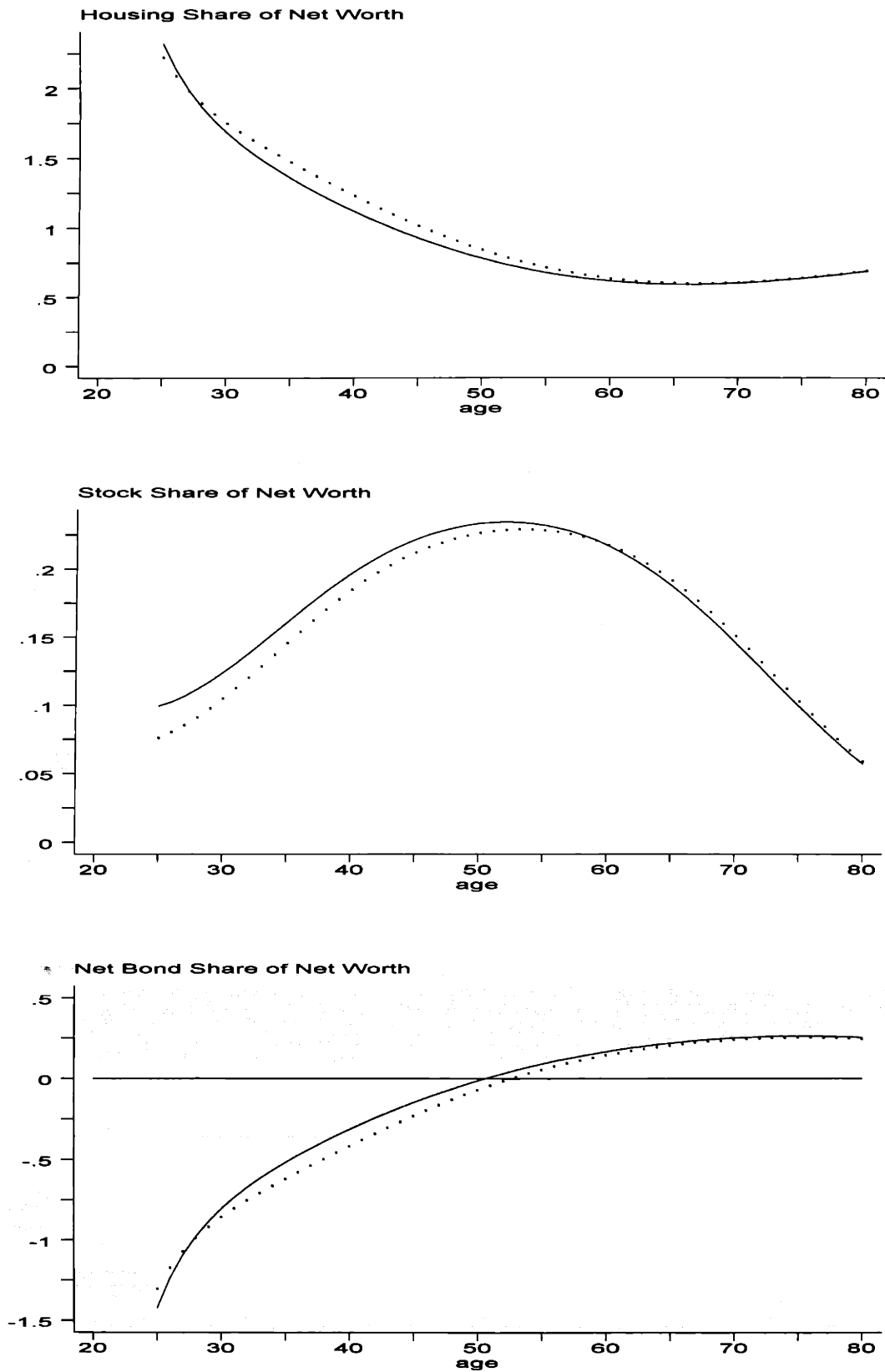


Figure 4.5a

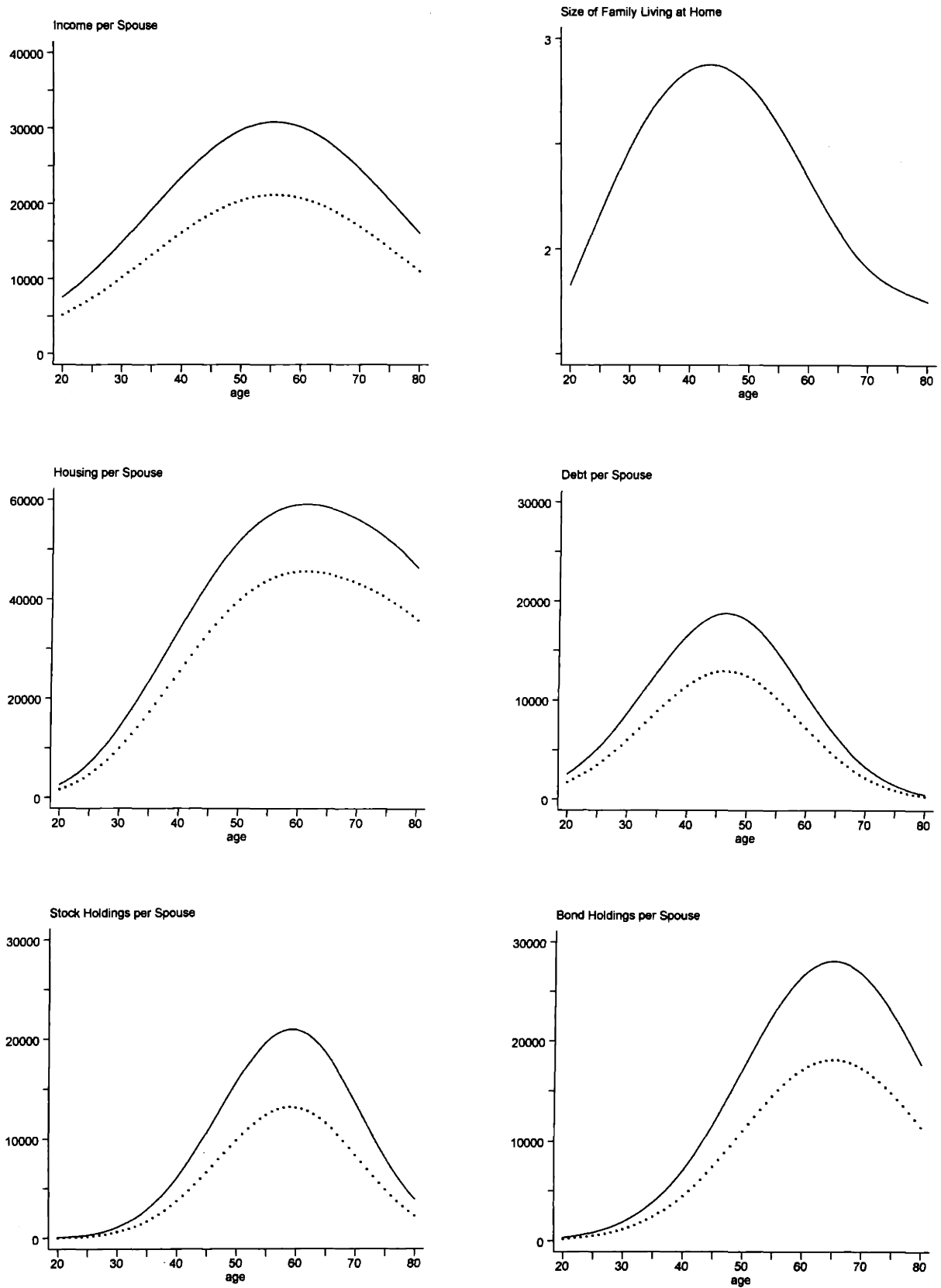


Figure 4.5b

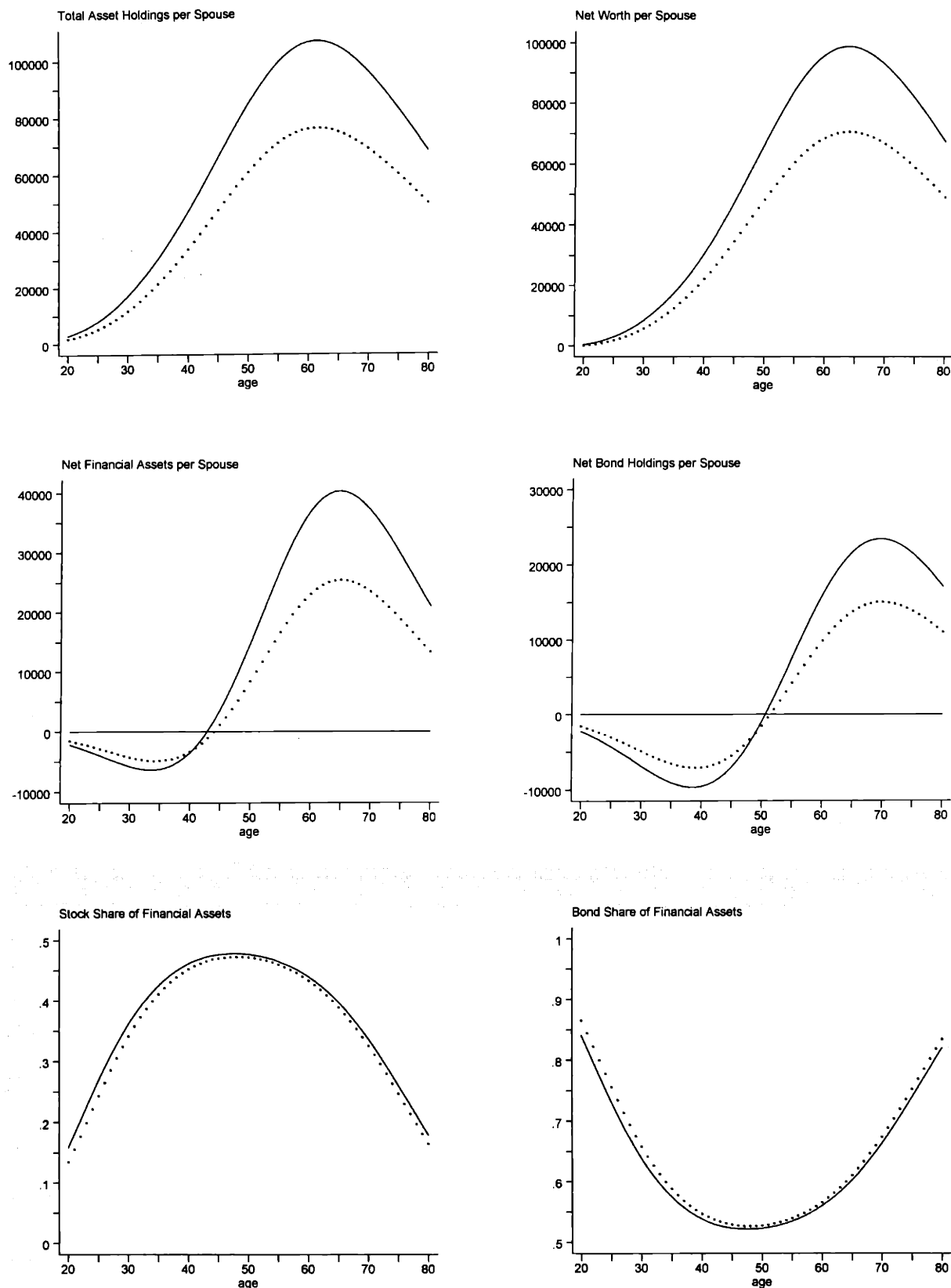
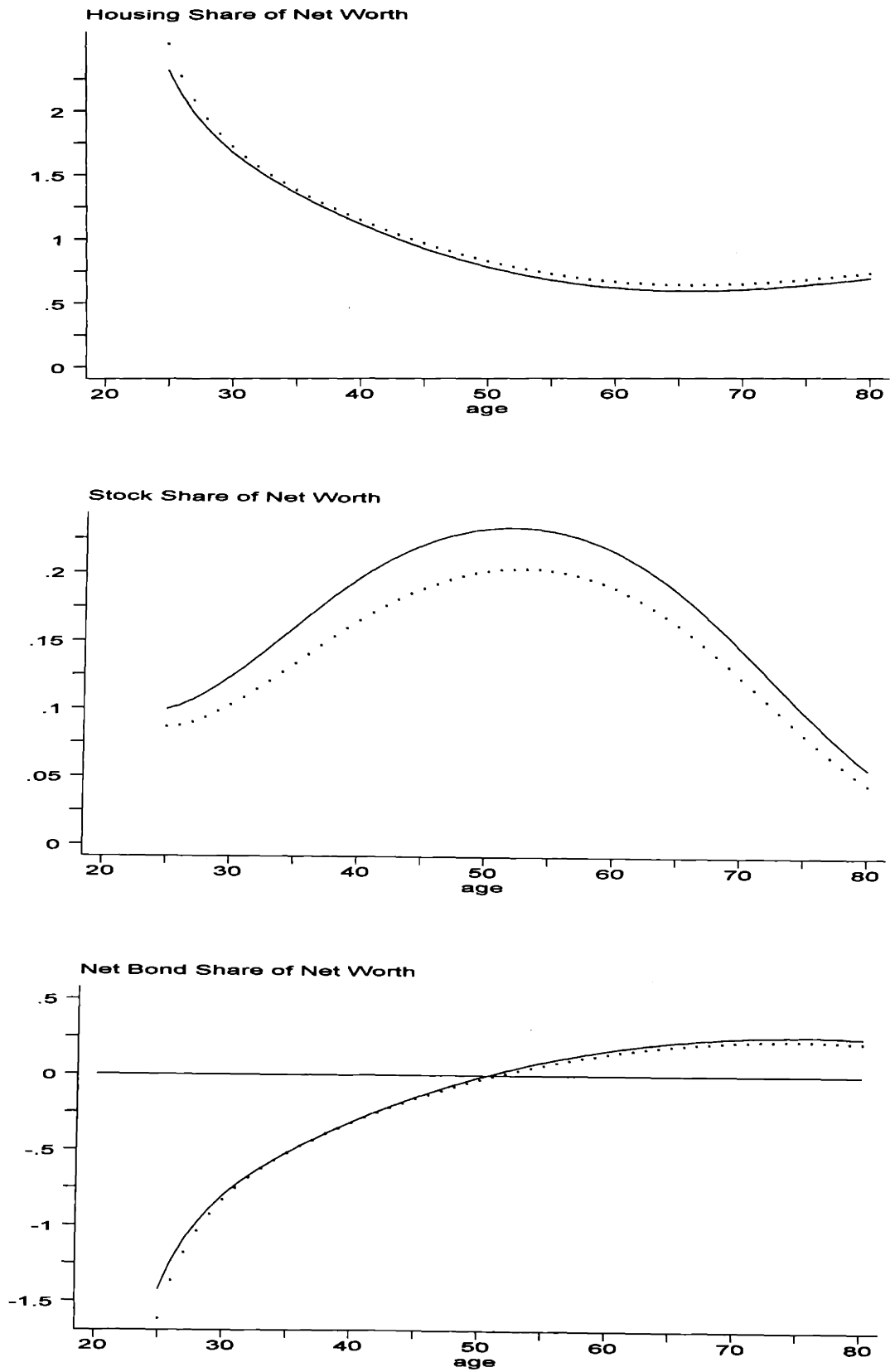


Figure 4.5c



Given the assumption of a 1.5% annual cohort effect in log real income growth, someone age 75 in 1995 would tend to have about 31% less income at every age than someone 25 years his junior. The result is that, at every age throughout the adult life cycle, this individual has substantially lower holdings of housing, stocks, and bonds than the typical baby boomer. Per spouse holdings of housing at age 60 are about 23% lower for this individual, while per spouse holdings of stocks and bonds are, respectively, about 37% and 36% lower at age 60 than for the typical baby boomer. Debt per spouse is also lower at every age than for the typical baby boomer, since, at every age, this individual has less future income against which to borrow.

Looking at Figure 4.5b we see that even though the reduction in lifetime income causes total assets and net worth to be lower at all ages, net financial assets and net bonds are actually higher (but still negative) at young ages. Thus, the reduction in borrowing at young ages more than offsets the accompanying lower levels of investment in financial assets. The flip side of this, however, is that the individual with lower lifetime income acquires far less financial wealth during middle age than does the typical baby boomer.

Looking at the bottom panel of Figure 4.5b, one sees that, as with the addition of children, a reduction in lifetime income doesn't significantly impact the distribution of total financial assets. Notice, however, that it does lead to a significant reduction in the share of net worth invested in stocks, as can be seen in the middle panel of Figure 4.5c. In contrast, the housing and net bond shares of net worth displayed in that figure are left more or less unaffected by the reduction in lifetime income. One possible explanation for the apparent shift out of stocks and into bonds (net of debt) is, as described previously, that the reduction in income is equivalent to a reduction in bond holdings and so requires that individuals increase actual bond holdings if they are to maintain the same level of risk exposure in their overall, i.e. income inclusive, portfolio. The housing share of net worth is left more or less unaffected by the reduction in lifetime income because much of the reduction in household holdings of housing are offset by accompanying reductions in mortgage debt.

The combined effects on life cycle asset holdings of having more children and less income are displayed in Figures 4.6a-4.6d. Looking first at Figure 4.6a, one sees that, even though having additional children creates an increased demand for housing, the large negative impact on housing demand of having lower lifetime income is more than enough to offset

Figure 4.6a

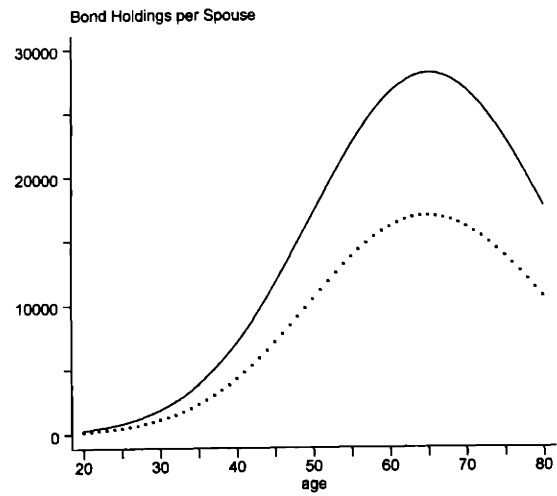
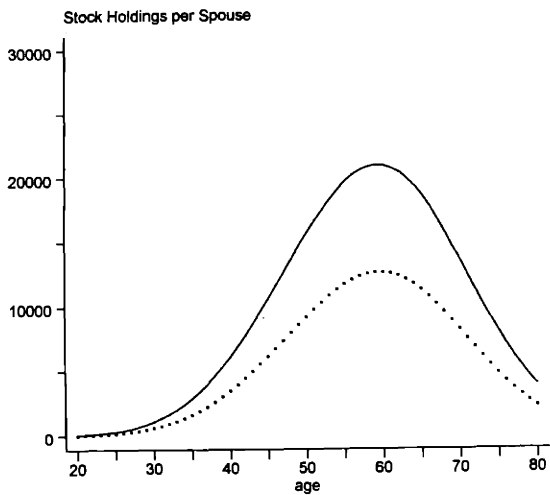
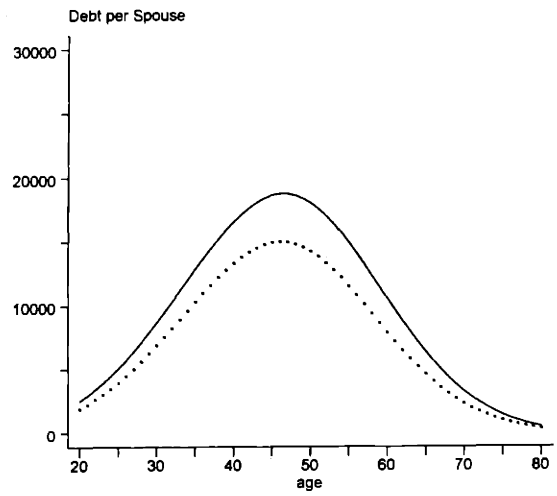
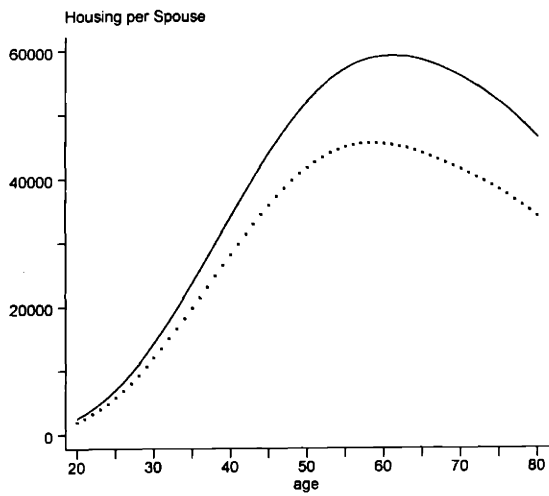
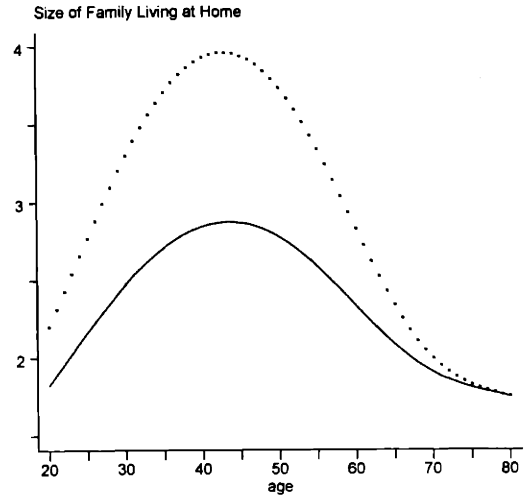
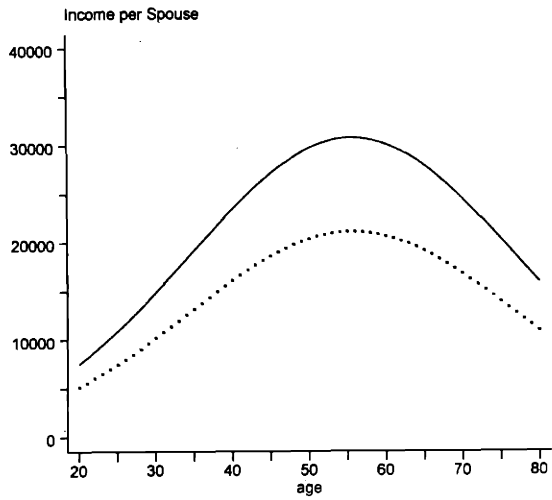


Figure 4.6b

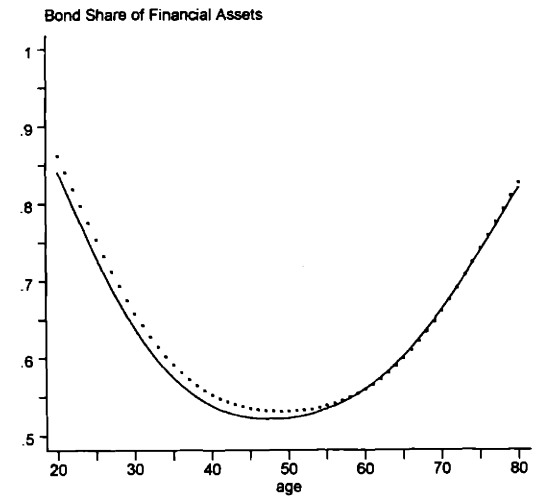
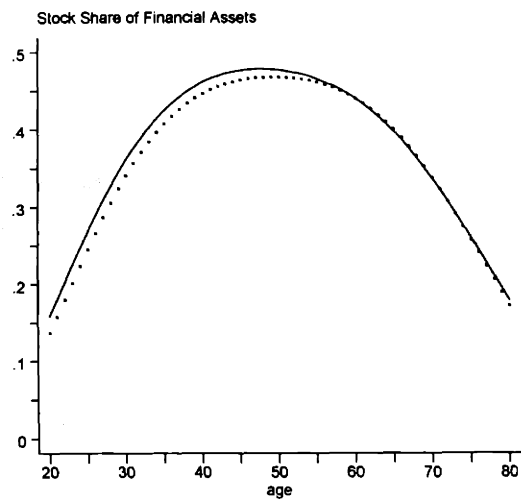
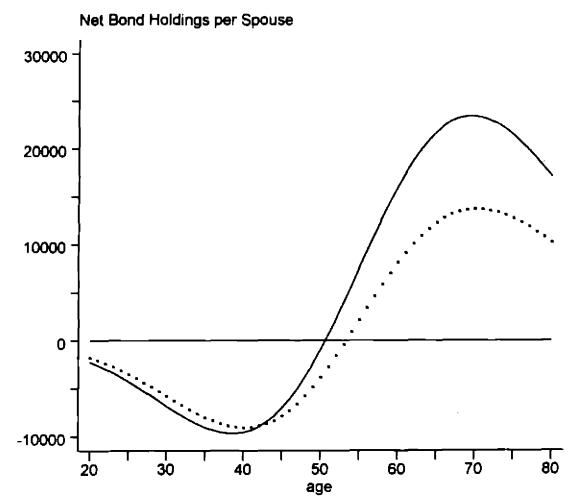
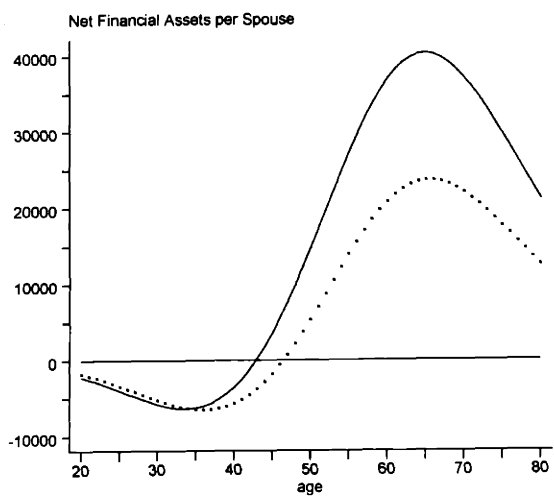
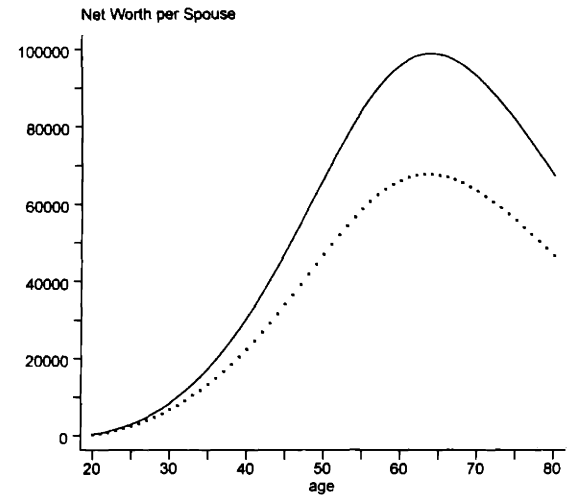
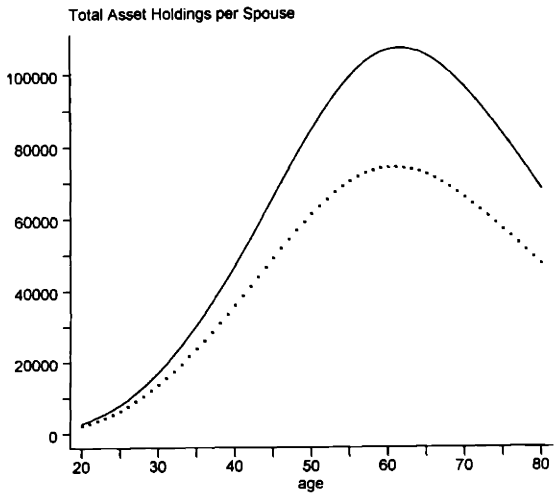


Figure 4.6c

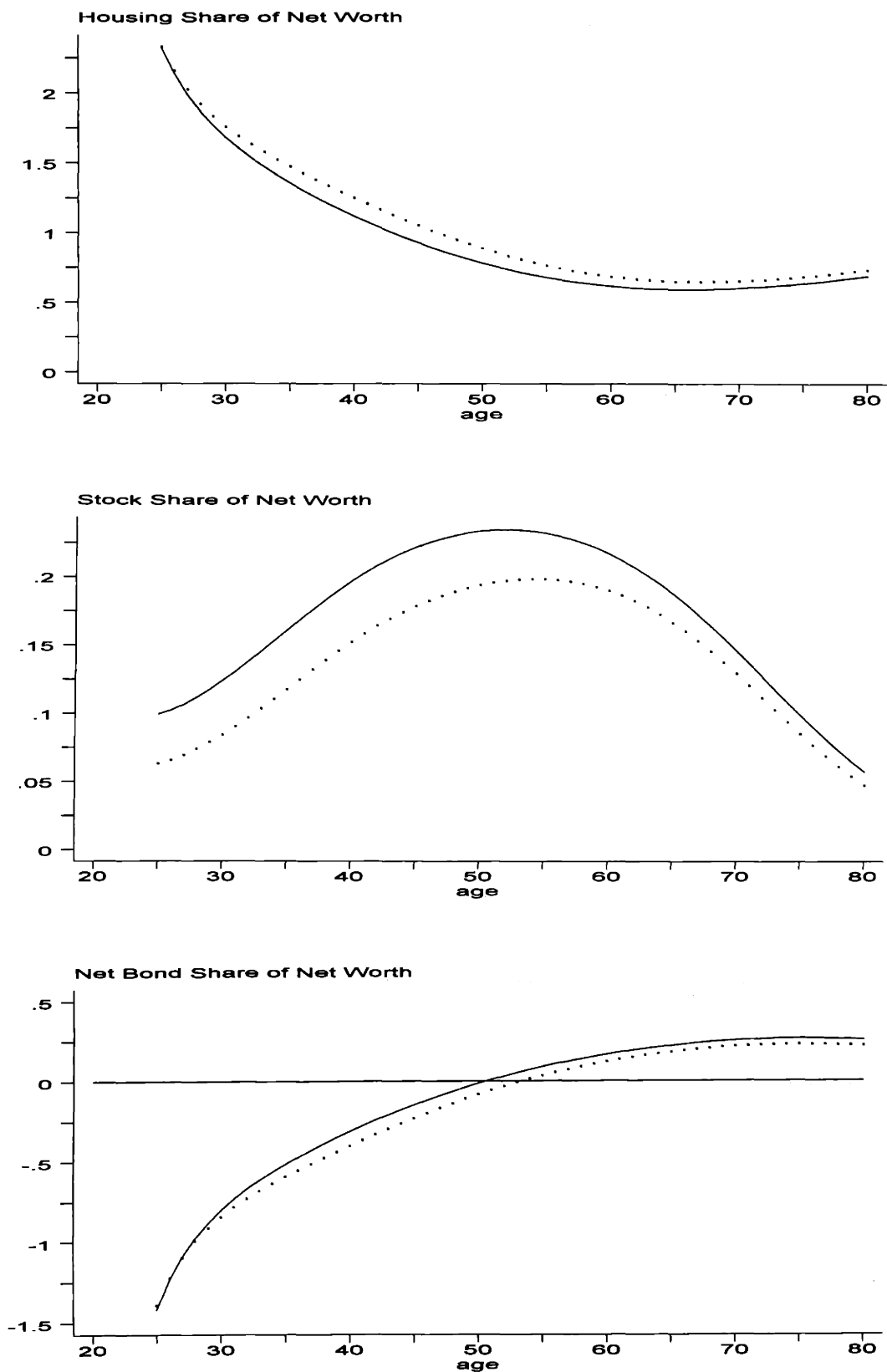
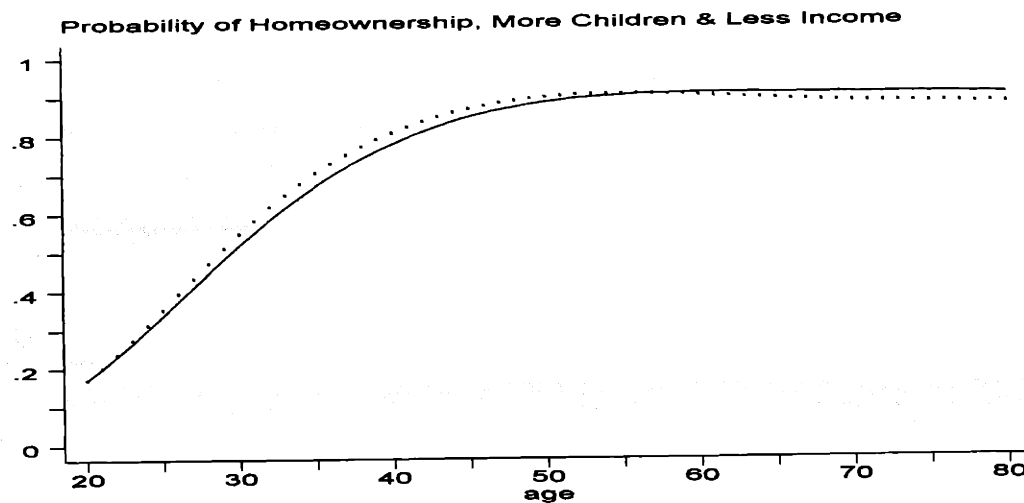
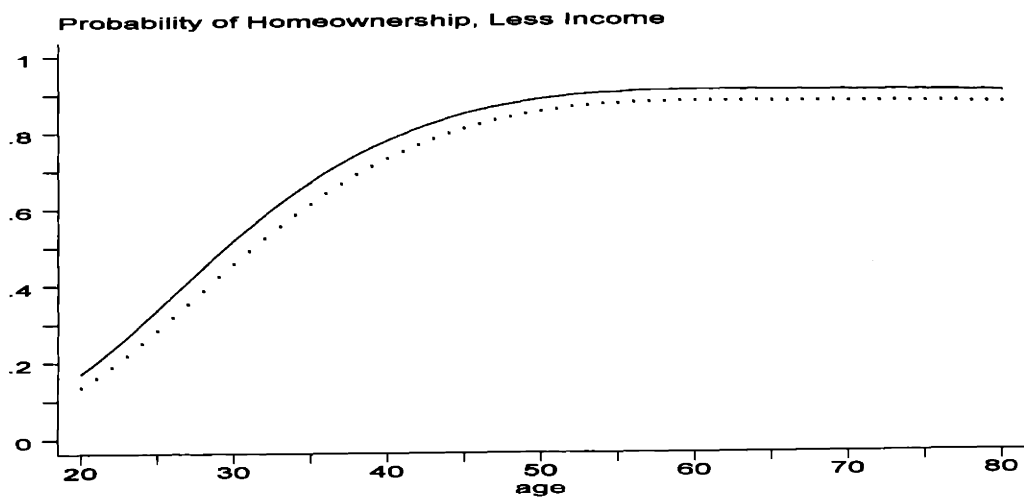
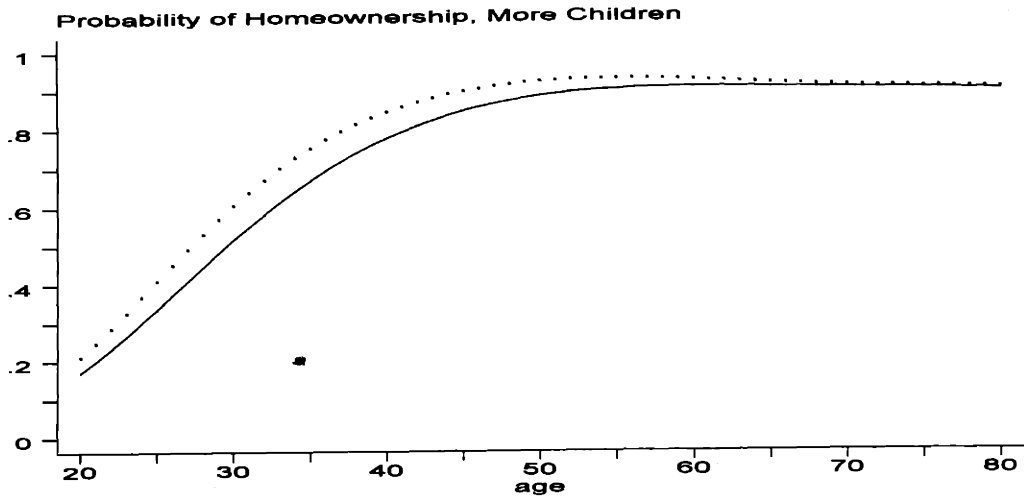


Figure 4.6d



this. The result is that, despite having twice as many children as the typical baby boomer, the typical parent of a baby boomer holds substantially less housing. Per spouse holdings of housing at age 60, for example, are about 23% lower. As can be seen in Figure 4.6d, this difference does not appear to reflect any significant reductions in homeownership rates; rather, it reflects mostly a reduction in the size and/or quality of homes owned.

Looking at the life cycle profiles for total debt, one sees that the increased demand for debt brought on by having additional children is more than offset by the negative effect of having lower lifetime income. As a result, household debt is about 25% lower at age 60 for the typical parent of a baby boomer than for the typical baby boomer.

Since the effects on financial asset demand of having more children and lower income reinforce one another, the reduction in holdings of these assets is much larger than in the case of housing or debt. Holdings of stocks and bonds per spouse are about 40% lower at age 60 than for the typical baby boomer. In dollar terms the difference in stock holdings is a little more than \$8,000 per spouse and the difference in bond holdings net of debt is a little less than \$8,000 per spouse. Thus, the net financial assets at age 60 of the typical parent of a baby boomer are about \$16,000 less than for the typical baby boomer.

This difference in net financial assets can also be seen in the middle panel of Figure 4.6b. Looking at the graphs in Figure 4.6b, one can see that the typical parent of a baby boomer has lower total assets and net worth at every age than does the typical baby boomer and requires an additional four years before becoming a net supplier of financial assets. Notice, however, that the distribution of total financial assets does not differ much from that of the typical baby boomer. It is only when we look at the distribution of net worth, displayed in Figure 4.6c, that we see the full extent to which life cycle portfolio allocation is affected. As would be expected, the largest effect is on the stock share of net worth, which is about four percentage points lower at age 50 than for the typical baby boomer (19% vs 23%).

4.3.5 Life Cycle Asset Holdings: Child of Baby Boomer

Figures 4.7a-4.7c present life cycle profiles for someone age 25 in 1995. Given the birth rates displayed in Figure 2.1, we can assume that the two generations will have about the same family size profiles. The only difference, therefore, is that someone age 25 in 1995 will receive about 31% more income at every age than the typical baby boomer. The effects of

the higher lifetime income on life cycle asset holdings are the reverse of what was presented in Figures 4.5a-4.5c. The typical person age 25 in 1995 can be expected to hold more housing, stocks, bonds, and debt than the typical baby boomer. Once again, the higher debt levels, especially at younger ages, reflect the fact that this individual has more future income against which to borrow. Consequently, as seen in Figure 4.7b, net financial asset holdings per spouse are lower at ages under forty than for the typical baby boomer, but rise much more rapidly after age forty and reach a maximum at age 65 that is 57% higher than the maximum net financial asset holdings achieved by the typical baby boomer, and more than 168% higher than the maximum net financial asset holdings achieved by the typical parent of a baby boomer. Finally, looking at Figure 4.7c, one sees that having higher lifetime income leads the typical child of a baby boomer to invest a significantly larger share of his net worth in stocks than either his parents or grandparents.

Overall, the cross sectional and life cycle profiles of asset demand analyzed in this chapter are consistent with what we had anticipated. Young households tend to draw credit out of financial markets, primarily to fund the purchase of a home, middle-aged households tend to invest heavily in financial assets above and beyond any borrowing they may do, and older households tend to draw down on previously accumulated wealth, especially previously accumulated financial wealth, in order to fund consumption during retirement. The estimated responses of life cycle asset holdings to changes in family size and lifetime income were also much what we would have expected, and highlighted the magnitude of differences in asset demand across cohorts.

Figure 4.7a

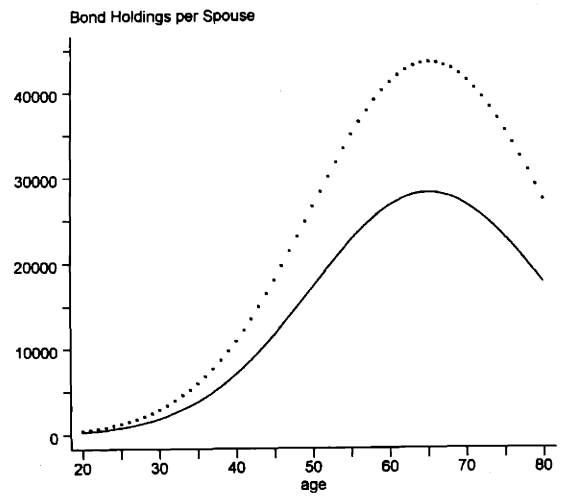
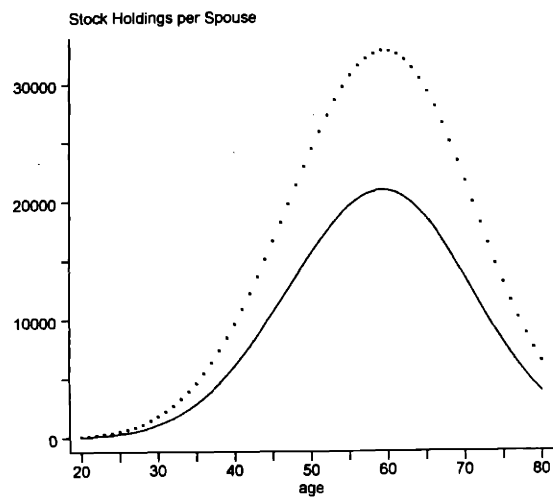
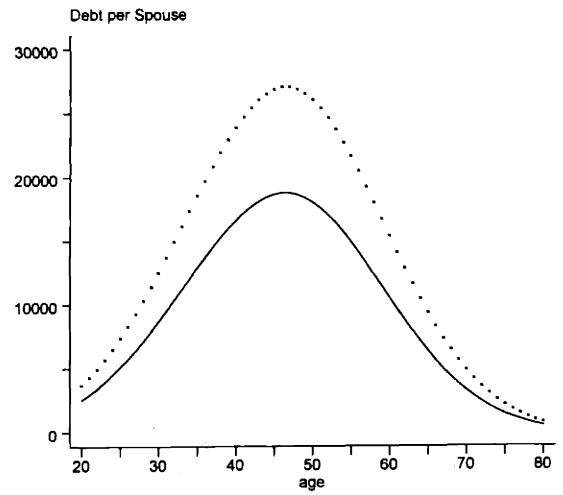
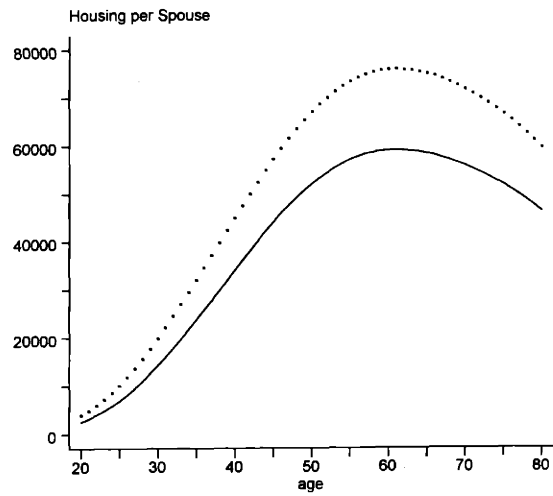
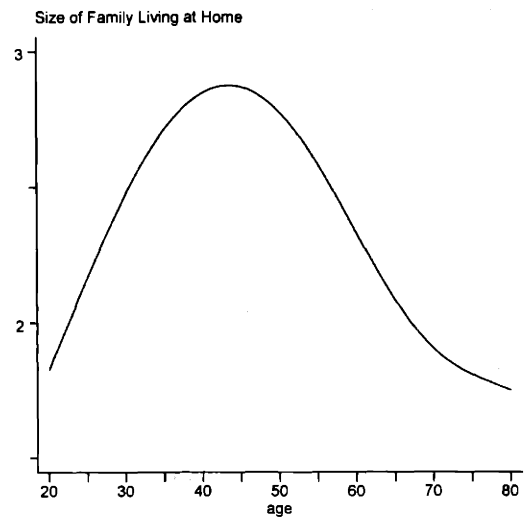
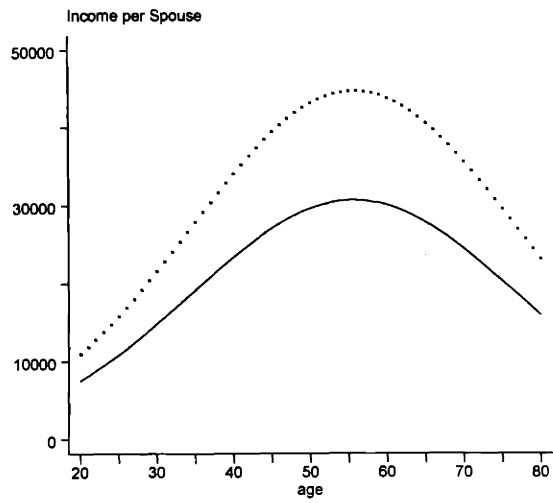


Figure 4.7b

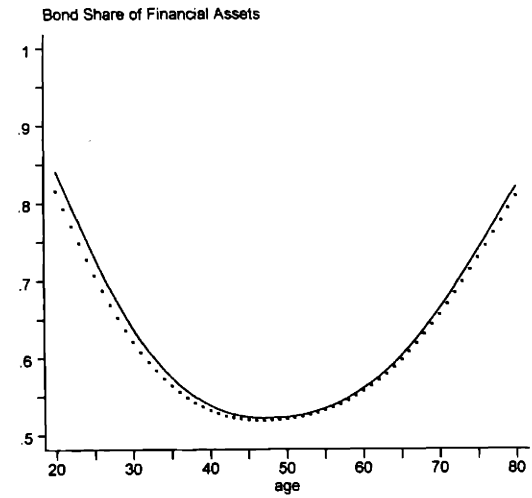
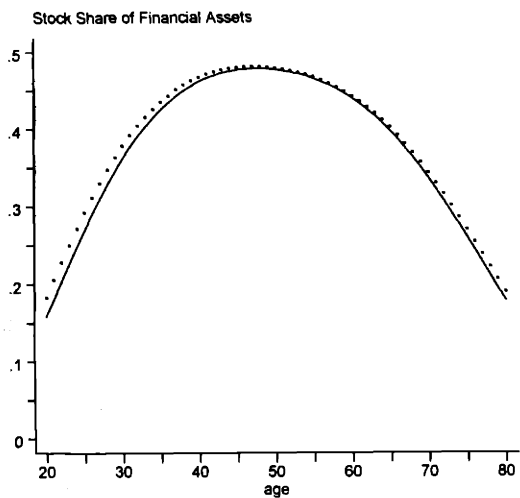
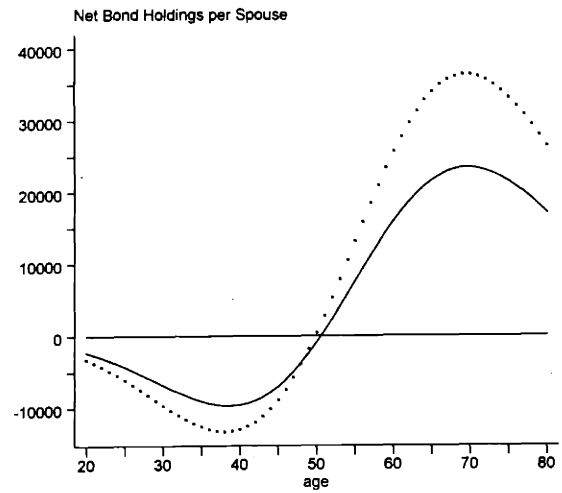
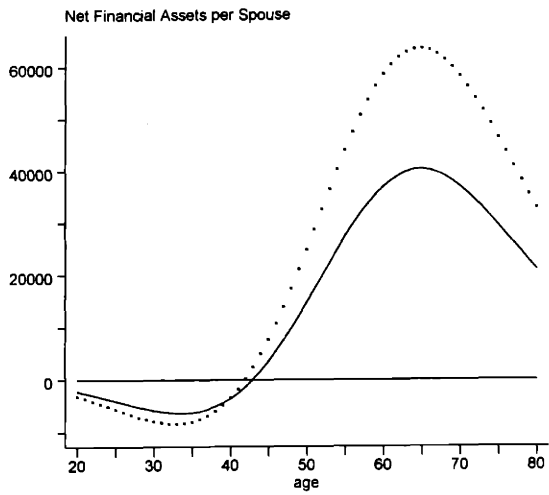
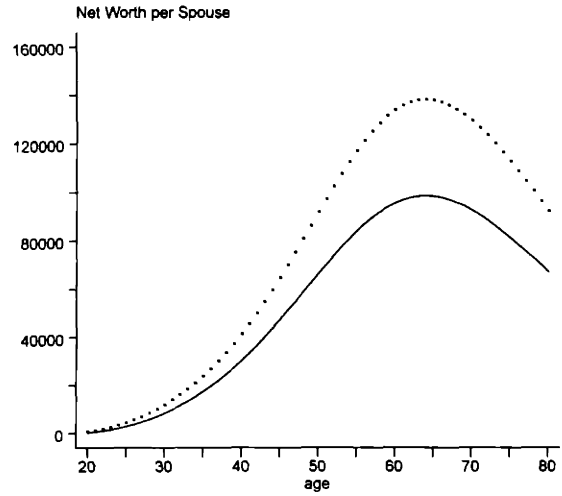
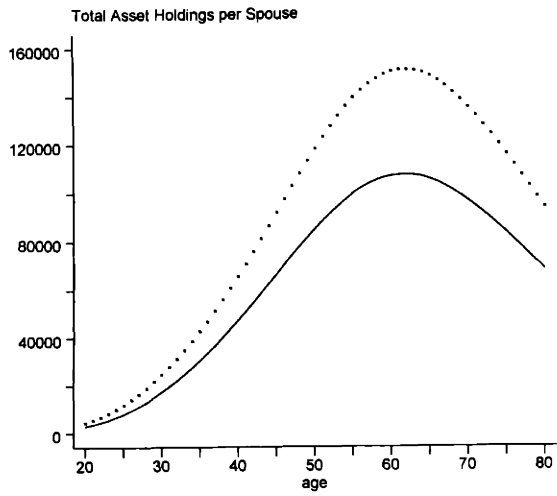
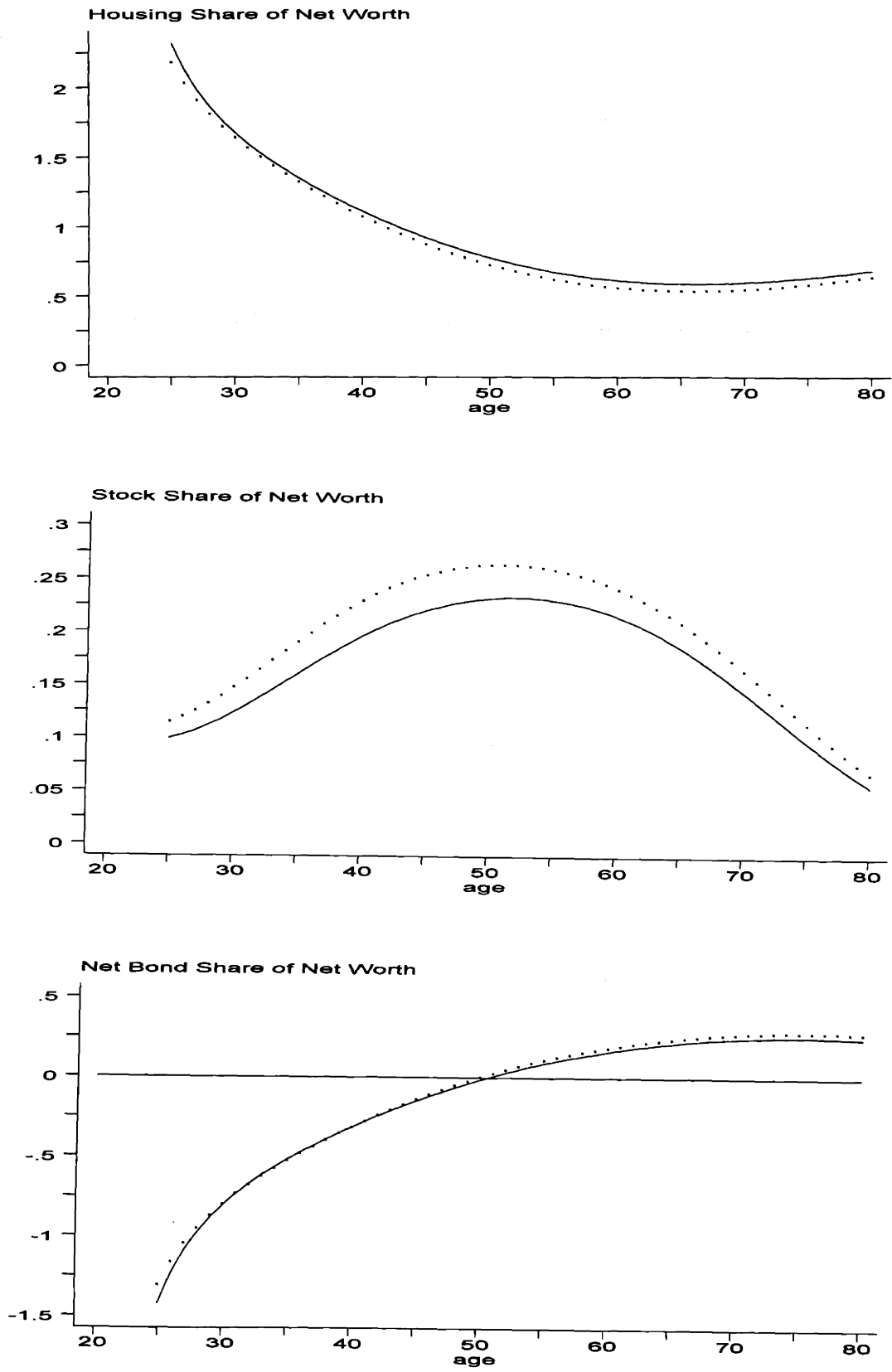


Figure 4.7c



Appendix

The present value of employer provided pension benefits was calculated as the sum of account balances from defined contribution pension plans, the present value of pension benefits currently being received, and the present value of anticipated future pension benefits from defined benefit plans. The present value of benefits currently being received was calculated by treating annual pension benefits as an annuity whose payment ends when the beneficiary dies. In cases where pension benefits would continue to be paid to a surviving spouse, payments were assumed to end when the final beneficiary dies. The expected age of death used in the present value calculations was 75, regardless of the current age of the primary beneficiary and any secondary beneficiaries. Thus, someone age 76 who was retired and receiving pension benefits at the time of the survey had calculated pension wealth of zero. Similarly, the only secondary beneficiaries whose potential payments were included in pension wealth were those who were younger than the primary beneficiaries, since they are the only ones who would still be under age 75 at the time when the primary beneficiary reaches that age. The discount rate used in performing the annuity calculations was set to 4% if the benefits were inflation adjusted and 8% otherwise.

The present value of anticipated future pension benefits from defined benefit plans were calculated in a similar manner. Individuals who expected to receive pension benefits were asked when they expected to begin receiving those benefits, what the benefit payments would be and at what frequency they would occur. In all cases the age of first benefit payment was set to the maximum of age 60 and the age reported by the individual. The present value of future benefits was then calculated as an annuity beginning at that age and continuing until age 75. Since individuals were not asked if their pension benefits would be inflation adjusted, it was assumed that they would not and an 8% discount rate was used. In cases where individuals expected a lump sum payout, the present value of that single payout was calculated. Finally, when individuals reported their pension benefits as a percentage of pay at retirement, their pay at retirement was assumed to be equal to their current salary.

The assumptions used in estimating pension wealth are admittedly quite conservative, but there is a reason for this. Recall that what we wish to investigate in terms of the financial asset holdings of households is how their net supply of credit to financial markets

changes over the course of the life cycle. For this reason we want estimated household financial assets to measure all direct and indirect sources of saving by the household. In particular, we are not interested in recording the value of pension benefits that an individual is entitled to; rather, we wish to estimate the value of any saving that has been done to provide for those pension benefits. Since individuals who were older than age 75 in any of the three survey years are likely to have exhausted any saving that was done in anticipation of their retirement, we don't want to record the present value of their current benefits as accumulated wealth. Similarly, by assuming that retirement cannot occur before age sixty and that pay at retirement is equal to current pay, we reduce the chances of overestimating the accumulated pension wealth of younger households. Finally, since the federal government has de facto been using social security deposits to fund current government spending, the social security taxes of individuals are treated as a form of indirect consumption and are excluded from calculated total financial wealth.

Chapter 5

Demographics and Asset Prices in the U.S.

In this chapter we use the estimated life cycle profiles from Chapter 4 to construct aggregate demographic demand variables for housing, stocks, bonds, and debt and use them to examine the relationship between demographics and asset prices. Section 5.1 describes the construction of the demographic demand variables used in the analysis of this chapter. Section 5.2 presents empirical evidence on the relationship between demographics and asset prices, including an analysis of the strength of the relationship at different frequencies. Finally, Section 5.3 uses the estimated relationships between the demographic demand variables and corresponding asset price series to assess the historical importance of demographic factors in bringing about past asset price cycles, and to produce long run forecasts of future housing, stock, and bond prices.

5.1 Calculating Demographic Asset Demand

Aggregate demographic asset demand is calculated as follows. Cross sectional profiles for holdings of housing, stocks, bonds, and debt were calculated using the estimated coefficients from the regressions in Table 4.3, substituting in cross sectional profiles for real income and family size/composition. As with the life cycle profiles, past and expected future inheritances, trusts, and transfers were set equal to zero when constructing the cross sectional asset holdings profiles. The cross sectional income profiles were calculated using the estimated coefficients from the real income equation in Table 4.2, with an annual cohort effect

of 1.5% per year added in. Thus, for example, the ‘average’ log real income of individuals age 50 in 1994 was set equal to the ‘average’ log real income of individuals age 50 in 1995 minus 0.015. In generating cross sectional age profiles for family size and percent of family living at home, it was assumed that all birth cohorts, other than those born between 1920 and 1935, have ‘average’ life cycle profiles for number of children living at home that are consistent with the cross sectional profile estimated from the 1995 SCF sample. Individuals born between 1920 and 1935 are treated as the generation who parented the baby boom and so were assumed to have twice as many children living at home at every age than individuals from other cohorts.¹ The set of demographic asset demand variables constructed from these cross sectional profiles, therefore, incorporate both the effects of trend growth in real income on life cycle asset holdings, and an estimate of the effect of the baby boom generation on the behavior of their parents.

Measures of aggregate demographic demand for asset holdings were constructed from the time series of cross sectional profiles by using these year and age specific measures of demand for asset holdings to sum over the population of adults alive in each year. Specifically, if we let $A_t^j(a)$ denote the ‘average’ holdings of asset j by someone age a in year t , and let A_t^j denote aggregate demographic demand for holdings of asset j in year t , then A_t^j was calculated as,

$$A_t^j = \sum_{a=20}^{85^*} A_t^j(a)N_t(a)$$

where $N_t(a)$ is the number of people age a in year t , and where 85* denotes the group of people age 85 and older.²

The demographic portion of flow demand for each asset j , which we will refer to, simply, as the demographic demand for asset j , was calculated as $A_t^j - A_{t-1}^j$. The demographic demand variables for stocks, bonds, and debt were then used to calculate measures of the net demographic demand for financial assets and the demographic demand for stocks in excess of bonds. Specifically, the net demographic demand for financial assets, F_t , was calculated as the ratio of the demographic demand for stocks plus bonds to the demographic demand

¹The years 1920 and 1935 are chosen as the cutoff points for this generation because these are the individuals who turned twenty five (prime birthing age) at some point between 1945 and 1960.

²The Census Bureau population data groups together individuals age 85 and over until 1980. For consistency purposes, therefore, the ‘average’ asset holdings of all individuals age 85 and over were set equal to the estimated ‘average’ asset holdings for someone age 90, in each year.

for debt, while the demographic demand for stocks in excess of bonds, S_t , was calculated as the ratio of the demographic demand for stocks to the demographic demand for bonds. This last variable is intended to be a measure of aggregate portfolio preference for stocks over bonds and is included on the right hand side of stock and bond price regressions, along with the net demographic demand for financial assets, as part of an attempt to measure the effect of demographically driven shifts in aggregate portfolio preference on stock and bond prices.

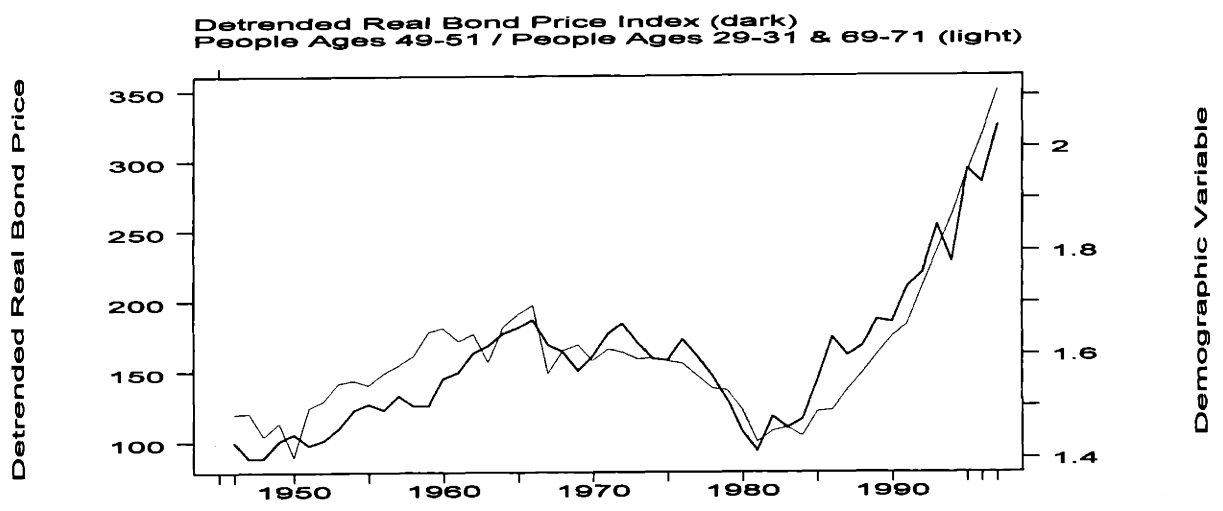
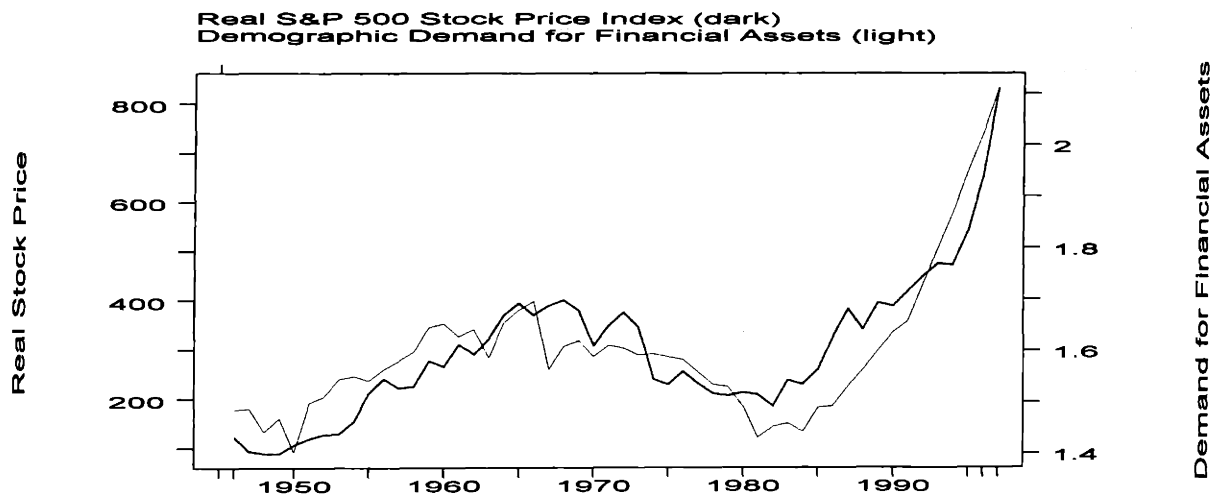
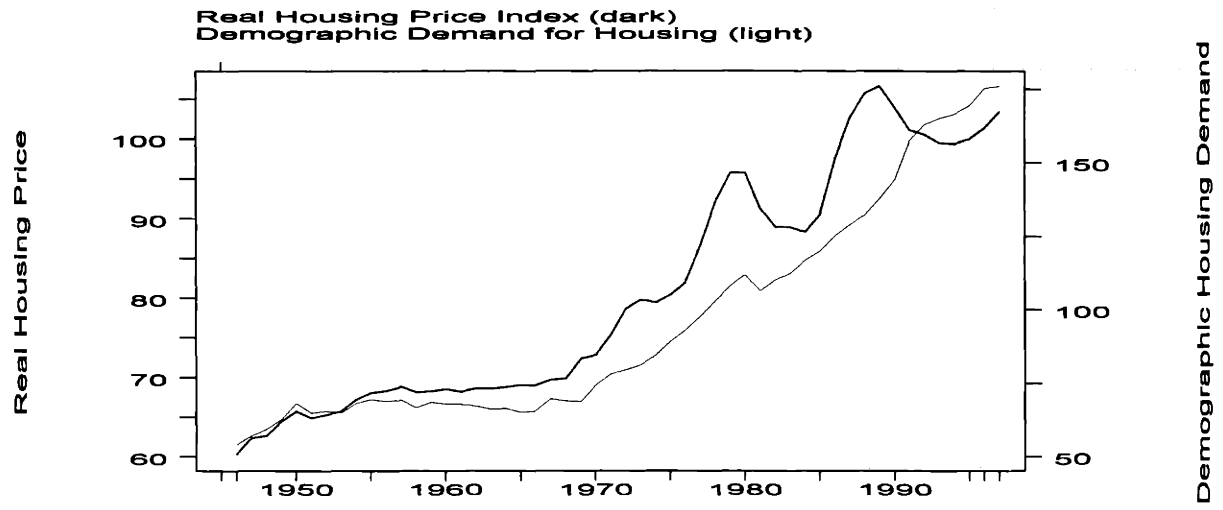
Before turning to the regression results of the next section, it seems appropriate to revisit the graphs of Figure 1.1, replacing the demand variables used in those graphs with the ones that we have just constructed. This is done in Figure 5.1. The top panel plots the real housing price index against the demographic demand for housing, H_t , while the bottom two panels plot, respectively, the real S&P 500 stock price index and the detrended real bond price index against the net demographic demand for financial assets, F_t .

The graphs in Figure 5.1 resemble those in Figure 1.1, and, as we would have hoped, tend to improve on them. This is most evident in the stock and bond price graphs in the bottom two panels, but is also true of the housing price graph in the top panel. It does appear, therefore, that Figure 1.1 was displaying something more than just a spurious relation. We will investigate this further in the regression analysis that follows.

5.2 Demographics and Asset Prices: Empirical Evidence

The purpose of this section is to test the statistical significance of the apparent correlations between the demographic asset demand variables and corresponding asset price series. It would also be interesting to know at what frequency these correlations become statistically significant and to see how the strength of these correlations changes with changes in frequency. The regression results presented in the subsections that follow attempt to address these issues.

Figure 5.1



5.2.1 Real Housing Price Appreciation and the Demographic Demand for Housing

The housing price variable used in this chapter, and in the introduction, is a composite of several different housing price indexes. From 1946 through 1952, nominal housing price appreciation is calculated from changes in the average annual chain type residential investment price index, published by the Bureau of Economic Analysis (BEA); from 1953 through 1967, it is calculated from changes in the average annual Consumer Price Index for shelter (including rental housing), published by the Bureau of Labor Statistics (BLS); from 1968 through 1979, it is calculated from changes in the median sale price of existing single family homes, published by the National Association of Realtors (NAR); and from 1980 through 1997 it is calculated from changes in a repeat transactions housing price index, published by the Office of Federal Housing Enterprise Oversight (OFHEO). The reason for using so many subindexes is that the only housing price index available for the entire post war period, the BEA residential investment price index, does not provide a satisfactory measure of single family housing price appreciation. The problems with the BEA index are twofold. First, it is a construction cost index and, second, its coverage is all residential investment. Thus, what the BEA index provides is a measure of changes in the cost of inputs for all residential investment (including, for example, apartment buildings), whereas what we would like is a measure of changes in the market value of single family homes. The most appropriate of the published indexes for our purposes is the OFHEO index, which measures price appreciation on single family homes from repeat sales and mortgage transactions on properties whose mortgages have been purchased or securitized by the Federal National Mortgage Association (Fannie Mae) or Federal Home Loan Mortgage Corporation (Freddie Mac). Unfortunately, it is only available for 1980 and subsequent years. Years prior to 1980 are filled in with the most appropriate housing price index available. Since the NAR index is available only for years after 1967, and the CPI-shelter index available only for years after 1952, the years between 1946 and 1952 are filled in with the BEA index.³

³Since other researchers may prefer internal consistency over external consistency in deciding how to use the available housing price data, it should be noted that the qualitative results presented in this chapter are robust to the choice of housing price index. Four different indexes were constructed and tested. They included the one just described, which is used throughout this thesis; one which drops the OFHEO index and extends the use of the NAR median sale price index through 1997; one that drops both the OFHEO and NAR indexes and extends the use of the CPI-shelter index through 1997; and one composed of just the BEA index. In every case, housing price appreciation was positively correlated with growth in the demographic

Table 5.1 presents results from OLS regressions of real housing price appreciation on growth in demographic housing demand. The columns in the table correspond to horizons of 1,2,3,4,5 and 10 years. The left hand side variable for the k year horizon regression is the (log) average annual rate of real housing price appreciation between years t and $t + k$. The top panel of the table presents results from regressions of this variable on a constant and the (log) average annual growth rate of demographic housing demand between years t and $t + k$. Below each estimated coefficient are two estimates of its standard error. Because the use of overlapping data in the multi-year regressions creates a serially correlated error term, the standard OLS estimates of the coefficient standard errors are inconsistent. One way to correct for this is to calculate Newey-West (1987) heteroskedasticity and autocorrelation consistent standard errors. Thus, the first number below each estimated coefficient lists the Newey-West standard error for the estimated coefficient, calculated setting autocovariances beyond lag $k-1$ to zero.⁴ Richardson and Stock (1989), however, point out that standard adjustments such as this may be inadequate when applied to overlapping data such as that used in this chapter. For this reason, the regression output includes a second standard error, denoted by an M.C. in the left hand column of the table, estimated from Monte Carlo simulations of the various regressions.

The Monte Carlo standard errors for the top panel were calculated as follows. First, one thousand annual housing price appreciation series were generated as i.i.d. normal random variables with mean and variance matching the sample mean and variance of the actual housing price appreciation series. These series were then used to calculate k year price appreciation series which were regressed on a constant and the k year annual growth rate of demographic housing demand. Since the true coefficients on the demographic demand variable in these regressions are zero, the estimated coefficients from the simulated regressions can be used to estimate the asymptotic standard errors of the estimated coefficients from the original regression under the null hypothesis of no correlation between demographic demand and real housing prices. Specifically, if we let $\hat{\beta}_k$ denote the estimated coefficient on the demographic housing demand variable in the k year regression, using the actual housing price series, and let $\hat{\beta}_k^i$ denote the estimated coefficient from the k year regression

demand for housing. Further, these correlations continue to be statistically significant when the OFHEO index is dropped and the NAR index extended.

⁴The reasoning for this is that the calculation of k year growth rates results in a $k - 1$ year overlap of data, and so yields an $MA(k - 1)$ error term.

using the i^{th} simulated housing price appreciation series, then the Monte Carlo estimate of the variance of $\hat{\beta}_k$ is

$$V(\hat{\beta}_k) = \frac{1}{1000} \sum_{i=1}^{1000} (\hat{\beta}_k^i)^2$$

Similarly, the Monte Carlo estimated variance for the constant term in the original regression is

$$V(\hat{\alpha}_k) = \frac{1}{1000} \sum_{i=1}^{1000} (\hat{\alpha}_k^i - \mu_h)^2$$

where the $\hat{\alpha}$ s denote estimated intercept terms and where μ_h is the true mean of the simulated housing price appreciation series, which, by construction, is the sample mean of the actual housing price appreciation series. Monte Carlo standard errors for the remaining panels in the table, and for subsequent tables of regressions were calculated in the same manner. As in previous regression tables, entries are emboldened if the corresponding estimated coefficient is statistically significant at the 5% level or below. Since we now have two sets of standard errors from which to calculate t-statistics, the standard error(s) for which the estimated coefficient is statistically significant is emboldened. It is interesting to note that, in the financial asset regressions, the Monte Carlo standard errors tend to be significantly larger than the Newey West standard errors, and so do, in fact, provide a more powerful test of the estimated coefficients' statistical significance.

Also included among the regression output are Monte Carlo adjusted R^2 s. Since the true correlation between the demographic demand variables and simulated housing price appreciation series are zero, the average R^2 s from the simulated regressions provide an estimate of the upward bias in the R^2 s of the actual regressions, allowing us to calculate R^2 s that adjust for both the number of explanatory variables in the regression and for the use of overlapping data. The R^2 s presented in the regression tables, therefore, provide rather conservative estimates of the correlation between the actual and fitted price appreciation series that can reasonably be compared across horizons and across specifications. The formula used to calculate the Monte Carlo adjusted R^2 s for the k year regressions is

$$\tilde{R}_k^2 = \max\{0, R_k^2 - \frac{1}{1000} \sum_{i=1}^{1000} (R_k^2)^i\}$$

where R_k^2 is the R^2 from the k year regression using the actual housing price appreciation series and where $(R_k^2)^i$ is the R^2 from the k year regression using the i^{th} simulated housing price appreciation series.⁵

We now turn to a discussion of the regression output presented in Table 5.1. Looking at the results in the top panel of the table, one sees that the estimated coefficients on the demographic housing demand variable are positive and statistically different from zero at the 5% level for every regression when using the Newey-West standard errors, and for every regression except the ten year ahead regression when using the Monte Carlo standard errors. The estimated elasticities range in value from 0.252 for the one year regression to a high of 0.377 in the four year regression, and are generally higher at longer horizons. The constant term in the regression is near zero and statistically insignificant in every regression except the ten year regression, and even there is significant only for the Newey-West standard error. This suggests that, after accounting for growth in demographic demand, there is no discernible trend in real housing prices. The Monte Carlo adjusted R^2 s at the bottom of the panel suggest that demographic housing demand can account for between 10% and 12% of the variation in real housing price appreciation over periods of one to five years and for more than 30% over periods of ten or more years.

In interpreting the results in this and later tables, it is important to keep in mind that, although the demographic variables measure growth in demand between years t and $t + k$, they are known in year t since their calculation only requires knowledge of the current age distribution of the adult population.⁶ The regressions in Tables 5.1 through 5.3, therefore, measure the ability of predictable future growth in demographic demand to forecast future rates of real price appreciation. Given the difficulty in forecasting asset price movements, the finding of a statistically significant relationship between the demographic housing demand variable and housing price appreciation series in Table 5.1 is impressive. It is made even more so by the decidedly lack luster performance of the business cycle variable used in the next panel of the table.

The regressions in the middle panel of Table 5.1 replace growth in demographic housing

⁵As can be seen in the tables, the adjustments were made even for the one year ahead regressions, which use no overlapping data.

⁶Actually, deaths and migration will also affect the calculation, but for countries with fairly predictable migration patterns and mortality rates, such as the U.S., one should be able to forecast the age distribution of the adult population up to 10 years out with extremely high accuracy.

Table 5.1: Demographic Housing Demand & Real Housing Price Appreciation

	Dependent Variable: $[\ln(P_{h,t+k}) - \ln(P_{h,t})]/k$					
	Sample: 1946 - 1997					
Horizon (years)	1	2	3	4	5	10
NOBS	51	50	49	48	47	42
$[\ln(H_{t+k}) - \ln(H_t)]/k$	0.252	0.322	0.364	0.377	0.367	0.344
N.W.	(0.115)	(0.162)	(0.183)	(0.179)	(0.166)	(0.096)
M.C.	(0.106)	(0.124)	(0.142)	(0.160)	(0.181)	(0.207)
Constant	0.005	0.003	0.002	0.002	0.002	0.003
N.W.	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.001)
M.C.	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.006)
R ²	0.117	0.143	0.173	0.196	0.213	0.530
M.C. adjusted R ²	0.096	0.110	0.123	0.126	0.120	0.332
$[\ln(Y_{t+k}) - \ln(Y_t)]/k$	0.121	0.257	0.258	0.215	0.093	-0.482
N.W.	(0.110)	(0.183)	(0.217)	(0.254)	(0.273)	(0.117)
M.C.	(0.129)	(0.157)	(0.179)	(0.219)	(0.251)	(0.371)
Constant	0.008	0.006	0.005	0.006	0.008	0.020
N.W.	(0.004)	(0.005)	(0.006)	(0.006)	(0.007)	(0.003)
M.C.	(0.004)	(0.004)	(0.005)	(0.005)	(0.006)	(0.008)
R ²	0.019	0.055	0.047	0.030	0.006	0.292
M.C. adjusted R ²	0.000	0.022	0.004	0.000	0.000	0.112
$[\ln(H_{t+k}) - \ln(H_t)]/k$	0.307	0.436	0.486	0.532	0.554	0.378
N.W.	(0.114)	(0.144)	(0.162)	(0.159)	(0.167)	(0.157)
M.C.	(0.111)	(0.130)	(0.145)	(0.163)	(0.190)	(0.218)
$[\ln(Y_{t+k}) - \ln(Y_t)]/k$	0.228	0.443	0.483	0.542	0.538	0.081
N.W.	(0.118)	(0.167)	(0.178)	(0.201)	(0.230)	(0.150)
M.C.	(0.136)	(0.165)	(0.181)	(0.220)	(0.256)	(0.359)
Constant	-0.001	-0.008	-0.010	-0.012	-0.012	0.001
N.W.	(0.004)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)
M.C.	(0.005)	(0.006)	(0.006)	(0.007)	(0.008)	(0.010)
R ²	0.177	0.288	0.320	0.351	0.356	0.534
M.C. adjusted R ²	0.135	0.222	0.229	0.229	0.200	0.263

$P_{h,t}$ is the real housing price index. H_t is the demographic housing demand variable defined, in Section 1 of Chapter 4. Y_t is real GDP per adult. Newey-West standard errors are calculated setting autocovariances beyond lag $k-1$ to zero, where k is the horizon length of the regression. Monte Carlo standard errors are calculated using 1000 simulations.

Figure 5.2

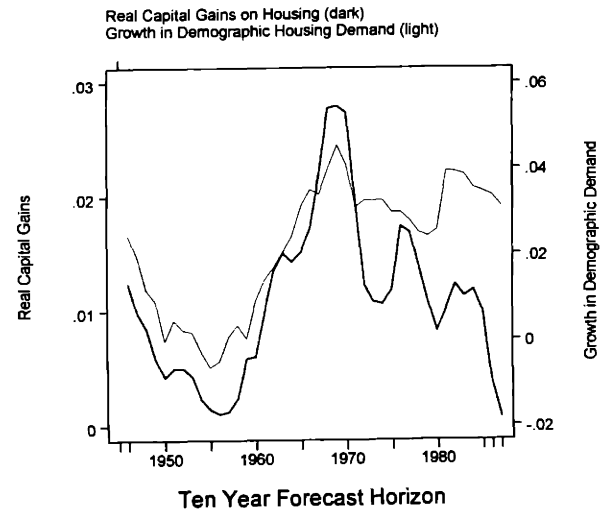
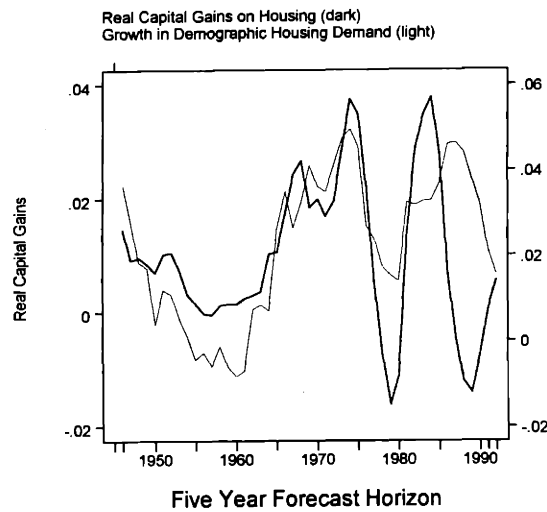
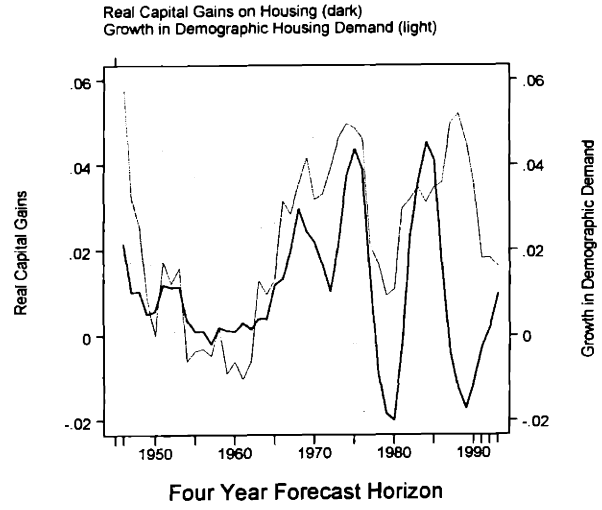
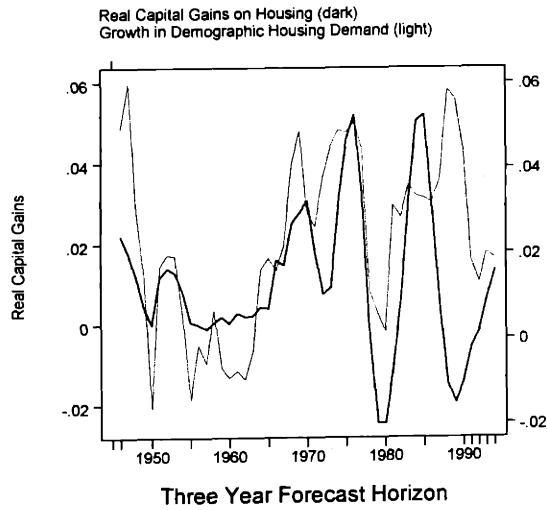
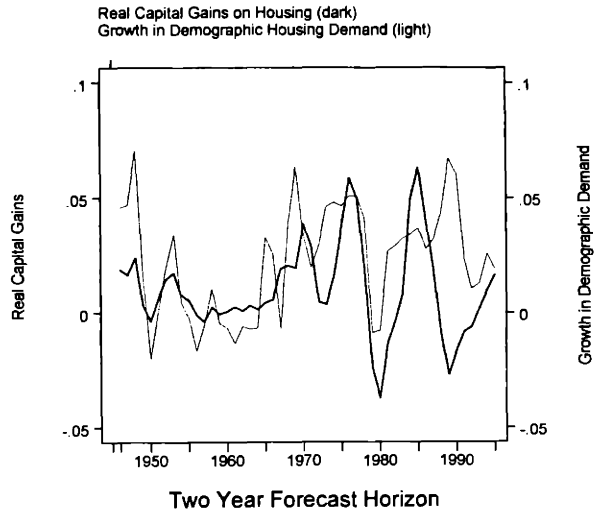
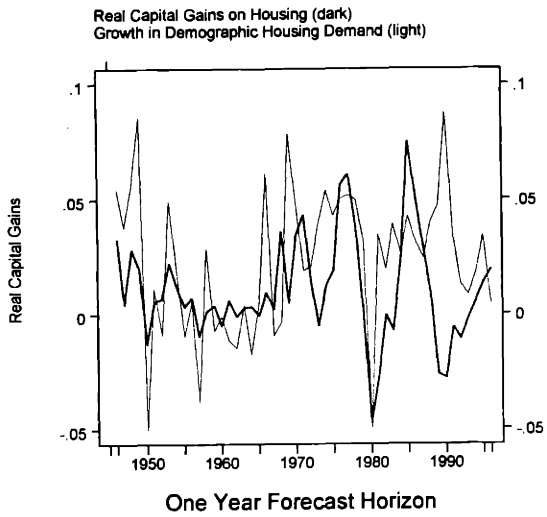
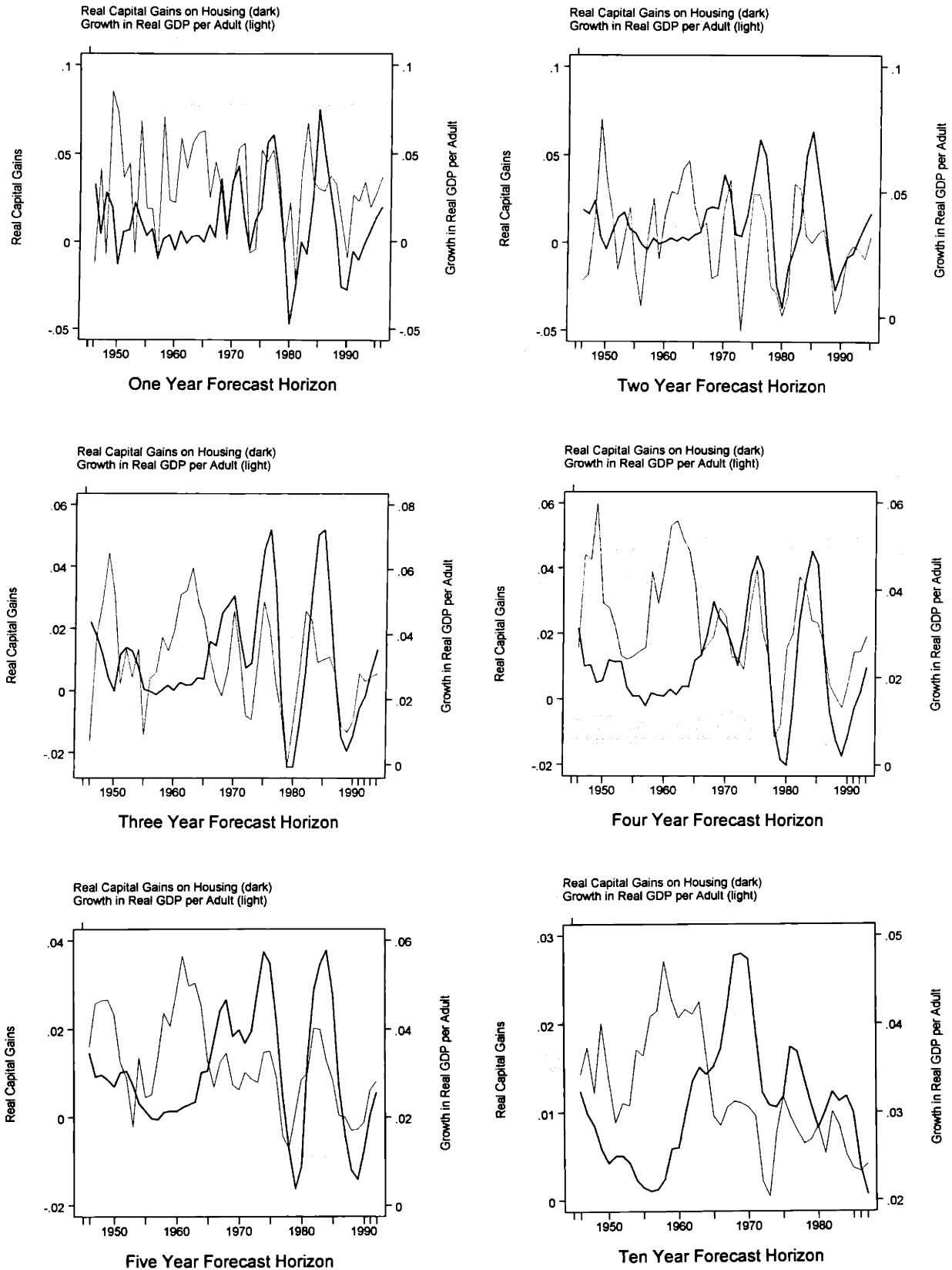


Figure 5.3



demand with growth in real GDP per adult (i.e. per person age 20 and over). To the extent that housing demand is related to income, one would expect real GDP growth to be positively correlated with real housing price appreciation. As in the top panel, the estimated coefficients on the income variable are generally positive, but are statistically insignificant regardless of the horizon length of the regression and standard error used in calculating the t-statistic. The one exception is in the ten year regression when using the Newey-West standard error, but, in this case, the estimated coefficient is negative. The estimated intercepts are statistically insignificant in most of the regressions, but are 300 to 600 basis points higher than those in the top panel of the table (1700 basis points higher in the ten year regression), suggesting that per adult income growth can not account for as much of the observed upward trend in real housing prices as can growth in the demographic demand for housing. Finally, notice that the Monte Carlo adjusted R^2 s in the middle panel are extremely low, ranging in value from 0 to 0.022 for the regressions in which the estimated coefficient on the income variable is positive, and so provide further evidence of a weak relationship between real housing prices and real income.

The regressions in the bottom panel of Table 5.1 use both the demographic demand for housing and real income per adult as explanatory variables. Once again, the demographic demand variable is statistically significant in every regression when using the Newey-West standard errors and in every regression except the ten year regression when using the Monte Carlo standard errors. Notice also that the estimated coefficients on this variable are significantly larger than in the top panel of the table for every regression horizon. The same is true for the income variable, which is now positive in every regression and statistically significant at the 5% level in all but two of the regressions, regardless of the standard errors used. The Monte Carlo adjusted R^2 at the bottom of the table are also much higher than in either of the first two panels, suggesting that the demographic demand and real income variables contain complementary information about real housing prices. This can also be seen in Figures 5.2 and 5.3.

The six panels of Figure 5.2 plot real housing price appreciation against the growth rate of demographic housing demand for each of the six horizons considered in Table 5.1. The positive correlation between real housing price appreciation and the growth rate of demographic housing demand is visible even at the one year horizon but becomes more noticeable at longer horizons, and is most obvious for the ten year horizon plotted in the

bottom left panel. As with the levels on levels graphs in Figure 5.1, however, there is a noticeable breakdown in the relationship following the second oil crisis in the late seventies and recessions of the early 1980s. Given the magnitudes of the economic downturn and subsequent recovery, it is no mystery that the correlation between demographics and real housing prices deteriorates over this period. It is a reminder of the fact that the relationship is a long term, low frequency one and so can be swamped over shorter periods of time by business cycle factors.

Figure 5.3, which displays a similar set of graphs for real GDP per adult, provides some information as to how the demographic demand and real income variables complement one another. As can be seen in the first few panels of the figure, the short run movements in real housing prices are highly correlated with the short run movements in real income per adult for the years after 1965. Indeed, fluctuations in real income per adult during the late 1970s and early 1980s appear to explain the breakdown between real housing prices and demographic housing demand over this period. Notice, however, that the positive short run correlation between real GDP and real housing prices becomes negative at longer horizons. Most notably, in the last panel of the figure, the decline in long run real GDP growth per adult between 1970 and 1980 (recall that the series forecast ten years ahead) moves opposite the steady increase in real housing prices over the same period. This somewhat counterintuitive observation is made more understandable by the corresponding graph in Figure 5.2, which shows that demographic housing demand was growing steadily over this same period of time.

5.2.2 Real Stock Price Appreciation and the Demographic Demand for Financial Assets

Table 5.2 presents results from regressions of real stock price appreciation on growth in the demographic demand for financial assets and excess demographic demand for stocks over bonds. The dependent variable in each regression is the average annual rate of real price appreciation on the S&P 500 index between years t and $t+k$. The data in this table provides strong evidence of a statistically significant, positive correlation between the demographic demand for financial assets and real stock price appreciation and somewhat weaker evidence of a positive correlation between demographically driven changes in aggregate portfolio preference and the rate of real stock price appreciation.

Table 5.2: Demographic Demand For Financial Assets and Real Stock Price Appreciation

Horizon (years)	Dependent Variable: $[\ln(P_{s,t+k}) - \ln(P_{s,t})]/k$					
	Sample: 1946 - 1997					
NOBS	1	2	3	4	5	10
	51	50	49	48	47	42
$[\ln(F_{t+k}) - \ln(F_t)]/k$	1.103	2.154	2.182	2.508	2.737	3.420
N.W.	(0.526)	(0.593)	(0.535)	(0.633)	(0.819)	(1.134)
M.C.	(0.709)	(0.900)	(0.999)	(1.093)	(1.191)	(1.353)
$[\ln(S_{t+k}) - \ln(S_t)]/k$	-1.355	-0.008	0.430	1.183	1.086	0.095
N.W.	(2.156)	(1.647)	(1.447)	(1.360)	(1.420)	(1.304)
M.C.	(2.323)	(2.576)	(2.696)	(2.785)	(2.856)	(2.959)
Constant	0.034	0.024	0.023	0.019	0.018	0.018
N.W.	(0.021)	(0.018)	(0.016)	(0.016)	(0.017)	(0.017)
M.C.	(0.020)	(0.020)	(0.021)	(0.022)	(0.022)	(0.023)
R ²	0.048	0.172	0.221	0.354	0.385	0.509
M.C adjusted R ²	0.008	0.102	0.116	0.209	0.199	0.148
$[\ln(D_{s,t+k}) - \ln(D_{s,t})]/k$	0.508	0.643	0.684	0.808	1.181	2.360
N.W.	(0.294)	(0.337)	(0.406)	(0.454)	(0.395)	(0.408)
M.C.	(0.312)	(0.344)	(0.407)	(0.475)	(0.592)	(0.841)
Constant	0.027	0.025	0.024	0.022	0.017	-0.006
N.W.	(0.020)	(0.018)	(0.017)	(0.018)	(0.018)	(0.012)
M.C.	(0.020)	(0.020)	(0.021)	(0.022)	(0.022)	(0.025)
R ²	0.052	0.103	0.122	0.165	0.251	0.668
M.C adjusted R ²	0.032	0.070	0.075	0.104	0.172	0.507
$[\ln(F_{t+k}) - \ln(F_t)]/k$	1.246	2.250	2.221	2.417	2.371	1.911
N.W.	(0.557)	(0.648)	(0.524)	(0.568)	(0.629)	(0.660)
M.C.	(0.714)	(0.901)	(1.000)	(1.089)	(1.200)	(1.327)
$[\ln(S_{t+k}) - \ln(S_t)]/k$	-0.672	0.567	0.805	1.445	1.156	0.787
N.W.	(2.327)	(1.662)	(1.294)	(1.143)	(1.181)	(0.682)
M.C.	(2.347)	(2.599)	(2.712)	(2.795)	(2.856)	(2.915)
$[\ln(D_{s,t+k}) - \ln(D_{s,t})]/k$	0.568	0.707	0.721	0.770	0.931	1.822
N.W.	(0.330)	(0.282)	(0.314)	(0.310)	(0.292)	(0.288)
M.C.	(0.319)	(0.347)	(0.410)	(0.475)	(0.596)	(0.833)
Constant	0.019	0.007	0.007	0.004	0.003	-0.007
N.W.	(0.023)	(0.018)	(0.014)	(0.013)	(0.013)	(0.008)
M.C.	(0.022)	(0.023)	(0.024)	(0.024)	(0.025)	(0.026)
R ²	0.110	0.295	0.356	0.502	0.534	0.809
M.C adjusted R ²	0.051	0.191	0.203	0.298	0.271	0.326

$P_{s,t}$ is the average real S&P 500 index for year t . F_t and S_t are the demographic demand for financial assets and excess demographic demand for stocks, respectively. Both are defined in Section 1 of Chapter 4. $D_{s,t}$ is real dividends per share on the S&P 500 index. Newey-West standard errors are calculated setting autocorrelations beyond lag $k-1$ to zero, where k is the horizon length for the regression. Monte Carlo standard errors are calculated using 1000 simulations.

Figure 5.4

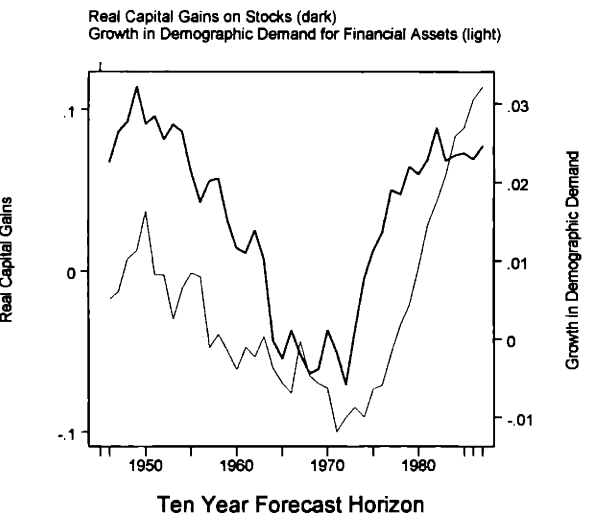
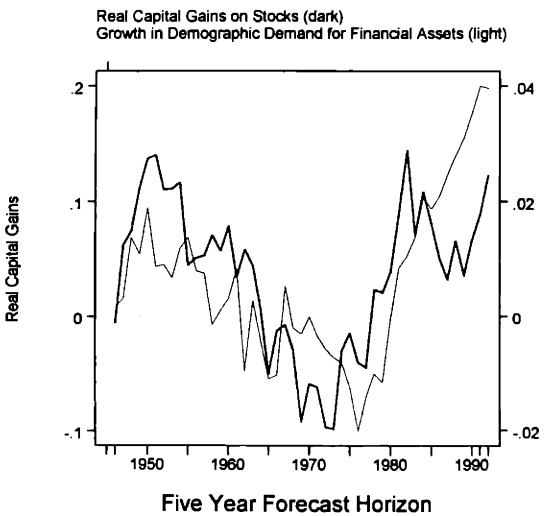
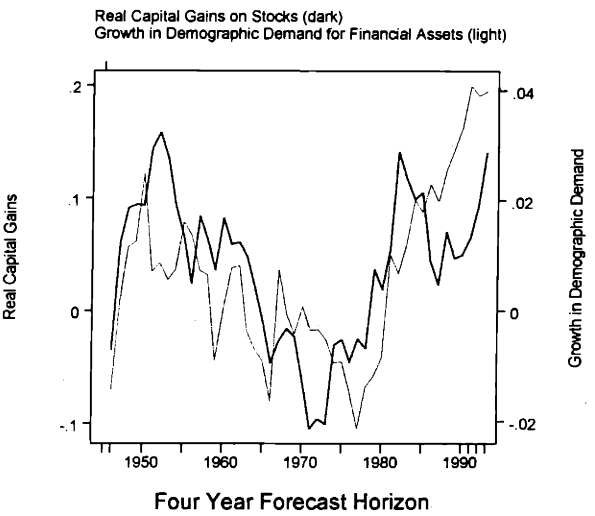
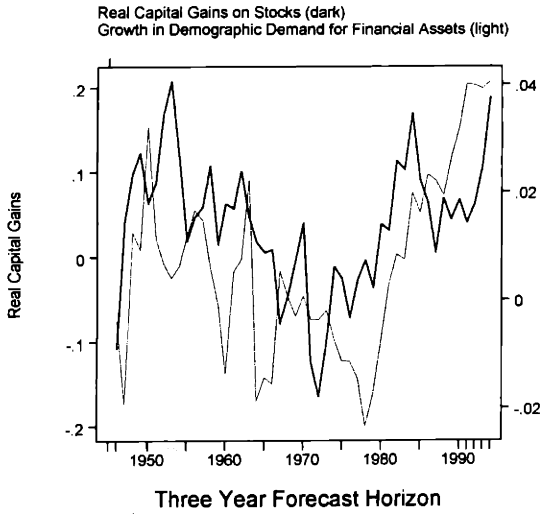
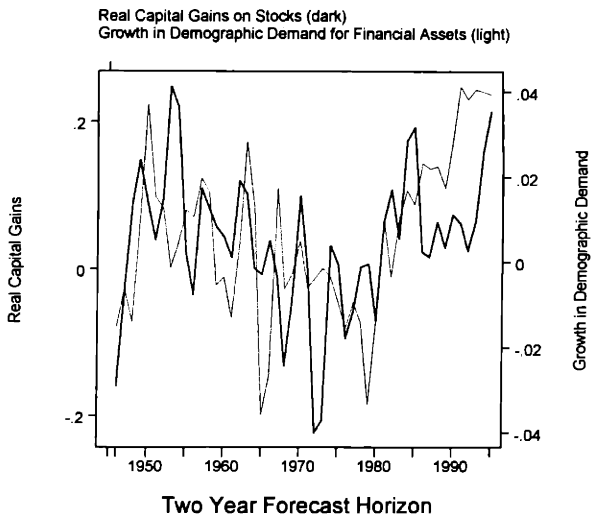
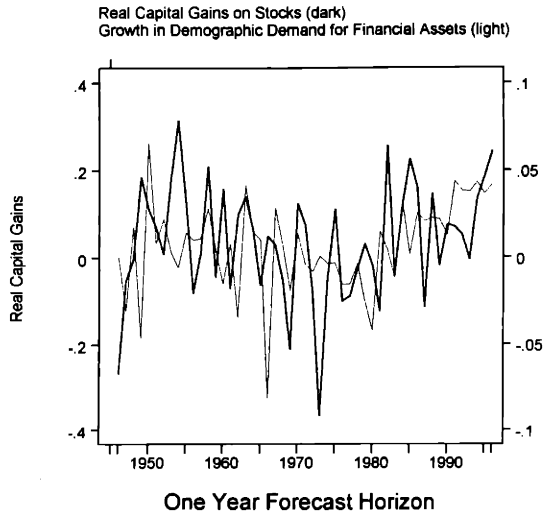


Figure 5.5

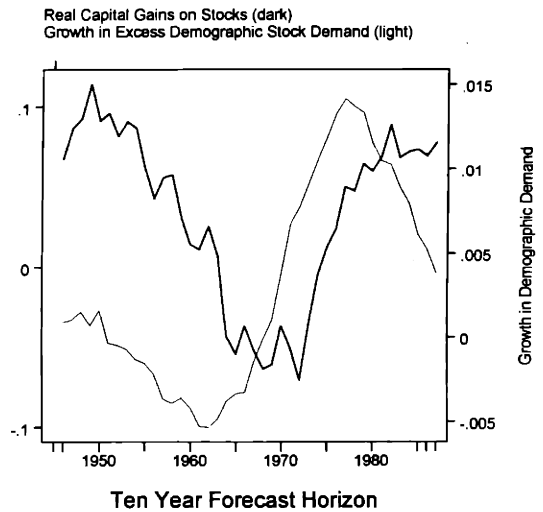
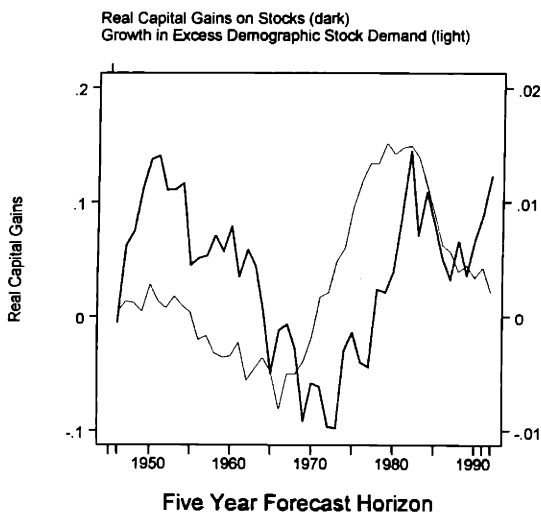
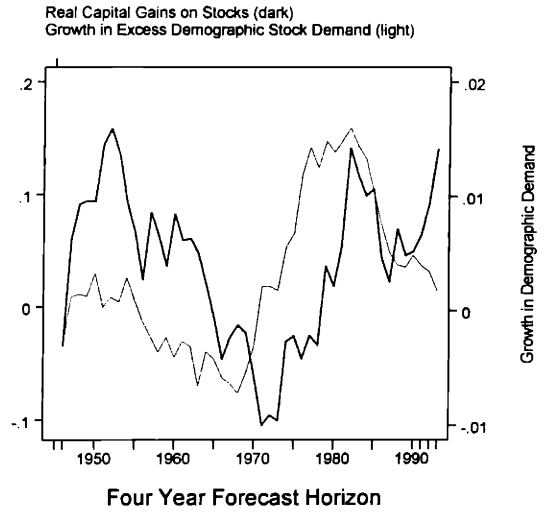
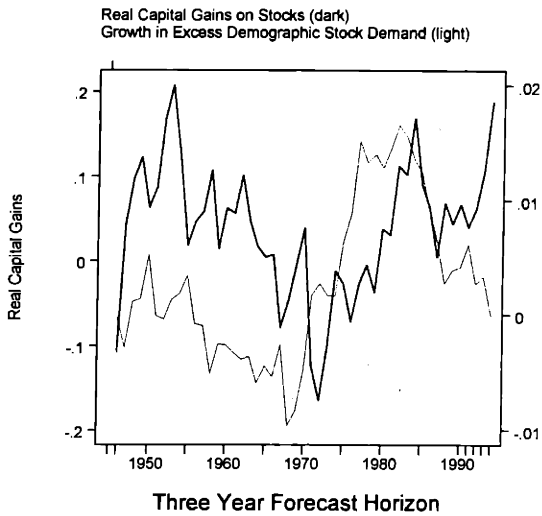
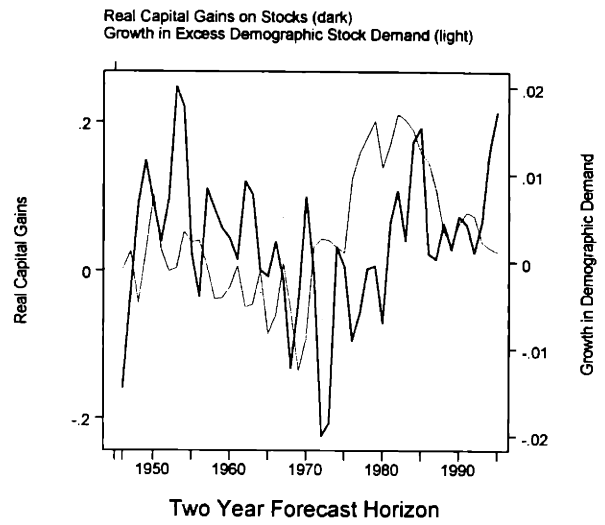
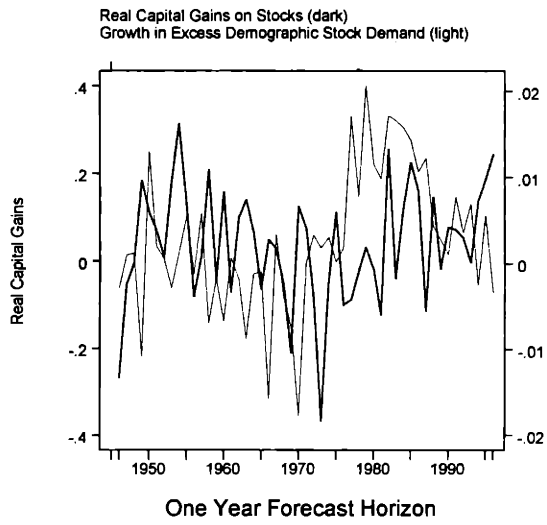


Figure 5.6

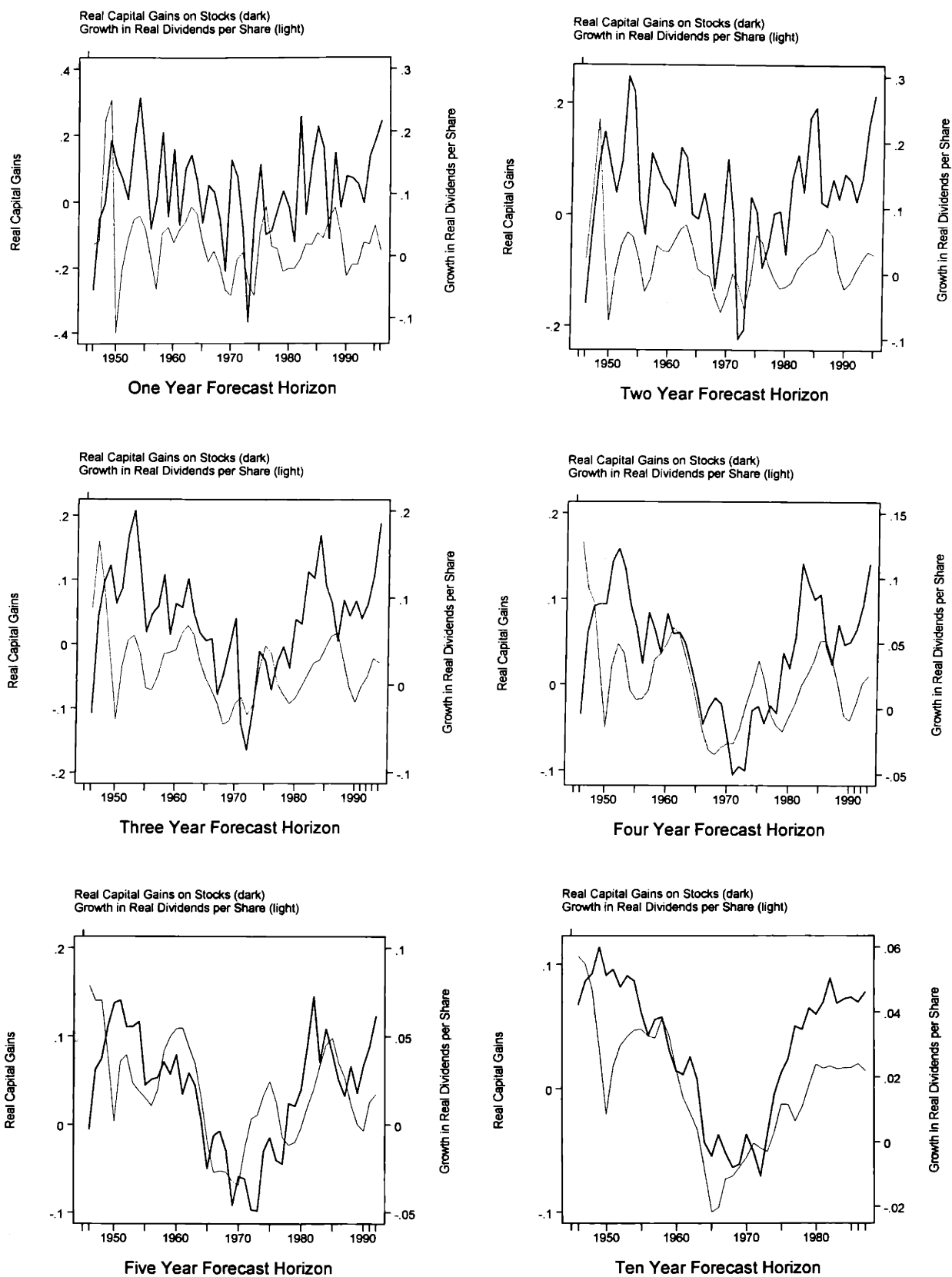
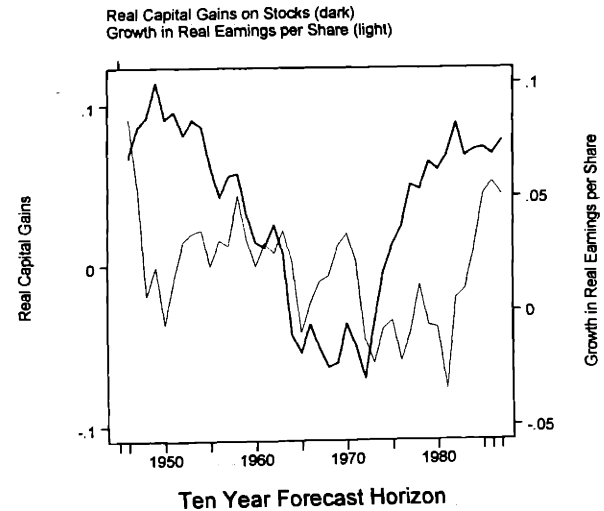
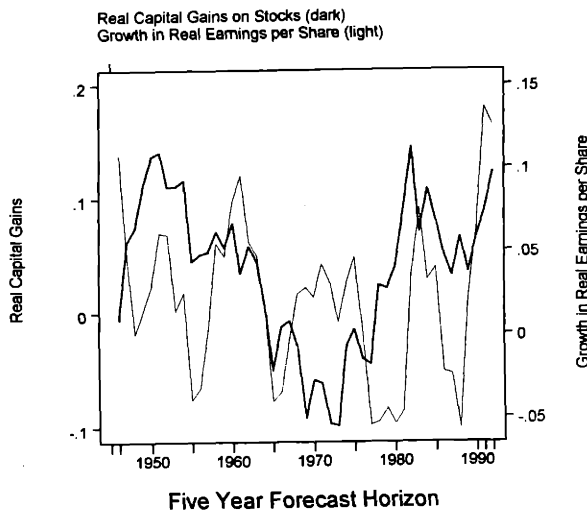
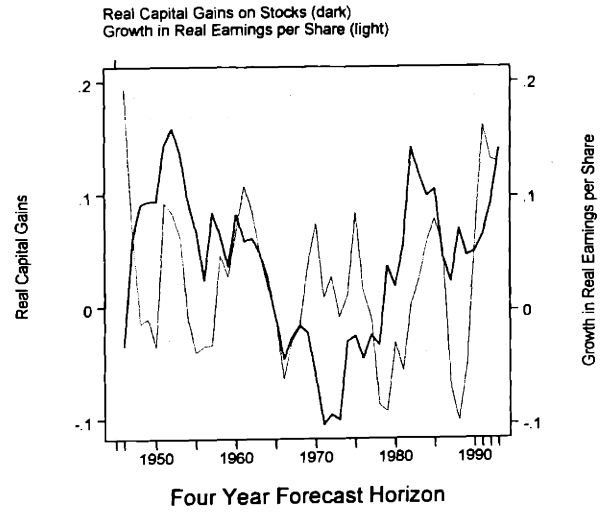
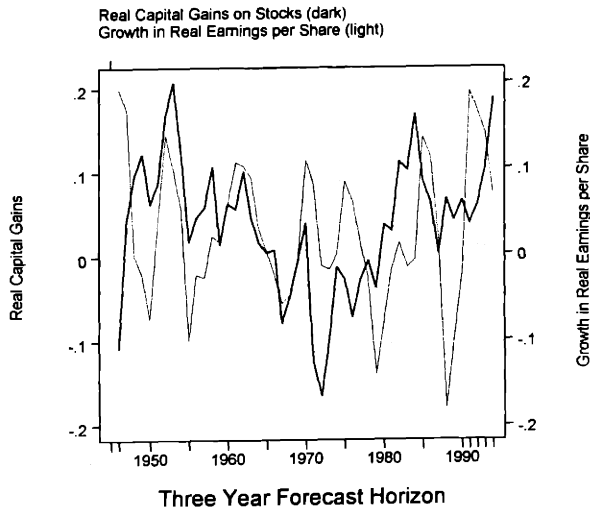
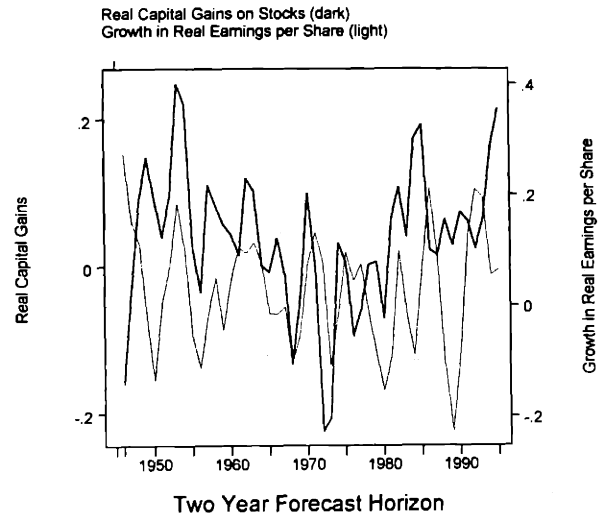
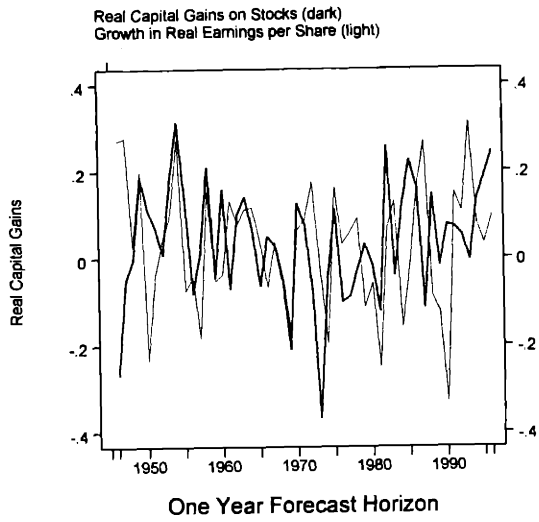


Figure 5.7



Looking at the results in the top panel of the table, we see that the estimated coefficients on the demographic demand for financial assets are positive and statistically significant in every regression when using the Newey West standard errors, and in every regression except the one year regression using the Monte Carlo standard errors. Notice also that the size of the estimated coefficients on this variable increase with the length of the regression horizon, suggesting that the relationship between demographic demand and stock prices becomes stronger at lower frequencies. The Monte Carlo adjusted R^2 s at the bottom of the panel provide additional evidence in support of this view, rising from 0.008 at the one year horizon to around 0.2 for the four and five year horizons before dropping back down to near 0.15 at the ten year horizon. Looking at the estimated coefficients on the excess stock demand variable, we see that they are positive in four of the six regressions, but are not statistically significant in any of the regressions. Thus, real stock prices appear to be positively correlated with aggregate portfolio preferences, but the correlation is not statistically significant.

The next panel in the table presents results from regressions of real stock price appreciation on real dividend growth. Similar regressions were run using real earnings growth in place of and along side real dividend growth, but are not included in the table because of a uniformly weak estimated relationship between earnings growth and real stock price appreciation.⁷ As in the top panel, the estimated coefficients on the dividend variable are positive and increasing in value with the length of the horizon. Notice, however, that the estimated coefficients on the dividend growth variable are statistically significant only in the five and ten year regressions. Moreover, the Monte Carlo adjusted R^2 s for this set of regressions is generally lower than for the corresponding regressions in the top panel of the table, the only exception being the ten year regression. It appears, therefore, that demographic factors are at least as successful in explaining real stock price movements as are changes in dividend growth. Again, this result is made even more striking by the observation that demographic demand is readily forecastable, whereas real dividend growth is much more difficult to predict.

The bottom panel of Table 5.2 combines the demographic demand and dividend vari-

⁷The lack of a statistically significant relationship between real stock price appreciation and real earnings growth, especially over shorter horizons, is consistent with the view in the corporate finance literature that changes in dividend payout policies contain more information about management's assessment of future profitability than do changes in current earnings.

ables. The statistical significance of the estimated relationship between the demographic demand for financial assets and real stock price appreciation is robust to the inclusion of dividends in the regression specification. Moreover, similar to what occurred in the bottom panel of Table 5.1, the performance of the dividend variable is improved by the presence of the demographic variables in the regression specification. The estimated coefficients on real dividend growth are now statistically significant in five of the six regressions when using the Newey West standard errors. Also, observe that the Monte Carlo adjusted R^2 s in the bottom panel are significantly larger than in the top and middle panels. It appears, therefore, that, similar to what was observed in the housing price regressions, the demographic demand for financial assets provides information about real stock price movements that complements the information contained in real dividend growth.

Figures 5.4 through 5.7 provide visual confirmation of these observations. In Figure 5.4, for example, the correlation between real stock price appreciation and the demographic demand for financial assets becomes more noticeable with increases in the forecast horizon and is quite pronounced at the five and ten year horizons. Figure 5.5 displays graphs of the excess demand for stocks and real stock price appreciation. As in the regressions, there is a noticeably positive correlation between the two series, but not one which appears capable of improving significantly on the information provided by the overall demand for financial assets. Figures 5.6 and 5.7 plot real dividend and real earnings growth against real stock price appreciation. As in the regression output presented in Table 5.2, real stock price appreciation appears to be positively correlated with real dividend growth, especially at longer horizons. The relation between real stock price appreciation and real earnings growth, in contrast, is much less visible.

5.2.3 Real Bond Price Appreciation and the Demographic Demand for Financial Assets

Table 5.3 presents results from regressions of real bond price appreciation on growth in the demographic demand for financial assets and excess demographic demand for stocks. The nominal bond price appreciation series used in these regressions is the capital appreciation on long term government bonds reported in *Stocks, Bonds, Bills, and Inflation, 1998 Yearbook*, published by Ibbotson Associates. As was the case with real stock prices, real bond price appreciation is positively correlated with growth in the demographic demand

for financial assets. Looking at the regressions in the top panel of the table, we see that the estimated coefficients on the financial asset demand variable are positive and statistically significant in every regression, regardless of the standard error used in calculating the t-statistics. Also notice that the estimated coefficients on the excess stock demand variable are all negative, providing further evidence of a correlation between demographically driven changes in aggregate portfolio preference and the relative returns on stocks and bonds. As in the stock price regressions, however, any such relationship is statistically insignificant. Finally, notice that the Monte Carlo adjusted R^2 s in the top panel are fairly large, and increase in value with the regression horizon. Demographic factors, it appears, can potentially explain 12% of the variation in annual real bond price appreciation over any given year, and more than 38% of the variation over periods of five or more years.

The regressions in the middle panel of Table 5.3 add growth in real GDP per adult to the specification, while the regressions in the bottom panel add real dividend growth. Neither inclusion has a significant impact on the estimated relationship between bond prices and financial asset demand. In both sets of regressions the coefficients on the demographic demand for financial assets are positive, about the same size as in the top panel of the table, and statistically significant at the 5% level in every regression. The estimated coefficients on the excess stock demand variable continue to be negative and statistically insignificant except in the four, five, and ten year regressions in the middle panel, where they are positive but statistically insignificant. The most notable impact of including the income and dividend variables is on the Monte Carlo adjusted R^2 s. The adjusted R^2 s in all of the middle panel regressions and in three of the six bottom panel regressions are lower than in the corresponding top panel regressions. It appears, therefore, that the business cycle/stock market cycle variables provide little, if any, improvement over the specification in the top panel of the table.

Figure 5.8 displays graphs of real bond price appreciation against growth in the demographic demand for financial assets. As in the case of the stock price graphs, there is a noticeably positive correlation between the two series that becomes more pronounced at longer horizons. It is also interesting to observe that the long run time profiles of real bond and stock price appreciation have much the same shape, and are, for the most part, an inversion of the time profile for long run housing price appreciation. Moreover, as discussed in the introduction, the long run (and even some of the short run) cycles in these profiles,

Table 5.3: Demographic Demand For Financial Assets and Real Bond Price Appreciation

Horizon (years)	Dependent Variable: $[\ln(P_{b,t+k}) - \ln(P_{b,t})]/k$					
	Sample: 1946 - 1997					
NOBS	1	2	3	4	5	10
	51	50	49	48	47	42
$[\ln(F_{t+k}) - \ln(F_t)]/k$	1.381	1.816	2.065	2.329	2.591	2.758
N.W.	(0.485)	(0.479)	(0.558)	(0.593)	(0.603)	(0.483)
M.C.	(0.534)	(0.678)	(0.753)	(0.824)	(0.898)	(1.020)
$[\ln(S_{t+k}) - \ln(S_t)]/k$	-3.042	-1.898	-1.067	-0.411	-0.200	-0.399
N.W.	(1.761)	(2.091)	(2.056)	(1.846)	(1.562)	(0.690)
M.C.	(1.751)	(1.942)	(2.033)	(2.100)	(2.153)	(2.231)
Constant	-0.049	-0.054	-0.057	-0.062	-0.064	-0.063
N.W.	(0.012)	(0.010)	(0.009)	(0.008)	(0.007)	(0.005)
M.C.	(0.015)	(0.015)	(0.016)	(0.016)	(0.017)	(0.017)
R ²	0.160	0.256	0.346	0.474	0.571	0.750
M.C adjusted R ²	0.121	0.186	0.240	0.330	0.385	0.389
$[\ln(F_{t+k}) - \ln(F_t)]/k$	1.406	1.822	1.987	2.211	2.479	2.482
N.W.	(0.488)	(0.453)	(0.548)	(0.549)	(0.491)	(0.291)
M.C.	(0.537)	(0.693)	(0.769)	(0.840)	(0.911)	(0.979)
$[\ln(S_{t+k}) - \ln(S_t)]/k$	-3.103	-1.912	-0.753	0.271	0.644	1.108
N.W.	(1.802)	(2.159)	(2.138)	(1.831)	(1.478)	(0.763)
M.C.	(1.764)	(1.952)	(2.075)	(2.180)	(2.259)	(2.432)
$[\ln(Y_{t+k}) - \ln(Y_t)]/k$	-0.212	-0.034	0.513	0.994	1.177	1.699
N.W.	(0.592)	(0.482)	(0.538)	(0.506)	(0.474)	(0.494)
M.C.	(0.573)	(0.709)	(0.813)	(1.006)	(1.156)	(1.715)
Constant	-0.046	-0.054	-0.067	-0.081	-0.087	-0.096
N.W.	(0.018)	(0.014)	(0.013)	(0.010)	(0.010)	(0.011)
M.C.	(0.018)	(0.020)	(0.022)	(0.025)	(0.028)	(0.038)
R ²	0.163	0.256	0.361	0.525	0.631	0.822
M.C adjusted R ²	0.103	0.153	0.213	0.323	0.372	0.350
$[\ln(F_{t+k}) - \ln(F_t)]/k$	1.473	1.869	2.084	2.291	2.490	2.310
N.W.	(0.440)	(0.439)	(0.509)	(0.552)	(0.584)	(0.381)
M.C.	(0.538)	(0.679)	(0.754)	(0.821)	(0.905)	(1.001)
$[\ln(S_{t+k}) - \ln(S_t)]/k$	-2.604	-1.577	-0.882	-0.303	-0.180	-0.194
N.W.	(1.737)	(2.134)	(2.056)	(1.834)	(1.562)	(0.681)
M.C.	(1.769)	(1.959)	(2.045)	(2.107)	(2.153)	(2.198)
$[\ln(D_{e,t+k}) - \ln(D_{e,t})]/k$	0.365	0.395	0.356	0.315	0.256	0.542
N.W.	(0.143)	(0.133)	(0.126)	(0.114)	(0.171)	(0.163)
M.C.	(0.240)	(0.262)	(0.309)	(0.358)	(0.449)	(0.628)
Constant	-0.059	-0.064	-0.065	-0.068	-0.068	-0.070
N.W.	(0.012)	(0.011)	(0.010)	(0.008)	(0.006)	(0.004)
M.C.	(0.017)	(0.017)	(0.018)	(0.018)	(0.019)	(0.020)
R ²	0.206	0.330	0.403	0.516	0.591	0.812
M.C adjusted R ²	0.147	0.226	0.250	0.311	0.328	0.328

Nominal price appreciation on long term government bonds is taken from *Stocks, Bonds, Bills and Inflation, 1998 Yearbook*, published by Ibbotson Associates. F_t and S_t are the demographic demand for financial assets and excess demographic demand for stocks, respectively. Both are defined in Section 1 of Chapter 4. $D_{e,t}$ is real dividends per share on the S&P 500 index. Newey-West standard errors are calculated setting autocovariances beyond lag $k-1$ to zero, where k is the horizon length for the regression. Monte Carlo standard errors are calculated using 1000 simulations.

Figure 5.8

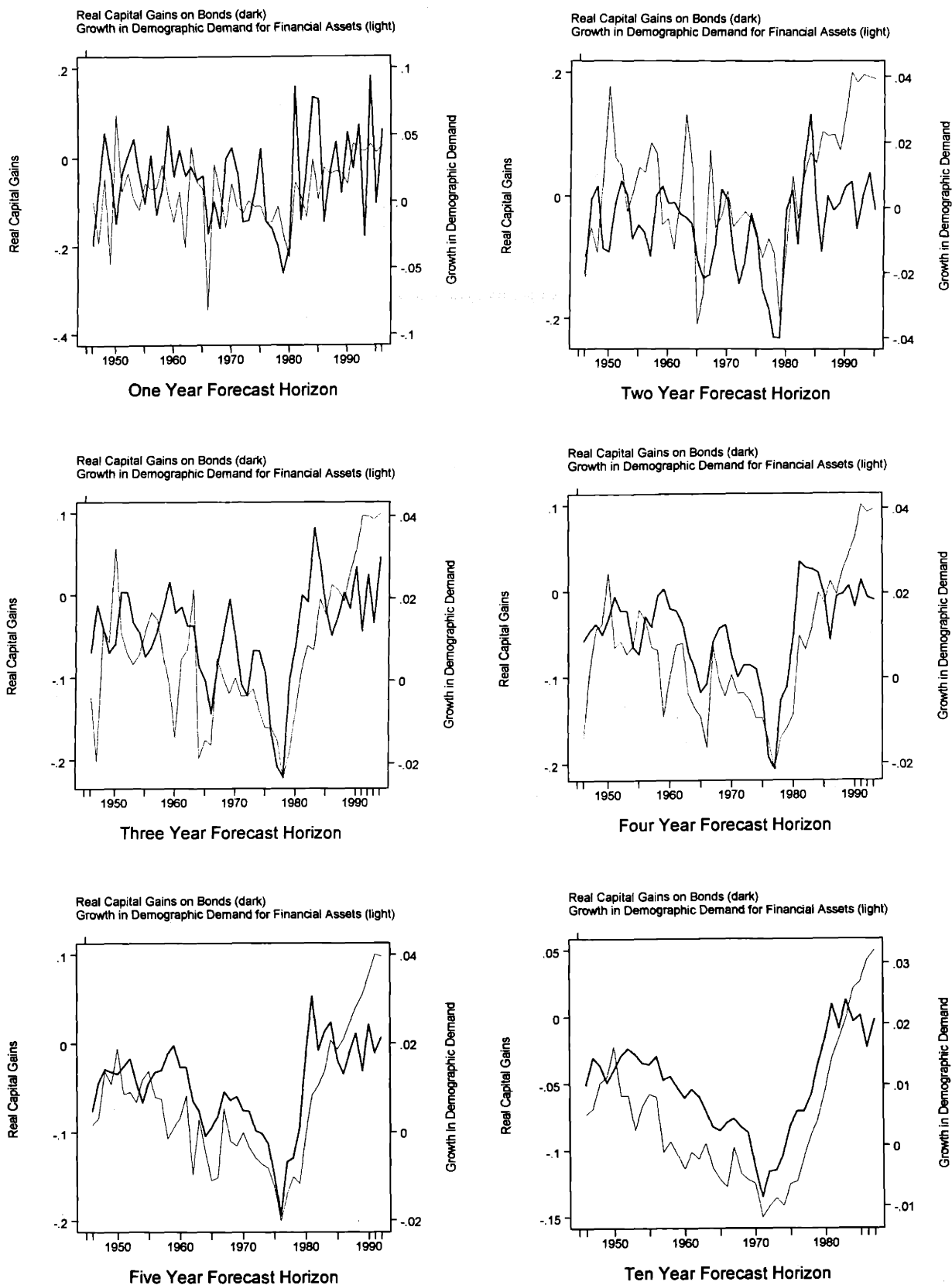


Figure 5.9

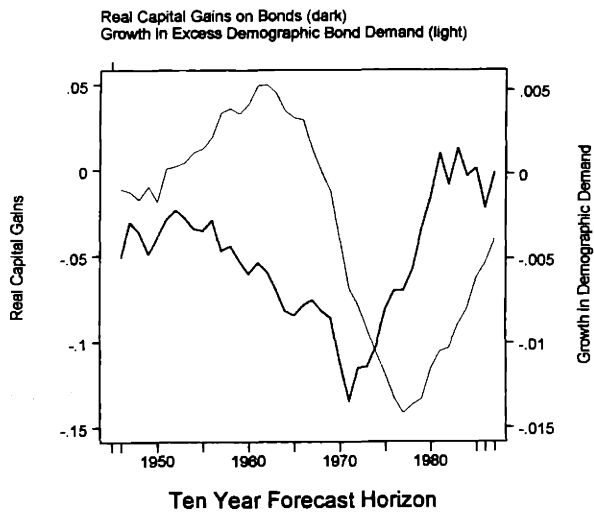
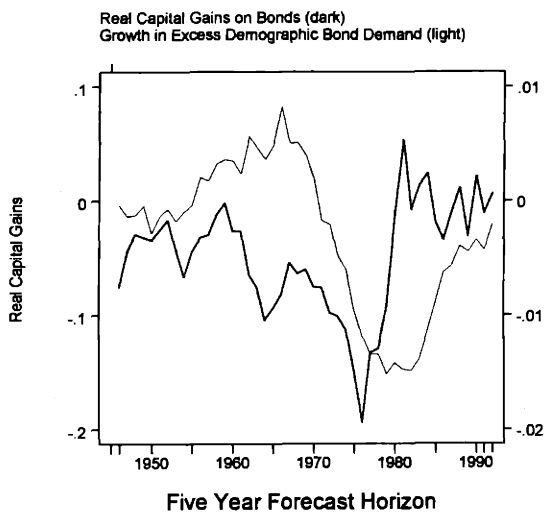
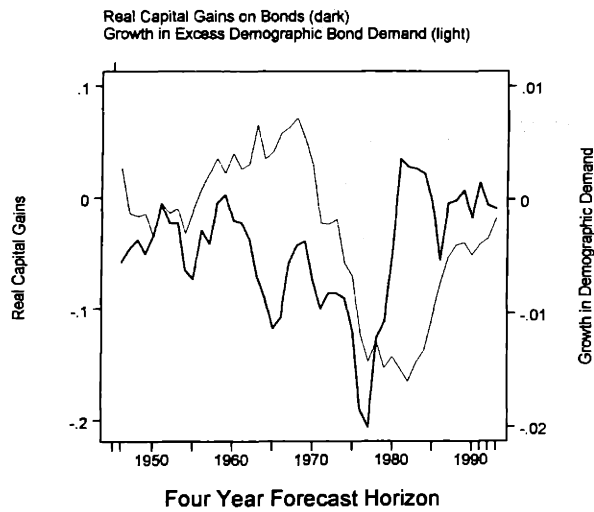
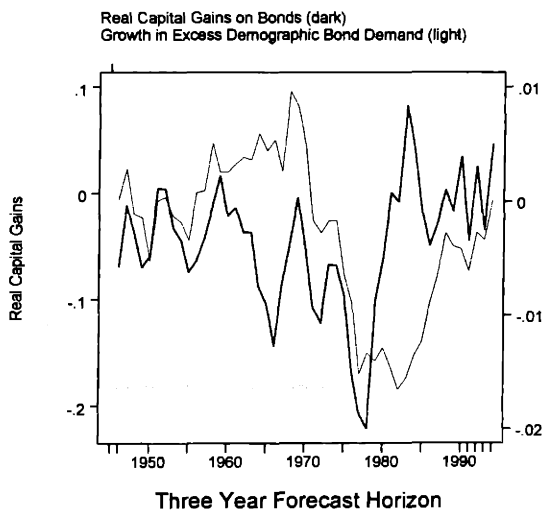
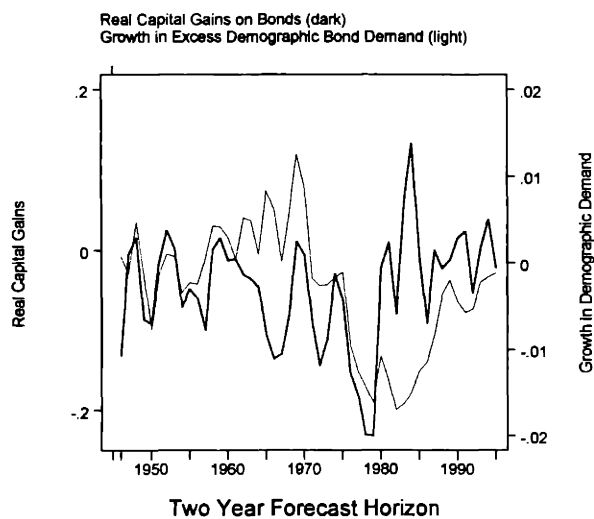
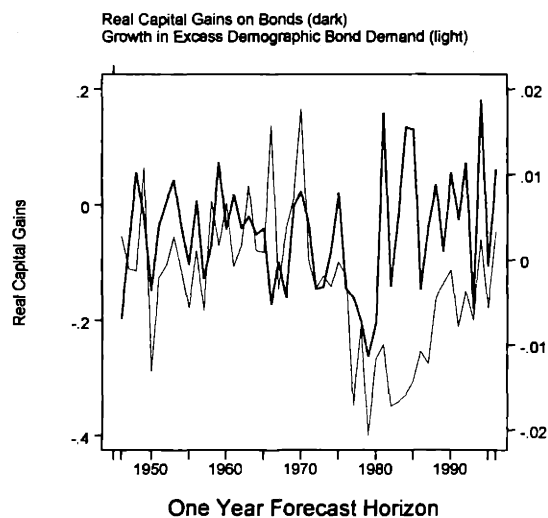


Figure 5.10

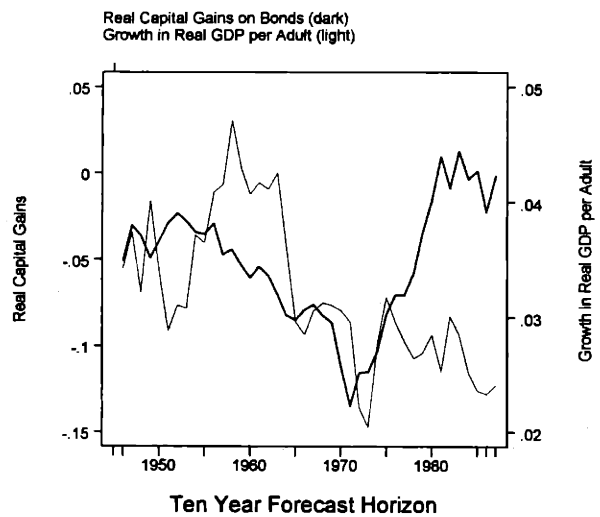
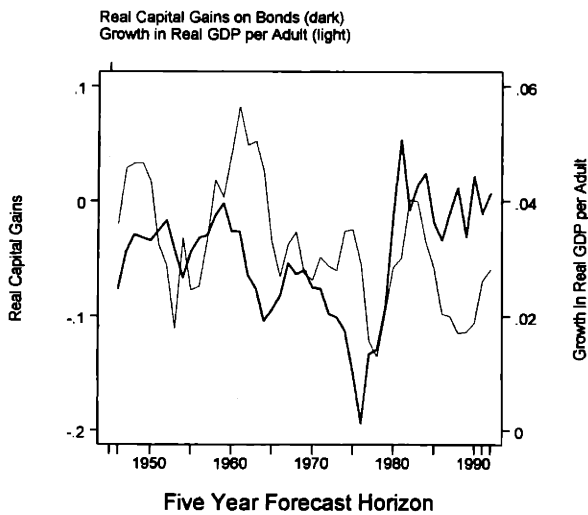
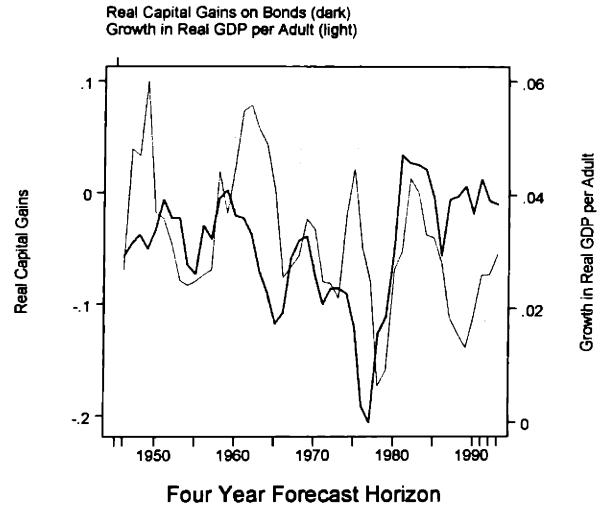
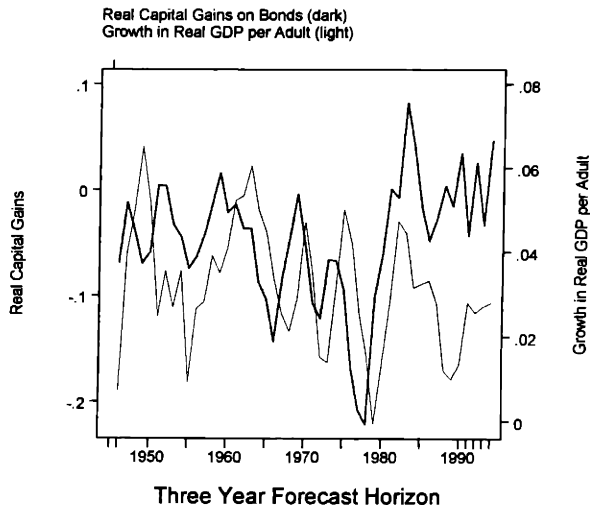
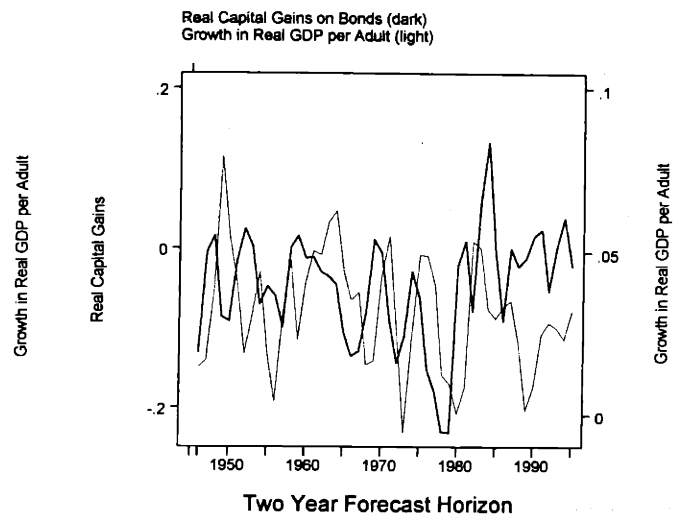
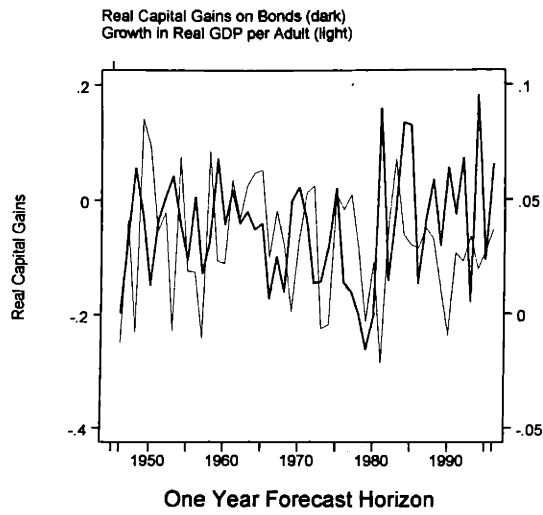
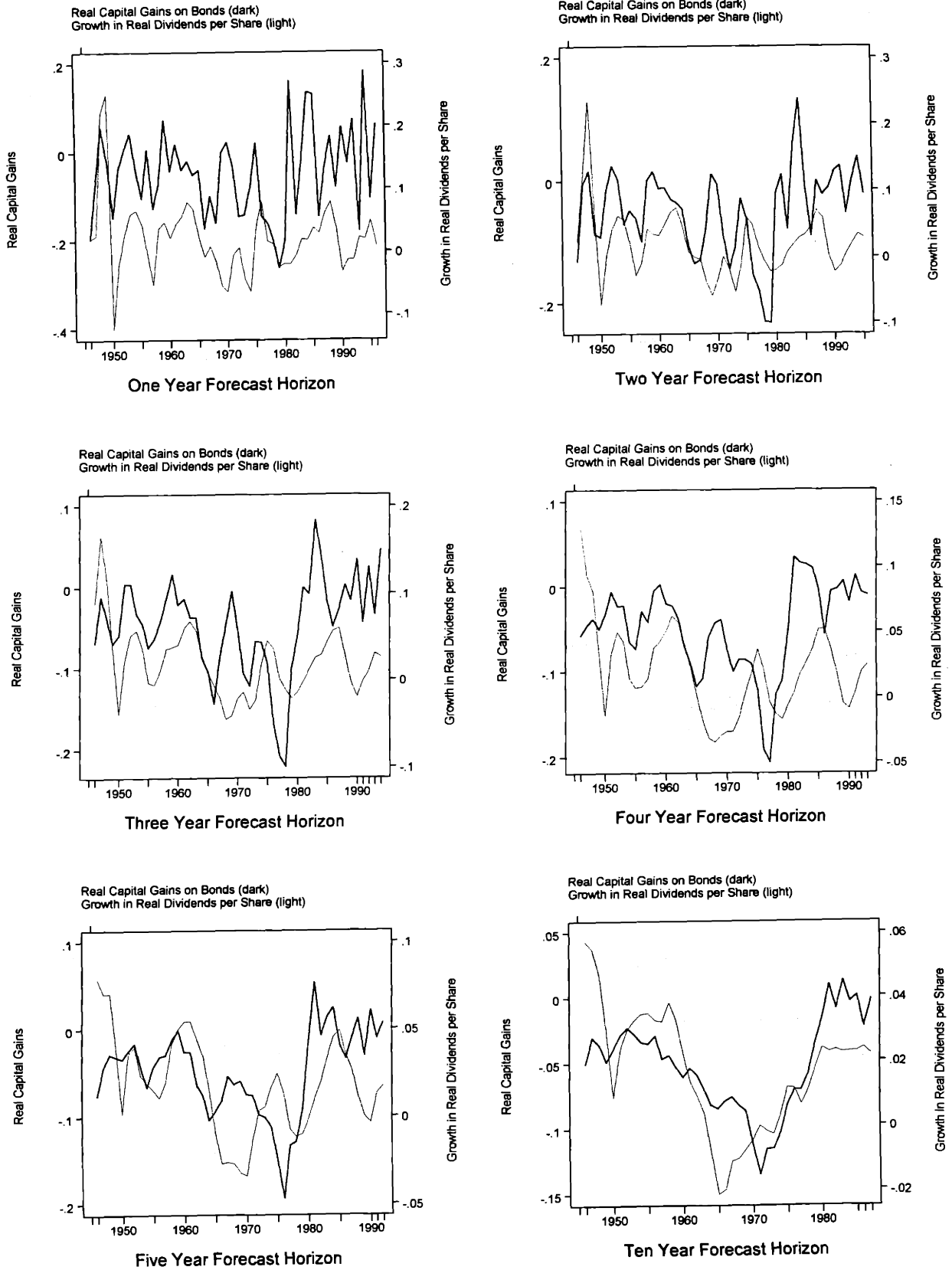


Figure 5.11



match up quite closely with movements of the baby boom generation through what we have described as the home buying/borrowing, and retirement saving stages of life.

Figure 5.9 plots real bond price appreciation against growth in the excess demographic demand for bonds, the latter calculated as the negative of growth in the excess demand for stocks. As with stock prices, movements in bond prices do appear to be positively correlated with movements in aggregate portfolio preference, but not to an extent that is significant relative to the effect on bond prices of changes in the overall demand for financial assets. Figures 5.10 and 5.11 plot similar graphs for growth in real GDP per adult and real dividend growth. As in the regressions, both series display a positive correlation with real bond price appreciation.

5.2.4 Excess Stock Price Appreciation and the Excess Demographic Demand for Stocks

The regressions in Table 5.4 provide the excess stock demand variable an opportunity to speak on the subject of excess stock price appreciation (i.e. in excess of bond price appreciation). The top panel of the table displays results from regressions of excess stock price appreciation against growth in the excess demand for stocks over bonds. As in the previous two tables, the results are suggestive of a link between aggregate portfolio preference and relative returns, but are not statistically significant. The estimated coefficients on the excess stock demand variable are positive but statistically insignificant in every regression. The regressions in the middle panel of Table 5.4 replace excess stock demand with real dividend growth, while the regressions in the bottom panel include both excess stock demand and real dividend growth as explanatory variables. The results are similar in all regressions, positive but statistically insignificant coefficients and Monte Carlo adjusted R^2 s that equal or are close to zero, the only notable exception being the ten year horizon regression for dividends.

The fundamental point made by the regression results presented in this and the preceding two tables, seems to be that demographic factors can help explain overall movements in financial asset prices, and hence equilibrium expected rates of return, but have very little to say about the relative returns on competing financial assets, such as stocks and long term (government) bonds. More generally, the message contained in all the regression results of this section is that demographically driven changes in aggregate asset demand, whether it

Table 5.4: Excess Demographic Demand For Stocks and Excess Stock Price Appreciation

	Dep. Var.: $[\ln(P_{s,t+k}) - \ln(P_{s,t})]/k - [\ln(P_{b,t+k}) - \ln(P_{b,t})]/k$					
	Sample: 1946 - 1997					
Horizon (years)	1	2	3	4	5	10
NOBS	51	50	49	48	47	42
$[\ln(S_{t+k}) - \ln(S_t)]/k$	1.520	1.971	1.514	1.614	1.302	0.657
N.W.	(2.761)	(1.882)	(1.384)	(1.249)	(1.163)	(1.031)
M.C.	(2.507)	(2.797)	(2.932)	(3.032)	(3.111)	(3.236)
Constant	0.082	0.081	0.081	0.082	0.083	0.083
N.W.	(0.021)	(0.015)	(0.013)	(0.013)	(0.014)	(0.014)
M.C.	(0.021)	(0.021)	(0.022)	(0.022)	(0.022)	(0.023)
R ²	0.007	0.024	0.025	0.043	0.030	0.016
M.C adjusted R ²	0.000	0.000	0.000	0.000	0.000	0.000
$[\ln(D_{s,t+k}) - \ln(D_{s,t})]/k$	0.170	0.267	0.339	0.435	0.659	1.146
N.W.	(0.358)	(0.312)	(0.332)	(0.340)	(0.332)	(0.209)
M.C.	(0.340)	(0.374)	(0.442)	(0.516)	(0.644)	(0.914)
Constant	0.082	0.081	0.078	0.078	0.075	0.066
N.W.	(0.023)	(0.016)	(0.014)	(0.014)	(0.014)	(0.007)
M.C.	(0.022)	(0.022)	(0.023)	(0.024)	(0.024)	(0.028)
R ²	0.005	0.021	0.045	0.082	0.139	0.447
M.C adjusted R ²	0.000	0.000	0.000	0.021	0.059	0.287
$[\ln(S_{t+k}) - \ln(S_t)]/k$	1.810	2.230	1.706	1.764	1.323	0.862
N.W.	(2.859)	(1.875)	(1.325)	(1.180)	(1.065)	(0.656)
M.C.	(2.539)	(2.823)	(2.950)	(3.043)	(3.111)	(3.229)
$[\ln(D_{s,t+k}) - \ln(D_{s,t})]/k$	0.215	0.305	0.364	0.458	0.662	1.163
N.W.	(0.371)	(0.298)	(0.308)	(0.297)	(0.281)	(0.174)
M.C.	(0.344)	(0.377)	(0.445)	(0.518)	(0.644)	(0.911)
Constant	0.076	0.074	0.073	0.073	0.071	0.063
N.W.	(0.024)	(0.016)	(0.013)	(0.013)	(0.013)	(0.006)
M.C.	(0.023)	(0.024)	(0.024)	(0.025)	(0.026)	(0.029)
R ²	0.015	0.051	0.076	0.133	0.170	0.489
M.C adjusted R ²	0.000	0.000	0.000	0.000	0.000	0.121

$P_{s,t}$ is the average real S&P 500 index for year t . Nominal price appreciation on long term government bonds is taken from *Stocks, Bonds, Bills and Inflation, 1998 Yearbook*, published by Ibbotson Associates. S_t is the excess demographic demand for stocks, defined in Section 1 of Chapter 4. $D_{s,t}$ is real dividends per share on the S&P 500 stock price index. Newey-West standard errors are calculated setting autocovariances beyond lag $k-1$ to zero, where k is the horizon length for the regression. Monte Carlo standard errors are calculated using 1000 simulations.

Figure 5.12

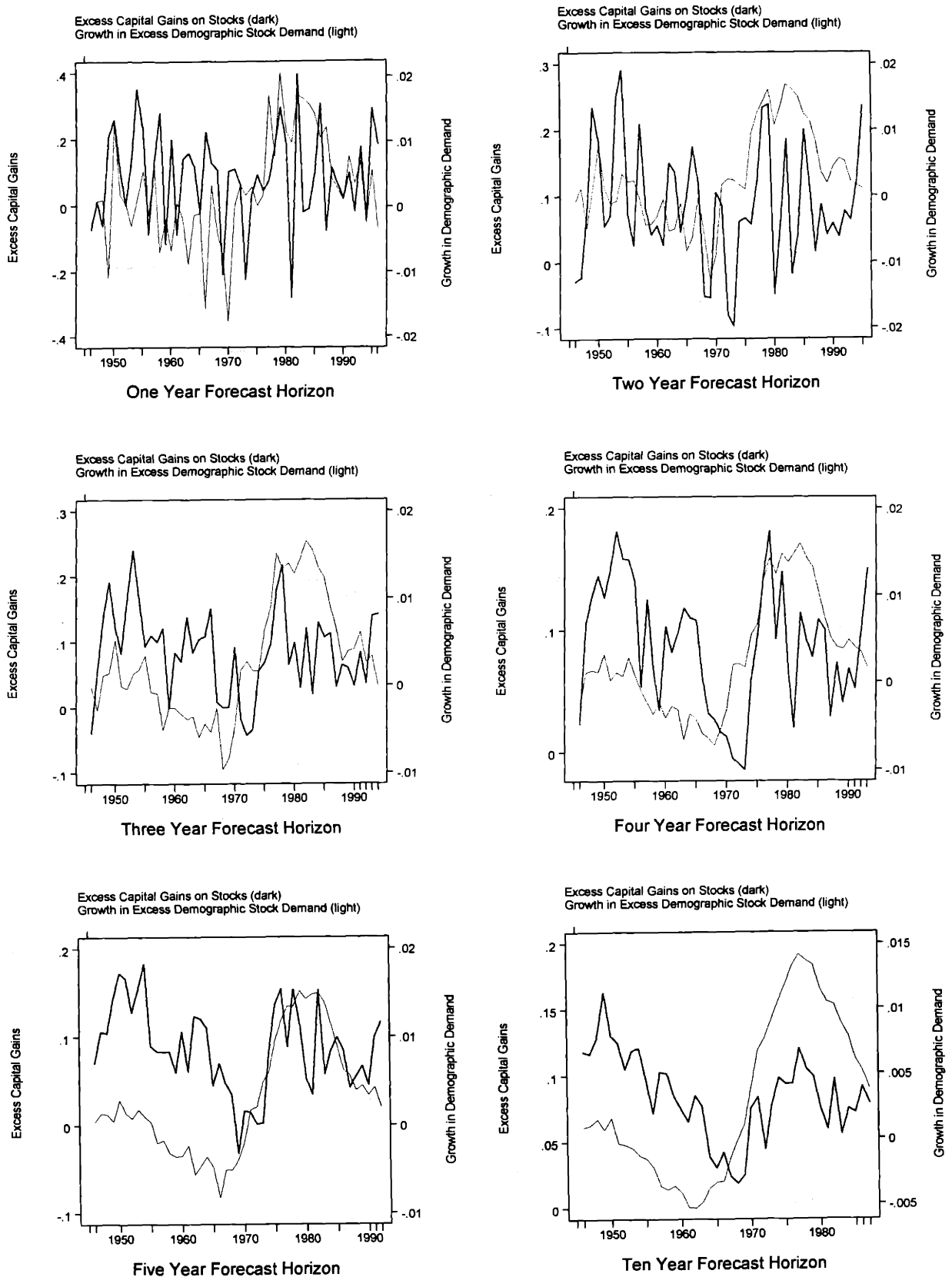


Figure 5.13

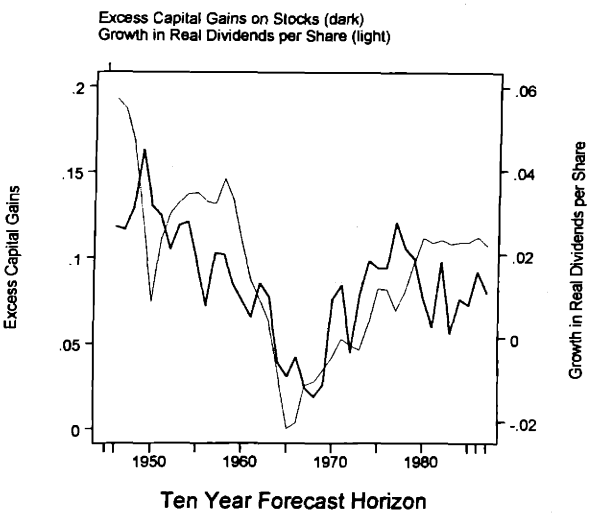
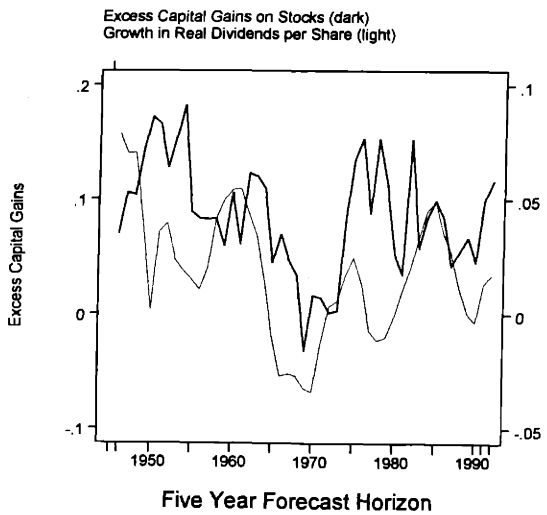
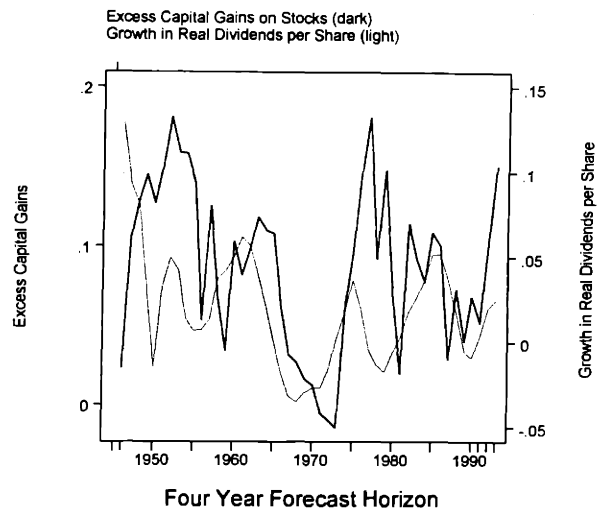
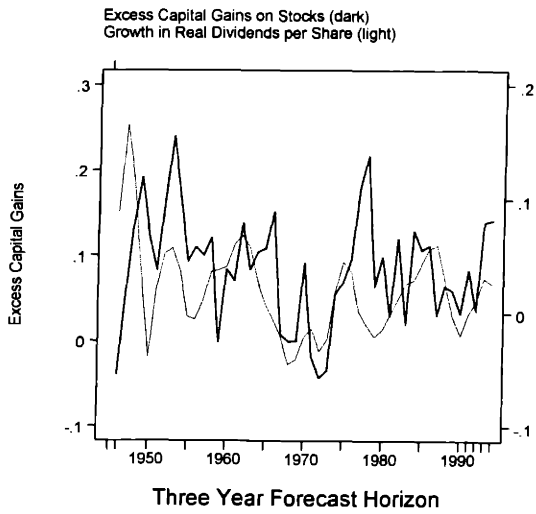
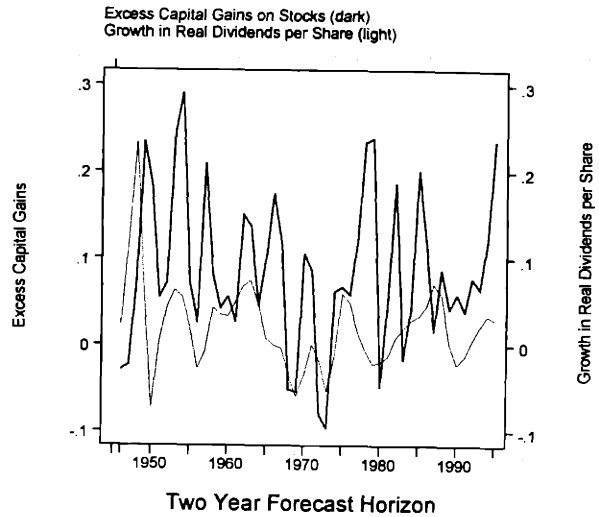
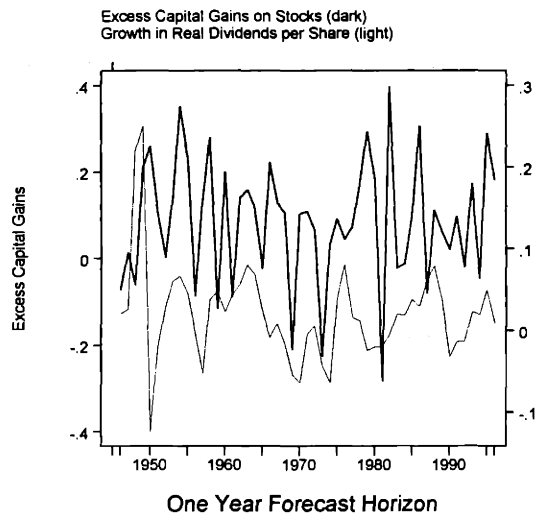
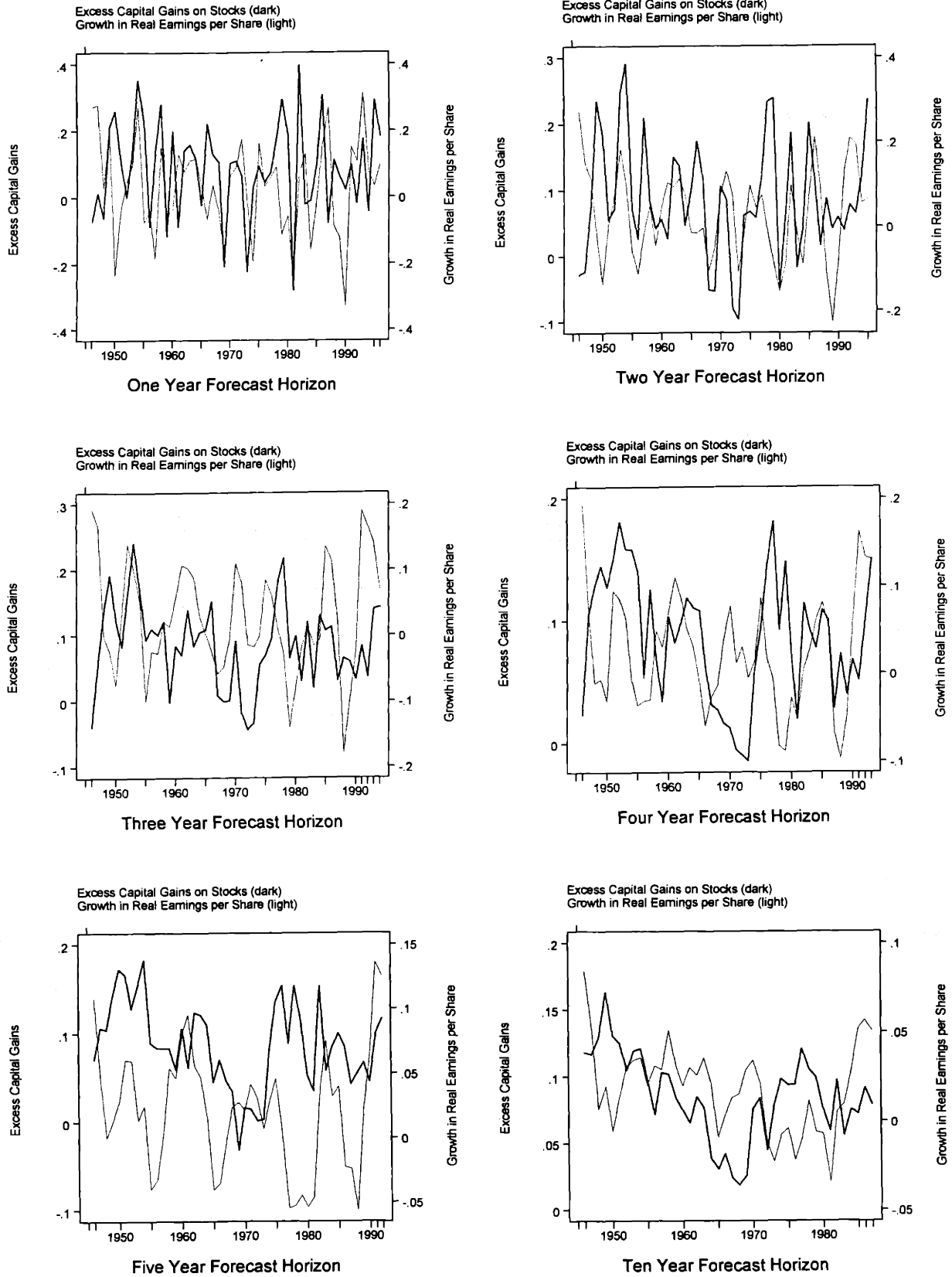


Figure 5.14



be the demand for nonfinancial assets such as single family homes or for financial assets such as stocks and bonds, have a statistically significant impact on the equilibrium prices of those assets. Moreover, the frequency analysis presented in the regression tables suggests that the relationship between demographics and asset prices, although primarily a low frequency one, is statistically significant over periods as short as two years, and, in the case of housing and bond prices, statistically significant over periods as short as a year.

5.3 Demographics and Long-Run Asset Price Cycles

One of the stated goals of this thesis was to try and assess the extent to which the aging of the baby boom generation has contributed to observed movements in real housing, stock and bond prices over the post World War II period. In doing this we will focus our attention on the time periods discussed in the introduction, that is, 1946–1966, 1966–1986, and 1986–1997. The first period covers the twenty years prior to the entrance of the first cohort of baby boomers into the adult population, the second period covers their passage through the home buying/borrowing stages of life, and the last period covers the eleven years since they turned forty. Since we are interested in long run price movements, we want as an input to our calculations a measure of the long run elasticities of housing, stock, and bond price appreciation with respect to changes in the demographic demand for housing and financial assets. We could use the estimated elasticities from the five or ten year regressions in the previous section, but a preferable approach is to run a set of price level regressions and use the estimated elasticities from these regressions. The reason for doing this is that, since differencing the data discards some of its low frequency fluctuations, the price level regressions will yield better estimates of the long run elasticities than will the price appreciation regressions.

Table 5.5 contains the price level regressions used to estimate the elasticities. The first two columns present results from housing price regressions, the second two columns present results from stock price regressions, and the last two columns present results from bond price regressions.⁸ The excess stock demand variable was excluded from the final specifications of the stock and bond price regressions since, as in the previous section, the estimated

⁸The real bond price index used in these regressions is calculated from the real bond price appreciation series used in the regressions of the previous section.

coefficients on this variable were statistically insignificant. The estimated elasticities on both the demographic demand and business cycle variables in Table 5.5 fall within the range of estimates obtained in the price appreciation regressions of Tables 5.1 through 5.4. The estimated elasticities used to calculate rates of price appreciation implied by changes in demographic housing or financial asset demand are the ones from the AR(1) regressions. The primary reason for doing this is that the AR(1) regressions yield more conservative estimates of the elasticities of asset prices with respect to changes in demographic asset demand.

Table 5.6 contains estimates of the housing, stock, and bond price changes implied by changes in the corresponding demographic demand and business cycle variables. The estimated elasticities of real housing prices with respect to the demographic demand for housing suggest that demographic factors can account for approximately 59% of the observed annual increase in real housing prices between 1966 and 1986. In comparison, growth in real GDP per adult can account for at most 31% of the annual increase in real housing prices over the 1966 to 1986 period. Similarly, demographically driven changes in the demand for financial assets can account for approximately 77% of the observed annual increase in real stock prices between 1986 and 1997 and can account for at least 81% of the observed annual increase in detrended real bond prices. In contrast, real dividend growth can account for about 32% of the observed annual increase in real stock prices between 1986 and 1997, and growth in real GDP per adult can account for less than 12% of the observed annual increase in real bond prices.

As for the future, current Census Bureau population projections suggest that annual growth in demographic housing demand will provide a positive stimulus of about 0.35% per year to real housing price appreciation between 1997 and 2007, down from about 0.98% per year for the period between 1986 to 1997. Growth in the demographic demand for financial assets is expected to provide a positive stimulus to real stock and bond price appreciation of about 8.76% per year between 1997 and 2007, up from about 6.62% per year over the period between 1986 and 1997.

Figure 5.15 provides a visual summary of the historical relationship between asset prices and demographic asset demand, and also provides a glimpse at what expected demographic changes in the population have to say about the future direction of asset prices. The top panel of the table plots the actual log real housing price index against fitted and forecasted

values. The latter are based on the AR(1) regression in Table 5.5 and assume 1.5% annual growth in GDP per adult into the indefinite future.⁹ Similarly, the middle panel of the table plots the actual log real S&P 500 index against fitted and forecasted values, the latter assuming 2.0% annual growth in real dividends per share.¹⁰ The bottom panel of the table plots the detrended real bond price index against the detrended fitted and forecasted values.

The graphs suggest that the upward trend in asset prices over the past 11 years will continue for some time into the future. More importantly, however, the apparent comovement of stock and bond prices suggests that what is driving the current growth in asset prices and what will drive any future growth is a reduction in equilibrium interest rates, itself driven by the retirement saving of a very large group of people.

⁹Average annual (log) growth in real GDP per adult over the sample period, 1946-1997, was about 1.5%.

¹⁰Average annual (log) growth in real dividends per share over the sample period, 1946-1997, was about 2.0%.

Table 5.5: Demographic Asset Demand and Asset Prices

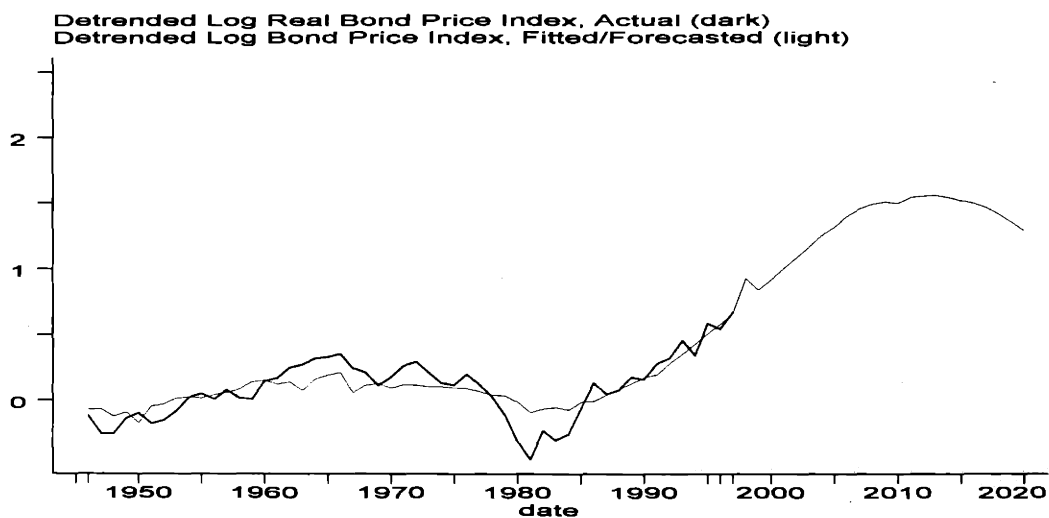
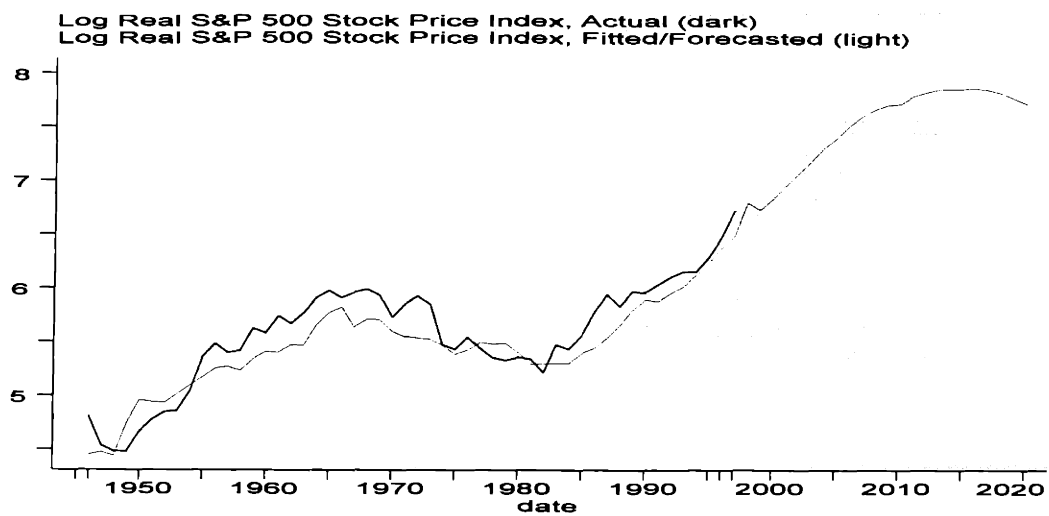
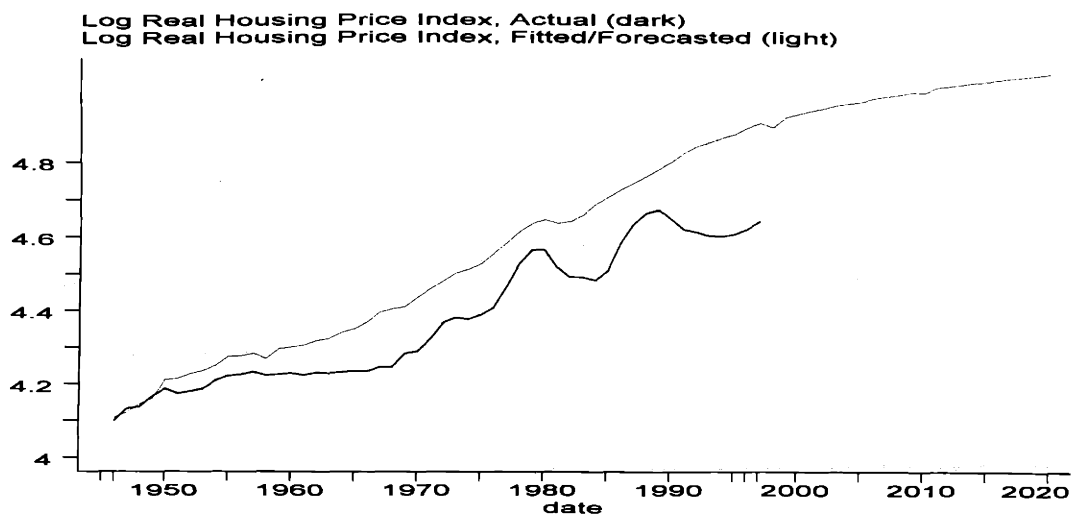
	Sample: 1946 - 1997					
	ln(P _{h,t})		ln(P _{s,t})		ln(P _{b,t})	
	OLS	AR(1)	OLS	AR(1)	OLS	AR(1)
Time trend	-0.005 (0.005)	0.000 (0.004)	-0.002 (0.003)	0.004 (0.005)	-0.080 (0.004)	-0.071 (0.008)
ln(H_t)	0.438 (0.098)	0.315 (0.098)	-	-	-	-
ln(F_t)	-	-	2.427 (0.343)	2.099 (0.495)	2.574 (0.202)	2.102 (0.336)
ln(Y_t)	0.347 (0.175)	0.229 (0.125)	-	-	0.942 (0.241)	0.477 (0.412)
ln(D_{s,t})	-	-	1.427 (0.185)	1.222 (0.296)	-	-
Constant	-1.026 (2.046)	0.625 (1.407)	1.174 (0.345)	1.632 (0.621)	-10.288 (2.350)	-5.559 (4.033)
Rho	-	0.872 (0.071)	-	0.656 (0.098)		0.594 (0.114)
NOBS	52	51	52	51	52	51
DW	0.307	1.036	0.732	1.810	1.100	1.943
R²	0.955	0.954	0.898	0.887	0.987	0.985

P_{h,t} is the real housing price index, P_{s,t} the real S&P 500 stock price index, and P_{b,t} a real bond price index calculated from the real bond price appreciation series used in Chapter 4. H_t, F_t, Y_t, and D_{s,t} are, as defined previously, the demographic demand for housing, the demographic demand for financial assets, real GDP per adult, and real dividends per share on the S&P 500. Standard errors are in parantheses. The pseudo R²s for the AR(1) regressions are calculated as the squared correlation coefficient between the actual and fit asset price series.

Table 5.6: Demographic Asset Demand and Long Run Cycles in Real Asset Prices

Housing Prices	Annual Growth in $P_{h,t}$	Trend Growth in $P_{h,t}$	Excess Growth in $P_{h,t}$	Annual Growth in H_t			Annual Growth in $P_{h,t}$			Annual Growth in Y_t		
				Low	Medium	High	Low	Medium	High	Low	Medium	High
1946 - 1966	0.67%	0.00%	0.67%	0.96%	0.12%	0.30%	0.49%	2.61%	-0.04%	0.60%	1.24%	
1966 - 1986	1.73%	0.00%	1.73%	3.23%	0.40%	1.02%	1.64%	1.13%	-0.02%	0.26%	0.53%	
1986 - 1997	0.53%	0.00%	0.53%	3.10%	0.38%	0.98%	1.57%	1.41%	-0.02%	0.32%	0.67%	
1997 - 2007	-	-	-	1.11%	0.14%	0.35%	0.57%	1.50%	-0.02%	0.34%	0.71%	
Stock Prices	Annual Growth in $P_{s,t}$	Trend Growth in $P_{s,t}$	Excess Growth in $P_{s,t}$	Annual Growth in F_t			Annual Growth in $P_{s,t}$			Annual Growth in $D_{s,t}$		
				Low	Medium	High	Low	Medium	High	Low	Medium	High
1946 - 1966	5.54%	0.00%	5.54%	0.66%	0.75%	1.39%	2.03%	4.48%	2.88%	5.48%	8.08%	
1966 - 1986	-0.64%	0.00%	-0.64%	-0.64%	-1.96%	-1.34%	-0.72%	-0.44%	-0.79%	-0.53%	-0.28%	
1986 - 1997	8.54%	0.00%	8.54%	3.15%	3.56%	6.62%	9.68%	2.26%	1.45%	2.76%	4.08%	
1997 - 2007	-	-	-	4.17%	4.71%	8.76%	12.81%	2.00%	1.28%	2.44%	3.60%	
Bond Prices	Annual Growth in $P_{b,t}$	Trend Growth in $P_{b,t}$	Excess Growth in $P_{b,t}$	Annual Growth in F_t			Annual Growth in $P_{b,t}$			Annual Growth in Y_t		
				Low	Medium	High	Low	Medium	High	Low	Medium	High
1946 - 1966	-3.98%	-7.10%	3.12%	0.66%	0.95%	1.39%	1.82%	2.61%	-0.86%	1.25%	3.36%	
1966 - 1986	-7.44%	-7.10%	-0.34%	-0.64%	-1.77%	-1.34%	-0.92%	1.13%	-0.37%	0.54%	1.45%	
1986 - 1997	-1.46%	-7.10%	5.64%	3.15%	4.55%	6.63%	8.71%	1.41%	-0.47%	0.67%	1.82%	
1997 - 2007	-	-	-	4.17%	6.03%	8.77%	11.52%	1.50%	-0.50%	0.72%	1.93%	

Figure 5.15



Chapter 6

Conclusion

The empirical evidence presented in this thesis suggests that demographic factors have substantial effects on the dynamic behavior of equilibrium asset prices. What makes these results believable is that the demographic demand variables used to generate them were derived from observed age profiles of demand for housing, stocks, bonds, and debt. Further, the shapes of these profiles are consistent with reasonable hypotheses about life cycle behavior. Nonetheless, what will prevent some readers from accepting the conclusion that demographics affect asset prices is the implication of predictability of long-run asset price movements. Indeed, Figures 5.1 and 5.15 suggest that asset prices are highly forecastable using publicly available population data. Is such predictability consistent with the assumption of rational expectations? It is, and the bottom two panels presented in Figures 5.1 and 5.15 provide some insight as to why it is.

Predictability of asset prices, and more specifically, financial asset prices, suggests that a rational investor could, and would, allocate his/her portfolio over time to be heavily weighted toward those assets whose prices are expected to rise and less heavily weighted toward those assets whose prices are expected to fall. Indeed, all investors would choose to do this, with the end result being to eliminate the differences in long run price cycles. Notice, however, that this does not rule out the possibility of common price cycles, as observed in the bottom two panels of Figures 5.1 and 5.15.

As evidenced by these graphs and the regression results presented in Chapter 5, the rational allocation of financial assets between stocks and bonds tends to eliminate any differences in the long run price cycles of these two assets. It does not, however, eliminate

their joint movement. The common price cycles in stocks and bonds displayed in Figures 5.1 and 5.15 represent shifts in the equilibrium interest rate; shifts, which appear to be due to changes in the demographic structure of the population. Not only are these shifts in interest rates, and hence in asset prices, consistent with rational behavior, they must occur in order for financial markets to be in equilibrium.

In particular, when large percentages of the population are at stages in their lives where the tendency is to borrow against future income or cash in on past savings, equilibrium interest rates must rise in order to insure that the supply of credit rises enough, and the demand for credit falls enough, to make the two equal. Correspondingly, equilibrium prices on financial assets must fall. When large percentages of the population are at stages in their lives where the tendency is to accumulate financial wealth, equilibrium interest rates must fall in order to insure that the demand for credit rises enough, and the supply of credit falls enough, to make the two equal. Correspondingly, equilibrium prices on financial assets must rise.

Thus, rather than looking at the apparent predictability of stock and bond price movements as evidence of irrationality, one could look at their comovement as depicting the effects of rational investors responding to changes in the economic environment brought on by changes in the demographic structure of the population. The observation that housing price movements do not mimic more closely those of stocks and bonds reflects the fact that homes act as both a durable consumption good and as a form of investment, whereas stocks and bonds are purely vehicles for investment. Since the age profiles of housing demand estimated in Chapter 4, which capture the combined effects of both sources of life cycle housing demand, differ from the estimated age profiles of net financial asset demand, one would expect the observed path of real housing prices to differ from the observed paths of stock and bond prices, even if individuals act rationally in making investment decisions. The empirical evidence presented in this thesis and summarized in Figures 5.1 and 5.15, therefore, is not an attack on rational expectations models, but rather, a reaffirmation of the fundamental economic principles of supply and demand.

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