Portfolio Choice with Risky Housing
Non-technical Summary

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Abstract

The open source computational tools we developed with generous support from TFI are the first accessible framework for analyzing consumer financial choices when the consumer has both a house and a mortgage and investments in risky assets (for retirement saving, for example). The model indicates that appropriate choices depend substantially on consumers' degree of risk aversion. For example, a consumer with substantial housing wealth who was risk tolerant might be inclined to invest heavily in the stock market. But another consumer in similar circumstances might be daunted by the combined risks of housing price fluctuations and stock market risk. The model is capable of giving the appropriate advice to each consumer based on their circumstances and preferences.

Keywords Life-cycle, Portfolio Choice, Housing, Mortgage, Financial Risk

1 Introduction

Economists have long sought to use models of mathematically optimal behavior to try to understand saving and investment decisions over a household's life-cycle[1]. If there were no uncertainty (about, say, investment returns), calculating optimal choices would not be hard. For example, consumers would want to invest their whole financial portfolio in whatever asset they knew (in advance) would yield the highest rate of return.

But in the real world, assets that – on average – yield higher returns (like stocks), also are much riskier than low-return safe assets (like bank deposits). Aversion to risk is a perfectly rational motivation, so how much to invest in risky versus safe assets is far from obvious. Furthermore, there are many other risks (to job, health, to house prices, and more) that should further temper any rational person's appetite for risky investment.

[1] See Gomes (2020) for a survey of portfolio choice over the life-cycle.

As noted in Carroll (2020)[2], calculating truly optimal behavior in a realistically uncertain world is such a difficult challenge that only recently has it become feasible to do with a reasonably high degree of realism. Rational choice models like the one we examined there must account for many important features of reality, including different types of uncertainty (labor income risk, mortality risk, and stock market risk), and should allow for reasonable choices of risk aversion, impatience, and other preferences. They need properly to account for for the path of income over the life cycle and into retirement, effects of aging and mortality, interest rates and economic growth, and myriad other factors.

All of this is so difficult that professional financial advisors do not attempt it, relying instead on rules of thumb and intuition to guide their clients. Indeed, despite the current excitement about the wonders of artificial intelligence, even online "robo-advisors" do not incorporate the degree of realism described above. Serious mathematical optimization efforts have been restricted to the pages of top academic economics journals – and the associated computer code used to solve the models in those papers has been so impenetrable as to be unusable.

A tempting interpretation of the discrepancy between the models' predictions and people's actual choices is that most people are just making a mistake in not investing more in stocks. Another possibility, though, is that the models are still missing some vitally important (and rational) factor that weighs on people's actual decisions; in this case, people might be making rational decisions and the models might be wrong.

There's an obvious candidate for the missing factor. For most households homeownership is the biggest financial decision in their lives. Homeownership *should* matter for consumers' choices about how willing they should rationally be to expose themselves to risky financial assets, for at least two reasons. First, homeownership exposes consumers to housing market price risk, which should have the effect of reducing their appetite for being exposed to other kinds of risk. Second, homeownership is associated with certain payment obligations (not just mortgages, but property taxes, maintenance costs, and so on), which reduces the flexibility they may have in adjusting their spending in response to income fluctuations.

These points may seem obvious, but there is a good reason they have not been incorporated in previous analyses of households' optimal choice: Taking account of these complexities greatly increases the computational difficulty of calculating optimal decisions. This technical report describes results obtained using the latest tools to be

[2]This blog post replicates results from Cocco, Gomes, and Maenhout (2005).

added to the Econ-ARK toolkit; with these tools, it should be much easier for economists, financial planners, and others to understand the appropriate role of homeownership in modifying investors' optimal saving and financial choices.

2 Literature Review

Beginning with Merton (1969) and Samuelson (1969), there is an extensive literature on portfolio choice over the life-cycle. Cocco, Gomes, and Maenhout (2005) develop a model of portfolio choice under incomplete markets and with labor income risk [3]. Although they are successful in solving a realistically calibrated life-cycle portfolio choice model, their results imply that most households, and in particular young households with low liquid wealth should invest *all* of their assets in the stock market. In reality, however, people choose a degree of stock market participation and risky share of assets much lower than what the model proposes would be optimal even for a person with very high risk aversion[4]. This gap between observed and actual stock market participation is known as the stock market participation puzzle, and it remains an open question that is not explained by state-of-the-art quantitative life-cycle models.

One possible explanation for the stock market participation puzzle could be the absence of additional forms of asset holding and risk exposure that households face. In particular, housing has dual properties: Both as an asset and as a source of consumption services . Housing, however, is different from other assets in that it is illiquid and durable, providing both future expected wealth (house value of liquidation) as well as shelter as a consumption service. CHETTY, SÁNDOR, and SZEIDL (2017) empirically quantify the effect of housing on portfolio choice. Looking at the Survey of Income and Program Participation (SIPP) panel from 1990 to 2008, the authors establish the importance of property value and home equity (value minus mortgage debt) on stock market participation. Importantly, they find that a \$10,000 increase in mortgage debt (holding home equity constant) causes the risky portfolio share to decrease by 0.6 percentage points or \$275, which amounts to 3.9% of mean stockholdings in their data. Importantly for our purposes, they establish the need to distinguish the effects of home equity and mortgage debt in order to quantify the effect of housing on portfolios.

This project builds a quantitative model of housing and portfolio choice that can be used to interpret the empirical findings CHETTY, SÁNDOR, and SZEIDL (2017)

[3] Other life-cycle portfolio choice models are Gomes and Michaelides (2005) and Yao and Zhang (2005)

[4] See Carroll (2020).

in a rich framework that includes liquid wealth, illiquid housing (size and value), and mortgage debt, in order to capture the effects of home equity and mortgage debt on portfolio choice. While other recent work has attempted to shed light on this topic, this model is the first of its kind to explicitly track home value and mortgage debt separately, allowing them each to evolve with the decisionmaker's choices and with economic shocks (say, to house prices). The 2-period model CHETTY, SÁNDOR, and SZEIDL (2017) develop misses the life-cycle properties of housing choice and income risk. Additionally, although their empirical findings reveal the importance of distinguishing home equity and mortgage debt, their model does not allow these variables to be chosen. Cocco (2005) and Yao and Zhang (2005) do allow choice of house size but do not distinguish between home equity and mortgage debt, instead only keeping track of net wealth as the total value of assets minus liabilities.

3 Theoretical Framework

Perhaps the biggest financial decision in a household's life is buying a house. Houses come in different sizes (and therefore costs), but they are generally an expensive asset whose value is at least a few times the household's yearly income. Young households usually cannot buy their houses outright, as they start with little to no assets and take time to accumulate enough resources. They therefore usually rely on mortgages to purchase their houses. These young and leveraged households might thus be sensitive to stock market risk, causing them to reduce their stock market participation.

During the repayment period, households' market resources (or liquid assets) are reduced by at least the fixed mortgage payment. This has two effects on risky asset choice: 1) It reduces 'market resources' (current income, plus current non-housing wealth) today, making households relatively less wealthy, and 2) It reduces market resources in following periods for any given level of current savings, making households more risk averse due to the precautionary motive. The fixed nature of mortgage payments has another important effect: since the household must be sure to have sufficient resources in the next period to pay their mortgage and the cost of house maintenance, they might want to save more of their resources in a safe account rather than in the risky stock market.

Houses are also subject to price fluctuations that depend on local housing market conditions as well as broader national trends, such as recessions and expansions. The uncertain sale price of your house, then, constitutes additional uncertainty in future net worth and could thus have significant implications for portfolio decisions. One way to think about this is to realize that the owner of a house has an implicit holding of a risky asset, which should motivate them to want to reduce their exposure to additional risk in another risky asset, the stock market.

4 Results

4.1 Homeownership increases intensive margin of stock market participation

We examine here the behavior of retired households on the cusp of the liquidation of the value of their house. As usual, we are assuming that the household anticipates some form of guaranteed pension income ('Social Security'), but expects to finance any other consumption out of the returns on their assets.

The proportion of liquid assets invested in the stock market is known as the risky portfolio share, or **risky share** for short.

Carroll (2020) reviewed the logic of the model without housing. For a person with no housing wealth and little liquid wealth, the first dollar of investment in the stock market poses very little risk, so the model implies that the proportion of any additional wealth that will be invested in the stock market is 100 percent. But as wealth gets very large, the consumer becomes reluctant to put all of it in the stock market, because that would be putting more and more of their consumption at risk[5].

Figure 1 shows how the picture is modified for consumers who, in addition to their liquid assets, own homes of various sizes.

According to the model, retired households who own their homes and expect to sell them by next period have a higher risky share than retired households who rent, and their risky share increases with house size, holding liquid wealth constant.

Clearly, the bigger the house size, the wealthier the agents are in terms of net worth. In the standard portfolio choice model, wealthier households actually reduce their risky share to reduce risk in next period's consumption. In the presence of housing, however, households still reduce their risk exposure as liquid wealth increases, but at a lower rate.

A better comparison is to add the expected value of the house to liquid wealth. In this way, we compare an agent with w net worth with all liquid wealth and no home, with an agent with w net worth, some of which is liquid wealth m, and the rest is the illiquid expected house valuation $\mathbb{E}[Q]h$, such that $w = m + \mathbb{E}[Q]h$, where Q denotes

[5] See Carroll (2020) for further discussion of this point.

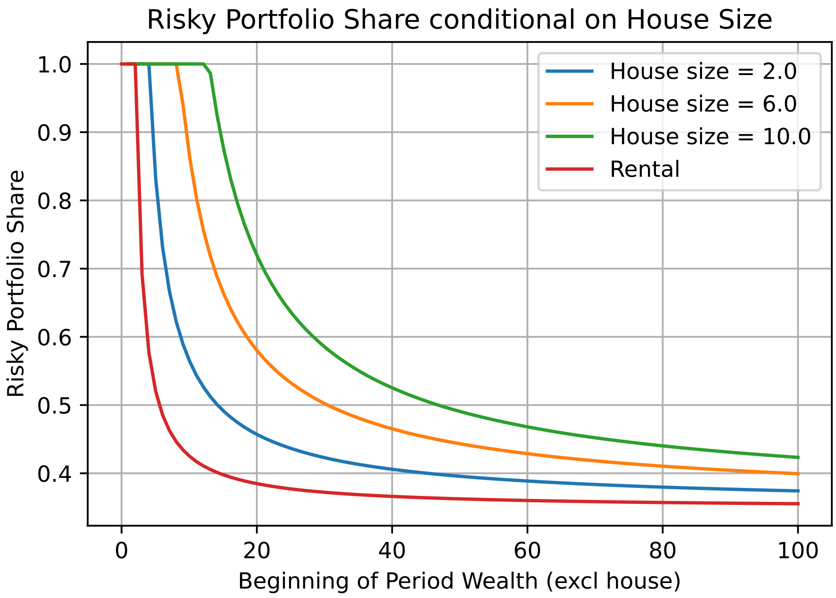

Figure 1 House size increases risky portfolio share

house prices and h represents the size of the agent's house[6]. As we see in figure 2, the increase in the risky portfolio share is more significant when considering home equity as part of net worth. Holding net wealth constant, households whose wealth is tied up in an illiquid asset have more risk appetite the larger the proportion of home equity to net wealth is.

4.2 Increasing house price risk decreases risky share

The volatility of the housing market can have strong implications for the portfolio decisions of households who own their houses. A higher standard deviation in house prices implies a larger implicit holding of a risky asset (the house), regardless of house size. For this reason, households would optimally choose to avoid risk in other risky assets. As we see in figure 3 for 2 households who have a house of equal size, the risky share of a household in a more volatile market is lower than that of a household in a less volatile market, except at low levels of market resources. Households that experience high price volatility in the housing market reduce their exposure to risk elsewhere, leading to lower risky portfolio shares.

[6]In this particular case, the household has fully paid their mortgage and home equity is the full home value

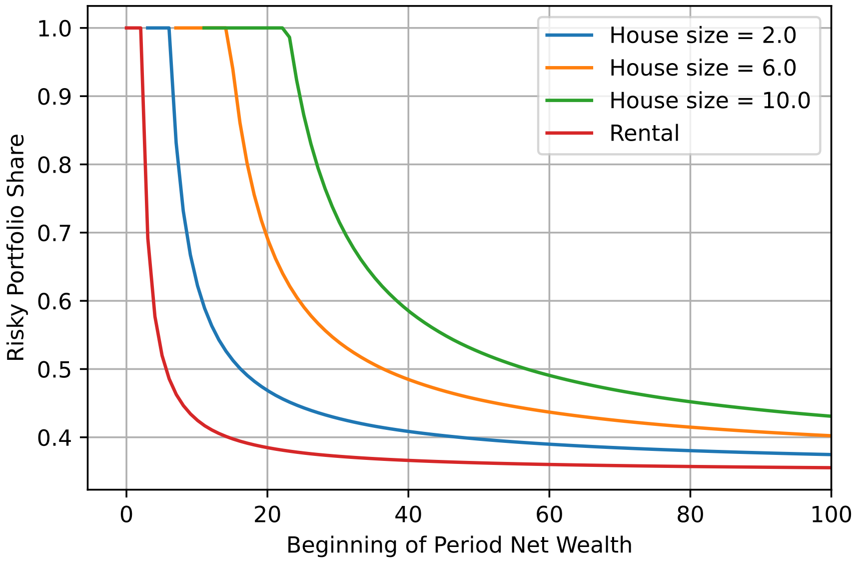

Figure 2 Risky Share conditional on net worth

4.3 House size crowds out investment

However, when comparing households on a total wealth basis, i.e. their liquid assets plus expected house liquidation, we can see that house size crowds out investment for households with low liquid wealth. In figure 4, we can consider a household whose house size is equal to 5 (5 times their yearly net income) and liquid assets are 0, so their total expected wealth is 5. As this household becomes wealthier, they invest all of their liquid assets in the stock market (such that their risky share is 100 percent), up to the point where they start rebalancing their portfolio between the risky and the safe asset. In this region, they are constrained from investing in the stock market by their low liquid wealth, as they surely would like to invest more in the market. This point becomes clearer by comparing the household to an equally wealthy peer with a smaller house. At the point where the household with house size of 5 has liquid wealth of 1 (1 times their yearly net income), they are investing less into the stock market in absolute terms than an equally wealthy household whose house size is equal to 2 and liquid assets are equal to 4. The total expected wealth of both these households is 6, but the household with the larger house is investing fewer assets in the stock market than the household with the smaller house. As their total wealth increases, however, both households are unconstrained by their house size and end up investing about the same amount into the stock market in absolute terms.

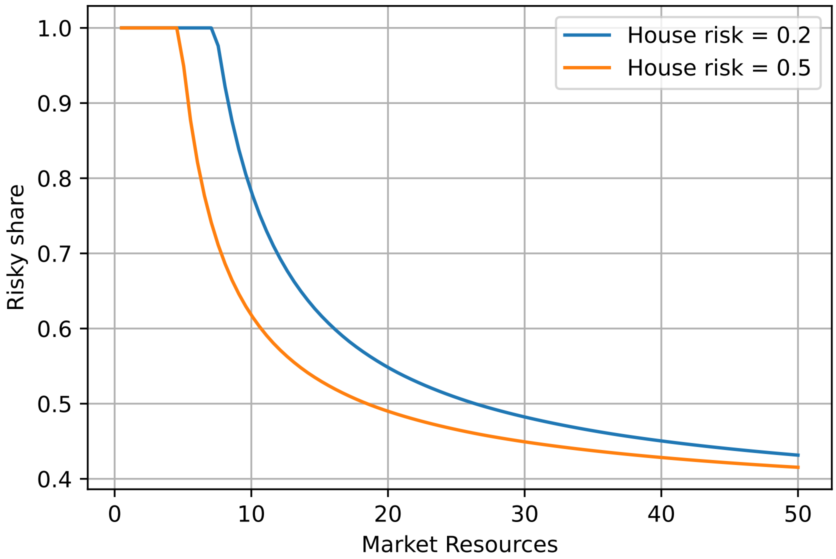

Figure 3 Increasing house price risk decreases risky share

5 Conclusions

Most people who need advice about how to invest in financial markets are also homeowners. But until now, even the most sophisticated and realistic analyses of how people should optimally invest in financial markets have not accounted for the (undeniably important) ramifications of homeownership for their financial choices.

That's because constructing a model that correctly tracks all the potential interactions between homeownership, financial risk, and other kinds of risk is remarkably difficult. This report describes a free, publicly available open-source software tool that does these complex calculations. Sponsorship by the Think Forward Initiative has allowed us to add this tool to the free, open-source, Econ-ARK toolkit, thus making it available to financial institutions, financial planners, robo-advisors, academics, and anyone else who might be interested in a rigorous analysis of these questions.

Despite their combinatorial complexity, the answers that come from the model make intuitive sense. A first conclusion is that greater uncertainty about future house prices should make you less willing to invest in the stock market. In other words, a homeowner who lives in a place with wild house-price swings will find it best to have less exposure to other kinds of risk (like stock market risk) than someone with circumstances that are otherwise similar, but who lives in a place where house prices are more stable.

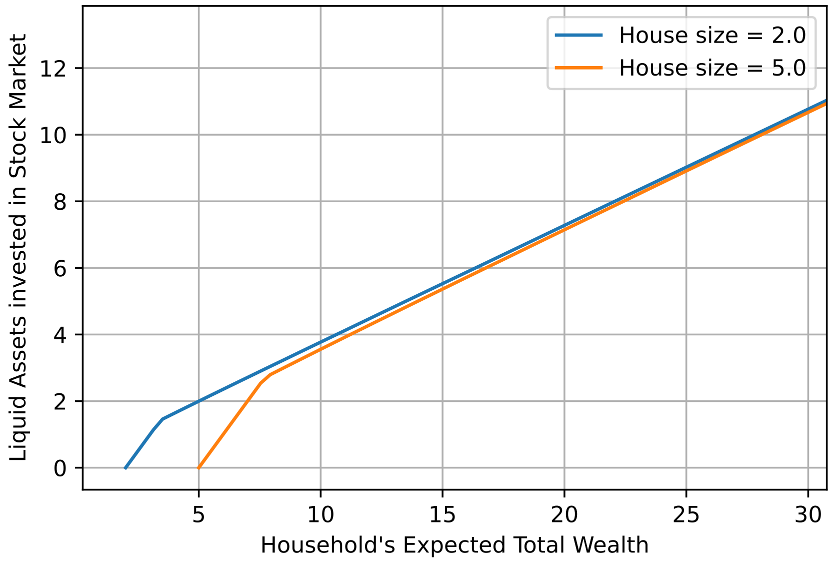

Figure 4 House size crowds out investment

Another conclusion might seem to push in the other direction, but really does not: Among homeowners whose mortgage is paid off, for a given level of *nonhousing* net worth (say, $200K of financial assets net of mortgage debt), a person whose house is more valuable should invest more in risky financial asset. The reason is simple: For a given amount of liquid assets, the person with a bigger house is richer, and a richer person will want to have more money (in absolute terms) invested in the stock market).

The final point is that the existence of homeownership does not reverse one of the more surprising implications of the baseline model without homeownership: The richer you are, the lower is the optimal share of your portfolio in risky assets. This implication of the model does not match the available data well. The conclusion is easy to reverse by introducing a bequest motive in which bequests are a luxury good; but how exactly such a motive should be constructed is by no means a settled question, either among financial planners or among academic researchers. It is a topic we hope to address in future releases of our toolkit.

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