Journal of Monetary Economics 71 (2015) 67–83

Contents lists available at ScienceDirect

Journal of Monetary Economics

journal homepage: www.elsevier.com/locate/jme

# Life-cycle portfolio choice with liquid and illiquid financial assets

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ARTICLE INFO

*Article history:*
Received 11 December 2013
Received in revised form
5 November 2014
Accepted 5 November 2014
Available online 15 November 2014

*Keywords:*
Household portfolio choice
Self-insurance
Cash-in-advance
Transaction cost

ABSTRACT

Traditionally, quantitative models that have studied households' portfolio choices have focused exclusively on the different risk properties of alternative financial assets. We introduce differences in liquidity across assets in the standard life-cycle model of portfolio choice. More precisely, in our model, stocks are subject to transaction costs, as considered in recent macroliterature. We show that when these costs are calibrated to match the observed infrequency of households' trading, the model is able to generate patterns of portfolio stock allocation over age and wealth that are constant or moderately increasing, thus more in line with the existing empirical evidence.


## 1. Introduction

The last decade has witnessed a substantial surge of academic interest in the problem of households' financial decisions. A number of empirical facts have been documented regarding in particular the stockholding behavior of households. These include the moderate (albeit increasing) stock market participation rates and the equally modest share allocated to stocks by those who do participate in the stock market. It has also been documented that the share of financial wealth allocated to stocks is increasing in wealth and roughly constant or moderately increasing in age.[1] Equally important has been the development of life-cycle models of portfolio choice that incorporate frictions, constraints, and key sources of risk. These models generate a puzzle that is the extensive-margin equivalent of the equity premium puzzle: given the historical equity premium, households should invest most of their financial wealth in stocks, something that is at odds with the empirical evidence. In the context of asset allocation decisions this puzzle is further compounded with the fact that the patterns of stock holdings by wealth and age are also inconsistent with the data.

The current paper adds to this latter line of research by exploring the role played by differences in the liquidity of different classes of financial assets. In order to do this we essentially augment the standard life-cycle model of Cocco et al. (2005) with the monetary model in Alvarez et al. (2002). More precisely we assume that agents receive a stochastic

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[1] Among the papers that have uncovered the patterns of household financial behavior are Ameriks and Zeldes (2004), Bertaut and Starr-McCluer (2000) and Heaton and Lucas (2000) for the US. The book by Guiso et al. (2001) documented the same facts for a number of other industrialized countries as well and the work by Calvet et al. (2007) has gone in much greater details to document stock-holding behavior among Swedish households.

http://dx.doi.org/10.1016/j.jmoneco.2014.11.008
0304-3932/

uninsurable earnings stream during working life and face both borrowing and no short sale constraints. They have access to two assets, one riskless and one risky (equities). As in Alvarez et al. (2002) we assume that the assets are held in separate accounts, respectively stock account and monetary/liquid account, and that transactions between these two accounts require payment of a fixed cost.

Households receive their wages in the monetary account and a cash-in-advance constraint holds, so that consumption goods can only be purchased with the available money. This gives the liquid asset an advantage as an asset to insure consumption levels early in life, and this advantage is stronger the greater the transaction cost. Similarly a retired agent who is using accumulated wealth to supplement her pension income would like to hold a certain balance in the liquid account rather than paying the fixed cost in every period. In the paper, and following the literature, we model this as a pure monetary cost, but it is also meant to capture the time and information processing cost that is involved in making the associated financial plan. This cost is then reflected in the frequency of transactions that we observe among households.[2,3]

The standard model with no transaction costs can only generate the well-known policy functions for the stock share that start at 100 percent when the agent has very little wealth and then monotonically decline as wealth increases.[4] In the model presented here the current share of stocks becomes a state variable. The optimal stock share decision depends on the current stock share—as well as current wealth and earnings—and displays more complex shapes that include patterns that are increasing in wealth especially when both wealth and current earnings are small. The model then generates a life-cycle stock share profile that is either hump-shaped or moderately increasing, depending on the parametrization used. With respect to wealth the simulated data show portfolio allocations to stocks that are increasing over the bottom to mid-quartiles of the distribution and then level off or moderately decline at the top. This occurs also when the behavior of stock shares over wealth is conditioned on age. While still not a perfect match with the data these patterns represent a significant improvement over those produced by conventional models.

Our paper belongs to the growing literature on life-cycle asset allocation with labor income risk.[5] Particularly related are the recent papers by Benzoni et al. (2007), Gomes and Michaelides (2003), Lynch and Tan (2011), Polkovnichenko (2007) and Wachter and Yogo (2010) which have looked for explanations of patterns of household stock market investment over the life-cycle and over wealth levels. Benzoni et al. (2007) and Lynch and Tan (2011) consider alternative specifications of the labor income process which can also deliver portfolio shares that are increasing in wealth, conditional on age. However, in Benzoni et al. (2007) this effect only takes place early in life, since it is driven by the low-frequency correlation between stock return and labor income. Naturally, as the agent approaches retirement this correlation becomes irrelevant. The objective of their paper is to match the unconditional share as a function of age, so it is only necessary to generate this effect early in life. Likewise, in Lynch and Tan (2011) the result is driven by business cycle fluctuations in the conditional distribution of income shocks, and therefore the effect is again only present for young households. Gomes and Michaelides (2003) and Polkovnichenko (2007) generate this increasing pattern by assuming habit formation preferences; however they point out that, in order to get strong effects within this model, the importance of the habit must be very high, and therefore it implies counter-factually high levels of wealth accumulation. Wachter and Yogo (2010) achieve the same result assuming multiple goods, and their model generates an increasing relationship between wealth and the portfolio share of risky assets conditional on age. However, in their preferred calibration, the average life-cycle profile is declining, [and] hence does not match the data very well. We see our theory as complementary to the ones mentioned above. The advantage of our approach is that it allows us to match the weakly increasing pattern of the portfolio share both over the life-cycle and over wealth, conditional on age without the need to resort to any form of correlation between labor earnings and market returns, something that is absent during retirement and is likely to be weak at the end of the working life.

A second related strand of literature includes models of monetary economics that assume a portfolio choice between money and other assets, like capital or bonds, and some frictions. Examples are the papers by Alvarez et al. (2002), Akyol (2004) and Khan and Thomas (2011). Alvarez et al. (2002) construct a model that is similar to the current one in the assumption about the cash-in-advance constraint on consumption purchases; their model is focused on studying the effects of money injections on interest rates and exchange rates. Their framework though is different from the incomplete market model used here. Akyol (2004) uses the incomplete market model to study the optimality of the Friedman rule when agents have access to two assets, money and a bond. In his model a friction is introduced by assuming that trading in the bond market can be performed only before the uncertainty about labor earnings is resolved. Khan and Thomas (2011) consider a model with endogenous market segmentation and show that it can generate sluggish and persistent adjustments of prices and interest rates to a monetary shock in an endowment economy as well as a hump-shaped response of employment and output to productivity shocks.

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[2] The empirical evidence in this respect shows that transactions in stock accounts are rare for a large fraction of households, suggesting that once the planning costs are factored in the overall cost is non-trivial (see Bilias et al., 2010; the Investment Company Institute report "Equity Ownership in America", 2002 and 2005).

[3] An alternative approach is to assume observation costs (e.g. Abel et al., 2007). Alvarez et al. (2012) construct a model with both observation and transaction costs, and find stronger empirical support for the latter. This lends support to our choice to study the behavior of conditional portfolio shares under infrequent portfolio adjustment by assuming a fixed transaction rather than an observation cost.

[4] This holds under the assumption of no or small correlation between earnings and risky returns. More discussion on this issue will be given later.

[5] As initially explored by Heaton and Lucas (1997, 2000) and Haliassos and Michaelides (2003) in an infinite horizon setting and by Campbell et al. (2001), Cocco et al. (2005) and Gomes and Michaelides (2005) in a life-cycle setting.