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Implications of heterogeneity in preferences, beliefs and asset trading technologies in an endowment economy ☆

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ABSTRACT

This paper analyzes and computes the equilibria of economies with large numbers of heterogeneous agents who have different asset trading technologies, preferences and beliefs. We illustrate the value of our method by using it to evaluate the implications of these heterogeneities through several quantitative exercises.

1. Introduction

This paper extends the methodology developed by Chien, Cole and Lustig (2011, 2012) (hereafter, CCL2011 and CCL2012) to analyze and compute the equilibria of economies with heterogeneous agents who have different asset trading technologies, and are subject to both aggregate and idiosyncratic income risk. The different asset trading technologies, which are designed to replicate the portfolio behavior we see in the data, fall into two classes. *Active traders* manage the composition of their portfolios and choose how much to save. *Passive traders* take their portfolio composition as given and choose only how much to save. Within each of these two classes, there can be a wide variety of different cases. For active traders, the trading technology varies according to the set of assets that they can use, while for passive traders it varies according to the specific portfolio composition rule. In CCL2011 and CCL2012, all of our agents had the same CRRA flow utility functions, discount rates and beliefs. In this extension, we relax this restriction, greatly extending the set of economies to which our method applies. This richer degree of heterogeneity allows the model to match up with a number of key features of the data.

To compute and characterize equilibria we utilize a recursive multiplier method and analytic aggregation results with respect to consumption shares and the stochastic discount factor that rely on a single cross-sectional moment of the multi-

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plier distribution. As a result, we can compute equilibria via an iterative method in which we guess and recover a transition rule for the updating of this moment. In these iterations we do not need to compute "market clearing prices" since we know them analytically as a function of the updating rule. Instead, we simply solve the analog of a dynamic programming problem for each type of agent with respect to their individual multipliers to determine their individual multiplier updating rule. The only input into this problem is the stochastic discount rate implied by the conjectured updating rule for the key cross-sectional multiplier moment. We then pass their individual multiplier updating rules through a stochastic panel of aggregate and individual shocks to determine the implied updates of the key cross-sectional multiplier moment. If we recover the same updating rule we conjectured, then we have solved for an equilibrium of our economy. Otherwise, we use the implied updating rule to modify our conjectured rule and continue to iterate on the aggregate multiplier transition rule.

Because the economies studied typically feature a continuum of agents with a rich degree of heterogeneity, approximating the state space is an integral part of the computation along with determining the requisite pricing and transition rules. The standard approach in the literature has been to approximate the distribution of wealth using various moments of the wealth distribution. While we could do something similar with respect to the multiplier distribution, we use instead finite histories. Ergodicity naturally implies that history dependence dies out. Moreover, one commonly finds that this dying out is monotone. For this reason, we have found that using finite history states as our fundamental state space is both computationally very tractable and at the same time quite accurate.

In CCL2011 and CCL2012, we relied on the homogeneity of the inverse of the marginal utility of consumption when all households have common CRRA preferences, discount rates and beliefs. In our extension, we create (i) a parallel economy of reference traders who have common CRRA preferences, discount rates and beliefs and (ii) a mapping rule which maps our standard household's multiplier into a multiplier for the reference traders such that their consumptions are equal history-state-by-history-state if state prices are the same. All of our aggregation results hold in the parallel economy. Our extended methodology takes advantage of this by using a guess and recover method for the transition rule for the key cross-sectional moment of the reference economy multipliers. We use the regular economy to determine updating rules for their individual multipliers, given the state prices implied by the transition rule for the key moment of the reference trader's multiplier distribution. We then use these individual updating rules to determine the realized individual multipliers in a stochastic panel. We map these multipliers into the multipliers for our reference traders and then determine the cross-sectional moment and updated transition rule in the parallel economy. The new procedure essentially adds one small step to the original algorithm. However, now the procedure can accommodate any economy for which we can construct a multiplier mapping rule for the reference traders. This turns out to be a very broad set.

Our methodology is well suited to exploring the implications of a rapidly growing literature on household finance that studies the portfolio decisions of households for the macroeconomy. This literature finds that many households do not use asset markets as our standard theory would predict: both the extent of the assets they use and how they use these assets differs in important ways (see Guiso and Sodini, 2012 for a survey of this literature). First, many households do not use all of the available assets. Second, even households which hold equities make very few adjustments in their financial positions. Third, many households who do adjust their portfolios seem to do so in a backward-looking manner that leads them to systematically mistime the market. These empirical findings suggest that many households are either completely unresponsive to variations in the pricing of risk or respond in the wrong direction. This pattern of asset usage by households is potentially important since it creates a form of market segmentation that can have wide-ranging implications for many aspects of our models' predictions, such as household consumption behavior, the distribution of wealth, and, most directly, asset prices.

CCL2011 and CCL2012 used this methodology to evaluate the impact of heterogeneous portfolio behaviors on asset pricing, risk sharing and wealth distribution. We found that having a large number of investors who invest only in low-risk/low-return portfolios means that other investors have to take on more risk – in particular aggregate risk. We also found that having a large number of investors who invest in equities very passively, which implies their equity positions must move in a pro-cyclical manner, force a small fraction of traders to have large counter-cyclical aggregate risk exposure. The concentration of counter-cyclical aggregate risk into a small number of active traders generates both a high and a highly volatile market price of risk, which has been a challenge for our asset pricing models (see Lettau and Ludvigson, 2010). Also, having a large number of households who do not use assets well can explain their failure to smooth their consumption to the degree that the richness of actual financial markets would allow. Finally, the fact that households realize very different returns on their investments can explain the distribution of wealth: both that wealth is highly skewed relative to income and that equity investment is highly correlated with wealth.

In this paper, we apply this new methodology to several quantitative experiments. In the first set of experiments we examine the impact of different attitudes towards the future through either belief heterogeneity or patience. For belief heterogeneity, we consider a case where a fraction of active traders have recency bias, meaning that they overweight of recent events when forming their beliefs. More specifically, these active traders become more (less) optimistic about the likelihood of a good growth shock after recent expansions (recessions). As a result, the investment behavior of recency bias traders is less responsive to the price of risk, forcing the standard active traders to have large counter-cyclical aggregate risk exposure. This leads the recency-bias active traders to mistime the market and substantially increases the counter-cyclical volatility of the market price of risk. This mechanism is complementary to the mechanisms we explored in CCL2011 and CCL2012 because it involves a different set of traders and a similar cyclical concentration of risk for the standard active traders. For patience heterogeneity, we find that the inclusion of active traders with reduced patience has very little impact on asset prices. This is because these reduced-patience traders take very similar portfolio positions as the standard active