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# A class of tractable incomplete-market models for studying asset returns and risk exposure<sup>☆</sup>

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## ABSTRACT

We present a class of tractable incomplete-market models, where agents face both aggregate risk and limited participation in financial markets. Tractability relies on the assumptions of small asset volumes and of a period utility function that is linear beyond a threshold, in line with Fishburn's (1977) contribution in decision theory. We prove the existence of an equilibrium and derive theoretical results regarding asset prices and consumption choices. This small-trade model is able to reproduce a low safe return and a high equity premium, together with a realistic representation of household exposure to both idiosyncratic and aggregate risks.

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## 1. Introduction

Infinite-horizon incomplete insurance-market models with credit constraints are known to be difficult to solve in the presence of aggregate shocks. These models generate a large amount of heterogeneity, reflected by the time-varying distribution of agents' wealth with large support, meaning that numerical methods are required to approximate the equilibrium (Krusell and Smith, 1998). In this paper, we use a class of incomplete-market models to conduct theoretical investigations of equilibrium allocations and asset prices. We prove the existence of an equilibrium in the presence of aggregate shocks, heterogeneous levels of idiosyncratic risk, and stock-market participation costs, for which we can analytically examine the main determinants of risk allocation and of asset prices.<sup>1</sup> Our modeling strategy is based on two assumptions. First, we assume

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<sup>1</sup> Note that the existence of simple recursive equilibria in such environments is still an open question (Miao, 2006).

that the period utility function is linear above a certain threshold, strictly concave below the threshold, but globally smooth and concave. This utility function was first introduced in decision theory by Fishburn (1977) to analyze risk for “below-target returns”.<sup>2</sup> The way the utility function provides tractability in incomplete-market models is interesting compared to alternative approaches. In particular, incomplete-market models have often relied on quasi-linearity in the labor supply to reduce the state space dimension (Challe et al., 2013; Lagos and Wright, 2005; Le Grand and Ragot, 2016; Scheinkman and Weiss, 1986; Wen, 2015, among others). Assuming linearity in the labor supply has the drawback that the consumption of agents with infinite labor elasticity is constant and independent of wealth and income. This infinite elasticity is also far too high at the household level (see Hall, 2010, for a recent survey). The Fishburn utility function, linear beyond a given threshold, may thus be an attractive alternative for studying consumption dynamics and realistic labor income processes, as we do in this paper. Our second assumption is that the supply of securities is not too large. This implies that credit constraints are binding for agents who have experienced only a small number of consecutive bad idiosyncratic shocks, which generates an equilibrium with a small number of heterogeneous agents. Our economy therefore features a *small-trade* equilibrium, where prices can be analytically studied, as in no-trade equilibria (see below for references), but where we can also investigate consumption allocations and the role of security volumes.

The goal of the paper is to show the usefulness of this setup by theoretically investigating the properties of an environment where two groups of agents face two different labor income processes together with limited participation in financial markets. The motivation for such an environment is based on previous results in the literature. First, it is known that incomplete insurance-markets models can help to solve some asset pricing puzzles but that they are generally unable to reproduce a high equity premium for a realistic calibration (Krusell et al., 2011; Krusell and Smith, 1998, among many others). Second, adding limited participation in financial markets can help to reproduce relevant aspects of asset prices (Allen and Gale, 1994; Guvenen, 2009) and is consistent with empirical evidence (Bricker et al., 2014). Third, empirical investigations of income risks in the US show that high-income households face lower risk than low-income households, who generally do not participate in financial markets.<sup>3</sup>

We derive two main sets of results. First, we prove the existence of an equilibrium and exhibit the structure of this limited-heterogeneity equilibrium. We then theoretically show how the model can generate a low return for the safe asset and a high equity premium. We also characterize the effects of risks and volumes on asset prices, deriving explicit formula to identify all effects at stake. In particular, a higher volume of securities reduces asset prices and improves consumption smoothing, whereas a higher level of idiosyncratic risk generates both a decrease in the bond interest rate and an increase in stock prices.

Second, the calibrated model satisfactorily reproduces household risk exposures and asset price properties. The model generates a more volatile consumption growth rate for low-income households than for high-income households, as in the data. High-income households are also found to bear a larger fraction of the aggregate risk than low income households (Parker and Vissing-Jorgensen, 2009), while the latter face a larger total risk.

The paper contributes to the theoretical literature on incomplete-market models. In this literature, analytical tractability can be obtained in a no-trade equilibrium, as in Constantinides and Duffie (1996) or Krusell et al. (2011). In these economies, assets can be priced, even in absence of trade. In our model, trades do actually occur at the equilibrium. We show that limited asset market participation is sufficient to explain both a high equity premium and the volatility of consumption, with a risk aversion as low as 1 in the concave part of our benchmark calibration. Our assumption of a concave-linear utility function is similar to several papers that consider linearity in consumption utility, in leisure utility, or in the production function in order to reduce ex-post heterogeneity, such as Scheinkman and Weiss (1986), Lagos and Wright (2005), Kiyotaki and Moore (2005, 2008), Dang et al. (2017), Wen (2015), or Miao and Wang (2017), among others. Finally, this paper generalizes previous work on small-trade models (Challe et al., 2013; Challe and Ragot, 2014; Le Grand and Ragot, 2016). The paper is also related to the vast literature on asset prices with heterogeneous agents. Our contribution to this literature is to analyze the interaction of two frictions in a tractable framework: limited participation and incomplete insurance markets with heterogeneous income-risk exposure.<sup>4</sup>

The remainder of the paper is organized as follows. In Section 2, we present the model and derive our equilibrium existence result. In Section 3, we present the intuition underlying our model in simplified versions of our framework. In Section 4, we perform a quantitative exercise to show that the model can reproduce household risk exposures and asset returns. Section 5 concludes.

<sup>2</sup> This captures the idea that investors are averse to risk for low returns (below a given target), but much less concerned about risk for high returns.

<sup>3</sup> See DeGiorgi and Gambetti (2017), Gârleanu et al. (2012), Meyer and Sullivan (2013) and Bricker et al. (2014), among others, for empirical evidence.

<sup>4</sup> Among the recent quantitative papers, Guvenen (2009) studies a model with limited participation and household heterogeneity in intertemporal elasticities of substitution. Constantinides and Ghosh (2017) build on Constantinides and Duffie (1996) to construct a no-trade equilibrium with Epstein-Zin preferences. Chien et al. (2011, 2012) consider an incomplete-market model featuring exogenous trading restrictions, which can easily be simulated. Gomes and Michaelides (2008) and Favilukis (2013) consider models with preference heterogeneity (in terms of intertemporal elasticity of substitution or bequest motive) together with incomplete markets or limited participation.

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