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Pricing assets in a perpetual youth model

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ABSTRACT

This paper constructs a general equilibrium model where asset price fluctuations are caused by random shocks to beliefs about the future price level that reallocate consumption across generations. In this model, asset prices are volatile, and price–earnings ratios are persistent, even though there is no fundamental uncertainty and financial markets are sequentially complete. I show that the model can explain a substantial risk premium while generating smooth time series for consumption. In my model, asset price fluctuations are Pareto inefficient and there is a role for treasury or central bank intervention to stabilize asset price volatility.

A large literature in finance seeks to reconcile features of financial data with features of aggregate time series (Gabaix, 2012). Typically, these explanations combine some version of the rare disasters hypothesis of Rietz (1988) and Barro (2006) with the variable long-run risk model of Bansal and Yaron (2004). To successfully explain financial data in an equilibrium model, the theorist must explain why the price of risk is highly volatile, while consumption data are smooth.

Most equilibrium explanations of financial data are based on the assumption that all shocks to the economy are fundamental. For example, in the long-run risk model of Bansal and Yaron (2004), consumption growth is exogenous and has a small highly persistent component. In the rare disaster model of Rietz (1988) and Barro (2006) there is, occasionally, a large negative shock to the aggregate endowment.

This paper explores an alternative approach. I build on the work of David Cass and Karl Shell (1983), by constructing a model where asset price fluctuations are caused by non-fundamental shocks to people's beliefs. Cass and Shell presented this idea in a two-period real model. I show that a calibrated version of their model can explain real world data.

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I construct a general equilibrium model where asset price fluctuations are caused by random shocks to beliefs about the future price level that reallocate consumption across generations. In this model, asset prices are volatile and price–earnings ratios are persistent even though there is no fundamental uncertainty and financial markets are sequentially complete. Because I am interested in the ability of non-fundamental shocks to explain asset prices, my model has no fundamental uncertainty of any kind.

I refer to the random variable that drives asset prices in equilibrium as a *belief shock* and I refer to the mapping from belief shocks to realizations of the price level as a *belief function* (Farmer, 1993). I treat belief shocks and the belief function as new fundamentals that select one of the many possible equilibria of the underlying monetary model.

My work differs in three ways from standard asset pricing models. First, I allow for birth and death by exploiting Blanchard's (1985) concept of perpetual youth. Second, my model contains an asset, government debt, denominated in dollars. Third, there are two types of people that differ in the rate at which they discount the future. The perpetual youth assumption and the existence of a nominal asset are essential to generate volatile asset prices in the presence of sequentially complete asset markets. The assumption of two types of people allows me to construct equilibria where there are active trades in the financial markets by people of different types.

I model a government with two branches; a central bank and a treasury. The central bank operates an interest rate peg and the treasury adjusts the tax rate periodically to ensure the government remains solvent. Because debt is denominated in dollars, this policy leads to indeterminacy of the initial equilibrium price level. For every initial price in a certain set, there is a different allocation of the present value of taxes between current and future generations. For each allocation of taxes, there is a different non-stationary perfect foresight equilibrium price sequence. Each of these sequences converges to the same steady-state equilibrium.

I exploit the indeterminacy of the set of perfect foresight equilibria to construct a rational expectations equilibrium in which non-fundamental shocks cause asset price fluctuations. The people in my model believe the future price level is a random variable, driven by a belief shock, and they write financial contracts contingent on its realization. In equilibrium, their beliefs turn out to be correct. Because the unborn cannot buy or sell contracts traded before they are born, belief shocks have real effects that reallocate resources between people of different generations.

I am pursuing an alternative explanation for asset price fluctuations because I am ultimately interested in a normative question. Should the treasury and or the central bank intervene in asset markets to reduce volatility? If all asset market fluctuations are caused by the responses of a representative agent to unavoidable endowment shocks, the government should not seek to intervene. If instead, a large component of asset price fluctuations is due to Pareto inefficient re-allocations of consumption goods between people of different generations, there is a potential role for an active financial policy, of the kind discussed in Farmer and Zabczyk (2016), to stabilize those fluctuations.

1. Antecedents

An active body of scholars seek to explain asset price data using the representative agent model. Some of the modifications to this model that have been tried include richer utility specifications (Abel, 1990; Constantinides, 1990; Campbell and Cochrane, 1999; Bansal and Yaron, 2004) adding technology shocks with exogenous time-varying volatility (Bansal and Yaron, 2004), and assuming that technology is occasionally hit by rare disasters (Rietz, 1988; Barro, 2005, 2006; Wachter, 2013; Gourio, 2012; Gabaix, 2012).

Here, I take an alternative approach. I build on the idea that non-fundamental shocks can have real effects when there is incomplete participation in asset markets. Cass and Shell (1983) refer to non-fundamental shocks as 'sunspots' and Azariadis (1981) and Farmer and Woodford (1997) call them 'self-fulfilling prophecies'. Although the term 'sunspot' is widely understood by economic theorists, I have found that it represents a source of confusion when explaining the idea to a lay audience and I use the term 'belief shock' in this paper to mean non-fundamental uncertainty that may have real effects.

My work is closely related to four working papers, Farmer (2002a,b, 2014) and Farmer et al. (2012). Farmer (2002b) develops a version of Blanchard's (1985) perpetual youth model with capital and aggregate uncertainty, Farmer (2002a) adds nominal government debt to explain asset price volatility and Farmer et al. (2012) construct a model with multiple types.[2] The current paper relies on all three of these pieces; perpetual youth, nominal debt and multiple types.[3]

The idea of constructing stationary stochastic rational expectations equilibria by randomizing over multiple steady states is due to Azariadis (1981). The first paper to exploit randomizations across indeterminate perfect foresight paths in a monetary model is by Farmer and Woodford (1997). Farmer et al. (2015) show how to solve models with indeterminacy using standard solution methods by redefining a belief shocks to be a new fundamental and I draw on a non-linear extension of their technique in this paper. In the Farmer–Woodford paper there is a single type of person in each generation. As a consequence, there is no active trade in the asset markets which serve simply to determine prices at which people choose

[2] Farmer et al. (2012) claim to generate equilibria, driven by non-fundamental shocks. That claim is incorrect as their model fails to equate the marginal rates of substitution of each type of agent in every state and consequently, the paper does not fulfill its claim to generate sunspot equilibria. I am grateful to Markus Brunnermeir and Valentin Haddad for discussions on this point.

[3] Two earlier versions of the current paper appeared, one with title "Global Sunspots and Asset Prices in a Monetary Economy" (Farmer, 2015) and one with the title "Pricing Assets in an Economy with Two Types of People" (Farmer, 2016). The current version is different, in a number of important ways from both of these versions and for that reason I have changed the title.