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Habit persistence, impediments to production factor adjustments, and asset returns in general equilibrium models with self-fulfilling expectations

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ABSTRACT

I examine asset returns in the context of real dynamic stochastic general equilibrium economies with multiple equilibria (indeterminacy) that allow for aggregate fluctuations due to non-fundamental belief shocks. The two models include habit formation in preferences. Model 1 combines restrictions on factor mobility and adjustment costs in a one-sector economy. Model 2 uses restrictions on factor mobility in a two-sector economy. Results demonstrate that Model 1 fails to match the stylized financial facts. Model 2 replicates the low risk-free rate and the standard deviation of the return on the risk-free asset, but underestimates the equity premium and standard deviation of the return on equity.

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1. Introduction

In this study I investigate the asset pricing implications of real dynamic stochastic general equilibrium (DSGE) economies with multiple sunspot equilibrium solutions. Multiple equilibria or indeterminacy arise when agents act based on expectations, not grounded in fundamentals of the economy. By their behavior these beliefs may become self-fulfilling.

Models with self-fulfilling expectations enjoy a measure of success in explaining the stylized facts of the business cycle, and in this regard they are difficult to distinguish from the neo-classical real business cycle (RBC) models with unique equilibriums. However, neo-classical (determinate) and indeterminate economies differ greatly with respect to the shock propagation mechanism, and, consequently, in their policy implications. [See Benhabib and Farmer (1999) for a detailed survey of literature on indeterminacy.] Financial implications of models with multiple equilibria have not been extensively studied.

Indeterminacy of equilibrium in a model economy allows for the introduction of belief or "sunspot" shocks. Sunspot equilibria may involve large fluctuations in macroeconomic variables. In the context of DSGE models, in which asset prices and macroeconomic variables are endogenously connected, sunspots influence asset returns. This connection is a potentially attractive feature of the models with indeterminacy, since financial markets are driven to a large extent by investors' beliefs.

My first objective in this research is to evaluate the extent to which self-fulfilling expectations change the asset pricing implications of DSGE models. I focus on matching the equity premium, average risk-free rate, and the volatilities of asset returns observed in US data. My second objective is to contrast the financial implications of indeterminate models with asset pricing results obtained in their counterpart models with determinate (unique) equilibrium.

The two models, I analyze, share both habit formation in investors' preferences and factor market inflexibilities in production. However, they differ in their production technologies. The first specification combines capital adjustment costs with increasing returns to scale in a one-sector model with predetermined labor. The second is a two-sector model with increasing returns in the investment producing sector only, and restricted capital and labor mobility between sectors.

The logic underlying this particular choice of features is that habit formation in preferences of representative investors breaks the link between the model's stochastic discount factor (pricing kernel) and the rate of consumption growth. Without habit, the standard deviation of the pricing kernel, itself proportional to consumption growth, must be low in order to replicate the standard deviation of the consumption growth rate of about 1% estimated in the data. Alternatively, the Hansen and Jagannathan (1991) study implies that accounting for the high equity premium in the US data in the context of the consumption-based DSGE framework requires the standard deviation of the stochastic discount factor to be at least 50%

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annually. Habit formation dramatically increases investors' desire to smooth consumption while factor market inflexibilities, such as adjustment costs, predetermined labor, and restricted factor mobility between production sectors, prevent instantaneous costless factor adjustments. Researchers often use a combination of the two elements to improve asset pricing implications in general equilibrium in the determinate (no sunspots) setting. Mehra and Prescott (2003) and Campbell (1999) present extensive reviews of the asset pricing literature on the determinate DSGE framework.

To explore the effectiveness of these features in explaining the stylized financial facts in a multiple equilibria setting, I first establish that they are compatible with indeterminacy. The next step is to quantitatively evaluate the asset pricing implications of the two models. I find that the one-sector model with self-fulfilling expectations is not consistent with the high equity premium and the volatility of the return on equity. In contrast, the determinate one-sector model matches these features of asset returns well, although it produces an extremely volatile risk-free rate. The two-sector model with sunspots is able to replicate the average risk-free rate and the standard deviation of the return on the risk-free asset observed in the data. This is an improvement over the corresponding determinate model developed in Boldrin, Christiano and Fisher (2001), which results in extremely volatile return on the risk-free asset. On the other hand, the indeterminate two-sector model does not reproduce the high equity premium observed in the US data. The corresponding determinate model matches the equity premium.

The paper proceeds as follows: Section 2 outlines the two models with self-fulfilling expectations and presents the solution method that I use throughout this paper. In Section 3 I describe my choice of parameters and analyze the implication of habit formation and restrictions on factor mobility for indeterminacy. In Section 4 I discuss the quantitative implications of two indeterminate models and contrast them with quantitative implications of the corresponding determinate models. Section 5 concludes.

2. Two models with self-fulfilling expectations

In this section I outline two decentralized production economies and explicitly define the prices of financial securities.

2.1. Workers–investors

A large number of households seek to maximize their expected lifetime utility over consumption and leisure by choosing financial asset holdings and a fraction of time endowment devoted to work. The preferences of the representative household are:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{(c_t - bc_{t-1})^{1-\xi}}{1-\xi} - Bn_{ht} \right] \quad \xi > 0, b \geq 0 \quad n_{ht} \leq 1 \tag{1}$$

where β $(0<\beta<1)$ is the subjective discount factor, c_t denotes consumption of the household in period t and $0 \leq n_{ht} \leq 1$ denotes time t labor. In the two-sector model $n_{ht} = n^c_{ht} + n^i_{ht}$ here, and in what follows, the superscript c denotes the consumption producing sector and superscript i denotes the investment producing sector. When $b>0$, preferences include habit persistence, I choose the internal habit specification proposed by Constantinides (1990). The parameter ξ is the coefficient of the relative risk aversion. I choose B so that total hours worked match the fraction of time devoted to work in the data.

In the one-sector model, the representative household's budget constraint is:

$$c_t + z^e_{t+1} p^e_t + z^b_{t+1} p^b_t \leq z^e_t (p^e_t + d^e_t) + z^b_t + w_t n_{ht} \tag{2}$$

where w_t denotes the wage rate, z^e_t is the number of equity shares, and z^b_t is the number of risk-free bonds held in period t. The price and dividend of the equity security at time t is denoted by p^e_t and d^e_t. The price of the risk-free asset, which pays out one unit of consumption in every state of nature, is given by p^b_t. The number of equity shares is normalized to one and the risk-free asset is in zero net supply.

In the two-sector model, the representative household's budget constraint is given by:

$$c_t + z^{e,c}_{t+1} p^{e,c}_t + z^{e,i}_{t+1} p^{e,i}_t + z^b_{t+1} p^b_t \leq z^{e,c}_t (p^{e,c}_t + d^c_t) + z^{e,i}_t (p^{e,i}_t + q_t d^i_t) + z^b_t + w^c_t n^c_{ht} + q_t w^i_t n^i_{ht} \tag{3}$$

In Eq. (3), q_t denotes the relative price of the investment good in units of the consumption good.

The first-order conditions for the household's problem in the one-sector economy are:

$$z^e_{t+1}: \quad p^e_t = E_t[m_{t+1}(p^e_{t+1} + d_{t+1})] \tag{4}$$

$$z^b_{t+1}: \quad p^b_t = E_t[m_{t+1}] \tag{5}$$

$$n_{ht}: \quad B = \lambda_t w_t \tag{6}$$

where $m_{t+j} = \beta^j \frac{\lambda_{t+j}}{\lambda_t}$ is the intertemporal marginal rate of substitution in consumption (stochastic discount factor). With preferences as in Eq. (1), the marginal utility of consumption is given by $\lambda_t = (c_t - bc_{t-1})^{-\xi} - \beta b E_t[(c_{t+1} - bc_t)^{-\xi}]$.

In the two-sector economy the first-order conditions are:

$$z^{e,c}_{t+1}: \quad p^{e,c}_t = E_t[\beta \frac{\lambda_{t+1}}{\lambda_t} (p^{e,c}_{t+1} + d^c_{t+1})] \tag{7}$$

$$z^{e,i}_{t+1}: \quad p^{e,i}_t = E_t[\beta \frac{\lambda_{t+1}}{\lambda_t} (p^{e,i}_{t+1} + q_{t+1} d^i_{t+1})] \tag{8}$$

$$n^c_{ht}: \quad \lambda_t w^c_t = B \tag{9}$$

$$n^i_{ht}: \quad \lambda_t q_t w^i_t = B \tag{10}$$

and the first-order condition (5) with respect to the investment into the risk-free asset.

2.2. Production in the one-sector economy

The representative firm begins period t with the stock of capital k_t carried over from the previous period. The capital stock evolves according to:

$$k_{t+1} = (1-\delta)k_t + g(i_t / k_t)k_t \quad k_0 \text{ given} \tag{11}$$

where i_t is investment in period t and δ is the constant depreciation rate. The adjustment cost is given by the standard concave function, previously used by Jermann (1998) and Boldrin et al. (2001) among others:

$$g(i_t / k_t) = \frac{\delta^{1/\phi}}{1 - 1/\phi} \left(\frac{i_t}{k_t} \right)^{1-1/\phi} + \frac{\delta}{1-\phi}, \tag{12}$$

The economy without capital adjustment costs corresponds to $\phi \to \infty$.

Each firm uses capital and labor, n_t, to produce output, y_t, according to technology:

$$y_t = a_t x_t k^{\alpha}_t n^{1-\alpha}_t \tag{13}$$

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