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# Imperfect competition and indeterminacy of aggregate output

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**Abstract**

This paper shows imperfect competition can lead to indeterminacy in aggregate output in a standard DSGE model with imperfect competition. Indeterminacy arises in the model from the composition of aggregate output. In sharp contrast to the indeterminacy literature pioneered by Benhabib and Farmer [J. Benhabib, R. Farmer, Indeterminacy and increasing returns, J. Econ. Theory 63 (1) (1994) 19–41] and Gali [J. Gali, Monopolistic competition, business cycles, and the composition of aggregate demand, J. Econ. Theory 63 (1) (1994) 73–96], indeterminacy in our model is global; hence it is more robust to structural parameters. In addition, sunspots in our model can be autocorrelated. The paper provides a justification for exogenous variations in desired markups, which play an important role as a source of cost-push shocks in the monetary policy literature. Our model outperforms a standard RBC model driven by technology shocks in several dimensions, including the volatility of labor market and the hump-shaped output dynamics.


*JEL classification:* E31; E32

*Keywords:* Indeterminacy; Global sunspots; Self-fulfilling expectations; Procyclical productivity; Marginal costs; Counter-cyclical markup; Cost-push shocks; Hump-shaped impulse responses

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## 1. Introduction

A well-accepted set of stylized facts of the business cycle includes: (1) aggregate consumption, investment, employment, marginal cost and productivity comove with aggregate output; (2) the detrended components in these aggregate quantities are highly persistent; (3) the impulse responses of output (as well as other variables) are hump-shaped; and (4) consumption and productivity are less volatile than output, employment is roughly as volatile as output, and investment is more volatile than output during a cycle.[1] As shown by Kydland and Prescott [36], many of these stylized facts can be explained by technology shocks in a perfectly competitive general equilibrium model. However, standard RBC models driven by technology shocks fail to explain all of the aforementioned stylized facts. For example, under technology shocks, the relative volatility of labor to output in a standard model is too small to match the U.S. data (e.g., see Prescott [39]). Even with the assumption of an infinitely large labor supply elasticity (e.g., Hansen's [26] indivisible labor), employment is still not volatile enough relative to output to match the U.S. data. In addition, as pointed out by Bils [7], technology shocks cannot explain why the marginal cost is procyclical (or why the markup is counter-cyclical), which is an empirical regularity well-documented in the literature.[2]

Conventional Keynesian wisdom argues the level of aggregate output is essentially indeterminate (i.e., the supply curve is flat), hence autonomous changes in aggregate demand (e.g., due to animal spirits) are the main driving force of the business cycle. A major challenge to this wisdom, however, is to model autonomous shifts in expectations as an independent source of shocks in general equilibrium with rational agents. To do so, the ability to model extrinsic uncertainty (uncertainty not related to the fundamentals) is key. The seminal works of Shell [48], Azariadis [2], and Cass and Shell [9], among others, opened up this possibility and provided the first breakthrough in meeting the challenge. Using dynamic equilibrium models, these works show that economic fluctuations can be driven by agents' self-fulfilling expectations without changes in the fundamentals, such as preferences, technologies, and endowments. These important works, however, fall short in confronting the time series data of the business cycle. It was not until the seminal work of Kydland and Prescott [36] that quantitative models of the business cycle which can be calibrated to confront time series data became available. Benhabib and Farmer [3], Farmer and Guo [16], and Gali [19] are among the first to show the possibility of generating quantitative predictions of the business cycle within the framework of Kydland and Prescott using shifts in agents' expectations as a key driving force.[3]

However, this new generation of expectations-driven business-cycle models typically relies on local indeterminacy of the steady state to generate fluctuations driven by sunspots.[4] Since many structural parameters jointly determine the eigenvalues of a dynamic model near the steady state, the reliance on local indeterminacy imposes severe restrictions on the structures of the economy. If such restrictions are not satisfied, equilibria with expectation-driven fluctuations are not possible. For example, indeterminacy in the Benhabib–Farmer type of models requires the

[1] See, e.g., Kydland and Prescott [36], Prescott [39], Hansen [26], Bils [7], Cogley and Nason [12], and Rotemberg and Woodford [40,43,44], among others.

[2] See, e.g., Bils [7], Martins, Scarpetta, and Pilat [37], and Rotemberg and Woodford [40,44], among others.

[3] For the earlier literature along this line of research, see Farmer and Woodford [17] and Woodford [55–57], among others.

[4] Recent literature along this line includes Benhabib and Farmer [4,5], Farmer [15], Weder [51], Wen [52], Harrison and Weder [27], and Jaimovich [30], among many others.