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Product scope and endogenous fluctuations ☆

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ABSTRACT

Recent empirical evidence suggests that product creation is procyclical and it occurs largely within existing firms. Motivated by these findings, the current paper investigates the role of intra-firm product scope choice in a general equilibrium economy with oligopolistic producers. It shows that the multi-product nature of firms makes the economy susceptible to sunspot equilibria. The model is estimated via Bayesian methods. Artificial business cycles closely resemble empirically observed fluctuations with sunspots explaining a significant portion of U.S. business cycles.

1. Introduction

This paper explores a model of business cycles in which product creation and firm dynamics generate *soi-disant* sunspot equilibria which ultimately drive movements in the economy's real output. It builds on a growing body of empirical work that suggests that a large portion of firms are multi-product producers. Bernard et al. (2010), for example, report that close to half of U.S. manufacturing firms produce in multiple 5-digit SIC industries. The importance of this finding becomes apparent once noticing that these firms account for about 90 percent of total sales. Broda and Weinstein (2010) arrive at similar conclusions. In particular, they document that over 90 percent of product creation and destruction occurs within firms (i.e. as firms adjust their product scopes). This alludes that the contribution to aggregate output from product scope variations is at least as important as that from net business formation.

The current paper picks up on these empirical observations by laying out an artificial economy that generates procyclical product creation within firms, while also giving rise to endogenous business cycles. Specifically, we investigate the roles of net product creation and net business formation in a general equilibrium economy with oligopolistic intermediate goods firms. Endogenous changes in firms' product scopes create sunspot equilibria at very realistic parametric situations, which are not attainable when firms only produce a single product. We then estimate the indeterminate model and show that a

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combination of both belief shocks (i.e. sunspots) and fundamental shocks generates artificial business cycles that resemble empirically observed fluctuations. Our findings suggest that a substantial fraction of U.S. output fluctuations are related to sunspot events.

Indeterminacy arises in the economy because net business formation and firms' product scope choices affect labor demand; phrased alternatively, net product creation gives rise to an endogenously shifting efficiency wedge. Furthermore, the oligopolistic market structure leads to countercyclical markups that act as an additional shifter of production possibilities – as a consequence, the wage-hours locus becomes upwardly sloping. Intuitively, sunspots come into effect as follows. Assume that people feel more optimistic about the future path of income: a wealth effect that causes a rise in the demands for consumption and leisure. Labor supply shifts inwards along an upwardly sloping wage-hours locus, thereby raising employment and output, and subsequently allowing the initial beliefs about higher incomes to become self-fulfilling.[1]

Our artificial economy parallels Feenstra and Ma (2009) and Minniti and Turino (2013) who introduce multi-product firms into general equilibrium. While also studying business cycles, however, Minniti and Turino (2013) consider fundamental disturbances only.[2] Relating to endogenous fluctuations, Jaimovich (2007) demonstrates how procyclical net business formation can lead to indeterminacy via the generation of countercyclical markups. Pavlov and Weder (2012) investigate the role of variety effects in generating sunspot equilibria. Both of these papers feature mono-product firms and hence do not consider firms' product scope choices. Furthermore, while most of the indeterminacy literature simulates calibrated models by sunspot shocks only, we use Bayesian methods to estimate several small-scale versions of the indeterminate model with both sunspots and fundamental disturbances to preferences, government expenditures and technology.[3] By and large, we follow estimation approaches put forward by Farmer et al. (2015) and Lubik and Schorfheide (2004).[4]

The remainder of this paper evolves as follows. Section 2 lays out the model. Section 3 analyzes the local dynamics. Variable capital utilization is added to the economy in Section 4. The indeterminate model is estimated and simulated in Section 5. We offer some interpretation of the results in Section 6. Section 7 concludes.

2. Model

The economy consists of intermediate good firms who are able to choose how many products to produce. These goods are differentiated and hence bring about market power for these oligopolistic firms. The commodities are bought by competitive firms that weld them together into the final good that can be consumed or, by adding it to the capital stock, invested. People own the two factors of production and rent out their respective services on competitive markets.

2.1. Final goods

Final output, Y_t, is produced under perfect competition using the range of intermediate inputs supplied by M_t multi-product firms indexed i. Each firm supplies $N_t(i)$ varieties of goods. Accordingly, the final good is constructed via two nested CES aggregators like in Minniti and Turino (2013). The first encompasses the varieties from an individual firm i that, when put together, compose

$$Y_t(i) = N_t(i)^{1+\tau}\left(\frac{1}{N_t(i)}\int_0^{N_t(i)} y_t(i,j)^{\frac{\gamma-1}{\gamma}}dj\right)^{\frac{\gamma}{\gamma-1}} \qquad \tau>0,\gamma>1. \tag{1}$$

Here, $y_t(i,j)$ is the amount of the unique intermediate good j produced by firm i. Parameters τ and γ stand for the intra-firm variety effect and the elasticity of substitution between goods, respectively. The firm-composite goods are then stacked together to yield the final output

$$Y_t = M_t^{1+\omega}\left(\frac{1}{M_t}\int_0^{M_t} Y_t(i)^{\frac{\theta-1}{\theta}}di\right)^{\frac{\theta}{\theta-1}} \qquad \omega\geq 0,\theta>1 \tag{2}$$

where ω is the inter-firm variety effect and θ is the elasticity of substitution between the firms' composite goods. Variety effects are separated from the elasticity of substitution as there is no *a priori* reason for a strong link between them.[5] Moreover, the separation allows us to clearly distinguish the variety effect and its impacts from that of imperfect competition.

[1] See Benhabib and Farmer (1994) and Wen (1998) for early examples of models that rest on increasing returns to scale. More recently, Benhabib and Wang (2013) and Liu and Wang (2014) introduced indeterminacy models where financial frictions can lead to non-uniqueness.

[2] Moreover, we separate the elasticity of substitution parameters from the variety effects (a.k.a. taste for variety or increasing returns to specialization) in the production of final goods, which makes the theoretical mechanisms in our paper far more transparent.

[3] Our paper also shares some aspects with Angeletos et al. (2015). While Angeletos et al. do not consider multiple equilibria economies, they characterize the business cycle as largely driven by confidence shocks.

[4] See Farmer and Guo (1995) for an early attempt to estimate a sunspot model.

[5] Benassy (1996).