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Revisiting the effect of a technology shock on hours☆

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HIGHLIGHTS

- Develop a flexible price RBC model of hyperbolic discounting.
- Show that hours fall following a technology shock.
- Show that dynamic responses of key macroeconomic aggregates are similar to those corroborated by previous studies.
- Naive belief plays a crucial role in generating the results.

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ABSTRACT

A number of studies demonstrate that a positive technology shock leads to a short-run decline in hours (employment). This paper shows that a standard flexible price model can deliver the negative response of hours to the technology shock when hyperbolic discounting is incorporated into the model. This paper also finds that the model can produce similar dynamic responses of key macroeconomic aggregates to those corroborated by previous empirical studies.

1. Introduction

Standard real business cycle (RBC) models predict that a positive technology shock leads to a short-run increase in hours. The seminal paper by Galí (1999), however, presents a contradictory finding that hours fall in response to the technology shock.[1] Subsequent studies based on various specifications and methodologies also confirm this empirical result (e.g., Francis and Ramey, 2005; Basu et al., 2006; Rebei, 2014). Furthermore, Francis and Ramey (2005) and Basu et al. (2006) argue that investment may decline following the technology shock. This overall result seems to cast doubt not only on the validity of flexible price RBC models but also on the quantitative importance of technology shock as a main force of aggregate fluctuations.

This paper contributes to this literature by showing that a positive technology shock can yield a short-run decline in hours in a flexible price model of hyperbolic discounting. Hyperbolic discounting that captures time-inconsistency implies that individuals give extra weight to the present moment, relative to future moments. One type of people with such discounting is called naïve individuals who perceive themselves to exhibit time-inconsistent preferences today but are unaware of their time-inconsistency in the future. Many researchers explain behavioral implications using models with naiveté (e.g., Strotz, 1956; Akerlof, 1991; O'Donoghue and Rabin, 1999; Findley and Caliendo, 2015).

The main result shows that hours fall on impact following the technology shock. This result follows from the naïve belief. Naïve individuals tend to pursue instantaneous gratification (consumption) by procrastinating unpleasant activities (labor supply), with a belief that they can be exponential discounters tomorrow. In addition to this main result, the model developed in this paper also shows that the transitional path of other macroeconomic aggregates is quite similar to that presented by earlier empirical studies.

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[1] Galí (1999) also argues that the inability of neoclassical models to generate the negative effect of the shock on hours is the evidence in favor of sticky-price new Keynesian models.

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To the best of my knowledge, this paper is the first to show that without recourse to nominal frictions, dynamic responses of key macroeconomic variables in a standard neoclassical model with the behavioral feature can accord well with stylized facts.

This paper proceeds as follows. Section 2 lays out the model. Section 3 describes the calibrated values and discusses results. Section 4 concludes.

2. The model

2.1. Households

The representative household derives utility from consumption C_t, adjusted by internal habit and disutility from hours worked N_t. Hyperbolic discounting implies that the household discounts future events using short-run and long-run discount factors. The household's intertemporal problem is then given by

$$\text{Max } E_t \left[\ln (C_t - \phi C_{t-1}) - \zeta N_t + \beta \sum_{i=1}^{\infty} \delta^i \left(\ln (C_{t+i} - \phi C_{t-1+i}) - \zeta N_{t+i} \right) \right], \tag{1}$$

where β, δ, ϕ and ζ denote the short-run discount factor, long-run discount factor, degree of habit persistence and disutility parameter for hours worked, respectively. The distinct feature from standard models of exponential discounting is the presence of the short-run discount factor that governs the degree of time-inconsistency (short-run impatience). The household gives more weight to the current moment as β is smaller. The household's budget constraint and capital accumulation are

$$C_t + I_t = w_t N_t + r_t K_t, \tag{2}$$

$$K_{t+1} = (1-d) K_t + I_t, \tag{3}$$

where I_t, K_t, w_t, r_t and d denote investment, capital, real wage, real return on capital and depreciation rate, respectively. The first order conditions are given by

$$\begin{aligned} &(C_t - \phi C_{t-1})^{-1} - \beta\delta\phi E_t (C_{t+1} - \phi C_t)^{-1} \\ &\quad = \beta\delta E_t \left[(C_{t+1} - \phi C_t)^{-1} - \delta\phi (C_{t+2} - \phi C_{t+1})^{-1} \right] \\ &\qquad \times (r_{t+1} + 1 - d), \end{aligned} \tag{4}$$

$$\left[(C_t - \phi C_{t-1})^{-1} - \beta\delta\phi E_t (C_{t+1} - \phi C_t)^{-1} \right] = \frac{\zeta}{w_t}. \tag{5}$$ [2]

Setting $\beta = 1$ recovers the standard optimality conditions with exponential discounting. For brevity, I call the model of hyperbolic (exponential) discounting the naïve (standard) model henceforth.

2.2. Firms

The competitive firm uses the typical Cobb–Douglas technology to produce output using labor and capital

$$Y_t = A_t K_t^{\alpha} N_t^{1-\alpha}, \tag{6}$$

where α, Y_t and A_t denote the share of capital, output and technology shock with a AR(1) process,

$$\ln A_t = \rho \ln A_{t-1} + \varepsilon_t. \tag{7}$$

[2] Derivation of (4) and (5) is given in Appendix.

The real rate of return on capital and real wage is given by

$$r_t = \alpha \frac{Y_t}{K_t}, \tag{8}$$

$$w_t = (1-\alpha) \frac{Y_t}{N_t}. \tag{9}$$

2.3. Aggregate resource constraint

Using the household budget constraint, capital accumulation, equilibrium real rental rate and real wage gives the aggregate resource constraint

$$C_t + I_t = Y_t. \tag{10}$$

3. Results

3.1. Parameterizing the model

The appropriate choice of discount factors is required to make a fair comparison of the naïve model to the standard model. Caliendo and Findley (2014) propose a useful method to select δ_N for given β and δ_S.[3] Laibson et al. (2015) present $\beta = 0.35$ by estimating a structural buffer-stock model with annual US data. The standard value of annual discount factor is $\delta_S = 0.96$. Using the method and these two discount factors yields $\delta_N = 0.985$. Since the model is based on the quarterly frequency, however, I convert the annual discount factors into the quarterly values. The final discount factors are then given by $\beta = 0.77$, $\delta_N = 1.00$ and $\delta_S = 0.99$, respectively.[4]

For other structural parameters, I choose the standard values that have been widely used in RBC literature. The parameter ϕ is set at 0.90 following Boldrin et al. (2001). The parameter ζ is set to match the steady state labor with 1/3. The parameters ρ, α and d are set at 0.96, 0.36, and 0.025, respectively.

3.2. Response of macroeconomic aggregates to a technology shock

The typical responses of key macroeconomic variables following the technology shock are as follows: (a) hours show an immediate decline, which is at odds with the prediction of standard neoclassical models; (b) output increases gradually; (c) consumption shows a sluggish rise; (d) investment dips and shows a hump-shape rise. Fig. 1 summarizes these findings.[5]

Fig. 2 displays the impulse response of key macroeconomic aggregates to a 1% technology shock in the naïve (line with asterisks) and standard (solid line) models. The response is the percent deviation from the steady state. Casual inspection of Fig. 2 suggests that the overall dynamics of variables from the two models considerably differ.[6]

Consider first the response of hours, which is the main focus in this paper. The technology shock causes hours to rise immediately in the standard model, whereas it leads to an immediate decline in hours in the naïve model. This result follows from the naïve belief. Naïve individuals tend to pursue immediate-reward activities and procrastinate immediate-cost activities by believing that they can

[3] See Caliendo and Findley (2014) for an exposition of this method. The subscripts N and S denote naïve and standard, respectively.

[4] Akerlof (1991) explores behavioral implications of naïve individuals using $\delta_N = 1$ and $0 < \beta < 1$.

[5] I present it for an illustration of empirical findings. Galí (1999) also presents similar responses.

[6] Even small departures from the simple deterministic neoclassical model of hyperbolic discounting used by Barro (1999) can produce observational nonequivalence results (e.g., Gong and Zhu, 2006).