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Government spending multipliers: New results from a model of naiveté

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Abstract

The aim of this paper is to explore dynamic impacts of a government spending shock on key macro-aggregates by developing a neoclassical model of naiveté. The main finding reveals that the model of naiveté delivers much larger present-value multipliers of output than a typical neoclassical model. Moreover, the model of naiveté can resolve the consumption puzzle of government spending by producing the crowding-in effect on consumption. Dynamic responses and multiplier effects of other variables are also discussed.

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1. Introduction

What is the size of the government spending multiplier? This is a classic question in macroeconomics, and in particular the recent Great Recession has put this issue on the front burner. Though a large theoretical literature has grappled with this important issue, little consensus has been reached due to a wide range of the multipliers. For instance, some studies based on standard neoclassical models show that spending multipliers are decidedly below unity (e.g., Baxter and King 1993, and Burnside *et al*. 2004). Others using new Keynesian models, however, report that the multipliers can be above unity (e.g., Galí *et al*. 2007, and Christiano *et al*. 2011). Despite the use of various models, previous studies employ models of exponential discounting as a common model structure.

This paper takes a distinct approach from the early studies by developing a simple macroeconomic model of naiveté to explore not only government spending multipliers but also dynamic responses of key macro-aggregates. Naiveté is a term that connotes a naïve perception that is characterized by hyperbolic discounting.[1] For a clear understanding of the role of naiveté, this paper compares results from the model of naiveté to those from a model of exponential discounting. This paper is the first to attempt to explain effects of government spending in the hyperbolic model. In this regard, this paper puts behavioral flesh on the fiscal-policy literature, which is the core contribution of this paper.

The main results show that the hyperbolic model produces wildly different dynamic paths of variables from those in the exponential model. Following the government spending shock, the exponential model shows the negative (positive) response of consumption and investment (output and labor), which is in line with the neoclassical prediction. In contrast, the responses of consumption, investment, labor and output are all positive in the hyperbolic model, delivering larger present-value multipliers of output (i.e., greater than unity) than the exponential model. It implies that even a neoclassical model with a behavioral ingredient can yield the output multipliers larger than one, which are different from what standard neoclassical models predict. Furthermore, the positive response of consumption suggests that the hyperbolic model can resolve the consumption puzzle of government spending.[2]

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

2. Theoretical framework

The model consists of households, firms and government. The representative household maximizes the lifetime utility defined over consumption c_t adjusted by internal habit and labor h_t by discounting the future streams of utility using short- and long-run discount factors. The household's problem is then given by

$$Max\ E_t\left[U(c_t, c_{t-1}, h_t) + \beta\sum_{i=1}^{\infty}\delta^i U(c_{t+i}, c_{t-1+i}, h_{t+i})\right], \quad U = \ln\left(c_t - bc_{t-1} - \frac{h_t^{1+\xi}}{1+\xi}\right), \tag{1}$$

[1] Strotz (1956), one of the seminal papers on this type of preferences, carefully lays out this assumption. A number of subsequent studies have examined behavioral characteristics of naiveté (e.g., Akerlof 1991, O'Donoghue and Rabin 1999, Choi 2017 and Augenblick and Rabin 2018). I refer to the model of naiveté (exponential discounting) as the hyperbolic (exponential) model henceforth.

[2] The consumption puzzle implies the negative response of consumption to a government spending shock in typical neoclassical models, which is at odds with empirical evidence (e.g., Galí *et al*. 2007). Section 3 provides an exposition of how the naïve perception can resolve the consumption puzzle.

subject to the budget constraint

$$c_t + x_t + z_t = w_t h_t + r_t k_t, \tag{2}$$

$$k_{t+1} = x_t + (1-d)k_t - \frac{\chi}{2}\left(\frac{k_{t+1}}{k_t} - 1\right)^2 k_t, \tag{3}$$

where c_t, h_t, k_t, x_t, w_t, r_t, z_t, b, d, χ, ξ, β and δ indicate consumption, labor, capital, investment, real wage, real rental rate, lump-sum taxes, intensity of habit persistence, depreciation rate, parameter of convex capital adjustment cost, inverse of Frisch elasticity, short- and long-run discount factor, respectively. The parameter β measures the degree of time inconsistency.

The household's problem of (1) to (3) is recursively formulated by two value functions due to time inconsistency.[3] The current-value function W with the discount factor $\beta\delta$ solves

$$W\left(k_t, c_{t-1}\right) = \ln\left(c_t - bc_{t-1} - \frac{h_t^{1+\xi}}{1+\xi}\right) + \beta\delta E_t V\left(k_{t+1}, c_t\right). \tag{4}$$

The continued-value function V with the same δ from period $t+1$ onwards solves

$$V\left(k_{t+1}, c_t\right) = \ln\left(c_{t+1} - bc_t - \frac{h_{t+1}^{1+\xi}}{1+\xi}\right) + \delta E_{t+1} V\left(k_{t+2}, c_{t+1}\right). \tag{5}$$

The first-order conditions of (4) with respect to k_{t+1} and h_t read

$$\left[X_t + \beta\delta E_t V_2(k_{t+1}, c_t)\right]\left(1 - \chi + \chi\frac{k_{t+1}}{k_t}\right) = \beta\delta E_t V_1(k_{t+1}, c_t), \tag{6}$$

$$X_t h_t^{\xi} = \left[X_t + \beta\delta E_t V_2(k_{t+1}, c_t)\right] w_t. \tag{7}$$

where $X_t = \left(c_t - bc_{t-1} - \frac{h_t^{1+\xi}}{1+\xi}\right)^{-1}$. Total differentiation of (5) with respect to k_{t+1} gives

$$V_1(k_{t+1}, c_t) - V_2(k_{t+1}, c_t)\left(1 - \chi + \chi\frac{k_{t+1}}{k_t}\right) = \left[X_{t+1} + \delta E_{t+1} V_2(k_{t+2}, c_{t+1})\right] \times \tag{8}$$

$$\left[w_{t+1}\frac{\partial h_{t+1}}{\partial k_{t+1}} + r_{t+1} + 1 - d - \frac{\chi}{2}\left(\frac{k_{t+2}}{k_{t+1}} - 1\right)^2 - \chi\left(\frac{k_{t+2}}{k_{t+1}} - 1\right)\frac{\left(\partial k_{t+2}/\partial k_{t+1}\right)k_{t+1} - k_{t+2}}{k_{t+1}} - \frac{\partial k_{t+2}}{\partial k_{t+1}}\right]$$

[3] This paper follows the solution method proposed by Choi (2017) who derives optimality conditions using a macroeconomic model that features naiveté to explore business-cycle implications of hyperbolic discounting.

$$+bX_{t+1}\left(1-\chi+\chi\frac{k_{t+1}}{k_t}\right)-X_{t+1}h_{t+1}^{\xi}\frac{\partial h_{t+1}}{\partial k_{t+1}}+\delta E_{t+1}V_1(k_{t+2},c_{t+1})\frac{\partial k_{t+2}}{\partial k_{t+1}}.$$

Naïve individuals perceive themselves to have time-inconsistent preferences today under the belief that they will behave themselves in the future according to their current preferences. The first-order conditions of (5) and the envelope condition with respect to c_t are then given by

$$\left[X_{t+1}+\delta E_{t+1}V_2(k_{t+2},c_{t+1})\right]\left(1-\chi+\chi\frac{k_{t+2}}{k_{t+1}}\right)=\delta E_{t+1}V_1(k_{t+2},c_{t+1}), \tag{9}$$

$$X_{t+1}h_{t+1}^{\xi}=\left[X_{t+1}+\delta E_{t+1}V_2(k_{t+2},c_{t+1})\right]w_{t+1}, \tag{10}$$

$$V_2(k_{t+1},c_t)=-bX_{t+1}. \tag{11}$$

Cancelling out some terms in (8) using (9), (10) and (11) yields

$$V_1(k_{t+1},c_t)=\left[X_{t+1}-\delta bE_{t+1}X_{t+2}\right]\left[r_{t+1}+1-d+\frac{\chi}{2}\left(\frac{k_{t+2}}{k_{t+1}}-1\right)\left(\frac{k_{t+2}}{k_{t+1}}+1\right)\right]. \tag{12}$$

Plugging (11) and (12) into (6) and (7) finally gives the Euler equation and optimal labor supply equation

$$(X_t-\beta\delta bE_tX_{t+1})\left(1-\chi+\chi\frac{k_{t+1}}{k_t}\right) \tag{13}$$

$$=\beta\delta E_t(X_{t+1}-\delta bX_{t+2})\left[r_{t+1}+1-d+\frac{\chi}{2}\left(\frac{k_{t+2}}{k_{t+1}}-1\right)\left(\frac{k_{t+2}}{k_{t+1}}+1\right)\right],$$

$$X_th_t^{\xi}=(X_t-\beta\delta bE_tX_{t+1})w_t, \tag{14}$$

where $X_t=\left(c_t-bc_{t-1}-\frac{h_t^{1+\xi}}{1+\xi}\right)^{-1}$. Note that (13) and (14) reduce to the standard ones when $\beta=1$.

The representative firm maximizes its profits using the typical Cobb-Douglas production technology with capital and labor $y_t=A_tk_t^{\alpha}h_t^{1-\alpha}$, where α, y_t and A_t denote the capital share, output and technology shock with an AR(1) process, $\ln A_t=\rho_A\ln A_{t-1}+\varepsilon_t^A$. The optimal choice of labor and capital is then given by

$$r_t=\alpha\frac{y_t}{k_t}, \tag{15}$$

$$w_t=(1-\alpha)\frac{y_t}{h_t}. \tag{16}$$

Government finances its spending through lump-sum taxes, and its budget constraint is given by $z_t = g_t$. Government spending follows an AR(1) process, $\ln g_t = \rho_g \ln g_{t-1} + \varepsilon_t^g$. Plugging the government budget constraint, (15) and (16) into (2) finally yields the aggregate resource constraint,

$$c_t + x_t + g_t = y_t. \tag{17}$$

3. Dynamic responses of macro-aggregates and present-value multipliers

The policy experiment requires parameter values. A distinct feature of the hyperbolic model is β and δ. Laibson et al. (2018) estimate the time preferences using a buffer-stock model with field data and report $\beta=0.50$ and $\delta=0.98$ as annual values. Converting the parameter values into the quarterly counterparts gives $\beta=0.84$ and $\delta=0.99$. All other parameter values that are frequently used in macroeconomics are selected: $\alpha=0.30$, $\xi=2$, $b=0.90$, $\chi=10$, $d=0.025$, $g/y=0.09$, $\rho_A=0.95$ and $\rho_g=0.95$.

Figure 1 plots dynamic impacts of a government spending shock on key macroeconomic variables in the hyperbolic (line with asterisk) and exponential (line with circle) models. Casual inspection of Figure 1 suggests sharply different results from the two models.[4] The exponential model shows an immediate increase (decrease) in output and labor (consumption and investment), which is consistent with the neoclassical results. The hyperbolic model, however, produces positive responses of all variables during the transition period. In particular, the crowding-in effect of government spending on consumption in the hyperbolic model, which is in stark contrast to the consumption behavior in the exponential model, solves the consumption puzzle.[5] Since consumption and investment are the large components of output, the rise in these two variables leads to much higher output than the exponential model in all periods, implying that government spending in the hyperbolic model plays an important role in stimulating output via the aggregate demand (AD) channel.

All the results from the hyperbolic model come out of a naïve perception with a tendency to pursue immediate pleasure. People with the naïve perception increase consumption for their gratification despite the negative wealth effect induced by government spending. Since paying taxes lowers income to enjoy consumption, however, they also increase a large amount of labor and investment to earn real wage and real rental rate as income for their pleasant activity.

To quantify the dynamic impacts of government spending, this paper uses the present-value multipliers that summarize the cumulative effects of government spending on variables along the entire path of responses up to a given period.[6] Table I reports output and

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[4] Gong and Zhu (2006) demonstrate that even small deviations from the simple neoclassical model of hyperbolic discounting used by Barro (1999) can produce observationally nonequivalent results to the model of exponential discounting. In fact, the result that the hyperbolic model delivers wildly different dynamic responses of the variables from those in the exponential model suggests the observational nonequivalence between the two models.

[5] Previous studies have used different assumptions to solve this issue: A large fraction of rule-of-thumb consumers (Galí *et al*. 2007).

[6] Unlike the past studies using the impact multipliers, the bulk of recent research has used this method. I adopt the method proposed by Uhlig (2010) to compute the present-value multipliers. See Uhlig (2010) for the formula with detailed explanations.

consumption multipliers.[7] A glance at Table I reveals that the hyperbolic model delivers much larger multiplier effects than the exponential model. For example, the output multipliers from the hyperbolic model are greater than unity at all horizons, which hover around the average value of 1.25. In contrast, the standard model produces the output multipliers that remain well below unity (-0.62 ~ 0.18) at all horizons, which accord well with the results from typical neoclassical models. The similar results emerge in the consumption multipliers. The hyperbolic model delivers the positive consumption multipliers at all horizons (0.05 ~ 0.45), whereas the multipliers from the exponential model are all negative (-1.42 to -0.08).

Figure 1: Dynamic responses of key macro-aggregates across models

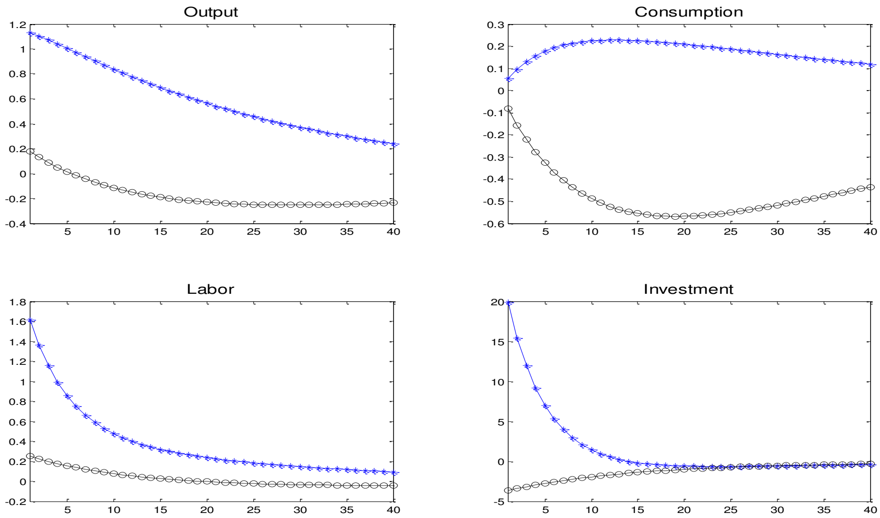

Table I: Present-value multipliers

Period	Impact	4	8	12	16	20	LR
Output							
Hyperbolic model	1.13	1.17	1.21	1.24	1.27	1.29	1.41
Exponential model	0.18	0.12	0.05	-0.01	-0.07	-0.12	-0.61
Consumption							
Hyperbolic model	0.05	0.12	0.18	0.22	0.26	0.29	0.44
Exponential model	-0.08	-0.20	-0.33	-0.45	-0.56	-0.65	-1.41

Note: Impact and LR indicate the impact and long-run multipliers (200 quarters).

4. Conclusion

This paper explores dynamic effects, measured by the present-value multipliers, of government spending in a macroeconomic model that features naiveté. The main findings reveal that the model delivers the output multipliers greater than unity, which are different from the prediction produced by typical neoclassical models, and solves the consumption

[7] Most studies usually report the output multipliers, but I also present the consumption multipliers because it is another important result produced in the hyperbolic model.

puzzle by showing the positive response of consumption, which is corroborated by empirical studies.

Though the model is simple, the model with a behavioral feature provides new insights into the effects of government spending on the economy. It implies that other macroeconomic issues related to monetary and fiscal policies merit further exploration.

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