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MACROECONOMICS OF SUBSISTENCE POINTS

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This paper explores the macroeconomic consequences of preferences displaying a subsistence point. It departs from the existing related literature by assuming that subsistence points are specific to each variety of goods rather than to the composite consumption good. We show that this simple feature makes the price elasticity of demand for individual goods procyclical. As a result, markups behave countercyclically in equilibrium. This implication is in line with the available empirical evidence.

Keywords: Nonhomothetic Preferences, Time-Varying Markups, Business Cycles

1. INTRODUCTION

This paper studies a model of imperfect competition in which households' preferences are subject to goods-specific subsistence points. There is a long literature in microeconomics, going back to the seminal work of Stone (1954) and Geary (1950), studying the role of nonhomothetic preferences for the specification of demand functions. The presence of subsistence points implies that the intertemporal elasticity of substitution is wealth dependent and therefore that savings rates depend on household wealth. This idea is empirically supported by panel data studies; see for example, Atkeson and Ogaki (1996, 1997) for recent contributions.

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In macroeconomics, the presence of subsistence points has been studied mainly in terms of its implications for development and transitional growth. In particular, because of the effect that such nonhomothetic preferences have on savings rates, their existence may give rise to low-development traps and may help account for low speeds of conditional convergence in poor countries. King and Rebelo (1993) show that the existence of subsistence points approximately halves the speed of adjustment toward the steady state when initial consumption is close to the subsistence point [see Matsuyama (2002) for an analysis of subsistence points and development in a model with productivity growth; and Steger (2000) for the implications for β-convergence].

Little attention, however, has been devoted to exploring the consequences of Stone-Geary preferences for the propagation of aggregate shocks over the business cycle, which is the topic of this paper. The novel element of our analysis is to introduce subsistence points at the level of *individual* varieties of goods, as opposed to at the level of *aggregate* consumption. We embed the assumption of good-specific subsistence points into an economy with monopolistically competitive firms. In this setting, the existence of subsistence points leads not only to time-variations in the intertemporal elasticity of substitution but also to supply-side ramifications through time-varying markups.

In particular, subsistence points in consumption of individual goods varieties imply that the demand for an individual variety features a time-varying price elasticity. In the monopolistic competition setting, time-variations in the price elasticity of demand lead firms to charge time-varying markups. In our model, markups are countercyclical because the price elasticity of demand facing individual suppliers is procyclical. Such variations in markups, in turn, lead to shifts in labor demand that propagate shocks to the economy. This mechanism is potentially important for understanding the effects of aggregate demand shocks. Empirical evidence indicates that wages and consumption rise in response to positive aggregate demand shocks. Our model might account for these finding as a result of the induced variations in labor demand that arise through the response of markups. In this respect, the model with good-specific Stone-Geary preferences brings data and theory a step closer. Thus, we identify a new and interesting transmission mechanism that arises when subsistence points are modeled at the level of individual goods.

The intuition behind the countercyclicality of markups in a model with good-specific subsistence points is straightforward. Applying the standard Dixit-Stiglitz aggregation assumption, the demand for individual varieties is of the form $q_{it} = p_{it}^{-\eta} q_t$, where q_{it} denotes the demand for good i, p_{it} denotes the relative price of good i, and q_t is a measure of aggregate demand. This formulation of demand obtains either in the absence of subsistence points or when subsistence points are modeled at the level of aggregate consumption. This demand function features a constant price elasticity, η. As a result, monopolistically competitive producers charge a constant markup of prices over marginal costs. When subsistence points are good-specific, the demand function for good i becomes $q_{it} = p_{it}^{-\eta}(q_t - q^*) +$

q_i^*. Here, q_i^* denotes the subsistence level of consumption of good i, and q^* is a constant. This demand function is the sum of an isoelastic term, $p_{it}^{-\eta}(q_t - q^*)$ and a price inelastic term, q_i^*. Thus, the price elasticity of demand is a weighted average of η and 0. The weight on the price-elastic term is determined by the importance of the price-elastic component of demand, in total demand. An expansion in aggregate demand (an increase in q_t) is associated with a rise in the price elasticity of demand, which lowers the markup. The countercyclical behavior of markups is in line with the available empirical evidence; see Rotemberg and Woodford (1999) for a recent survey.

One may question the relevance of studying the role of subsistence points for the propagation of business cycles in developed countries on the grounds that as an economy grows, the relative importance of subsistence absorption in aggregate demand may be expected to vanish. This view is correct if subsistence points are understood in a narrow sense such as the minimum amount of food, clothing, and shelter necessary to sustain life. However, a broader interpretation of necessities would include those dictated by social norms.[1] Luxuries in a poor society, such as tap water, inside plumbing, and health care, are considered necessities in developed countries. Thus, it is conceivable that subsistence points might be appropriately modeled as an increasing function of long-run measures of output.[2] In this case, nonhomotheticities in preferences may remain relevant for understanding business cycle fluctuations even for rich economies.

The remainder of the paper is organized in three sections. Section 2 presents the model. Section 3 discusses the business-cycle implications of the model. Section 4 concludes.

2. THE MODEL

The model is a standard real-business-cycle model augmented with a monopolistically competitive product markets à la Dixit-Stiglitz. Our innovation is to assume the existence of subsistence consumption at the level of individual varieties as opposed to at the level of the composite good and the combination of this aspect with monopolistic competition.

2.1. Households

Consider an economy populated by a continuum of identical households with preferences described by the utility function

$$E_0 \sum_{t=0}^{\infty} \beta^t U\left(x_t^c - v_t, h_t\right), \tag{1}$$

where x_t^c denotes consumption of a composite good, h_t is labor effort, and v_t an exogenous and stochastic preference shock following a univariate autoregressive process of the form

$$v_t = \rho_v v_{t-1} + \epsilon_t^v,$$

with $\rho_v \in [0, 1)$ and ϵ_t^v distributed i.i.d. with mean zero and standard deviation σ_v. This shock is meant to capture innovations to the level of private nonbusiness absorption.

The composite consumption good x_t^c is composed of a continuum of differentiated goods indexed by $i \in [0, 1]$. Specifically x_t^c is assumed to be given by

$$x_t^c = \left[\int_0^1 (c_{it} - c_i^*)^{1-1/\eta} di \right]^{1/(1-1/\eta)}, \quad (2)$$

where c_i^* denotes the subsistence level of consumption of good i. The novel aspect of our analysis relative to other contributions to the literature on subsistence points is that we assume goods-specific subsistence points. Each consumption good is purchased at the price P_{it}. Solving the dual problem of minimizing consumption expenditure gives the demand for any variety i:

$$c_{it} = \left(\frac{P_{it}}{P_t} \right)^{-\eta} x_t^c + c_i^*, \quad (3)$$

where $P_t \equiv [\int_0^1 P_{it}^{1-\eta} di]^{\frac{1}{1-\eta}}$ is a nominal price index.

Households own physical capital and the capital stock held by the household, denoted k_t, is assumed to evolve over time according to the following law of motion:

$$k_{t+1} = (1 - \delta) k_t + x_t^k, \quad (4)$$

where x_t^k denotes investment in period t. Investment is a composite good produced using a continuum of differentiated goods via the following technology:

$$x_t^k = \left[\int_0^1 (d_{it} - d_i^*)^{1-1/\eta} di \right]^{1/(1-1/\eta)}. \quad (5)$$

Here, $d_i^* > 0$ denotes a minimum level of good-specific investment required to produce new capital goods. We introduce this feature to maintain symmetry across the various components of aggregate absorption.[3] The optimal level of d_{it} for $i \in [0, 1]$ is given by

$$d_{it} = \left(\frac{P_{it}}{P_t} \right)^{-\eta} x_t^k + d_i^*. \quad (6)$$

The demand functions (3) and (6) are key. The presence of a good-specific subsistence point alters the demand function implied by the Dixit-Stiglitz aggregator in a fundamental way, as the price elasticity of demand is no longer constant. Now the consumption demand function, for example, is the sum of an isoelastic term, $(P_{it}/P_t)^{-\eta} x_t^c$, and a price inelastic term, c_i^*. The price elasticity of either component of demand is therefore a weighted average of the elasticity of the isoelastic term, η, and the elasticity of the inelastic term, 0. The presence of good-specific subsistence points therefore increases the market power of the producer of good i. More important, the price elasticity of demand is time-varying and increasing in aggregate demand because the weight on the isoelastic components increases with x_t^c and x_t^k, respectively, which are measures of aggregate demand. In other words, in expansions subsistence points affect aggregate demand relatively less than in recessions. The procyclicality of the price elasticity of demand is the basic element driving the result that in equilibrium markups are countercyclical.

Every period, households rent their stock of capital to firms at the rate u_t. There is a complete contingent claims markets. Let $r_{t,t+j}$ denote the stochastic discount factor such that $E_t r_{t,t+j} z_{t+j}$ is the period-t price of a random payment z_{t+j} in period $t+j$. In addition, households are entitled to the receipt of pure profits from the ownership of firms, Φ_t. The representative household faces a sequence of budget constraints:

$$x_t^c + x_t^k + \psi_t + E_t r_{t,t+1} z_{t+1} = z_t + w_t h_t + \Phi_t + u_t k_t, \tag{7}$$

where $\psi_t \equiv \int_0^1 (P_{it}/P_t)(c_i^* + i_i^*)di$ and w_t denotes the real wage rate. Households are also assumed to be subject to a borrowing constraint that prevents them from engaging in Ponzi games. The optimality conditions associated with the households' problem are (4), (7), a transversality condition, and

$$-\frac{U_h\left(x_t^c - v_t, h_t\right)}{U_x\left(x_t^c - v_t, h_t\right)} = w_t,$$

$$U_x\left(x_t^c - v_t, h_t\right) = \beta E_t U_x\left(x_{t+1}^c - v_{t+1}, h_{t+1}\right)[1 - \delta + u_{t+1}],$$

$$U_x\left(x_t^c - v_t, h_t\right) r_{t,t+1} = \beta U_x\left(x_{t+1}^c - v_{t+1}, h_{t+1}\right).$$

These differ from the conditions arising from the standard neoclassical model only through the wealth dependency of the elasticity of intertemporal substitution that arises as a result of the presence of subsistence points.

2.2. The Government

Each period $t \geq 0$, nominal government spending is given by $P_t g_t$ and we assume that spending is financed through lump-sum taxation. Real government expenditures, denoted by g_t, are exogenous, stochastic, and follow a univariate first-order autoregressive process:

$$\ln(g_t/\bar{g}) = \rho_g \ln(g_{t-1}/\bar{g}) + \epsilon_t^g,$$

where the innovation ϵ_t^g is assumed to be distributed as an i.i.d. process with mean zero and standard deviation σ_g. The government allocates spending over individual varieties of goods, g_{it}, so as to maximize the quantity of a composite good produced with differentiated varieties of goods according to the relationship

$$x_t^g = \left[\int_0^1 (g_{it} - g_i^*)^{1-1/\eta} di\right]^{1/(1-1/\eta)}.$$

The parameters g_i^* denote good-specific levels of subsistence consumption of public goods. As in the case of investment demand, good-specific subsistence levels of government consumption is introduced to preserve symmetry in the specification of aggregate demand. The government demand for each differentiated goods $i \in [0, 1]$ is then

$$g_{it} = \left(\frac{P_{it}}{P_t}\right)^{-\eta} x_t^g + g_i^*, \tag{8}$$

where $x_t^g = g_t - \int_0^1 \frac{P_{it}}{P_t} g_i^* di$.

2.3. Firms

Each individual good $i \in [0, 1]$ is manufactured by a monopolist using labor and capital as inputs via the following production technology:

$$y_{it} = A_t F(k_{it}, h_{it}) - \phi, \tag{9}$$

where y_{it} denotes output of good i, k_{it} and h_{it} denote services of capital and labor, and ϕ fixed costs of production. Although we assume that F is homogeneous of degree 1, the presence of fixed costs introduces increasing returns to scale in the production technology. We include fixed costs to ensure that profits are relatively small on average as is the case for the U.S. economy. The variable A_t denotes an aggregate technology shock. We assume that the logarithm of A_t follows a first-order autoregressive process:

$$\ln A_t = \rho_a \ln A_{t-1} + \epsilon_t^a, \tag{10}$$

where ϵ_t^a is a white-noise disturbance with standard deviation σ_a.

Firms are monopolistic price setters. In exchange, they must stand ready to satisfy demand at the announced prices. Formally, firm i must satisfy

$$A_t F(k_{it}, h_{it}) - \phi \geq c_{it} + d_{it} + g_{it}, \tag{11}$$

where c_{it}, d_{it}, and g_{it} are given by equations (3), (6), and (8), respectively.

Firm i's problem consists of choosing processes $p_{it} \equiv P_{it}/P_t$, c_{it}, g_{it}, d_{it}, h_{it}, and k_{it}, so as to maximize the present discounted value of profits, which is given by

$$E_0 \sum_{t=0}^{\infty} r_{0,t} \left[p_{it}(c_{it} + d_{it} + g_{it}) - w_t h_{it} - u_t k_{it}\right], \tag{12}$$

subject to (3), (6), (8), and (11), given processes $r_{0,t}$, w_t, u_t, A_t, x_t^c, x_t^g, and x_t^k. Letting $x_t = x_t^c + x_t^g + x_t^k$, $x_i^* = c_i^* + g_i^* + d_i^*$, and mc_{it} denote the Lagrange multiplier on constraint (11), the first-order conditions for the firm's problem are equations (3), (6), (8), (11), and

$$\mathrm{mc}_{it} = \frac{w_t}{A_t F_h(k_{it}, h_{it})},$$

$$\mathrm{mc}_{it} = \frac{u_t}{A_t F_k(k_{it}, h_{it})},$$

$$\frac{p_{it}}{\mathrm{mc}_{it}} = \left[1 - \frac{1}{\eta(1 - x_i^*/y_{it})}\right]^{-1}.$$

The first two of these optimality conditions simply state that the marginal cost of producing good i equals the factor price divided by its marginal product.

The third optimality condition contains the essence for why the model with good-specific subsistence points provides a theory of countercyclical markups. It relates the markup of prices over marginal costs, p_{it}/mc_{it}, to the price elasticity of demand, $\eta(1-x_i^*/y_{it})$. When $x_i^* = 0$, the price elasticity of demand is constant and equal to η and the markup is therefore also time-invariant [and equal to $\eta/(\eta-1)$]. When $x_i^* > 0$, the price elasticity is increasing in sales, y_{it}, and therefore the markup is decreasing in this variable.[4]

2.4. Symmetric Equilibrium

We assume that the level of subsistence of each component of absorption is invariant across varieties, $c_i^* = c^*$, $g_i^* = g^*$, and $d_i^* = d^*$, for all varieties $i \in [0, 1]$. We restrict attention to symmetric equilibria in which all firms charge the same price. It follows that in equilibrium the relative price of each variety, p_{it}, equals unity. Therefore, we can drop the subscript i from all variables. Moreover, in equilibrium $x_t^c = c_t - c^*$, $x_t^k = d_t - d^*$, and $x_t^g = g_t - g^*$. A stationary symmetric equilibrium is then given by stationary stochastic processes k_{t+1}, h_t, w_t, u_t, y_t, c_t, d_t, and μ_t that satisfy the optimality conditions above when evaluated in the symmetric equilibrium [see Ravn, Schmitt-Grohe, and Uribe (2004) for details] given the stochastic processes describing v_t, A_t, g_t, and the initial condition k_0.

One noticeable feature of the symmetric equilibrium is that our model implies the same Euler equation as the one that arises in models with subsistence points at the level of aggregate consumption. In particular, the Euler equation is given by

$$U_x(c_t - c^* - v_t, h_t)r_{t,t+1} = \beta U_x(c_{t+1} - c^* - v_{t+1}, h_{t+1}).$$

Therefore, the intertemporal elasticity of substitution depends on wealth in the presence of subsistence points. This is the mechanism stressed by the existing macroeconomic literature that have applied Stone-Geary type preferences. This aspect implies slow convergence at low rates of development since savings rates respond less to returns on capital the closer is c_t to c^*, see, for example, King and Rebelo (1993). Our innovation is that the goods-specificity of the presence subsistence consumption lead to supply-side ramifications.

3. CYCLICAL BEHAVIOR OF MARKUPS

From the optimality conditions of the firm, it is straightforward to see that the equilibrium markup, which we denote by μ_t, is given by

$$\mu_t = \left[1 - \frac{1}{\eta(1 - x^*/y_t)}\right]^{-1}.$$

Clearly, because the subsistence level of absorption, x^*, is necessarily less than total absorption, y_t, it follows immediately that for a given value of η, the equilibrium markup is larger than the markup that would obtain in the absence of subsistence absorption, given by $\eta/(\eta-1)$.[5] Furthermore, it is clear that, given x^*, the larger is the level of aggregate activity, y_t, the smaller is the markup. In other words, the markup is countercyclical because an increase in aggregate demand makes subsistence points less important and therefore increases the price elasticity faced by producers.

One important aspect of the countercyclical feature of the markup in the present model is that this feature occurs only because the price elasticity of demand facing individual producers depends on aggregate activity. This distinguishes this model from other competing models of countercyclical markups.[6] In Rotemberg and Woodford (1992), countercyclical markups occur for intertemporal reasons. There variations in aggregate demand do not affect the elasticity of demand but affect the markup that a collusion of firms can charge because higher demand makes it more tempting for individual firm to deviate from the collusive behavior. Ravn, Schmitt-Grohe, and Uribe (2006) analyze a model with goods-specific habits. That setup is akin to the one analyzed here in that it features variations in the price elasticity of demand but, in addition, implies that intertemporal considerations affect the markup because firms consider how current pricing policies affect future demand. The present formulation thus considers separately the elasticity effect and investigates its importance for countercyclical markups in isolation.

The issue is then how important the price elasticity effect is. Letting ϵ_t^μ denote the elasticity of the equilibrium markup with respect to aggregate demand, we have that

$$\epsilon_t^\mu = -\frac{x^*/y_t}{(1-x^*/y_t)[\eta(1-x^*/y_t)-1]} < 0.$$

Under the maintained assumption that the price elasticity of demand exceeds unity, the output elasticity of the markup is negative. Table 1 illustrates how the markup and the elasticity of the markup change as the share of subsistence absorption in total output increases from 0 to 0.8. In the table, we assume that η takes a value of 6. The table shows that for low values of the markup, the income elasticity of the markup is quite small. For example, in the extreme case when subsistence demand accounts for 50% of total absorption, the equilibrium markup is 50% (a high value given the available empirical evidence), but the output elasticity of the markup is only 0.5. Thus, a 1% increase in output lowers the markup by less than one percentage point, from 50 to 49.25%. It appears that although this model has the potential of generating countercyclical markups, the output elasticity of the markup is moderate for realistic values of the steady-state markup.

Figure 1 displays impulse responses to preference, government spending, and productivity shocks. The calibration of the model follows Ravn, Schmitt-Grohé, and Uribe (2006). We set the share of subsistence absorption in total absorption to 30% ($x^*/y = 0.3$). In this case the average markup equals 37%. Table 2 displays the values assigned to the remaining deep structural parameters of the benchmark economy. This economy is shown with solid lines in the figure. For

TABLE 1. The markup and the output elasticity of the markup as functions of the share of subsistence absorption

x^*/y_t	μ_t	ϵ_t^{μ}
0	1.2	0
0.1	1.23	−0.03
0.2	1.26	−0.07
0.3	1.31	−0.13
0.4	1.38	−0.26
0.5	1.5	−0.5
0.6	1.71	−1.07
0.7	2.25	−2.91
0.8	6.0	−20.0

Note: x^* denotes subsistence absorption, y_t denotes aggregate demand, μ_t denotes the gross markup, and ϵ_t^{μ} denotes the elasticity of the markup with respect to aggregate demand. The parameter η is assumed to be 6.

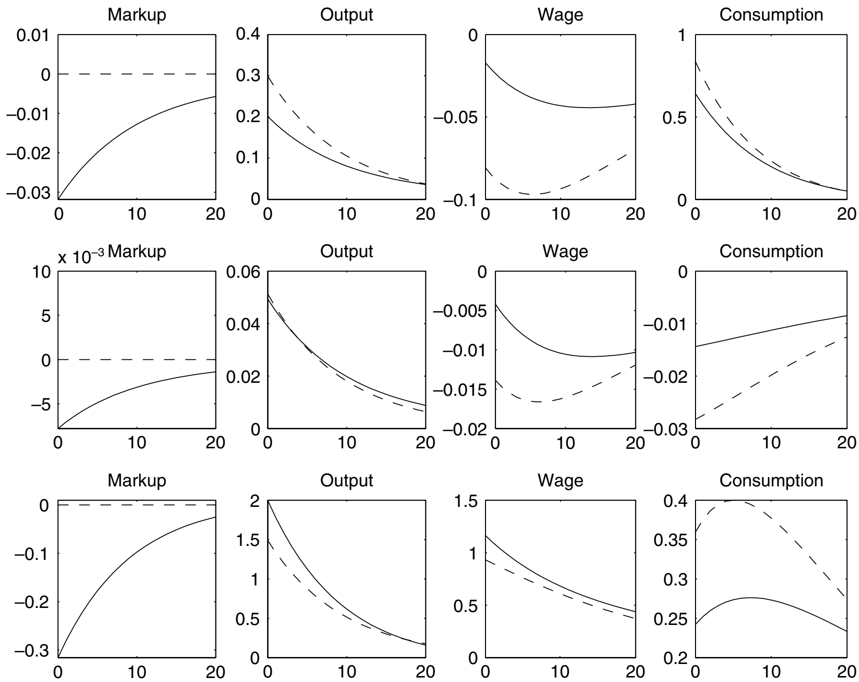

FIGURE 1. Impulse responses to positive preference, government spending, and productivity shocks: row 1, preference shock; row 2, government spending shock; row 3, technology shock. Impulse responses are measured in percent deviations from steady state. Horizontal axes display the number of quarters after the shock.

TABLE 2. Calibration

Symbol	Value	Description
β	0.9902	Subjective discount factor
σ	2	Inverse of intertemporal elasticity of substitution
c^*	0.064	Subsistence level of consumption
g^*	0.011	Subsistence level of public consumption
i^*	0.016	Subsistence level of investment
α	0.25	Capital elasticity of output
δ	0.01	Quarterly depreciation rate
η	5.3	Elasticity of substitution across varieties
ϵ_{hw}	1.3	Frisch elasticity of labor supply
h	0.2	Steady-state fraction of time devoted to work
$\bar{g}$	0.0367	Steady-state level of government purchases
ϕ	0.1129	Fixed cost
ρ_v, ρ_g, ρ_a	0.9	Persistence of exogenous shocks

comparison, we include with broken lines, the response of an economy without subsistence absorption ($x^*/y = 0$).

The model economy without subsistence absorption exhibits no movements in markups. We note that in an economy with subsistence points at the level of aggregate absorption (as opposed to at the level of each variety of goods), markups are also constant along the business cycle. This is because in this case the demand functions faced by the monopolistic producers of each variety are price-isoelastic.

By contrast, in the economy with good-specific subsistence points, the markup responds countercyclically to all three shocks. However, quantitatively the predicted markup movements are small. In particular, the decline in markups in response to demand shocks is not strong enough to overturn the negative response of wages. The reason why wages decline less in the model with good-specific subsistence points than in the model without this feature is that the increase in demand lowers the markup, which shifts out the aggregate labor demand curve [recall that the demand for labor takes the form $w_t = A_t F_h(k_t, h_t)/\mu_t$]. Thus, when the markup is countercyclical, its effect on the demand for labor is similar to the effect of positive productivity shocks. Rotemberg and Woodford (1992) show that in U.S. postwar data, wages increase in response to demand shocks in the form of innovations in public consumption. They use this feature of the data to judge the empirical plausibility of various models of the business cycle.

In the model without good-specific subsistence points, an increase in government purchases is associated with a decline in private consumption. This effect is a consequence of a negative wealth effect caused by the increase in unproductive government spending. In the economy with good-specific subsistence points, consumption also falls in response to the increase in public absorption, but by less than in the economy with homothetic preferences. The reason is again that the decline in markups leads to a smaller fall in wages, which causes a substitution effect toward consumption and away from leisure. This substitution effect is not sufficiently strong to offset the negative wealth effect. As a result, consumption falls. This prediction of the model brings theory and data a step closer. Available evidence suggests that positive government purchases shocks are associated with expansions in private consumption; see Galí et al. (2003) and Blanchard and Perotti (2002).

4. CONCLUSION

This paper demonstrates that the simple introduction of subsistence points at the level of individual goods in the context of an otherwise quite standard dynamic general equilibrium model gives rise to a theory countercyclical markups. The resulting theory contributes to understanding two important aspects of the data, namely, the cyclical behavior of real wages and private consumption in response to government spending shocks. In effect, the standard neoclassical model implies a strong negative correlation between wages and aggregate spending, originating in negative wealth effects associated with unproductive public spending. The countercyclicality of markups induces expansions in the demand for labor during booms and the reverse during contractions, thereby reducing the tendency for wages and government spending to move in opposite directions.

Although the model with Stone-Geary preferences at the level of individual varieties represents a step in the right direction, it leaves much ground to be covered. In particular, like other theories of endogenous markups, the good-specific subsistence point model faces a steep trade-off between the level of the markup and the elasticity of the markup with respect to output. The higher the markup, the higher the output elasticity of the markup. For realistic markup levels, the subsistence point model implies a relatively small elasticity, which limits the model's ability to explain the observed wage and consumption dynamics in response to demand shocks. Alleviating the level-elasticity trade-off of markups is an important challenge for future research.

NOTES

1. Layard (2003) proposes that consumer rivalry gives rise to increasing subsistence consumption over time. Clark and Oswald (1996), among others, argue along similar lines that relative income (or consumption) enters individuals' utility functions.
2. Ravn, Schmitt-Grohe, and Uribe (2006) examine these issues further in a habit formation model. A key difference between the present analysis and the habit model is that the price inelastic term adjusts over time in the habit model but not in the Stone-Geary formulation.
3. This way we isolate the effects of good specific price-inelastic demands on the dynamic behavior of markups. Assuming that $d^* = 0$ implies that the weight of the components of aggregate demand that are subject to time-varying price elasticity changes in response to shocks.
4. Had we assumed the absence of subsistence points in investment or in government spending, the composition of aggregate demand also would enter this expression.
5. For the individual firm's problem to be well defined, it must be the case that the price elasticity is greater than 1, that is, $\eta(1 - x^*/y_t) > 1$. In what follows, we will assume that this condition is satisfied.

6. Bergin and Feenstra (2001) analyze a model with translog preferences that also displays time-varying price elasticities.

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