News about Aggregate Demand and the Business Cycle*

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Abstract

We show that an otherwise standard one-sector real business cycle model with variable capital utilization and mild increasing returns-to-scale is able to generate qualitatively as well as quantitatively realistic aggregate fluctuations driven by news shocks to future consumption demand. In sharp contrast to many studies in the existing expectations-driven business cycle literature, our results do not rely on non-separable preferences or investment adjustment costs.

Keywords: News Shocks; Aggregate Demand; Business Cycles.

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1 Introduction

Since the work of Beaudry and Portier (2004, 2007), it is now well known that under the assumptions of perfectly competitive markets and constant returns-to-scale in production, a standard one-sector real business cycle (RBC) model is unable to exhibit qualitatively realistic expectations-driven cyclical fluctuations, *i.e.* simultaneous expansions of output, consumption, investment and hours worked in response to good news about future technological progress. Due to the dominating intertemporal income effect, forward-looking agents will raise their current consumption and leisure, which in turn lead to decreases in today's output and investment. As a result, a news-driven prototypical one-sector RBC model fails to predict the positive co-movement among key macroeconomic aggregates observed in the data. In order to resolve this "co-movement puzzle", subsequent research incorporates some of the following features into a RBC-type economy: a convex production possibility frontier, multiple production sectors, non-separable preferences, investment adjustment costs, knowledge capital, imperfect competition, countercyclical markups, sticky prices, and costly technology adoption, among others.[1]

Parallel to the early development of the original real business cycle literature, almost all the existing studies have focused on news shocks to forthcoming productivity improvement (a supply disturbance). In this paper, our attention is turned to examine the theoretical as well as quantitative plausibility of expectations-driven business cycles within a one-sector RBC model subject to aggregate demand impulses.[2] Specifically, we consider shocks to the marginal utility of consumption *à la* Baxter and King (1991) that may affect the household's urge to consume. As a result, this preference disturbance creates a wedge between the marginal rate of substitution between consumption and leisure and the marginal product of labor.[3] Our main objective is striving for *parsimonious departures* from a standard one-sector RBC formulation, driven by expectational shocks to future consumption demand, that is able to

[1] Representative examples include Christiano, Ilut, Motto and Rostagno (2008), Jaimovich and Rebelo (2009), Tsai (2009), Dupor and Mehkari (2010), Karnizova (2010), Nutahara (2010), Wang (2011), Gunn and Johri (2011), and Pavlov and Weder (2012).

[2] See, for example, Beraudry and Lucke (2009) and Schmitt-Grohé and Uribe (2012) for empirical support that anticipated demand shocks play non-negligible roles in accounting for the U.S. business cycle. On the theoretical front, see Ramey (2011, section IV.B) for an analysis of expectational disturbances to government spending; and Beaudry and Portier (2007, section 4.4), Mertens and Ravn (2011) and Sirbu (2011) for studies on anticipated tax policy shocks.

[3] The ratio between the marginal rate of substitution of consumption for leisure and the marginal product labor is dubbed as the "labor wedge" in the literature. See Shimer (2009) for a recent review on the labor wedge.

account for, not only qualitatively but also quantitatively, the post-war U.S. business cycle. In particular, we maintain additive separability of the household utility among two normal goods ("net consumption" and leisure) both intratemporally and intertemporally. Moreover, our analytical framework does not include any investment adjustment costs. Many previous studies (*e.g.* Jaimovich and Rebelo [2009], and Karnizova [2010]), on the other hand, have shown that non-separable preferences and/or capital adjustment costs are *sine quibus non* ingredients to successfully resolve the "co-movement puzzle" mentioned above.

Under the maintained assumptions of an additive separable utility function and no investment adjustment costs, we introduce variable capital utilization and positive productive externalities to an otherwise prototypical one-sector RBC model. Our theoretic analysis shows that the *necessary* condition for consumption and investment to move in the same direction states that the equilibrium wage-hours locus is positively sloped and steeper than the labor supply curve. In a calibrated version of the model economy, the degree of aggregate returns-to-scale in production needed to satisfy the requisite condition for positive macroeconomic co-movement is found to be mild and empirically plausible *vis-à-vis* recent empirical findings of Laitner and Stolyarov (2004). Furthermore, in response to the favorable news about changes in future aggregate demand, a macroeconomic boom will occur in the economy as output, consumption, investment and labor hours all rise during the announcement period. Intuitively, an optimistic expectational impulse causes a leftward shift of the labor supply curve, which will raise the anticipated future real wage and hours worked. This in turn leads to an increase in current consumption, and in other key aggregates as well, because the household's higher expected permanent income yields a stronger intertemporal wealth effect. We also obtain simulated second moments from five parametric versions of our model, and compare them with the Hodrick-Prescott (H-P) filtered U.S. time series data. It turns out that each variant performs quite well at matching the main empirical regularities, *i.e.* the relative standard deviations to output and contemporaneous covariances, of U.S. cyclical fluctuations after 1954.

Finally, it is worth pointing out that all our findings are obtained in an otherwise standard and highly-stylized model with slight modifications. In spite of its analytical simplicity, our one-sector RBC model, coupled with variable capital utilization and an empirically plausible level of increasing returns-to-scale, is able to yield qualitatively as well as quantitatively realistic aggregate fluctuations driven by news shocks to future consumption expenditures. In addition, maintaining the assumptions of additive separable preferences and no adjustment costs on capital investment highlights the quantitative business-cycle importance of anticipated impulses to the economy's demand side. This in turn allows the comparison of our results with those from previous studies to be focused and transparent.

The remainder of this paper is organized as follows. Section 2 describes the model and analyzes its equilibrium conditions. Section 3 analytically and quantitatively examines the plausibility of expectations-driven business cycles within our model economy. Section 4 concludes.

2 The Economy

Our economy is populated by a unit measure of identical infinitely-lived households, each endowed with one unit of time. The representative household maximizes a discounted stream of expected utilities over its lifetime

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{(c_t - \Delta_t)^{1-\sigma} - 1}{1-\sigma} - A \frac{h_t^{1+\gamma}}{1+\gamma} \right], \quad 0 < \beta < 1, \quad \sigma \geq 1, \quad \gamma \geq 0 \text{ and } A > 0, \tag{1}$$

where E is the conditional expectations operator, β is the discount factor, c_t is consumption, h_t is hours worked, γ is the inverse of the (Frisch) labor supply elasticity, and σ governs the degree of risk aversion or the intertemporal elasticity of substitution in consumption. Based on the empirical evidence for this preference parameter in the mainstream macroeconomics literature, our analyses are restricted to environments in which $\sigma \geq 1$. As in Baxter and King (1991), Δ_t is a random shock to preferences that affects the household's marginal utility of consumption. For example, an increase in Δ_t represents a positive disturbance to the economy's aggregate demand as it raises the urge to consume. We postulate that the unconditional mean of Δ_t (or its steady-state level denoted as Δ_{ss}) is zero[4][5], and that its innovation χ_t is specified as

$$\chi_t = \underbrace{\varepsilon_t}_{\text{unanticipated}} + \underbrace{v_{t-4}}_{\text{news}}, \tag{2}$$

where ε_t is a contemporaneous unanticipated impulse; and v_{t-4} represents an anticipated component which was announced or observed four periods beforehand and influences the forward-looking household's current utility, hence a news shock. Both random errors are normally

[4] It follows that the steady-state intertemporal elasticity of substitution in consumption is equal to $\frac{1}{\sigma}$. Moreover, our quantitative results, reported in sections 3.2 and 3.3, are robust to the values of Δ_{ss} as long as it is smaller than the consumption counterpart c_{ss}.

[5] It Δ_t is restricted to take on only positive values, then it can be interpreted as the time-varying minimum or subsistence consumption requirement that is taken as exogenous by all households. See, for example, Álvarez-Peláez and Díaz (2005).

distributed with zero means and variances σ_ε^2 and σ_v^2. It is further assumed that each series is uncorrelated over time, and that there is no correlation between them.

The representative agent also faces the following resource constraint that does not include investment adjustment costs:

$$c_t + \underbrace{k_{t+1} - (1-\delta_t)k_t}_{x_t} = y_t, \quad k_0 > 0 \text{ given}, \tag{3}$$

where k_t is physical capital, x_t is gross investment, and $\delta_t \in (0,1)$ represents the time-varying capital depreciation rate which takes on the functional form

$$\delta_t = \frac{1}{\theta} u_t^\theta, \quad \theta > 1, \tag{4}$$

where u_t is the rate of capital utilization that is endogenously determined by the household. The specification of $\theta > 1$ in (4) means that more intensive capital utilization accelerates its rate of depreciation. When $\theta \to \infty$, our model collapses to a standard RBC formulation with constant depreciation and utilization rates. Output y_t is produced by the Cobb-Douglas production function

$$y_t = Y_t^{\frac{\eta}{1+\eta}} (u_t k_t)^\alpha h_t^{1-\alpha}, \quad \eta \geq 0, \quad 0 < \alpha < 1, \tag{5}$$

where Y_t stands for the economy's aggregate output that is taken as given by each individual agent, and η denotes the degree of productive externalities. In a symmetric equilibrium where $y_t = Y_t$, the social technology is given by

$$y_t = (u_t k_t)^{\alpha(1+\eta)} h_t^{(1-\alpha)(1+\eta)}. \tag{6}$$

Notice that when $\eta = (>)\ 0$, equation (6) exhibits aggregate constant (increasing) returns-to-scale in utilized capital $u_t k_t$ and labor hours h_t.

The first-order conditions for the household's dynamic optimization problem are

$$A\,(c_t - \Delta_t)^\sigma\, h_t^\gamma = (1-\alpha)\frac{y_t}{h_t}, \tag{7}$$

$$\delta_t = \frac{\alpha}{\theta}\frac{y_t}{k_t}, \tag{8}$$

$$\frac{1}{(c_t - \Delta_t)^\sigma} = \beta E_t\left\{\frac{1}{(c_{t+1} - \Delta_{t+1})^\sigma}\left(1 - \delta_{t+1} + \alpha\frac{y_{t+1}}{k_{t+1}}\right)\right\}, \tag{9}$$

$$\lim_{t\to\infty} \beta^t \frac{k_{t+1}}{(c_t - \Delta_t)^\sigma} = 0, \tag{10}$$

where (7) equates the slope of household's indifference curve to the marginal product of labor, (8) equates the marginal gain (additional output) and marginal loss (higher depreciation) of a change in the rate of capital utilization u_t, (9) is the standard Euler equation for intertemporal consumption choices, and (10) is the transversality condition. Next, substituting (4) and (8) into (6) yields the following reduced-form social technology as a function of capital and labor inputs:

$$y_t = \alpha^{\frac{\alpha}{\theta-\alpha(1+\gamma)}} k_t^{\frac{\alpha(1+\eta)(\theta-1)}{\theta-\alpha(1+\eta)}} h_t^{\frac{\theta(1-\alpha)(1+\eta)}{\theta-\alpha(1+\eta)}}, \tag{11}$$

where $0 < \frac{\alpha(1+\eta)(\theta-1)}{\theta-\alpha(1+\eta)} < 1$, *i.e.* diminishing marginal product of capital, in order to guarantee the existence of an interior steady-state.[6]

3 Expectations-Driven Business Cycles

This section examines whether the above one-sector RBC model is able to generate, not only qualitatively but also quantitatively, realistic cyclical fluctuations driven by news shocks to future consumption demand. We first analytically derive the condition(s) under which the economy exhibits positive co-movement between consumption and investment. Under the assumption that this requisite condition is satisfied, we then undertake a quantitative investigation of the model's dynamic responses and business cycle statistics within a calibrated version of our economy.

3.1 Analytical Result

In our model economy, resolving the aforementioned "co-movement puzzle" amounts to looking for the condition(s) under which consumption c_t, investment x_t, and thus output y_t all move in the same direction. Hours worked h_t will co-move as well because capital is a predetermined variable and there is no change in the current-period economic fundamentals. Per Beaudry and Portier's (2004, Appendix A; 2007) temporary equilibrium approach, we use the totally-differentiated version of equations (3) and (7), together with the aggregate production technology (11), to obtain the analytical expression of $\frac{dc_t}{dx_t}$ as follows:

[6] Since $0 < \alpha < 1$, $\eta \geq 0$ and $\theta > 1$, the parametric restriction of $0 < \frac{\alpha(1+\eta)(\theta-1)}{\theta-\alpha(1+\eta)} < 1$ implies that $\theta - \alpha(1+\eta) > 0$.

$$\frac{dc_t}{dx_t} = \left\{ \frac{\left(\frac{\sigma y_t}{c_t - \Delta_t}\right)\left[\frac{\theta(1-\alpha)(1+\eta)}{\theta-\alpha(1+\eta)}\right]}{\frac{\theta(1-\alpha)(1+\eta)}{\theta-\alpha(1+\eta)} - 1 - \gamma} - 1 \right\}^{-1}, \tag{12}$$

which governs the sign of correlation between consumption and investment. Since $\sigma \geq 1$, $0 < \alpha < 1$, $\theta > 1$, $\eta \geq 0$, $\theta - \alpha(1+\eta) > 0$ (see footnote 6), and $\frac{1}{c_t - \Delta_t} > 0$ represents the period-t marginal utility of consumption, $\frac{dc_t}{dx_t} > 0$ requires that

$$\frac{\frac{\theta(1-\alpha)(1+\eta)}{\theta-\alpha(1+\eta)}}{\frac{\theta(1-\alpha)(1+\eta)}{\theta-\alpha(1+\eta)} - 1 - \gamma} > \frac{c_t - \Delta_t}{\sigma y_t} > 0. \tag{13}$$

Hence, consumption and investment will move in the same direction *only if*[7]

$$\frac{\theta(1-\alpha)(1+\eta)}{\theta - \alpha(1+\eta)} - 1 > \gamma, \tag{14}$$

which is independent of σ that governs the household's intertemporal elasticity of substitution in consumption.[8]

To understand the above condition, we note that under the assumption of perfect competition in the labor market, agents' intratemporal employment decision is governed by

$$(1-\alpha)\frac{y_t}{h_t} \overset{\text{demand}}{=} w_t \overset{\text{supply}}{=} A\,(c_t - \Delta_t)^{\sigma}\, h_t^{\gamma}, \tag{15}$$

where w_t is the real wage rate. Next, plugging the social technology (11) into the logarithmic version of labor demand shows that the slope of the equilibrium wage-hours locus is equal to $\frac{\theta(1-\alpha)(1+\eta)}{\theta-\alpha(1+\eta)} - 1$. In addition, taking logarithms on the second equality of (15) indicates that the slope of the household's labor supply curve is γ (≥ 0), and its position or intercept is affected by the level of "net consumption" ($c_t - \Delta_t$). It follows that the *necessary* condition for the economy to display positive co-movement between key macroeconomic aggregates, as in (14), states that the equilibrium wage-hours locus is upward sloping and steeper than the labor supply curve. Wen (1998, p. 16) finds that (14) is also a necessary condition for our model with variable capital utilization to exhibit a continuum of stationary perfect-foresight

[7] The inequality in (14) is not a "if and only if" condition for $\frac{dc_t}{dx_t} > 0$ because a negative preference shock could lead to $\frac{c_t - \Delta_t}{\sigma y_t} > 1$. However, when Δ_t is restricted to be the positive subsistence level of consumption (see footnote 5), $\frac{c_t - \Delta_t}{\sigma y_t}$ on the right-hand side of (13) must be smaller than one in that $\sigma y_t \geq y_t > c_t > c_t - \Delta_t > 0$. On the other hand, if (14) holds, then the left-hand side of (13) is larger than one. It follows that condition (14) is not only necessary, but also sufficient, for macroeconomic co-movement provided $\Delta_t > 0$.

[8] It is straightforward to show that under constant depreciation and utilization rates of capital, the requisite condition for consumption and investment to co-move in our model economy becomes $(1-\alpha)(1+\eta) - 1 > \gamma$.

equilibria.[9] Therefore, as pointed out by Eusepi (2009), the requisite conditions for positive macroeconomic co-movement and equilibrium indeterminacy to occur within a one-sector RBC framework are tightly connected.

3.2 Dynamic Responses

Based on the preceding analytical result, this subsection quantitatively examines a calibrated version of our model in response to agents' optimistic expectation about an upcoming change in aggregate demand, while maintaining saddle-path stability and equilibrium uniqueness. As in Beaudry and Portier (2004), the stochastic process for exogenous preference disturbances fed into our numerical experiments is postulated as follows: the economy starts at its steady state in period zero. At period 1, households receive a signal that the utility shifter will permanently increase to 0.01 from period 4 (denoted as Δ_4) onwards, and this good news turns out to be materialized in period 4.[10]

In our benchmark specification, we adopt the following quarterly parameterization that is commonly used in the real business cycle literature: $\alpha = 0.3$, $\beta = 0.99$, $\gamma = 0$ (*i.e.* perfectly elastic or indivisible labor supply *à la* Hansen [1985] and Rogerson [1988]), $\sigma = 2$, and the steady-state capital depreciation rate $\delta_{ss} = 0.025$. The selected values of β and δ_{ss} imply that $\theta = 1.404$. Given the calibrations of α, γ and θ, the threshold level of productive externalities that satisfies the necessary condition for positive co-movement between consumption and investment, as in (14), is $\eta_{\min} = 0.0945$. Notice that $\eta_{\min}$ is *ceteris paribus* monotonically increasing with respect to γ which governs the household's labor supply elasticity, *i.e.* $\frac{\partial \eta_{\min}}{\partial \gamma} > 0$.

Figure 1 presents the impulse response functions of our model economy in response to the above one-time positive innovation to future consumption expenditures under $\eta = 0.1$ for the purpose of clear illustration. Notice that the resulting level of aggregate return-to-scale in production $(= 1 + \eta)$ can be characterized as empirically plausible *vis-à-vis* recent empirical findings of Laitner and Stolyarov (2004) who have reported a preferred range of $1.09 - 1.11$ for the U.S. economy. In addition, the parameter A $(= 13.5113)$ in (1) is chosen such that the household spends one third of its time endowment on working at the steady state. As can been seen from Figure 1, an optimistic expectational shock yields a macroeconomic boom

[9] In an extended version of Wen's (1998) indeterminate one-sector RBC model, Benhabib and Wen (2004) examine the quantitative business cycle driven by unanticipated disturbances to consumption demand and government spending (thus no news impulses), and sunspot shocks to agents' animal spirits.

[10] Our findings in this and next subsections are qualitatively robust to the timing of news up to an eight-quarter horizon.

with simultaneous expansions of output, consumption, investment and hours worked in period 1 after the announcement of good news is made. That is, our one-sector RBC model with mild increasing returns is able to generate qualitatively realistic business cycles driven solely by agents' changing expectations about future aggregate demand.[11]

In order to understand the economic intuitions behind this result, it is useful to consider what will be the outcome that forward-looking agents, standing at period 1, expect to occur in the period-4 labor market with a positively sloped equilibrium wage-hours locus which intersects the labor supply curve from below as depicted in Figure 2. Upon receiving the positive signal about future demand, the representative household anticipates that a higher Δ_4 leads to an increase in consumption c_4. Due to the presence of sufficiently strong productive externalities ($\eta = 0.1$), the household's "net consumption" $(c_4 - \Delta_4)$ will rise, thus a leftward shift of the labor supply curve ensues. Figure 2 shows that the resulting excess demand for labor moves the equilibrium from E to E', raising the expected real wage w_4 and hours worked h_4, which in turn increases the expected marginal product of capital MPK_4. It follows that how agents' period-1 economic decisions react to these future changes depends on the relative strength of two opposing forces. On the one hand, the anticipation of a higher lifetime (labor) income results in an increase of consumption in $t = 1$ through a positive wealth effect. On the other hand, a higher expected rate of return on investment (*i.e.* MPK_4) induces households to reduce their consumption and invest more today through an intertemporal substitution effect. Our numerical simulations show that the income effect turns out to be stronger, hence current consumption c_1 rises in response to good news. Since $\frac{dc_t}{dx_t} > 0$ under our parameterization where condition (14) is satisfied, investment together with output and labor hours will be higher as well at the announcement period $t = 1$.

3.3 Simulation Results

So far, we have shown that a slightly modified one-sector RBC model is able to generate qualitatively realistic co-movement of macroeconomic aggregates in response to an anticipated impulse to future consumption demand. This subsection examines the corresponding statistical business cycle properties in comparison with those obtained from the H-P filtered cyclical components of the logarithmic U.S. quarterly time series for the period 1954:1 – 2009:2. We

[11] By contrast, it can be shown that when condition (14) holds, news about future technological improvement (a positive supply shock) will generate a counterfactual recession whereby key macroeconomic aggregates all fall at period 1 within our model economy. See Guo, Sirbu and Suen (2012) for the same finding in a one-sector RBC model with fixed capital utilization and positive productive externalities coming from aggregate capital and labor inputs.

first derive the model's unique interior steady state (a saddle point), and then take log-linear approximations to the equilibrium conditions in its neighborhood.[12]

3.3.1 Benchmark Parameterization

In our baseline numerical simulations, the calibrated values of α, β, γ, σ, δ_{ss}, θ, η $(= 0.1)$ and A remain unchanged as those in section 3.2. With regard to identifying or measuring the stochastic process for the preference shock, we follow Baxter and King (1991) and obtain the time series of Δ_t from the log-linearized version of the labor-supply portion in equation (15)[13]

$$\frac{\Delta_t}{c_{ss}} = \frac{1}{\sigma}\log A + \log c_t - \frac{1}{\sigma}\log w_t + \frac{\gamma}{\sigma}\log h_t, \tag{16}$$

where c_{ss} $(= 0.1977)$ denotes the model's steady-state level of consumption. Next, the resulting demand disturbance is found to be well described by the following first-order autoregressive regression with a linear time trend:

$$\begin{aligned} \Delta_t &= \underset{(0.01476)}{1.8566} + \underset{(0.01549)}{0.9831}\,\Delta_{t-1} + \underset{(0.000087)}{0.00066}\,t + \chi_t, \\ \text{Adjusted } R^2 &= 0.9993 \quad \text{and} \quad \text{Durbin-Waston statistic} = 1.9273, \end{aligned} \tag{17}$$

where numbers in parentheses are standard errors of the estimated parameters, and the standard deviation of innovations σ_χ is equal to 0.001205. Notice that Δ_t is highly persistent, with an autoregressive coefficient of $\rho = 0.9831$.[14] In addition, the correlation coefficient between the H-P filtered (linearly detrended) cyclical components of output and our measured preference shocks is 0.7416 (0.5096).

Since there is no direct evidence on the variabilities of the unanticipated and news components for the innovations to preference shocks (*i.e.* σ_ε and σ_v), we use the Simulated Method of Moments to calibrate these parameters, as in Beaudry and Portier (2004) and Karnizova (2010). In particular, σ_ε is selected to minimize the squared error between output volatility of the data σ_y $(= 2.3004\%)$ and that of model-generated time series averaged across simulations.

[12] Since $\Delta_{ss} = 0$, the proportionate deviations of the preference shock are computed relative the steady-state level of consumption.

[13] See the Appendix for detailed information on the U.S. time series data used in our quantitative analysis.

[14] We obtain very similar point estimates of ρ and σ_χ when the real wage is replaced with the marginal product of labor, *i.e.* $(1-\alpha)\frac{y_t}{h_t}$, where $\alpha = 0.3$, in the computation of Δ_t. In this case, equation (16) is changed to

$$\frac{\Delta_t}{c_{ss}} = \frac{1}{\sigma}\log\frac{A}{1-\alpha} + \log c_t - \frac{1}{\sigma}\log y_t + \frac{(1+\gamma)}{\sigma}\log h_t.$$

Given the benchmark parameterization described above, our model is simulated $N = 1{,}000$ times of length 220 periods. As a result,

$$\sigma_\varepsilon = \text{argmin } \left(\sigma_y - \frac{1}{N} \sum_{i=1}^{N} \sigma_{y,i} \right)^2 , \tag{18}$$

where $\sigma_{y,i}$ represents the standard deviation of output from the i-th simulation. Using equation (2), the volatility of the anticipated component for the random error to consumption demand can then be obtained by $\sigma_v = \sqrt{\sigma_\chi^2 - \sigma_\varepsilon^2}$, where $\sigma_\chi = 0.001205$. As it turns out, this computational procedure yields a standard error of simulated output (= 2.2964%) that closely matches with the targeted empirical moment. In addition, news impulses account for a significant proportion (about 77.23 percent) of the variance for preference innovations in that σ_v is found to be 0.00106.

Table 1 presents a set of H-P filtered second moments from the benchmark version of our model economy driven by consumption demand shocks, and compares them with the U.S. data. The statistics reported in column 3 are sample means from the numerical simulations. It turns out that our baseline configuration does a reasonably good job in quantitatively mimicking the ranking of cyclical volatilities in investment, GDP, labor hours and consumption, as well as their contemporaneous correlations with output. Moreover, the benchmark model overpredicts the variabilities of investment and employment relative to that of GDP, and the cross-correlation between output and labor hours.

3.3.2 Robustness

In terms of sensitivity analysis, we consider four other parameterizations with different degrees of risk aversion ($\sigma = 1$ and $\sigma = 3$) or a lower labor supply elasticity ($\gamma = 0.25$ *à la* King, Plosser and Rebelo [1988], and $\gamma = 0.5$ *à la* Gourinchas and Parker [2002]). For the latter two formulations with less elastic labor supply, the minimum degree of productive externalities $\eta_{\min}$ required to satisfy the necessary condition for positive macroeconomic co-movement (14) is raised to 0.2925 (when $\gamma = 0.25$) and 0.4699 (when $\gamma = 0.5$), respectively. Since Laitner and Stolyarov (2004) report that the 95% confidence intervals for their preferred empirical estimates on the U.S. aggregate returns-to-scale in production ($= 1 + \eta$) lie above 1 and below 1.2, we acknowledge that the figures of 1.2925 and 1.4699 are too large to be considered empirically plausible. To the extent that one objects to our return-to-scale calibration, the quantitative results below for these two specifications should be viewed more from a methodological perspective as illustrating the empirical "tension" between γ and $\eta_{\min}$ in our parsimonious model — a very elastic labor supply (a low value of γ) is needed to resolve the aforementioned "co-movement puzzle" under a reasonable degree of aggregate return-to-scale in production.

In all variants of our model economy, the utility parameter A is selected to ensure that hours worked are one third at the steady state. Moreover, for each configuration, we follow the identification and estimation procedure, given by equations (16)-(17), to obtain the corresponding persistence parameter for preference shocks ρ and the standard deviation of innovations σ_χ. Next, in simulating these alternative specifications, we adopt the same demand-disturbance process as in their benchmark counterpart. This allows us to better understand *ceteris paribus* the quantitative business-cycle effects of changing risk aversion or the labor supply elasticity, while maintaining condition (14) and saddle-path stability. Table 2 summarizes the calibrations of η, A, ρ and σ_χ across the four variants under consideration.

Although not shown here due to space limitation, the impulse response functions under these four parameterizations are qualitatively identical to those in Figure 1. That is, the current-period output, consumption, investment and labor hours all rise in response to a positive news shock to future consumption demand. Table 3 presents the corresponding numerical simulation results with different values of σ or γ. We use the Simulated Method of Moments approach, as in (18), to calibrate σ_ε which produces the best fit between the observed and simulated output volatilities for each alternative configuration. As in the benchmark specification, all four variants of our model are shown to generate quantitatively realistic business cycles in that they perform well at matching the relative variances and contemporaneous covariances observed in the U.S. data.

The first half of Table 3 shows that when the utility function (1) is logarithmic in "net consumption" ($\sigma = 1$), households are more willing to give up today's consumption in exchange for higher investment, thus yielding a higher relative standard deviation of consumption to GDP. We also note that within this specification, variations of the preference innovation are entirely caused by changes in its anticipated component, *i.e.* $\sigma_v^2/\sigma_\chi^2 = 1$ or $\chi_t = v_{t-4}$. When households are more risk averse with $\sigma = 3$, the ratios of σ_c/σ_y and σ_v^2/σ_χ^2 are both lower than those in the benchmark model. On the other hand, the second half of Table 3 demonstrates that with less elastic labor supply, agents are less willing to move out of leisure into labor, hence producing a lower relative volatility of hours worked to output. Finally, combining Tables 1 and 3 illustrates that an increase in σ leads to a less significant role of news shocks in numerically accounting for aggregate fluctuations; and that the quantitative business-cycle importance of expectational disturbances to future consumption expenditures, captured by σ_v^2/σ_χ^2, is monotonically decreasing with respect to the labor supply elasticity parameter γ.

4 Conclusion

It is now well known that a standard one-sector real business cycle model fails to exhibit news-driven business cycles. This conundrum boils down to its inability to produce positive co-movement between output, consumption, investment and labor hours in response to agents' changing expectations about future economic fundamentals. In this paper, we show that an otherwise prototypical one-sector real business cycle model, paired with variable capital utilization and mild increasing returns-to-scale in production, can successfully generate qualitatively as well as quantitatively realistic cyclical fluctuations driven by news shocks to future consumption demand. In sharp contrast to many previous studies, our results do not rely on non-separable preferences or investment adjustment costs.

This paper can be extended in several directions. For example, it would be interesting to examine the robustness of our results by considering alternative "frictions", such as nominal wage/price rigidity, habit formation in consumption, capital/labor adjustment costs and multiple production sectors, among others. These extensions will further enhance our understanding of the qualitative and quantitative plausibility of demand-news-driven aggregate fluctuations within real business cycle models. Moreover, it would be worthwhile to identify additional features which are needed to resolve the empirical "tension" discussed in section 3.3.2, thereby yielding positive macroeconomic co-movement in our model under a calibrated labor supply elasticity that is more in line with recent micro estimates.[15] We plan to pursue these research projects in the near future.

[15] See, for example, Chetty, Guren, Manoli and Weber (2011, 2012), and Keane and Rogerson (2012) for details.

5 Appendix

This appendix provides detailed information about the U.S. quarterly time series data used in our quantitative analysis. The time period covered is 1954:1 − 2009:2.

Consumption: Personal consumption expenditures on non-durable goods and services; NIPA Table 1.1.5 (line 5 + line 6), in current dollars

Investment: Gross private investment expenditures + personal consumption expenditures on durable goods; NIPA Table 1.1.5 (line 8 + line 4), in current dollars

Output: Consumption + Investment

Price Deflator: The implicit GDP deflator; NIPA Table 1.1.9 (line 1)

Population: Civilian non-institutional population of ages 16 and older; Bureau of Labor Statistics CNP16OV

Total Hours Worked: Hours of wage and salary workers on nonfarm private sector payrolls, seasonally adjusted; Bureau of Labor Statistics (ftp://ftp.bls.gov/pub/special.requests/opt/tableb10.txt) for the post-1964, and Valerie Ramey's website (http://weber.ucsd.edu/~vramey/research.html#data) for the pre-1964 years.

Wages: Wage and salary disbursements by private industries; NIPA Tables 2.2A and 2.2B (line 2), in current dollars

We use the series of GDP deflator and civilian population to obtain the real, per capita quantities of consumption, investment and output. We also use the series of GDP deflator and total hours worked to obtain the real wage per manhour.

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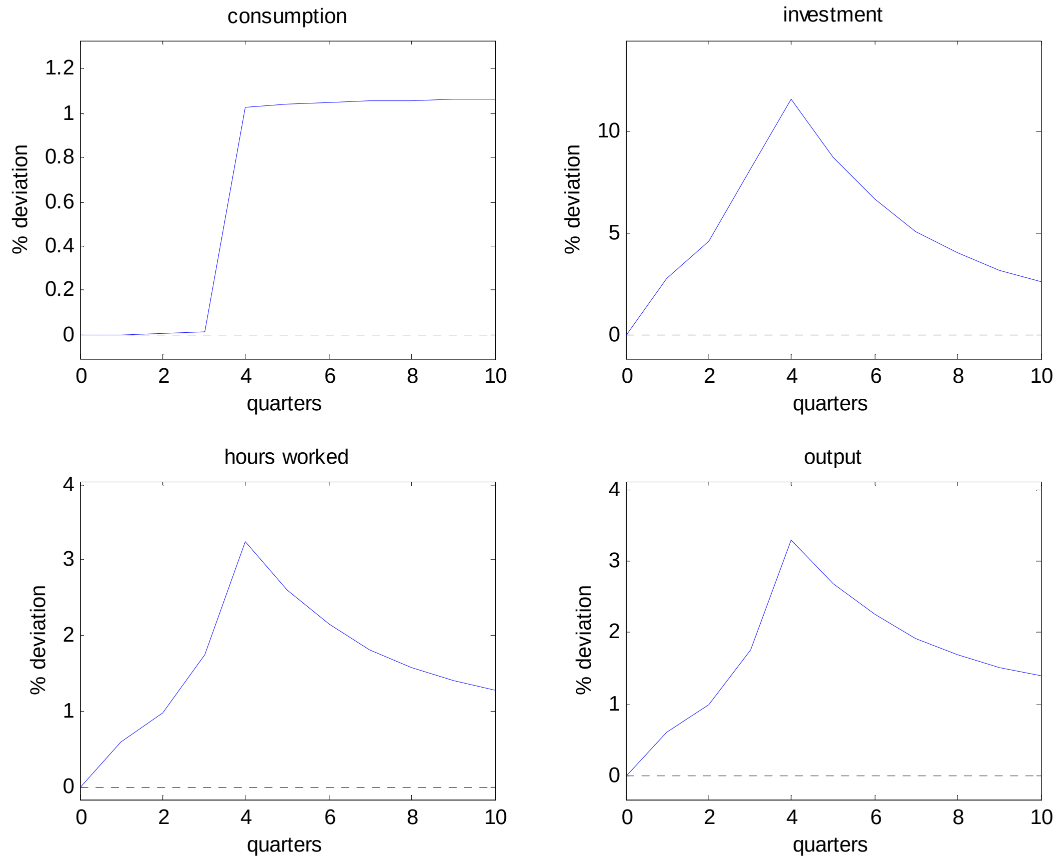

Figure 1: Impulse Response Functions

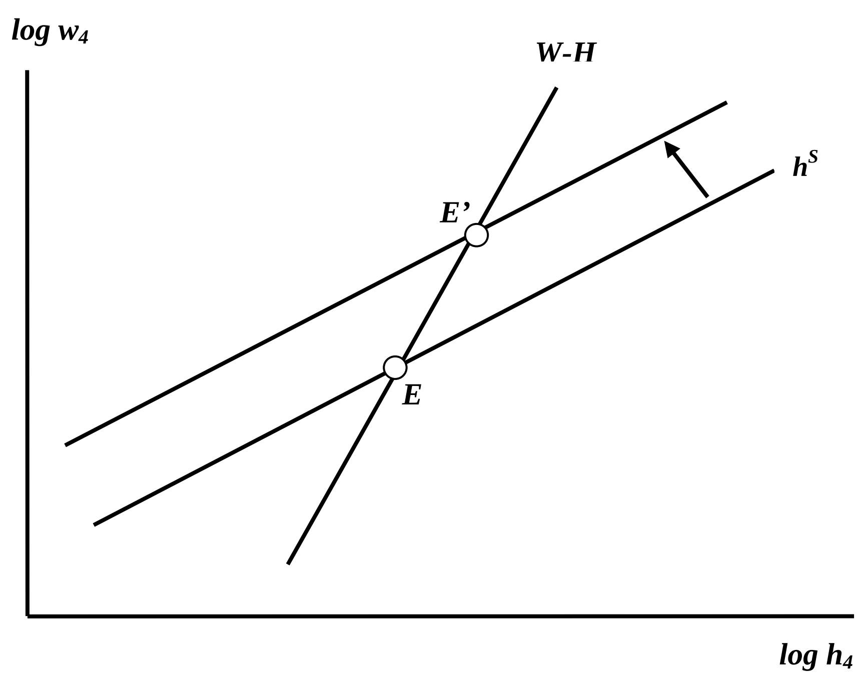

Figure 2: Anticipated Labor Market Outcomes at Period 4

Table 1: Business Cycle Statistics

	U.S. Data 1954:1-2009:2	Benchmark Model σ = 2 and γ = 0
Relative Standard Deviations to Output		
σ_c/σ_y	0.3792	0.3658
σ_x/σ_y	2.6428	3.8452
σ_h/σ_y	0.7903	0.9896
Contemporaneous Correlations with Output		
corr(c, y)	0.7972	0.7089
corr(x, y)	0.9809	0.9689
corr(h, y)	0.8641	0.9996
Relative Importance of News Shocks		
$\sigma_v^2 / \sigma_\chi^2$	-----	0.7723

Table 2: Alternative Parameterizations

	Varying Risk Aversion		Varying Labor Supply Elasticity	
	σ = 1	σ = 3	γ = 0.25	γ = 0.5
η	0.10*	0.10*	0.30**	0.48**
A	2.6706	68.3564	26.8362	55.1895
ρ	0.9685	0.9878	0.9879	0.9909
σ_χ	0.001726	0.001105	0.000870	0.000612

* This value of $\eta = 0.10$ is the same as that in the benchmark specification.
** These values are slightly higher than their respective levels of $\eta_{\min}$ described in the text.

Table 3: Sensitive Analysis

	U.S. Data	Varying Risk Aversion		Varying Labor Supply Elasticity	
	1954:1-2009:2	σ = 1	σ = 3	γ = 0.25	γ = 0.5
Relative Standard Deviations to Output					
σ_c/σ_y	0.3792	0.3956	0.3335	0.3996	0.4749
σ_x/σ_y	2.6428	3.8802	3.8193	3.3672	3.0297
σ_h/σ_y	0.7903	0.9879	0.9912	0.7915	0.6572
Contemporaneous Correlations with Output					
corr(c, y)	0.7972	0.6581	0.7689	0.9257	0.9567
corr(x, y)	0.9890	0.9591	0.9785	0.9859	0.9881
corr(h, y)	0.8641	0.9995	0.9996	0.9994	0.9991
Relative Importance of News Shocks					
$\sigma_v^2 / \sigma_\chi^2$	-----	1.0000	0.4718	0.2449	0.0229