News about Aggregate Demand and the Business Cycle*

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November 28, 2011

Abstract

We show that a 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.

JEL Classification: E32.

*We would like to thank Hung-Ju Chen, Nir Jaimovich, Charles Leung, Yiting Li, Chia-Hui Lu, Deokwoo Nam, Oscar Pavlov, Richard Suen, Yi-Chan Tsai, Hung-Jen Wang, Yong Wang, Jacob Wong and seminar participants at City University of Hong Kong, National Taiwan University, National Tsing Hua University (Taiwan), and National Chengchi University (Taiwan) for helpful discussions and comments. Part of this research was conducted while Guo was a visiting professor of economics at University of Adelaide, whose hospitality is greatly appreciated. Weder acknowledges generous financial support from the Australian Research Council. Of course, all remaining errors are our own.

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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 a 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 actual 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, 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, we examine the theoretical as well as quantitative plausibility of expectations-driven business cycles within a one-sector RBC model subject to demand impulses, specifically news about future preference shocks *a la* Baxter and King (1991) that may affect the household's marginal utility of consumption.[2] Our main objective is seeking *the most parsimonious departures* from a standard one-sector RBC formulation, driven by expectational shocks to future consumption demand, that is able to 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.

[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 (2010), and Gunn and Johri (2011).

[2] See Ramey (2011) for an analysis of news shocks to government spending; and Mertens and Ravn (2011) and Sirbu (2011) for studies on anticipated tax policy shocks.

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). Moreover, in response to a favorable news about future preference disturbances, an aggregate boom will occur in our model 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 three parametric versions of the model economy, and compare them with the Hodrick-Prescott (H-P) filtered U.S. time series data. It turns out that each variant of our model 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. In sum, this paper shows that with variable capital utilization and an empirically plausible level of increasing returns-to-scale, a one-sector RBC model is able to generate qualitatively as well as quantitatively realistic business cycles driven by news shocks to future consumption demand.

The remainder of this paper is organized as follows. Section 2 describes the model and analyzes the 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

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

where E is the conditional expectations operator, β is the discount factor, c_t is consumption, h_t is hours worked, and γ is the inverse of the intertemporal elasticity of substitution in labor supply. As in Baxter and King (1991), Δ_t is a random shock to preferences that affects the household's marginal utility of consumption.[3] For instance, an increase in Δ_t represents a positive disturbance to the economy's aggregate demand as it raises the urge to consume. The stochastic process for this preference shock is specified as

$$\log \frac{\Delta_t}{\Delta} = \rho \log \frac{\Delta_{t-1}}{\Delta} + \chi_t, \quad 0 < \rho < 1, \tag{2}$$

$$\chi_t = \underbrace{\varepsilon_t}_{\text{unanticipated}} + \underbrace{v_{t-4}}_{\text{news}}, \tag{3}$$

where Δ denotes the steady-state value of the preference shifter, and is assumed to be a fraction $\lambda \in (0,1)$ of the stationary level of consumption c_{ss}. Innovations to consumption demand χ_t consist of a contemporaneous unanticipated impulse ε_t; together with an anticipated component v_{t-4} that 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 distributed with zero means and variances σ_ε^2 and σ_v^2. We further assume 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:

$$c_t + \underbrace{k_{t+1} - (1-\delta_t)k_t}_{x_t} = y_t, \quad k_0 > 0 \text{ given}, \tag{4}$$

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

$$\delta_t = \frac{1}{\theta} u_t^{\theta}, \quad \theta > 1, \tag{5}$$

where u_t is the rate of capital utilization that is endogenously determined by the household. The specification of $\theta > 1$ in (5) means that more intensive capital utilization accelerates

[3] Alternatively, $\Delta_t > 0$ can be interpreted as the time-varying minimum or subsistence consumption requirement that is taken as exogenous by all households.

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

$$y_t = Y_t^{\frac{\eta}{1+\eta}} (u_t k_t)^{\alpha} h_t^{1-\alpha}, \quad \eta \geq 0, \quad 0 < \alpha < 1, \tag{6}$$

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

$$y_t = (u_t k_t)^{\alpha(1+\eta)} h_t^{(1-\alpha)(1+\eta)}. \tag{7}$$

Notice that when $\eta = (>)\ 0$, equation (7) 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

$$A\,(c_t - \Delta_t)\, h_t^{\gamma} = (1-\alpha)\frac{y_t}{h_t}, \tag{8}$$

$$\delta_t = \frac{\alpha}{\theta}\frac{y_t}{k_t}, \tag{9}$$

$$\frac{1}{c_t - \Delta_t} = \beta E_t \left\{ \left(\frac{1}{c_{t+1} - \Delta_{t+1}} \right) \left[1 - \delta_{t+1} + \alpha \frac{y_{t+1}}{k_{t+1}} \right] \right\}, \tag{10}$$

$$\lim_{t \to \infty} \beta^t \frac{k_{t+1}}{c_t - \Delta_t} = 0, \tag{11}$$

where (8) equates the household's marginal rate of substitution between consumption and leisure to the marginal product of labor, (9) equates the marginal gain (additional output) and marginal loss (higher depreciation) of a change in the rate of capital utilization u_t, (10) is the standard Euler equation for intertemporal consumption choices, and (11) is the transversality condition. Next, substituting (5) and (9) into (7) yields the following reduced-form social technology as a function of capital and labor inputs:

$$y_t = \alpha^{\frac{\alpha}{\theta - \alpha(1+\gamma)}} k_t^{\frac{\alpha(1+\eta)(\theta-1)}{\theta-\alpha(1+\eta)}} h_t^{\frac{\theta(1-\alpha)(1+\eta)}{\theta-\alpha(1+\eta)}}, \tag{12}$$

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.[4]

[4] 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 $\theta - \alpha(1+\eta) > 0$.

3 Expectations-Driven Business Cycles

This section systematically 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 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 equations (4) and (8), together with the aggregate production technology (12), to obtain the analytical expression of $\frac{dc_t}{dx_t}$ as follows:

$$\frac{dc_t}{dx_t} = \left\{ \frac{\left(\frac{y_t}{c_t - \Delta_t}\right)\left[\frac{\theta(1-\alpha)(1+\eta)}{\theta - \alpha(1+\eta)}\right]}{\frac{\theta(1-\alpha)(1+\eta)}{\theta-\alpha(1+\eta)} - 1 - \gamma} - 1 \right\}^{-1}, \tag{13}$$

which governs the sign of correlation between consumption and investment. Since $\theta > 1$, $0 < \alpha < 1$, $\eta \geq 0$, $\theta - \alpha(1 + \eta) > 0$ (see footnote 4), and $\frac{1}{c_t - \Delta_t} > 0$ represents the marginal utility of consumption, $\frac{dc_t}{dx_t} > 0$ requires that

$$\frac{\frac{\theta(1-\alpha)(1+\eta)}{\theta-\alpha(1+\eta)}}{\frac{\theta(1-\alpha)(1+\eta)}{\theta-\alpha(1+\eta)} - 1 - \gamma} > \frac{c_t - \Delta_t}{y_t} > 0. \tag{14}$$

Hence, consumption and investment will move in the same direction *only if*[5]

$$\frac{\theta(1-\alpha)(1+\eta)}{\theta - \alpha(1+\eta)} - 1 > \gamma. \tag{15}$$

[5] The inequality in (15) is not a "if and only if" condition for $\frac{dc_t}{dx_t} > 0$ because a negative preference shock could lead to $\frac{c_t - \Delta_t}{y_t} > 1$. However, when Δ_t is interpreted as the positive subsistence level of consumption (see footnote 3), $\frac{c_t - \Delta_t}{y_t}$ on the right-hand side of (14) must be smaller than one in that $y_t > c_t > c_t - \Delta_t > 0$. On the other hand, if (15) holds, then the left-hand side of (14) is larger than one. It follows that condition (15) is not only necessary, but also sufficient, for macroeconomic co-movement provided $\Delta_t > 0$.

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

$$(1-\alpha)\frac{y_t}{h_t} \overset{\text{demand}}{=} w_t \overset{\text{supply}}{=} A\,(c_t-\Delta_t)\,h_t^{\gamma}, \tag{16}$$

where w_t is the real wage rate. Next, plugging the social technology (12) 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 (16) 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 (15), states that the equilibrium wage-hours locus is upward sloping and steeper than the labor supply curve. Wen (1998, p. 16) finds that (15) is also a necessary condition for our model with variable capital utilization to exhibit a continuum of stationary perfect-foresight equilibria. Therefore, as pointed out by Eusepi (2009), the requisite conditions for positive 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 preferences, while maintaining saddle-path stability and equilibrium uniqueness. As in Beaudry and Portier (2004), the stochastic process for exogenous demand 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 there will be a one-percent permanent increase in the preference shifter from period 4 (denoted as Δ_4) onwards, and this good news turns out to be materialized in period 4.

For the "ratio" parameter $\lambda=\frac{\Delta}{c_{ss}}$, Benhabib and Wen (2004) arbitrarily set it to be 0.1, whereas Álvarez-Peláez and Díaz (2005) impose an upper bound of 0.4. On the other hand, with the logarithmic period utility function (1), the steady-state intertemporal elasticity of substitution in consumption, given by $IES=\frac{c_{ss}-\Delta}{c_{ss}}$, is equal to $(1-\lambda)$. Atkeson and Ogaki (1996, Table 7) find an average IES estimate of 0.4 from the U.S. time series data on aggregate consumption expenditures over the 1968−1988 period, thus $\lambda=0.6$. Drawing on these studies, λ is chosen to take a midpoint value of 0.3 in our benchmark configuration. We also 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.* indivisible labor), 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 (15), is $\eta_{\min} = 0.0945$.

Figure 1 presents the impulse response functions of our model economy in response to the above one-time positive innovation to future consumption demand 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 range of $1.09 - 1.11$ for the U.S. economy. In addition, the parameter A $(= 3.815)$ 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 with simultaneous expansions of output, consumption, investment and hours worked in period 1 after the announcement of a good news is made.[6] 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 preferences.[7]

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

[6] This result of qualitatively realistic news-driven business cycles is robust with respect to different values of $\lambda = \frac{\Delta}{c_{ss}} \in (0, 1)$.

[7] By contrast, it can be shown that when condition (15) 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 (2011) 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.

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 a good news. Since $\frac{dc_t}{dx_t} > 0$ under our parameterization where condition (15) 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 disturbance 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.[8] We first derive the unique interior steady state of our model (a saddle point), and then take log-linear approximations to the equilibrium conditions in its neighborhood. In the baseline numerical simulations, the calibrated values of α, β, γ, δ_{ss}, θ, η, λ, and A remain unchanged as those in section 3.2. We also follow Baxter and King (1991) and set the persistence parameter for the preference shock ρ to be 0.97, and the standard error of its innovations σ_χ to be 0.0097.

Since there is no direct evidence on the volatilities 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 actual data σ_y ($= 1.603\%$) and that of model-generated time series averaged across simulations. Given the benchmark parameterization described above, our model is simulated $N = 1{,}000$ times of length 220 periods. As a result,

$$\sigma_\varepsilon = \text{argmin} \left(\sigma_y - \frac{1}{N} \sum_{i=1}^{N} \sigma_{y,i} \right)^2, \tag{17}$$

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

where $\sigma_{y,i}$ represents the standard deviation of output from the i-th simulation. The volatility of the anticipated component for the random error to consumption demand can then be obtained by $\sigma_\upsilon = \sqrt{\sigma_\chi^2 - \sigma_\varepsilon^2}$, where $\sigma_\chi = 0.0097$. As it turns out, this computational procedure yields that news impulses account for a rather small proportion (about 1.11 percent) of the variance for preference innovations in that σ_υ is found to be 0.00102. As a sensitivity analysis, when $\lambda \left(= \frac{\Delta}{c_{ss}}\right)$ is raised to 0.4 and the parameter A (= 4.451) is re-calibrated to maintain the steady-state level of labor hours to be one third, we find that *ceteris paribus* the resulting relative variance $\frac{\sigma_\upsilon^2}{\sigma_\chi^2}$ increases significantly to 0.468. In this case, the expectational disturbance is nearly as quantitatively important as the unanticipated component. Moreover, fluctuations in the random error χ_t are completely accounted for by agents' changing expectations about future demand, *i.e.* $\sigma_\upsilon = \sigma_\chi = 0.0097$, under the parameterization of $\lambda = 0.48$ and $A = 5.136$. In sum, the quantitative importance of news shocks in explaining aggregate fluctuations is a monotonically increasing function of the "ratio" parameter λ.

Table 1 presents a set of H-P filtered second moments from the above-mentioned three parametric versions of our model economy, each driven by an identical sequence of innovations to the preference shock, and compares them with the U.S. data. Numbers in parentheses are the relative standard deviations to output, and the statistics reported in columns 3–5 are sample means from the numerical simulations. It turns out that our baseline configuration ($\lambda = 0.3$ and $A = 3.815$), in which demand disturbances are driven almost entirely by the unanticipated component, generates about 85% of the observed output variability. Moreover, this formulation does a reasonably good job in quantitatively mimicking the ranking of cyclical volatilities in GDP, consumption, investment and labor hours, as well as the contemporaneous correlations with output. As can be seen from the last two columns of Table 1, an increase in λ strengthens the household's incentive to consumer more because of a higher marginal utility, which in turn leads to a more volatile series of consumption $\left(\frac{\partial \sigma_c}{\partial \lambda} > 0\right)$ and a more important quantitative role of news shocks. We also note that while the corresponding standard deviations of output, investment and hours worked are higher than those in the benchmark model, their variations do not exhibit monotonicity as λ rises. As a result, these alternative specifications understate the contemporaneous correlation between GDP and consumption; and provide a closer match with the data on the volatilities of output, consumption and labor hours. Overall, our model is able to generate quantitatively realistic business cycles in that all three variants perform quite well at matching the relative standard deviations and contemporaneous covariances observed in the U.S. data.

Finally, under the assumption that news shocks are the only driving source behind the business cycle, we shut down the unanticipated component of preference innovations ε_t, and simulate the model economy solely with expectational impulses, *i.e.* $\chi_t = \upsilon_{t-4}$. The last row of Table 1 reports the standard deviation of news disturbances that is needed for each version of our model to match the output volatility with the actual data. It turns out that the requisite σ_υ is monotonically decreasing with respect to the "ratio" parameter λ which governs the household's desire to consume. Although not shown here due to space limitation, we find that the resulting relative variances and contemporaneous correlations with GDP are qualitatively as well as quantitatively robust to this alternative calibration strategy.

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, is able to 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.

5 Appendix

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

Output: Gross domestic product; NIPA Table 1.1.5 (line 1), in current dollars

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

Investment: Fixed investment; NIPA Table 1.1.5 (line 8), in current dollars

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

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

Average Hours Worked: Average nonfarm business hours (all persons); 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 intervals.

Employment: Total nonfarm employment (seasonally adjusted); Bureau of Labor Statistics PAYEMS

We use the series of GDP deflator and civilian population to obtain the real, per capita quantities of output, consumption and investment. Total labor hours are equal to the product of average hours worked and employment.

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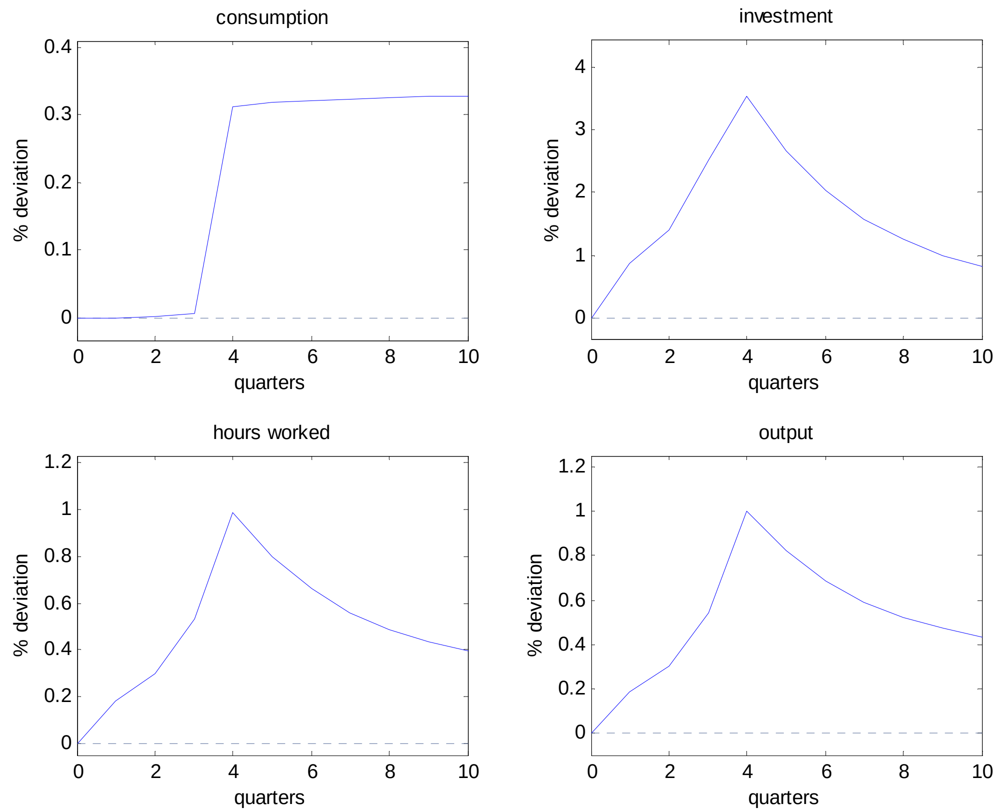

Figure 1: Impulse Response Functions

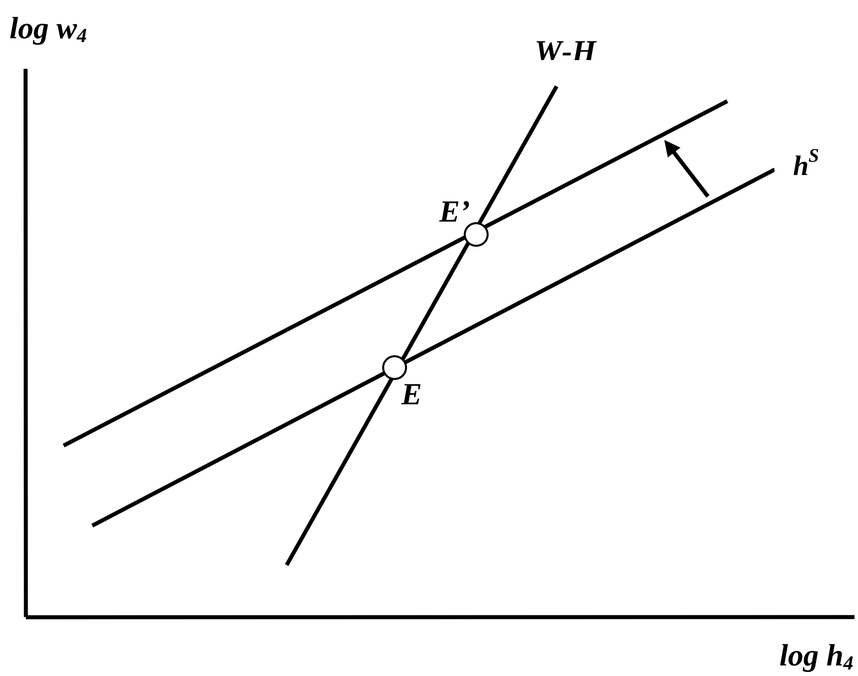

Figure 2: Anticipated Labor Market Outcomes at Period 4

Table 1: Observed and Simulated Second Moments

	U.S. Data 1954:1-2009:2	$\lambda = 0.30$ $A = 3.815$	$\lambda = 0.40$ $A = 4.451$	$\lambda = 0.480$ $A = 5.136$
Standard Deviations				
σ_y	1.603 (1.00)	1.366 (1.00)	1.609 (1.00)	1.589 (1.00)
σ_c	0.872 (0.54)	0.399 (0.29)	0.530 (0.33)	0.631 (0.40)
σ_x	5.150 (3.21)	5.188 (3.80)	6.152 (3.83)	6.155 (3.87)
σ_h	1.588 (0.99)	1.357 (0.99)	1.596 (0.99)	1.569 (0.99)
Contemporaneous Correlations with Output				
corr(c, y)	0.801	0.858	0.772	0.660
corr(x, y)	0.885	0.989	0.979	0.959
corr(h, y)	0.893	0.999	0.999	0.999
News Shocks Only to Match the Observed Output Volatility				
σ_v	-----	0.01530	0.01154	0.00973