RIETI Discussion Paper Series 07-E-062

Collateralized capital and News-driven cycles

KOBAYASHI Keiichiro
RIETI

NUTAHARA Kengo
the University of Tokyo / JSPS

Research Institute of Economy, Trade & Industry, IAA
The Research Institute of Economy, Trade and Industry
http://www.rieti.go.jp/en/

RIETI Discussion Paper Series 07-E-062

Collateralized capital and News-driven cycles

Keiichiro Kobayashi* and Kengo Nutahara†

November 30, 2007 (First Draft: July 2007)

Abstract

Kobayashi, Nakajima, and Inaba (2007) show that in the neoclassical business cycle models with collateral constraints, a boom can be generated in response to an optimistic change in expectations on the future state of the economy. They call this business cycle a news-driven cycle. In their models, land is used as collateral, and borrowing for working capital is limited by the value of collateralized land. We simplify their model to one without land. We show that in an economy where capital goods are used as collateral, news-driven cycles can be generated..

Keywords: News-driven cycles; collateral constraint; Tobin's Q.

JEL Classification: E22, E32, E37, G12.

---

* Research Institute of Economy, Trade and Industry,
e-mail: kobayashi-keiichiro@rieti.go.jp

† University of Tokyo, and JSPS research fellow

Collateralized capital and news-driven cycles

Keiichiro Kobayashi*† Kengo Nutahara‡

November 30, 2007

Abstract

Kobayashi, Nakajima, and Inaba (2007) show that in the neoclassical business cycle models with collateral constraints, a boom can be generated in response to an optimistic change in expectations on the future state of the economy. They call this business cycle a news-driven cycle. In their models, land is used as collateral, and borrowing for working capital is limited by the value of collateralized land. We simplify their model to one without land. We show that in an economy where capital goods are used as collateral, news-driven cycles can be generated.

Keywords : News-driven cycles; collateral constraint; Tobin's Q

JEL Classification : E22, E32, E37, G12

1 Introduction

Recently, there has been growing interest in the role of changes in expectations or news about the future state of the economy as a driving force of business cycles (see the seminal contribution by Beaudry and Portier [2004], which is followed by, for example, Christiano, Motto, and Rostagno [2006], and Jaimovich and Rebelo [2006]). As is well known, however, changes in expectations (or news shocks) move consumption and labor

*Research Institute of Economy, Trade and Industry (RIETI).

†Corresponding author. Postal address: 11th floor, Annex, Ministry of Economy, Trade and Industry (METI) 1-3-1, Kasumigaseki Chiyoda-ku, Tokyo, 100-8901. Tel.: +81-3-3501-8308. E-mail address: kobayashi-keiichiro@rieti.go.jp.

‡University of Tokyo, and JSPS research fellow.

in opposite directions due to the wealth effect in the standard neoclassical business cycle models. To enable news shocks to generate plausible business cycles in which consumption, labor, and investment comove, the recent literature introduces complicated modifications in preferences and/or technology. The business cycles generated by news shocks are called the news-driven business cycles.[1] Kobayashi, Nakajima, and Inaba (2007) (hereafter, KNI) show that if only working capital, such as labor payment, is subject to collateral constraint, the standard model can generate news-driven cycles. They assume that a productive asset with fixed supply ("land") is used as collateral, and that firms need to hold collateral to finance wage payment and payments for intermediate inputs: These payments are limited by the value of collateralized land. In this setting, the news of an increase in future productivity generates a boom as follows. The news raises the price of land, which relaxes the collateral constraint. Since the wage payment is collateral constrained, the relaxation of the collateral constraint reduces inefficiency in the labor market. This shifts the labor demand curve outward. If this force is sufficiently strong, it offsets the wealth effect on the labor supply schedule, and the equilibrium labor supply increases. As do output and investment. Consumption increases due to the wealth effect of the good news.

In the present paper, we show that the similar mechanism works in models without land. Instead of introducing land, we introduce adjustment costs for investment à la Hayashi (1982) in the standard neoclassical growth model. We assume that capital is used as collateral and the price of the collateralized asset is Tobin's Q. In our model, the good news about the future raises Tobin's Q and generates the news-driven cycle by relaxing the collateral constraint.

In this paper, we consider two models: the representative household model and the two-agent model with households and entrepreneurs. Both models are variants of Model 1 in KNI, in which collateral constraint à la Kiyotaki and Moore (1997) arises from the borrowers' lack of commitment.

[1] Some economists call them expectations-driven business cycles, boom-bust cycles, or Pigou cycles.

2 One-agent model

This model is identical to Model 1 in KNI except that there is no land in this model, capital goods are used as collateral, and capital goods are produced from consumption goods (i.e., investment) and the existing stock of capital.

During a given period, a household splits into a manager and a worker. The manager produces consumption goods buying labor input and material input from another household. The worker supplies the labor to a firm that is run by another household's manager. The manager needs to pay the costs for inputs in advance of production. We assume that the payment for inputs is made by trade credit, which is subject to collateral constraint. Collateral constraint arises because the managers cannot commit themselves to repay debt; and if the managers repudiate, the creditors seize collateralized capital stocks and collect on loans by selling capital stocks in the market.[2] We define the variables as follows: c_t is consumption, n_t labor supply of the worker, $\tilde{n}_t$ labor demand of the manager, k_t capital stock at the end of period t, i_t investment, z_t capital goods produced by investment technology (see below), w_t wage rate, A_t productivity (Harrod neutral), g_t growth rate of A_t ($g_t = \ln(A_t/A_{t-1})$), m_t material input, y_t gross output, q_t shadow price of capital (Tobin's Q). The household's problem is

$$\max_{c_t, n_t, k_t, i_t, \tilde{n}_t, m_t} E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left[c_t^{1-\gamma}(1-n_t)^{\gamma}\right]^{1-\theta}}{1-\theta}, \tag{1}$$

$$\text{s.t. } c_t + i_t \leq w_t n_t + y_t - w_t \tilde{n}_t - m_t, \tag{2}$$

$$y_t = A_t^{(1-\eta)(1-\alpha)} \cdot m_t^{\eta} \cdot k_{t-1}^{(1-\eta)\alpha} \cdot \tilde{n}_t^{(1-\eta)(1-\alpha)}, \tag{3}$$

$$w_t \tilde{n}_t + m_t \leq \varphi q_t k_{t-1}, \tag{4}$$

$$k_t = (1-\delta)k_{t-1} + z_t, \tag{5}$$

$$z_t = \Phi\left(\frac{i_t}{k_{t-1}}\right) k_{t-1}, \tag{6}$$

where (2) is the budget constraint, (3) is the production technology of consumption goods, (4) is the collateral constraint, (5) is the law of motion for capital, and (6) is

[2] See also KNI for more details about why collateral constraint arises.

investment technology that produces capital goods. Productivity evolves following an exogenous stochastic process:

$$\ln(A_{t+1}/A_t) = \rho_g \ln(A_t/A_{t-1}) + (1-\rho_g)\ln(\overline{g}) + \varepsilon^g_{t+1}, \tag{7}$$

where $0 \leq \rho_g < 1$ and ε^g_{t+1} is an i.i.d. shock. Investment technology is characterized by the installation function, $\Phi(x)$, where $\Phi(0) = 0$, $\Phi'(x) > 0$, $\Phi''(x) < 0$, and $\Phi(\delta) = \delta$. Note that the functional form of $\Phi(x)$ is different from the level specification for the adjustment cost proposed by Christiano, Motto, and Rostagno (2006). Christiano et al. use $\Phi_C(x) = x - \sigma_C(x-\delta)^2$. The difference is that $\Phi_C(x) < x < \Phi(x)$ for $0 < x < \delta$. In order to introduce collateral constraint (4), we need to assume that the capital stock can be traded in the decentralized market at price q_t. If we use $\Phi(x)$, the investment process is easily decentralized, while $\Phi_C(x)$ is not consistent with the assumption of a decentralized market for capital goods. In the experiment in Section 4, we assume $\Phi(x) = \sigma \ln(x+a) + b$. The market clearing conditions are

$$n_t = \tilde{n}_t, \tag{8}$$

$$c_t + i_t + m_t = y_t. \tag{9}$$

The competitive equilibrium is the set of prices $\{w_t, q_t\}_{t=0}^{\infty}$ and the associated allocations $\{c_t, n_t, \tilde{n}_t, i_t, k_t, m_t, y_t\}_{t=0}^{\infty}$, such that the allocations solve the households' problem given the prices and the initial capital stock k_{-1}, and that the market clearing conditions are satisfied.

3 Two-agent model

We can easily modify the model in the previous section to a two-agent version. There are representative households and entrepreneurs. Households consume, supply labor, and buy capital stocks. Entrepreneurs consume, produce consumption goods buying labor from households and material input from other entrepreneurs, and accumulate capital stocks. In order to decentralize the investment process, we assume that there are competitive investment firms that produce capital goods from consumption goods and existing capital stock.

We define the variables as follows: c_t is consumption of household, c_t' consumption of entrepreneur, n_t labor, k_t capital stock of household at the end of period t, k_t' capital stock of entrepreneur at the end of period t, K_t total capital input for production, i_t investment, z_t capital goods produced by investment firms, w_t wage rate, $r_{i,t}$ rental rate of capital for investment (i.e., production of capital goods), $r_{k,t}$ rental rate of capital for production of consumer goods, π_t profit of entrepreneur, m_t material input, y_t gross output, q_t stock price (Tobin's Q). The households' problem is

$$\max_{c_t,n_t,k_t} E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left[c_t^{1-\gamma}(1-n_t)^{\gamma}\right]^{1-\theta}}{1-\theta}, \tag{10}$$

$$\text{s.t. } c_t + q_t k_t \leq w_t n_t + \Big[r_{k,t} + r_{i,t} + q_t(1-\delta)\Big] k_{t-1}. \tag{11}$$

The entrepreneurs' problem is

$$\max_{c_t',k_t',K_t,n_t,m_t} E_0 \sum_{t=0}^{\infty} \beta'^t \frac{c_t'^{1-\psi}}{1-\psi}, \tag{12}$$

$$\text{s.t. } c_t' + q_t k_t' \leq \Big[(1-\delta)q_t + r_{i,t}\Big] k_{t-1}' + \pi_t, \tag{13}$$

$$\pi_t = y_t - w_t n_t - r_{k,t}\Big[K_t - k_{t-1}'\Big] - m_t, \tag{14}$$

$$y_t = A_t^{(1-\eta)(1-\alpha)} \cdot m_t^{\eta} \cdot K_t^{(1-\eta)\alpha} \cdot n_t^{(1-\eta)(1-\alpha)}, \tag{15}$$

$$r_{k,t}\Big[K_t - k_{t-1}'\Big] + w_t n_t + m_t \leq \varphi q_t k_{t-1}'. \tag{16}$$

The investment firms' problem is

$$\max_{z_t,K_t,i_t} \Big[q_t z_t - r_{i,t} K_t - i_t\Big], \tag{17}$$

$$\text{s.t. } z_t = \Phi\left(\frac{i_t}{K_t}\right) K_t. \tag{18}$$

The market clearing conditions are

$$c_t + c_t' + i_t + m_t = y_t, \tag{19}$$

$$k_{t-1} + k_{t-1}' = K_t, \tag{20}$$

$$K_{t+1} = (1-\delta)K_t + z_t. \tag{21}$$

The competitive equilibrium is the set of the prices $\{w_t, r_{k,t}, r_{i,t}, q_t\}_{t=0}^{\infty}$ and the associated allocations $\{c_t, c'_t, n_t, i_t, k_t, k'_t, K_t, m_t, y_t\}_{t=0}^{\infty}$, such that the allocations solve the households' problem, the entrepreneurs' problem, and the investment firms' problem, given the prices and initial capital stocks (k_{-1}, k'_{-1}), and that the market clearing conditions are satisfied.

4 News-shock experiments

Our numerical experiments follow KNI. For $t \leq 4$, the economy is at the deterministic steady state, where all agents believe that there shall be no productivity shock at all in the future: $\varepsilon_t^g = 0$ for all t. In period $t = 5$, the agents receive news that there will be a positive productivity shock at $t = 10$: $\varepsilon_{10}^g = .01$. The agents are totally confident about the news, so that, for $t = 5, \ldots, 9$, they believe that $\varepsilon_{10}^g = .01$ with probability one. At $t = 10$, however, the news may or may not turn out to be true. There is no productivity shock except possibly at $t = 10$: $\varepsilon_t^g = 0$ for $t \neq 10$.

Parameter values are given in Table 1. Most of them are taken from KNI.

[Insert Table 1]

The weight of leasure, γ, in households' utility is set so that the steady-state labor supply equals 1/3. We specify $\Phi(x)$ as $\Phi(x) = \sigma \ln(x + a) + b$, and $(a,\, b)$ is set to be a solution of the simultaneous equations: $\Phi(0) = 0$ and $\Phi(\delta) = \delta$, given σ. σ is the key parameter for our results. We set σ so that the production function of capital goods has a sufficient curvature. The tightness of the collateral constraints, φ, is set so that the constraints are binding.

We report the cases in which the news turns out to be false at $t = 10$. The simulation method is due to Uhlig (1999).[3] Figure 1 plots the dynamic response of the one-agent model to the news shock.

[Insert Figure 1]

[3]For details, see technical appendices (Kobayashi and Nutahara [2007]).

It shows that the good news raises output (value added), consumption, investment, and labor for $t = 5, 6, \cdots, 9$. It also shows that total factor productivity (TFP) moves procyclically. TFP in this figure, $\tilde{A}_t$, is defined by $y_t - m_t = \tilde{A}_t k_{t-1}^{\alpha} n_t^{1-\alpha}$. We introduce the material input to induce procyclical TFP. Our models without the material also can generate news-driven cycles. As KNI argue in detail, the boom in response to good news is generated from the decrease in inefficiency in the input markets. The inefficiency, x_t, is defined by $x_t = \mu_t/\lambda_t$, where λ_t and μ_t are Lagrange multipliers associated with (2) and (4), respectively. As Figure 1 shows, inefficiency falls for $t = 5, 6, \cdots, 9$.

Figure 2 plots the response of the two-agent model.

[Insert Figure 2]

In this case too, a good news about the future causes a boom for $t = 5, 6, \cdots, 9$. As KNI argue, having two types of agents brings about a new feature. In the one-agent model shown in Figure 1, when the news actually turns out to be false, the economy essentially jumps back to the initial steady state, although there are some transitional dynamics. In particular, false information does not cause a recession: the level of output does not get lower than the steady state level. Figure 2 shows that in our two-agent model, however, the economy falls into a recession if the news turns out to be wrong. The mechanism of recession is the same as that in the second model in KNI: When the good news arrives, the price of the collateral asset increases, and hence entrepreneurs need a lower share of capital to achieve the desired value of collateral. Hence, in response to the good news about the future, entrepreneurs sell their capital. When the news turns out to be wrong, the price of capital essentially goes back to its steady state level. However, since the share of capital held by entrepreneurs is lower than the steady state level, the value of their collateral becomes lower than the steady state level. It follows that the financial constraint becomes tighter, which increases the labor market inefficiency, and reduces labor, output, and consumption.

5 Conclusion

There is a growing amount of literature that proposes various models for news-driven cycles, or business cycles driven by changes in expectations or news about the future state of the economy. KNI show that a standard neoclassical model can generate news-driven cycles only if firms are collateral constrained in financing inputs and a productive asset with fixed supply, i.e., land, is used as collateral. We show that news-driven cycles can be generated in a standard model without land. If capital goods are used as collateral and they can be traded in the market at the market price, which equals Tobin's Q, the same mechanism as that in KNI works.

The common feature of our models and KNI's models is that the input costs, such as wage payment and costs for material inputs, are subject to collateral constraint and that the price of the collateralized asset moves in response to a change in expectations or news about the future. The input costs in our models may be interpreted as working capital or "liquidity" that firms inevitably need in their daily operations. Both our models and KNI's models indicate that the collateral constraint on liquidity may be a relevant and important feature in understanding business cycles in the real world.

References

[1] Beaudry, P. and F. Portier, 2004, An exploration into Pigou's theory of cycles, Journal of Monetary Economics 51, 1183-1216.

[2] Hayashi, F., 1982, Tobin's marginal q and average q: A neoclassical interpretation, Econometrica 50, 213-224.

[3] Christiano, L. J., R. Motto, and M. Rostagno, 2006, Monetary policy and a stock market boom-bust cycle, mimeo, Northwestern University.

[4] Jaimovich, N. and S. Rebelo, 2006, Can news about the future drive the business cycle?, NBER Working Paper 12537.

[5] Kiyotaki, N., and J. Moore, 1997, Credit cycles, Journal of Political Economy 105, 211-48.

[6] Kobayashi, K., T. Nakajima, and M. Inaba, 2007, Collateral constraint and news-driven cycles, RIETI Discussion Paper Series 07-E-013.

[7] Kobayashi, K. and K. Nutahara, 2007, Technical appendices: Collateralized capital and news-driven cycles, mimeo.

[8] Uhlig, H., 1999, A toolkit for analyzing nonlinear dynamic stochastic models easily, in: Marimon, R., and A. Scott, eds., Computational Methods for the Study of Dynamic Economies, (Oxford University Press, Oxford).

Table 1: Parameter values

parameter	symbol	value
discount factor of households	β	.99
curvature of households' utility function	θ	.75
steady-state labor supply	n	1/3
discount factor of entrepreneurs	β'	$\beta * .973$
curvature of entrepreneurs' utility function	ψ	1
share of material in production	η	.5
relative share of capital to labor in production	α	.36
steady-state technology growth	$\bar{g}$	0
parameter for capital production function	σ	.02
depreciation rate of capital	δ	.025
persistence of technology growth	ρ_g	.95
tightness of collateral constraint (one-agent model)	φ	.05
(two-agent model)		.15

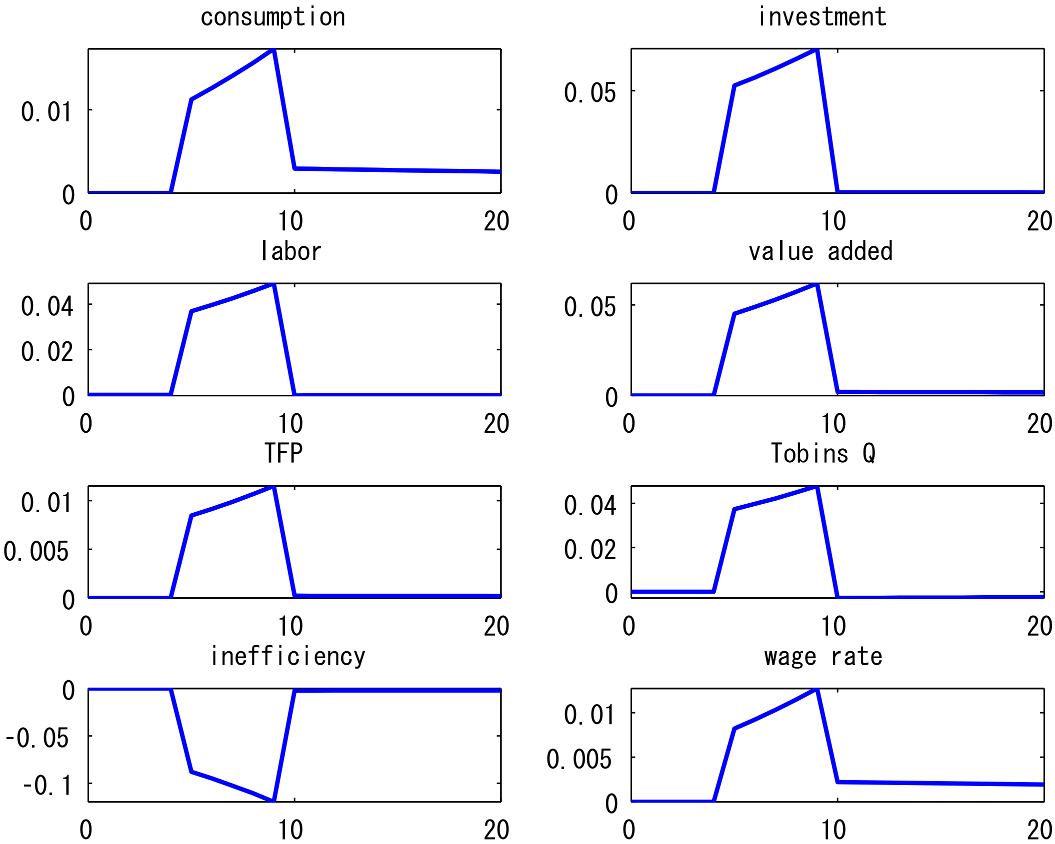

Figure 1: News-driven cycles (1): One-agent model

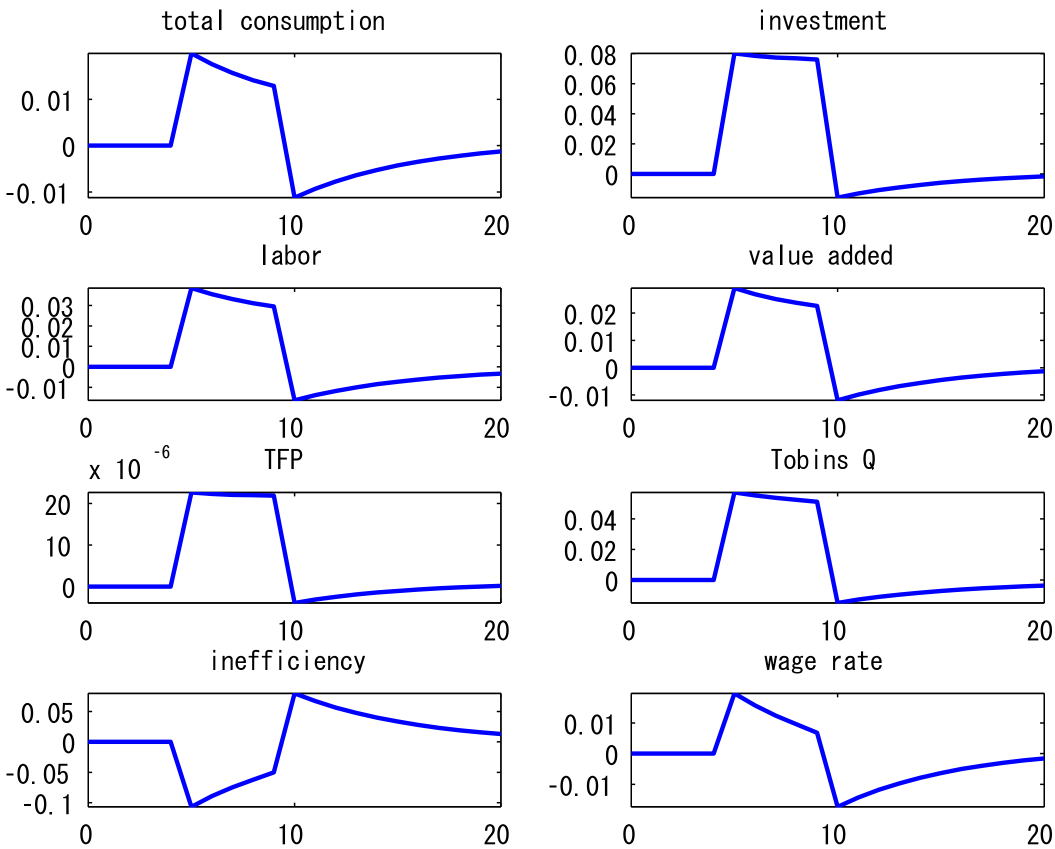

Figure 2: News-driven cycles (2): Two-agent model