Endogenous cycles and rent seeking [1]

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Abstract

This paper is an attempt to reconsider one of the fundamental results of endogenous cycle theory, which was reached in the paper by Farmer and Guo (1994), by introducing more realistic assumptions about profit allocation in the economy. The hypothesis that profit enters the household's budget through a separate channel is replaced by the hypothesis that economic profit turns into factor payments as a result of *rent seeking*. We believe that when economic profit occurs in the economy, a sector of agents which spend resources on capturing it appears, and this is the process referred to as rent seeking mechanism in our model. This assumption changes the agents' inter-temporal optimization problem, such that conditions for endogenous cycles to occur change depending on the persistency of return to rent seeking. In this paper it is shown that even under large returns to scale in the production sector and a rather low depreciation rate of efforts in the rent seeking sector endogenous cycles do not occur.

Keywords: indeterminacy, sunspots, rent seeking, endogenous cycles

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1. Introduction

Our research is based on the paper by Farmer and Guo (1994), where it was first shown that endogenous business cycles can occur in standard business cycle models under returns to scale of about 170%. In our opinion, one of the authors' hypotheses is inconsistent with reality. The authors assume that profit enters the household's budget through a separate channel, while in reality it is not possible to separate profit from factor remuneration: profit enters the budget together with labor and capital payments.

We believe that when economic profit occurs in the economy, a sector of agents which spend resources on capturing it appears, and this is the process referred to as rent seeking mechanism in our model. Hence, the hypothesis that profit enters the household's budget through a separate channel is replaced by the hypothesis that profit turns into factor payments as a result of rent seeking. Thus, in our model profit enters households' budget with production factor (labor and capital) payments, just as it is in reality.

It is important to point out that by spending resources these agents accumulate "efforts invested in rent seeking", and the share of total economic profit they receive is proportional to these efforts, which at the same time depreciate over time.

This assumption changes the agents' inter-temporal optimization condition in endogenous cycle models, such that conditions for endogenous cycles to occur change depending on the degree of the persistency of return to rent seeking. Even under large returns to scale and a rather low depreciation rate in the rent seeking sector endogenous cycles do not occur. This is the main conclusion of this paper.

2. Endogenous cycles: recent theory and applications

The fundamental concept underlying endogenous cycle theory first appeared in a paper by Azariadis (1981). Azariadis (1981) posed the following question: can such factors as the animal spirit, consumer sentiments, or prophecies influence the dynamics of an economy defined by standard neoclassical assumptions. Azariadis showed that this is possible in Diamond's overlapping generations model.

Under certain model parameters the equation of dynamics for a forward-looking variable in Diamond's model (in the original paper of Azariadis (1981) this variable is the price of consumer goods) has a stable root. In this case the Blanchard-Kahn conditions (Blanchard and Kahn, 1980) are violated, and the transversality conditions do not let solve the Sargent-Wallace problem and find a unique dynamic path for the economy. It is said that in this case the economy dynamics are not regular anymore: there is an infinite number of possible equilibrium paths, and the particular path to be realized is determined by the way expectations are formed. Thus, if expectations are formed based on consumer sentiments, prophecies or even sunspots, then all these variables will have an impact on the equilibrium, and this will be the very impact expected by experts.

However, as pointed out by Blanchard and Fisher (1989), the model of Azariadis (1981) is merely illustrative – indeterminacy in his paper is observed under unrealistic values of economy parameters. This theory was first accepted as a possible description of reality and not as a mathematical artifact due to papers by Benhabib and Farmer (1996) and Farmer and Guo (1994). These authors seek answers to the following questions: (i) is there a plausible structure of the economy under which indeterminacy occurs; and (ii) will such an economy possess properties which we observe in reality.

The aforesaid authors use a representative agent model to show that indeterminacy is possible under plausible parameter values in an economy with increasing returns to scale. At the same time, increasing returns to scale in a perfect competition economy imply negative economic profit. To solve this problem the authors considered two alternative hypotheses. Under the first hypothesis increasing returns to scale arise from externalities, while returns to scale equal one for each particular firm. Under the second hypothesis increasing returns to scale are combined with imperfect competition. Each of these hypotheses allows solving the negative profit problem.

Moreover, Benhabib and Farmer (1994), Farmer and Guo (1994) show that properties of models with indeterminacy are very similar to properties of real business cycle models; in fact, the formers offer a better description of the economy in some aspects. Because in such an economy fluctuations are endogenous and not exogenous (as is the case, e.g., with technology shocks), this area of economics was named “endogenous business cycle theory”.

The above papers gave rise to empirical research which could enable to determine the parameters defining the production sector more precisely, and thereby tip the scale in favor of one of the two theories: either the real business cycle theory or the endogenous cycle theory.

Basu and Fernald (1997), Burnside (1996) use microeconomic data on various industries and reach the conclusion that returns to scale of a typical American industry amount to about 103%. The aggregated returns to scale do not differ greatly from this value, which is much smaller than 170% necessary to justify indeterminacy in the models of Benhabib and Farmer (1994), Farmer and Guo (1994). Further research in this area was aimed at finding a structure of the economy which would be consistent with empirical data on the one hand and would allow for indeterminacy on the other.

Wen (1998) showed that even under slightly positive returns to scale endogenous cycles can exist when an endogenous rate of capital depreciation is introduced. Bernett and Farmer (2000) showed that under increasing returns to scale and a decreasing labor demand function with a utility function non-separable in labor and leisure endogenous cycles occur even under realistic returns to scale parameters, calculated for the US economy in Basu and Fernald (1997). Guo and Lansing (2005) showed that when capital installation costs are introduced into the model, returns to scale of 108%, which are in line with empirical research, suffice for endogenous cycles to occur.

Of a greater interest is research on modeling multi-sector economies. In papers of Benhabib and Farmer (1996), Weder (2000) a model with two production sectors is considered; it is shown that returns to scale need not be that high for endogenous cycles to occur. Harrison (2001) showed that in a two-sector model of the economy endogenous cycles can occur when there are externalities in the investment sector, even with no externalities in the production sector.

Papers on analyzing fiscal and monetary policies under endogenous cycles are of a special interest.

Applying financial mechanisms in monetary models results in a need to use the rational expectations hypothesis, which is necessary for understanding the possibility of indeterminacy taking place (Blanchard (1979), Tirole (1985), Michel and Wigniolle (2003)). A key issue in monetary general equilibrium models is the choice of optimal monetary policy under the possibility of endogenous cycles (Farmer (1986), Reichlin (1986), Schleifer (1986), Deneckre and Judd (1992), Boldrin (1992), Evans and Honkapohja (1993), Sims (1994), Goenka (1994), Cazzavillan (1996), Schmitt-Grohé and Uribe (1997), and Austin (1999)), as well as exploring the role of monetary policy as a means of stabilizing the economy and analyzing the parameters under which such dynamics may occur (Benhabib (1980), Grandmont (1985, 1986), Matsuyama (1991), Foley (1992), Sims (1994), Smith (1994), Woodford (1994), Chattopadhyay (1996), Michener and Ravikumar (1998), Benhabib, Schmitt-Grohé, and Uribe (2001)).

The optimal fiscal policy objective as such gives rise to the issue of a series of mechanisms leading to indeterminacy. In optimal fiscal policy models Kemp, Long and Shimomura (1993) show the plausibility of endogenous cycles when Hopf bifurcation takes place. Bong, Wang and Yip (1996), Ben-Gad (2000) have shown that taxes on capital can lead to endogenous cycles when human capital is introduced into the model. Guo and Harrison (2001) construct a model with externalities in the production sector and analyze fiscal policy efficiency under these conditions. They show that even with strong externalities a regressive tax system leads to stabilization, and under constant returns to scale and weak externalities the tax system can lead to endogenous cycles. Under realistic parameters of labor and capital taxation a balanced budget with predetermined government expenses can lead to endogenous cycles (Schmitt-Grohe and Uribe, 1997). However, such dynamics disappear when the government finances its expenses through a system of fixed tax rates (Guo and Harrison, 2004).

This research is based on the paper of Farmer and Guo (1994). In our opinion, one of the authors' hypotheses is inconsistent with reality. The authors assume that profit enters the household's budget through a separate channel, while in reality it is not possible to separate economic profit from factor remuneration: profit enters the budget together with labor and capital payments.

The idea that profit enters the household's budget through a separate channel is replaced by the hypothesis that profit turns into factor payments as a result of rent seeking (this idea was suggested in the paper by Arefiev and Baron (2006) in the context of optimal capital taxation analysis). If economic profit occurs in the economy, agents appear which are ready to spend resources on capturing it, and this is the process referred to as rent seeking mechanism in our model. Hence, in our model profit enters households' budget with production factor (labor and capital) payments.

In the rent seeking sector agents accumulate "invested efforts", and the share of total economic profit they receive is proportional to these efforts. This assumption changes the agents' inter-temporal optimization conditions in the model of Farmer and Guo (1994), such that conditions for endogenous cycles to occur change depending on the persistency of return (depreciation rate) to rent seeking. In the work it is shown that even under large returns to scale in the production sector and a rather low depreciation rate in the rent seeking sector endogenous cycles do not occur.

This paper consists of four parts. In the first part, a model of the economy consisting of households, firms and rent seeking agents is presented. We find the system’s equilibrium on the balanced growth path in part two. In the third part we determine the number of model solutions depending on model parameters, in particular, on the rent seeking sector parameters. Conclusions are made in part four.

3. Rent seeking mechanisms in endogenous cycle models

3.1. Households

Households maximize lifetime utility with respect to labor and consumption:

(1) $$\max_{C,L} \int_0^{\infty} e^{-\rho t} U(C,L) dt$$

(2) $$s.t.\ \dot{K} = wL + rK - C,$$

where C is the consumption amount, L is the labor amount, K is the capital stock, ρ is the discount rate, w denotes labor payments, r is the interest rate, $\dot{K}$ is the time derivative of capital stock function.

Profit is not included in the household's budget constraint since it enters the household's budget constraint as factor payments according to the rent seeking assumption.

To solve the dynamic optimization problem a Hamiltonian is constructed.

(3) $$H = U(C,L) + \gamma(wL + rK - C)$$

The corresponding first order conditions are the following:

(4) $$\frac{\partial H}{\partial C} = U_C - \gamma = 0$$

(5) $$\frac{\partial H}{\partial L} = U_L + \gamma w = 0$$

(6) $$\dot{\gamma} = -\gamma(r - \rho)$$

where γ is a co-state variable.

We use the following utility function specification:

(7) $$U(C,L) = \frac{(C^{\theta}(1-L)^{(1-\theta)})^{\sigma} - 1}{\sigma}$$

where $\sigma < 1$ is the elasticity of inter-temporal consumption substitution, θ is a parameter in the interval of (0;1).

It can be shown that the utility function (7) in logarithmic form approaches the following when $\sigma \to 0$ as in real business cycles models:

(8) $$\lim_{\sigma \to 0} U(C,L) = \theta \ln C + (1-\theta)\ln(1-L)$$

The first order conditions then take the form of:

(9) $$\gamma = \frac{(C^{\theta}(1-L)^{(1-\theta)})^{\sigma}\,\theta}{C}$$

(10) $$-\gamma w = -\frac{(C^{\theta}(1-L)^{(1-\theta)})^{\sigma}\,(1-\theta)}{1-L}$$

(11) $$\dot{\gamma} = -\gamma(r-\rho)$$

3.2. Firms

Firms maximize profit using labor L_1 and capital K_1 to produce goods and services:

(12) $$F(L_1, K_1) - wL_1 - rK_1 \to \max_{K_1, L_1}$$

We have abstained from including innovation shocks into the production function, since it simplifies representation of results and it is of no consequence for the existence of “sunspots” in the economy, as it was shown in a paper by Farmer (1993).

Because firms are monopolistic competitors, the profit maximization condition is expressed in terms of the inverse elasticity of demand by price ε .

The first order conditions:

(13) $$r + \delta = (1-\varepsilon)F_K$$

(14) $$w = (1-\varepsilon)F_L$$

(15) $$\pi = F(L_1, K_1) - (1-\varepsilon)\,(F_K K_1 + F_L L_1)$$

where δ is the depreciation rate of capital.

For the Cobb-Douglas production function:

(16) $$Y = K_1^{\alpha} L_1^{\beta}$$

we get the following conditions:

(17) $$\delta + r = (1-\varepsilon)\frac{\alpha Y(K_1, L_1)}{K_1}$$

(18) $$w = (1-\varepsilon)\frac{\beta Y(K_1, L_1)}{L_1}$$

(19) $$\frac{\pi}{Y} = (1-(1-\varepsilon)(\alpha+\beta))$$

3.3. Rent seeking sector

In real life accounting profit consists of the firm's revenues less its explicit costs, so accounting profit is mainly a payment to owners for renting capital. However, the funds and time invested in a firm could have been used in some other business. These implicit costs are part of the costs of doing business so we subtract it from accounting profit to get economic profit.

In our model we believe that when economic profit occurs in the economy, a sector of agents which spend resources on capturing it appears, and this is the process referred to as rent seeking mechanism in our model. In real life managers of firms or even individuals spend labor and capital on finding the ways of getting higher profits. So when economic profits are received, resources have already been spend.

As in ”creative destruction” models successful innovation is normally a source of temporary market power, eroding the profits and position of old firms, yet ultimately succumbing to the pressure of new inventions commercialized by competing entrants, that spend resources in order to get monopoly power on the market and profit. So competing entrants in ”creative destruction” models are rent seekers and their economic profit turns into factor payments (R&D).

In our model each agent involved in rent seeking maximizes the expected sum of discounted profits at each point in time. The *i-th* competitor’s state is determined at each point in time by the value of the functional $V_t^i[G_{t\pm j}]$, where the effectiveness of efforts to capture rent for agent *i* is determined at any moment in time $(t \pm j), j \in (-\infty;\infty)$ by a function $G_{t\pm j}\left(K_t^i, L_t^i\right)$ of resources amounts. The agent which reaches the higher value of the functional V_t^i has the higher probability of success. We assume that the probability p_i of receiving economic profit for agent *i* is the ratio of the value of his state V_t^i at the current point in time, which has a probabilistic characteristic of receiving profit depending on the resources used, to the total sum of the state functions for all agents:

(20) $$p_{it} = \frac{V_t^i}{\sum_j V_t^j}$$

We believe that an increase of the functional $V_t^i[G_{t\pm j}]$ occurs due to labor and capital inputs into rent seeking with an effectiveness measure determined by the function $G_t\left(K_t^i, L_t^i\right)$ at each point in time. Moreover, part of the efforts accumulated earlier is lost in time due to deprecation and changing technology efficiency at a rate which is constant over time (persistency of return to rent seeking). Consequently, agents involved in rent seeking take expected future rent income into account when solving the dynamic optimization problem, and they have a chance to spend factors on receiving future profits already at the current point in time.

The expected discounted profit maximization problem for continuous time takes the following form:

(21) $$\tilde{\pi}_i = E_0 \int_0^{\infty} \left(\frac{V_t^i}{\sum_j V_t^j}\pi_t - (r_t + \delta)K_t^i - w_t L_t^i\right) \cdot e^{-\int_0^t r(s)ds} dt \to \max_{K_i, L_i}$$

(22) $$\text{s.t. } \dot{V}_t^i = G_t\left(K_t^i, L_t^i\right) - \delta V_t^i$$

where π_t is the amount of economic profit for the whole economy at moment t, E is the expectation operator, K_i and L_i are the capital and labor amount, respectively, r is the interest rate which is used to discount profit in continuous time, δ - is the persistency of return to rent seeking (rate of depreciation of efforts accumulated in the rent seeking sector).

Assuming that the certainty equivalence principle holds, the first order conditions are:

(23) $$\frac{G_K}{G_L} = \frac{r+\delta}{w}$$

(24) $$\dot{\lambda} = -\left(\frac{\sum_j V_t^j - V_t^i}{(\sum_j V_t^j)^2}\pi_t \cdot e^{\int_0^t r(s)ds} - \lambda\delta\right)$$

(25) $$\dot{V}_t^i = G_t\left(K_t^i, L_t^i\right) - \delta V_t^i$$

with a corresponding transversality condition, where λ is the co-state variable.

Using the Cobb-Douglas function specification with constant returns to scale we get:

(26) $$G(K_2, L_2) = K_2^{\psi} L_2^{1-\psi}$$

where ψ is a parameter in the interval of (0;1), and L_2 and K_2 are the labor and capital amounts used in rent seeking in the economy, respectively.

As equation (20) holds, returns to scale do not influence the first order conditions for the function specification (26), therefore they are held constant.

Assuming that agents in the rent seeking sector are homogenous, the condition (24) can be modified in the following way:

(27) $$\dot{\lambda} = -\left(\frac{nV_t^i - V_t^i}{n^2 (V_t^i)^2} \pi_t \cdot e^{-\int_0^t r(s)ds} - \lambda\delta \right)$$

Note that when the returns to scale in the rent seeking sector are constant (or the returns to scale are slightly decreasing) we can assume that firms are small enough and their number is very large.

Therefore:

(28) $$\frac{nV_t^i - V_t^i}{n^2 (V_t^i)^2} \pi_t \cdot e^{-\int_0^t r(s)ds} = \frac{n-1}{n^2} \frac{1}{V_t^i} \pi_t \cdot e^{-\int_0^t r(s)ds} \xrightarrow[n\to\infty]{} 0$$

Assuming that agents involved in rent seeking are homogenous, their behavior can be described by the following system of equations:

(29) $$\dot{\lambda} = \lambda\delta$$

(30) $$\frac{1-\psi}{\psi} \frac{L_2}{K_2} = \frac{r+\delta}{w}$$

(31) $$\dot{V}_t = G_t\left(K_t^2, L_t^2\right) - \delta V_t^2$$

The free entry condition guarantees that all the rental income is used for factor remuneration:

(32) $$\int_0^{\infty} (\pi_t - (r_t + \delta)K_t^2 - w_t L_t^2) \cdot e^{-\int_0^t r(s)ds} dt = 0$$

3.4. Market equilibrium conditions

The total income in the economy is distributed between consumption, net investment and capital depreciation:

(33) $$Y = C + \dot{K} + \delta K$$

Capital and labor amounts in the economy are spent on production and rent seeking:

(34) $$K = K_1 + K_2$$

(35) $$L = L_1 + L_2$$

4. Model calibration and analysis of stability

4.1. Equilibrium

The model equilibrium is determined by a system of equations consisting of budget constraints and first order conditions for all agents. For households these are equations (2), (9)-(11), for firms they are (17)-(19), for rent seeking agents they are (29)-(31), and the market clearing conditions are (33)-(35).

Note that the budget constraint (2) can and must be excluded from consideration, since Walras` law holds.

4.2. Analysis of stability of the calibrated model

Let us determine the model dynamics around the balanced growth path. For this purpose we find the steady state of the system $SS^* = (Y^* \quad C^* \quad r^* \quad \pi^* \quad w^* \quad K^*_1 \quad K^*_2 \quad L^*_1 \quad L^*_2 \quad L^* \quad K^* \quad \gamma^* \quad \lambda^* \quad V^*)$, expressing the variables through the constant parameters of the model.

Linearization of the system around the equilibrium can be presented in matrix notation:

(36) $$M_1 J = M_2 S$$

(37) $$\dot{S} = M_3 J + M_4 S$$

where $J^T = (\hat{Y} \quad \hat{C} \quad \hat{r} \quad \hat{\pi} \quad \hat{w} \quad \hat{K}_1 \quad \hat{K}_2 \quad \hat{L}_1 \quad \hat{L}_2 \quad \hat{L})$, $S^T = (\hat{\gamma} \quad \hat{K} \quad \hat{\lambda} \quad \hat{V})$ are vectors of modified dynamic variables, describing the dynamics of deviations from the balanced growth path. Accordingly, $\dot{S}^T = (\dot{\hat{\gamma}} \quad \dot{\hat{K}} \quad \dot{\hat{\lambda}} \quad \dot{\hat{V}})$, while M_2, M_3 and M_4 are the respective matrices of coefficients calculated around the steady state, where:

$$M1=\begin{bmatrix} 0 & -\gamma C^{1-\theta\sigma}(-1+\theta\sigma) & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -(1-L)^{\sigma-\theta\sigma-1}\sigma(-1+\theta)\theta \\ 0 & \frac{\gamma w\theta}{C^{\theta}} & 0 & 0 & -\frac{\gamma w}{C^{\theta}\sigma} & 0 & 0 & 0 & 0 & -(1-L)^{\sigma-\theta\sigma-2}\left(\sigma-2\theta\sigma+\sigma\theta^2\right) \\ 1 & 0 & -\frac{\rho}{\rho+\delta} & 0 & 0 & -1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & -1 & 0 & 0 & -1 & 0 & 0 \\ 1 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & K1 & K1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & -L1 & -L2 & L \\ 1 & 0 & 0 & 0 & 0 & -\alpha & 0 & -\beta & 0 & 0 \\ 0 & 0 & K2\rho & -\pi & L2w & 0 & (\rho+\delta)K2 & 0 & L2w & 0 \\ 0 & 0 & -\frac{\rho}{\rho+\delta} & 0 & 1 & 0 & -1 & 0 & 1 & 0 \end{bmatrix}$$

$$M2=\begin{bmatrix} C^{1-\theta\sigma}\gamma & 0 & 0 & 0 \\ \frac{w}{C^{\theta\sigma}}\gamma & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & K & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$M3=\begin{bmatrix} 0 & 0 & -\gamma\cdot rho & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ Y & -C & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \psi L2^{1-\psi}K2^{2-\psi} & 0 & (1-\psi)L2^{1+\psi}K2^{\psi} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$M4=\begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & -\delta K & 0 & 0 \\ 0 & 0 & -\delta & 0 \\ 0 & 0 & 0 & -\delta V \end{bmatrix}.$$

From equation (36) we express:

(38) $$J = M_1^{-1} M_2 S$$

and substitute into (37):

(39) $$\dot{S} = (M_3 M_1^{-1} M_2 + M_4) S\ .$$

Therefore the system of dynamic equations can be presented as:

(40) $\dot{S} = \Omega S$,

where the matrix Ω is expressed as:

(41) $\Omega = (M_3 M_1^{-1} M_2 + M_4)$.

To analyze the model solutions' stability it is necessary to consider eigenvalues of matrix Ω. According to the Blanchard-Kahn condition (Blanchard and Kahn, 1980), in general, if there are *m* predetermined (backward-looking) variables in a system of equations, and the number of roots corresponding to stable path solutions is *n*, then for

m>n there are no solutions,

m=n there is a single solution,

m<n there are multiple solutions ("sunspots").

In the case of our model, *K* is a predetermined variable, γ is forward-looking, V is a predetermined variable, λ is forward-looking. Therefore, to get the results similar to those of real business cycle models, it is necessary that two eigenvalues of matrix Ω correspond to stable solution paths, and the other two – to unstable ones, taking the corresponding transversality conditions into account. If three or more eigenvalues are negative, then multiple equilibrium paths ("sunspots") occur.

To determine the eigenvalues of matrix Ω and the corresponding bifurcation frontiers we carry out a numerical model simulation under realistic parameter values of $\rho, \sigma, \theta, \varepsilon, \alpha, \beta, \delta, \psi$ in the intervals of:

(42) $0.01 < \psi < 1$

(43) $0.01 < \theta < 1$

(44) $0.1 < \beta < 3$

(45) $0.1 < \alpha < 3$

(46) $0.2 < \alpha + \beta < 5$

(47) $(1-(1-\varepsilon)(\alpha + \beta)) > 0$

(48) $-20 < \sigma < 1$

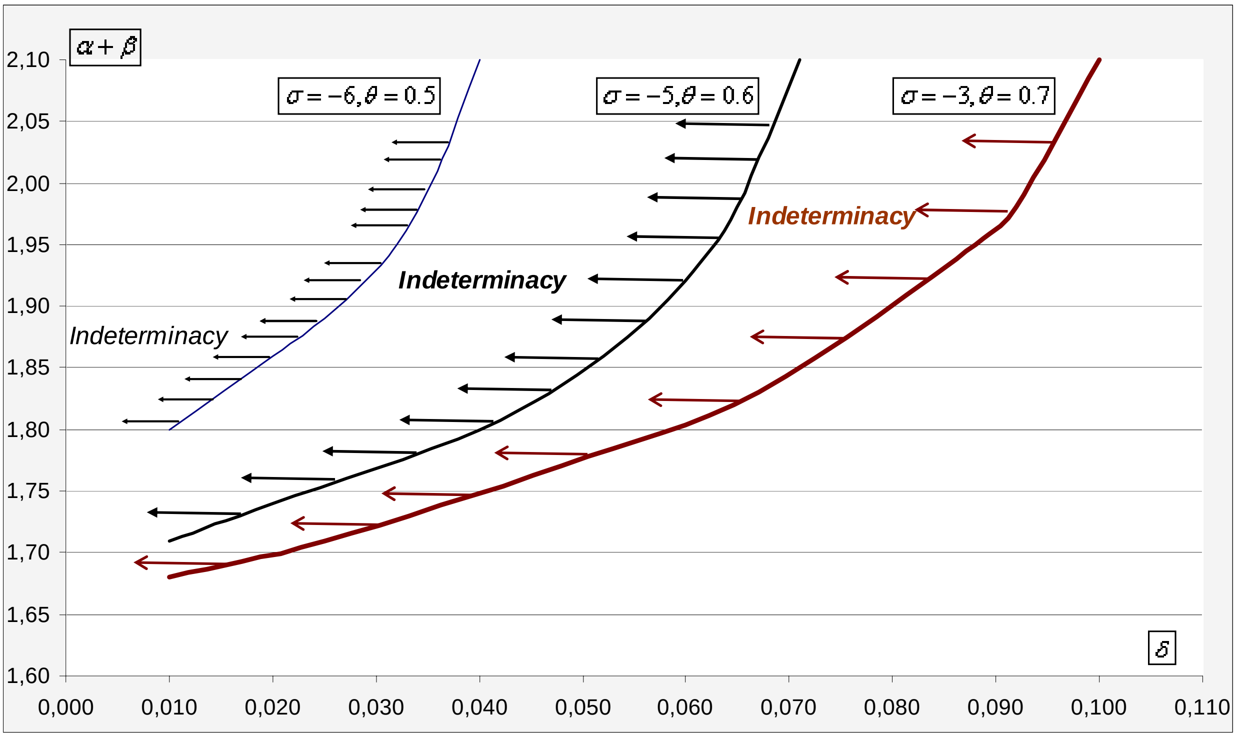
(49) $0.01 < \varepsilon < 0.33$

(50) $0.01 < \rho < 0.1$

(51) $0.01 < \delta < 0.1$.

Conditions (42)-(43) are stipulated by assumptions used in constructing functions (26) and (7); inequalities (44)-(46) are used for modeling decreasing, constant and increasing returns to scale of the production function (16); (47) is the condition for nonnegative profit existence in accordance with condition (19); inequality (48) follows from the construction of utility function (7), taking into account that according to empirical research the value of $\theta\sigma$ is about –3; inequality (49) is obtained from the imperfect competition condition ($\varepsilon > 0$) and from empirical estimates of economic profit in the economy in the paper by Basu and Fernald (1997) (approximately 4-5%); (50)-(51) are standard for numerical models.

To determine model parameter intervals under which endogenous cycles can occur we carry out numerical analysis of bifurcation frontiers, determining the change in dynamics of the main variables. Picture 1 shows the corresponding results of numerical modeling under different returns to scale parameters in the production sector ($\alpha + \beta$) and depreciation rate of accumulated efforts in the rent seeking sector (δ), assuming that labor and capital efficiency is the same in the rent seeking sector ($\psi = 0.5$), under the preferences discounting factor value of 2% ($\rho = 0.02$), and when the value of $\theta\sigma$ parameter is about (-3), as it should be according to empirical research.



Picture 1. Regions of indeterminacy under various returns to scale parameters ($\alpha+\beta$) in the production sector, persistency of return to rent seeking (δ) and household behavior parameters (σ and θ).

Note that the results are in general rather robust to values of main model variables, that is why we have considered the corresponding frontiers only as a function of returns to scale in the production sector and of depreciation of accumulated efforts in the rent seeking sector, under various values of model parameters determining consumption dynamics.

The result of numerical modeling is that endogenous cycles can occur in standard business cycle models under relatively large returns to scale in the production sector, in our case of over 160% (as it was first shown in the paper by Farmer and Guo, 1994).

According to the results we have obtained, when a more realistic mechanism of profit entering the households' budget through rent seeking is introduced, endogenous cycles do not occur even under low depreciation rate of accumulated efforts in the rent seeking sector (Picture 1); under realistic model parameters it is enough for δ not to exceed 10%.

It is important to mention that when parameter σ which characterizes inter-temporal consumption substitution elasticity is increased, a much lower depreciation of accumulated efforts in the rent seeking sector (δ) is needed for multiple equilibriums to occur under the same returns to scale in the production sector.

Introducing a rent seeking mechanism is in a way of general equilibrium models' generalization. Thus, when there is no depreciation of efforts accumulated in the rent seeking sector ($\delta = 0$) and the amount of efforts V accumulated in the economy is rather large, the model is a standard general equilibrium model with imperfect competition. When economic profit occurs while the economy is around the balanced growth path, profit is distributed between agents proportionally to the efforts accumulated in the rent seeking sector. Under a small deviation from steady state additional factors in the rent seeking sector are not used any longer, since the accumulated efforts invested in rent seeking are large enough and do not decrease over time.

5. Concluding remarks

Current literature devoted to endogenous cycles concentrates mostly on the issue of which structure and economy parameters enable endogenous cycle existence. This research is based on the model of Farmer and Guo (1994), which determines endogenous cycle occurrence in standard models under rather large returns to scale in the production sector. We included the rent seeking mechanism into this model, as a result profit enters the households' together with production factor payments, and not through a separate channel.

The model we obtained was linearized around the balanced growth path, the steady state of the system was determined, as well as the equilibrium stability type.

When modeling the rent seeking sector we assumed that each agent involved in rent seeking maximizes the expected sum of discounted profits at each point in time, which enables taking future rental income into account, and the agents have a chance to spend efforts on receiving future profits at any moment. At the same time, part of the efforts accumulated before is lost over time due to depreciation and changes in technology efficiency with a rate constant over time.

The persistency of return to rent seeking was exactly the key parameter which altered inter-temporal optimization conditions of agents, such that endogenous cycle occurrence conditions changed. This result lets us reconsider the fundamental conclusion of Farmer and Guo (1994), who first showed that business cycles can occur in standard business cycle models under returns to scale over 170%.

According to the obtained results, when a more realistic mechanism of profit entering the households' budget through rent seeking, endogenous cycles do not occur even under low depreciation rate of accumulated efforts in the rent seeking sector under realistic model parameters. This is the key result of this paper.

It is not unlikely that the rent seeking mechanism will change the conditions on endogenous cycle occurrence obtained in later papers (Wen, 1998; Weder, 2000; Harrison, 2001; Guo and Lansing, 2005 and others). This is a potential topic for further research in this area.

References

1. Arefiev, Baron (2006). La Fiscalité Optimale du Capital. Thesè. Chapter 4. Université Paris I Pantheon-Sorbonne.
2. Austin, D.A. (1999). “Social Security as an Economic Stabilization Program,” Journal of Macroeconomics, 21, 309-333.
3. Azariadis C. (1981). Self-Fulfilling Prophecies, Journal of Economic Theory 25, 380-396
4. Basu, S., Fernald, J.G. (1997). Returns to scale in U.S. production: estimates and implications. Journal of Political Economy 105, 249-283.
5. Baxter M. and King R.G. (1991). Productive Externalities and Business Cycles. Discussion Paper 53. Institute for Empirical macroeconomics, FRB of Minneapolis
6. Benhabib, J., Farmer, R.E.A. (1994). Indeterminacy and increasing returns. Journal of Economic Theory 61, 19–41.
7. Benhabib, J., Farmer, R. (1999). Indeterminacy and sunspots in macroeconomics. In: Taylor, J., Woodford, M. (Eds.), Handbook of Macroeconomics, Vol. 1A. North-Holland, Amsterdam, pp. 387–448.
8. Benhabib, J. (1980). “Adaptive Monetary Policy and Rational Expectations,” Journal of Economic Theory, 23, 261-266.
9. Blanchard, O. (1979). Speculative bubbles, crashes and rational expectations. Econ. Lett. 3, 387–389.
10. Ben-Gad, M. (2000). “Fiscal Policy and Indeterminacy in Models of Endogenous Growth,” University of Houston, manuscript.
11. Bennett Rosalind L., Farmer Roger E. A. (2000). Indeterminacy with Non-separable Utility. Journal of Economic Theory 93, 118-143 (2000)
12. Benhabib, J., S. Schmitt-Grohé, and M. Uribe. (2001). “The Perils of Taylor Rules,” Journal of Economic Theory, 96, 40-69.
13. Blancharrd I., Fisher S. (1989). Lectures on macroeconomics. MIT press.
14. Blanchard, O.J., Kahn, C.M. (1980). The solution of linear difference models under rational expectations. Econometrica 48 (5), 1305–1311.
15. Boldrin, M. (1992). “Dynamic Externalities, Multiple Equilibria, and Growth,” Journal of Economic Theory, 58, 198-218.

16. Bond, E.W., P. Wang, and C.K. Yip. (1996). “A General Two-Sector Model of Endogenous Growth with Human and Physical Capital: Balanced Growth and Transitional Dynamics,” Journal of Economic Theory, 68, 149-173.
17. Cazzavillan, G. (1996). “Public Spending, Endogenous Growth, and Endogenous Fluctuations,” Journal of Economic Theory, 71, 394-415.
18. Chattopadhyay, S.K. (1996). “Pareto Optimal Improvements for Sunspots: The Golden Rule as a Target for Stabilization,” Economic Theory, 8, 123-135.
19. Deneckere, R.J. and K.L. Judd. (1992). “Cyclical and Chaotic Behavior in a Dynamic Equilibrium Model, with Implications for Fiscal Policy,” in J. Benhabib, ed., Cycles and Chaos in Economic Equilibrium, pp. 308-329. Princeton, NJ: Princeton University Press.
20. Diamond, Peter A. (1985) National Debt in a neoclassical Growth Model. American Economic Review 55 (Dec): 1126-1150
21. Evans, G.W. and S. Honkapohja. (1993). “Adaptive Forecasts, Hysteresis, and Endogenous Fluctuations,” Federal Reserve Bank of San Francisco, Economic Review, 93(1), 3-13.
22. Farmer, R.E. (1999). The Economics of Self-Fulfilling Prophecies, 2nd Ed. MIT Press, Cambridge, MA.
23. Farmer, R.E.A., Guo, J.T. (1994). Real business cycles and the animal spirits hypothesis. Journal of Economic Theory 61, 42–73.
24. Farmer, R.E.A. (1986). “Deficits and Cycles” Journal of Economic Theory, 40, 77-88.
25. Ferreira R., Dufourta F.(2005) Free entry and business cycles under the influence of animal spirits, Journal of Monetary Economics.
26. Foley, D.K. (1992). “A Contribution to the Theory of Business Cycles,” Quarterly Journal of Economics, 107, 1071-1088.
27. Hansen G. (1985). Invisible labor and the business cycles. JME 16, 309-325
28. Goenka, A. (1994). “Fiscal Rules and Extrinsic Uncertainty,” Economic Theory, 4, 401-416.
29. Grandmont, J.-M. (1985). “On Endogenous Competitive Business Cycles,” Econometrica, 22, 995-1037.

30. Grandmont, J.-M. (1986). "Stabilizing Competitive Business Cycles," Journal of Economic Theory, 40, 57-76.
31. Guo J.T. (2004). Increasing returns, capital utilization, and the effects of government spending. Journal of Economic Dynamics & Control 28 (2004) 1059 – 1078
32. Guo J.T. and Harrison S. (2001). Tax Policy and Stability in a Model with Sector-Specific Externalities. Review of Economic Dynamics 4, 75–89 (2001)
33. Guo J.T. and Harrison S. (2004). Balanced-budget rules and macroeconomic (in)stability. Journal of Economic Theory 119 (2004) 357–363
34. Kemp, M.C., N. Van Long, and K. Shimomura. (1993). Cyclical and Non-Cyclical Redistributive Taxation, International Economic Review, 34, 415-429.
35. Guo J.T. and Lansing K. (2005). Maintainance expenditure and Indeterminacy under increasing returns to scale. WP 2005-10. FRB of San Francisco.
36. Krusell, P., Smith, A.A. (1996). Rules of thumb in macroeconomic equilibrium: a quantitative analysis. Journal of Economic Dynamics and Control 20, 527–558.
37. Matsuyama, K. (1991). "Endogenous Price Fluctuations in an Optimizing Model of a Monetary Economy," Econometrica, 59, 1617-1631.
38. Michener, R. and B. Ravikumar. (1998). "Chaotic Dynamics in a Cash-in-Advance Economy," Journal of Economic Dynamics and Control, 22, 1117-1137.
39. Michel, P., Wigniolle, B. (2003). Temporary bubbles. J. Econ. Theory 112, 173–183.
40. Reichlin, P. (1986). "Equilibrium Cycles in an Overlapping Generations Economy with Production," Journal of Economic Theory, 40, 89-102.
41. Sharon G. Harrison (2001). Indeterminacy in a model with sector-specific externalities. Journal of Economic Dynamics & Control, 25 (2001) 747-764

42. Shleifer, A. (1986). “Implementation Cycles,” Journal of Political Economy, 94, 1163-1190.

43. Sims, C.A. (1994). “A Simple Model for Study of the Determination of the Price Level and the Interaction of Monetary and Fiscal Policy,” Economic Theory, 4, 381-399.

44. Schmitt-Grohé, S. and M. Uribe. (1997). “Balanced-Budget Rules, Distortionary Taxes and Aggregate Instability,” Journal of Political Economy, 105, 976-1000.

45. Schmitt-Grohe S. (1997). Comparing Four Models of Aggregate Fluctuations due to Self-Fulfilling Expectations. Journal of economic theory 72, 96-147.

46. Sims, C.A. (1994). “A Simple Model for Study of the Determination of the Price Level and the Interaction of Monetary and Fiscal Policy,” Economic Theory, 4, 381-399.

47. Smith, B.D. (1994). “Efficiency and Determinacy of Equilibrium Under Inflation Targeting,” Economic Theory, 4, 327-344.

48. Tirole, J. (1985). Asset bubbles and overlapping generations. Econometrica 53, 1499–1528.

49. Naish, H.F., (1995). Keynesian real business cycles in a neoclassical framework. J. Econ. Behav. Organ. 27, 183–211.

50. Weder M. (2004) Near-rational expectations in animal spirits models of aggregate fluctuations, Economic Modelling 21 249–265

51. Wen, Y. (1998). Capacity utilization under increasing returns to scale. J. Econ. Theory 81, 7–36.

52. Woodford, M. (1994). “Monetary Policy and Price Level Determinacy in a Cash-in Advance Economy,” Economic Theory, 4, 345-380