Bargaining Delays in a Macroeconomic Context

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Abstract

A desirable movement toward a high skill and high wages economy may imply a broader employee participation in shaping investment/innovation strategies. This could extend collective bargaining over automating, timing of innovation in addition to issues involving employment, wages and other working conditions. This paper makes use of nonlinear differential equations and of a qualitative state space analysis to describe dynamic feedback system, based upon a Goodwin-like model of economic cyclical growth and income distribution. The patterns of behaviour are traced to the system's feedback structure (in particular, to delays and polarity of its feedback links and loops). It is shown that typically growth of labor productivity promotes a steady state labour bill share and employment ratio, although irrationality or myopic rationality in bargaining, disregarding regularities of the whole system, may be detrimental.

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Introduction

According to John Sculley, the modern reorganisation of work could prove as massive and wrenching as the Industrial Revolution. We agree with the experts who warn that these changes can only arise with social frictions (see Ehrbar, Roth, 1993). The limited possibilities of solving social conflicts over income distribution through involuntary learning have been simulated using a Goodwin-like dynamic model built in a system dynamics framework (Ryzhenkov 1993a, 1993b). The model, in Marxian tradition, connects the notion of value with income distribution and economic fluctuations. It extends a simplified version of van der Ploeg (1983) and Glombowski-Krüger (1984) models of fluctuating growth to allow for the effects of composition of capital upon real wage, thus augmenting the key relationship - the Phillips curve. This development has been prompted by the Valtukh information-value hypothesis, which accounts for reduction of qualified labour to simple labor based on amounts of information added by different groups of workers. By this way, we have elaborated the idea of van der Ploeg (1983) that a sufficient degree of endogenous technological progress produces a stabilizing influence on economic dynamics.

A desirable movement toward a high skill and high wages economy may imply a broader employee participation in shaping investment/innovation strategies. This could extend collective bargaining over automating, timing of innovation in addition to issues involving employment, wages and other working conditions. In line with previous research, this paper investigates effects of bargaining delays on economic growth and income distribution.

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1.The Model and Simplifications

The following most important assumptions are made:

(1) two social classes (capitalists and workers);
(2) only two factors of production, labour force and means of production, both homogenous and non-specific;
(3) only one good is produced for consumption and investment purposes, the price is identically one;
(4) production (supply) equals effective demand;
(5) all productive capacities are operated;
(6) all wages consumed, all profits saved and invested;
(7) steady growth in the labour force;
(8) real wage rate rises in the neighbourhood of full employment;
(9) a constant flow of invention and innovation over time;
(10) a constant labour intensity;
(11) a qualification of the labour force corresponds to technological requirements.

The model is formulated in continuous time. Time derivatives are denoted by a dot, while growth rates are indicated by a hat. The simplified version of the model consists of the following equations:

$$P = K/s \qquad (1.1)$$
$$a = P/L \qquad (1.2)$$
$$u = w/a \qquad (1.3)$$
$$a = m_1 + m_2(K/L),\ 0 < m_2 \qquad (1.4)$$

$$(K/L) = n_1+n_2u, \quad n_1 > 0, n_2 > 0 \qquad (1.5)$$
$$v = L/N \qquad (1.6)$$
$$N = N_0e^{nt}, n = \text{const}, N_0 = \text{const} > 0 \qquad (1.7)$$
$$w = -g_1 + rv, \quad g_1 > 0, \quad r > 0 \qquad (1.8)$$
$$P = (1 - w/a)P \qquad (1.9)$$
$$K = (1 - w/a)P. \qquad (1.10)$$

Equation (1.1) postulates a technical relation between the capital stock (K) and net output (P). The variable s is called capital-output-ratio. (1.2) relates labour productivity (a), net output (P) and labour input or employment (L). Equations (1.3) and (1.6) describe the shares of labour in national income (u) and the rate of employment (v), respectively. Equations (1.9) and (1.10) show that profit (P), savings, investment and incremental capital (K) are equal. Workers do not save at all. Investment lag is set aside. The model omits Goodwin´s assumption of constant capital-output ratio, but preserves his premise of the passivity of final demand. Equation (1.7) defines the exponential growth of the labour supply (N) with the rate n. Equation (1.8) represents the linear approximation of the real Phillips curve. A rising rate of employment is assumed to affect wage increases (in real terms). There is no money illusion.

Equation (1.4) is a linear form of Kaldor´s technical progress function. The hypothesis of a constant flow of invention and innovation over time underlies the assumption of a technical progress function with the constant parameters. A mechanisation function is introduced in (1.5). It relates the growth rate of capital per employee (of capital intensity) to income distribution. "Mechanisation is encouraged by a high wage share, i.e., high labour costs per unit of net product" (Glombowski, Krüger, 1984: 265).

Real wage changes at a slower pace than the corresponding qualification. The higher the qualification, the higher is the capital intensity. The latter may be used as an indicator of qualification (Valtukh, 1991: 21-44). This hypothesis will help us to extend the model of capital accumulation. Instead of assuming, as in the usual Phillips relation, that the rate of change of the wage rate (w) depends only on the employment rate (v), let this rate be additionally influenced by the rate of change of capital intensity (K/L):

$$w = -g_1+ rv +g_2 +b(K/L), \quad g_2 > 0, \quad b > 0, b < m_2. \qquad (1.11)$$

This modification also takes into consideration the historical or moral element in the value of labour power. Obsolescence of skills acquired on the former phases of technological advance is not reflected. The linear approximation is tentative and perhaps requires more precise definitions. Equation (1.11) will be used in obtaining a convenient statement of the model.

The diffusion of lean production in the industrialised countries based on re-engineering, training employees in multiple skills and pushing decision-making authority as far down in an organisation as possible empirically support these arguments (see Ehrbar, Roth 1993). Please note that we are abstracting from the institutional arrangements for the supply of skills.

The central variables of the modified model are the employment rate (v), the labour bill share (u) and the capital coefficient (s). Substitution and logarithmic differentiation yield (see Ryzhenkov 1993: 541-542):

$$s = -(m_1 + (m_2 - 1)(n_1 + n_2u))s \qquad (1.12)$$
$$v = ((1 - u)/s - (n_1 + n_2u) - n)v \qquad (1.13)$$
$$u = (-g + rv - m_1 + (b - m_2)(n_1 + n_2u))u. \qquad (1.14)$$

It may be easily shown that the system (1.12) - (1.14) is an example of a nonlinear competitive-cooperative network:

$$f_1(s)/\ v = 0,\ f_1(s)/\ u = (1 - m_2)n_2 s \begin{cases} < 0, \text{ if } m_2 > 1 \\ > 0, \text{ if } m_2 < 1 \end{cases} \qquad (1.15)$$

$$f_2(v)/\ s = -(1 - u)v/s^2 < 0,\quad f_2(v)/\ u = -v/s - n_2 v < 0 \qquad (1.16)$$

$$f_3(u)/\ s = 0,\quad f_3(u)/\ v = ru > 0. \qquad (1.17)$$

Our model is not only able to incorporate growth, but may also reflect the persistence of cycles too. Notice if $m_2 < 1$, then the increasing labour income share enhances the capital-output-ratio which adversely affects the employment rate. Explicit delays will be introduced in section 3.

2. A Steady-State Growth

We will use the simplest notion of equilibrium (a fixed point in a phase space). A nontrivial equilibrium is given by:

$$E_2 = (s_2, v_2, u_2), \text{ where} \qquad (2.1)$$

$u_2 = m_1/(n_2(1 - m_2)) - n_1/n_2$, $s_2 = (1 - u_2)/(n_1 + n_2u_2 + n)$ and
$v_2 = (g + m_1 + (m_2 - b)(n_1 + n_2u_2))/r = (g + (1 - b)\, m_1/(1 - m_2))/r$.
(s_2 follows from (1.13), v_2 - from (1.14) and u_2 - from (1.12).)

If $m_1 = 0$ and $m_2 = 1$, then s = 0 and the capital-output-ratio is determined by the initial condition ($s = s_0 > 0$). The system degenerates into the two-dimensional system:

$$v = ((1 - u)/s_0 - (n_1 + n_2u) - n)v \qquad (2.2)$$
$$u = (-g + rv + (b - 1)(n_1 + n_2u))u. \qquad (2.3)$$

The model is defined in terms of ratios, so that a finite area of behaviour can describe growth as well. Extended reproduction along the steady state path displays the following properties. Output grows at its "natural rate", the sum of labour supply growth and productivity growth:

$$P_2 = a_2 + n = m_1/(1 - m_2) + n.$$

The growth of labour productivity and real wage is at the rate

$a_2 = w_2 = m_1/(1 - m_2)$, if $m_1 = 0$ and $m_2 = 1$,
$a_e = w_e = n_1 + n_2u_e$ (see (2.4) above), if $m_1 = 0$ and $m_2 = 1$,

whereas the profit share, the capital-output ratio and, therefore, the rate of profit itself are constant. Capital stock increases at the rate $K_2 = P_2$ ($K_e = P_e$) which is equal to the profit rate

$P_2/K_2 = P_2 = K_2$ (or $P_e/K_e = K_e = P_e$ in the degenerated case).

The labour income share, the rate of employment and capital-output-ratio are constant. If $b < 1$, the higher the equilibrium growth rate of labour productivity $m_1/(1 - m_2)$, the higher is an eq[illegible]rium ratio of employment (v_2). Thus, for the model economy, failure to innovate is detrimental to employment. Technological innovations do not boost productivity at the expence of employment at least along the steady state growth path.

There is a good agreement between the properties of the steady-state growth in our model and Kaldor's five stylized facts:

1. Output per worker shows continuing growth with no tendency for a falling rate of growth of productivity.
2. Capital per worker is rising more or less in proportion to productivity.
3. The rate of return on capital is steady.
4. The capital-output ratio is steady.
5. Labor and capital receive constant shares of total income.

We have determined the shares of wages and profits as well as the rate of profit on capital quite independently of the principles of marginal productivity. The rate of profit on capital depends on the coefficients of the technical progress function which, in turn, determine the rate of growth of labour productivity. Our model typically yields the persistence of unemployment. It will be rather simple to reflect in a similar model such a prominent feature of the data as a negative correlation of population growth rates with the level of income.

Van der Ploeg has relaxed an assumption of Goodwin (1967) about a constant capital-output ratio by having firms maximize profits subject to a C.E.S. production function and come to the interesting conclusion: "For the general C.E.S. technology, the equilibrium share of wages in the national income is a decreasing function of the natural rate of growth ..." (Van der Ploeg, 1985: 225).

Our formula (2.1) provides us with a different conclusion: if there is a constant supply of labor ($n = 0$) the equilibrium share of wages in the national income (u_2) is an increasing function of the natural rate of growth which equals the rate of productivity growth $m_1/(1 - m_2)$. This seemingly paradoxical and counter-intuition result gives a partial explanation to the Goodwin observation, which was not analytically derived but obtained via computer simulations: "The most striking fact ... is that the share of labor is higher, the higher the growth rate. This may in part be due to the particular choice of parameters, but it does indicate that such a result is possible" (Goodwin, 1990: 79).

3. Consequences of Bargaining Delays

A behaviour of the modelling system can be influenced by labour contract terms and other bargaining delays. In particular, this system may give an elicited response to an introduction of wage lag in the modified Phillips equation (1.11), "caused by the extention of collective bargaining and particulary by the growth of arbitration and conciliation procedures" (Phillips, 1958: 293). C. Chiarella has introduced a time lag into the wage formation equation of the original Goodwin model and by use of the centre-manifold theory has shown that the resulting system of three differential equations displays the stable limit cycle behaviour at least for a relatively small time lag (Chiarella, 1990: 70-80). However, the dynamic properties in the model for larger values of the time lag have not yet been investigated.

We will address this problem in a broader context of social bargaining by applying a case study approach. Being mostly interested in macroeconomic consequences of a duration of bargaining we will treat the bargaining as a "black box" at a rather high level of abstraction. Notice that the anticipations of social tensions may lead to an abnormal increase in real wages, but we will not take this aspect into account.

The investigation consists of a number of case studies. Four of the case studies consider elementary bargaining over automating/wage/employment/timing of innovation (separately), and the fi case study analyses simultaneous bargaining over all of these issues. In numerical simulations we have used the first-order and the third-order exponential delays, represented by the DYNAMO built-in functions SMOOTH and DLINF3, respectively. Table 1 and Figure 1 reflect the results of our case studies.

Table 1. Effects of the bargaining delays.

Elementary bargaining	Variable	Factor	Delay (years)	Fluctuation
wage	w	v	0.25 0.18	exploding converging
automating	K/L	u	0.25	converging
innovating	â	K/L	0.25	converging
employment	v	â	0.25	conveging
Simultaneous bargaining			0.25 0.10	exploding converging

A purely illustrative constellation of coefficients has been chosen: $m_1 = 0.12$, $m_2 = 0.8$, $n_1 = 0.12$, $n_2 = 1.5$, $r = 1.8$, $b = 0.2$, $g = 1$, $n = 0.02$. It gives rise to the following equilibrium values of our most important variables: $s_2 = 1.0968$, $u_2 = 0.32$, $v_2 = 0.822$. It has been shown that this equilibrium is asymptotically stable (Ryzhenkov, 1993b: 8-10). We set the initial magnitude of the rate of employment $v_0 = 0.722 \neq v_2$ without an initial displacement of other variables from their equilibrium values ($u_0 = u_2$, $s_0 = s_2$). A damping cyclical motion is obtained, the length of the cycle being approximately 6 years (in the system without explicit delays). An introduction of the information lags not only raises a dimensionality of the system of the differential equations but alters the Routh-Hourwitz conditions of local stability as well.

In particular, wage change has been related not to the current employment ratio, but to the ratio lagged, on average, by several months. An explosive cyclical motion around the trend may be obtained, for example, by DEL = 0.25 (three months). The amplitude of oscillations grows faster if the model is extended by the third order delay. As a result of introduction of the delay, the system becomes considerably less stable. This sensitivity shows that wage lag is one of the most crucial parameters in determining the system´s dynamical performance. Delays which do not harm stability in elementary bargaining, under an illustrative constellation of the parameters and the initial conditions of the model, may violate stability in simultaneous bargaining. In order to guarantee stability, the latter should be less lengthy than the former.

The fluctuations are not strictly periodic. The amplitude and phasing of each variable are determined structurally (cf. in a linear case all variables oscilate with the same frequency and damping; only their amplitude and phasing differ, these being parameters fixed for each variable separately by extraneous factors or initial conditions). The model is not linear, hence it does not require shocks to explain the percistence of cycles and their irregularity, yet it no-way excludes the importance of shocks (cf. Goodwin 1990: 111-112).

The above results could be generalized for more advanced conceptions of equilibrium compared with the notion of a fixed point applied. This model seems to yield a stable limit cycle and strange attractor near an unstable local equilibrium if the control parameter(s) are properly chosen (see Ryzhenkov, 1993b: 8-10). More plausible parameters should be used in the further research.

Conclusion

A conflict may be an unintended or intended consequence of the overextended bargaining. The society only capable of involuntary learning is condemned to experience escalating conflicts, as has been illustrated. One should keep in mind, however, that growing systems usually develop in the direction of more elaborated adjustment processes. Voluntary learning which may alter structure, delays and amplifications should be incorporated in the Goodwin-like model(s) as well. With the assistance of the elaborated approach one can test the consequences of alternative modes of paying workers over the business cycle in "a wage economy" (considered above) and in "a share economy" where workers are paid in part via profit or revenue sharing. More interesting lag distribution can be explored, etc. It is also intresting to investigate, the effects of various types of policies pursued by workers, employers and state.

The main shortcoming of the above model, in my opinion, is the assumption of homogeneity of factors (labour force and means of production). I agree with the experts of the OECD, who believe, that in order to measure the effect of technological change on productivity growth more accurately, it is necessary to keep track of different vintages of fixed assets embodying different levels of knowledge, explicitly considering the link between the rate of technological progress and scrapping rates (cf. OECD, 1991: 137). The measurement of labour inputs should reflect changes over time in the average number of hours worked, and possibly capture qualitative attributes of the work force (education and skill levels). A great deal of work is necessary for modelling international differences in bargaining systems (in wage setting behaviour, in particular) in order to shorten the gap between complex industrial relation systems and the rather stylized characterizations employed in this paper.

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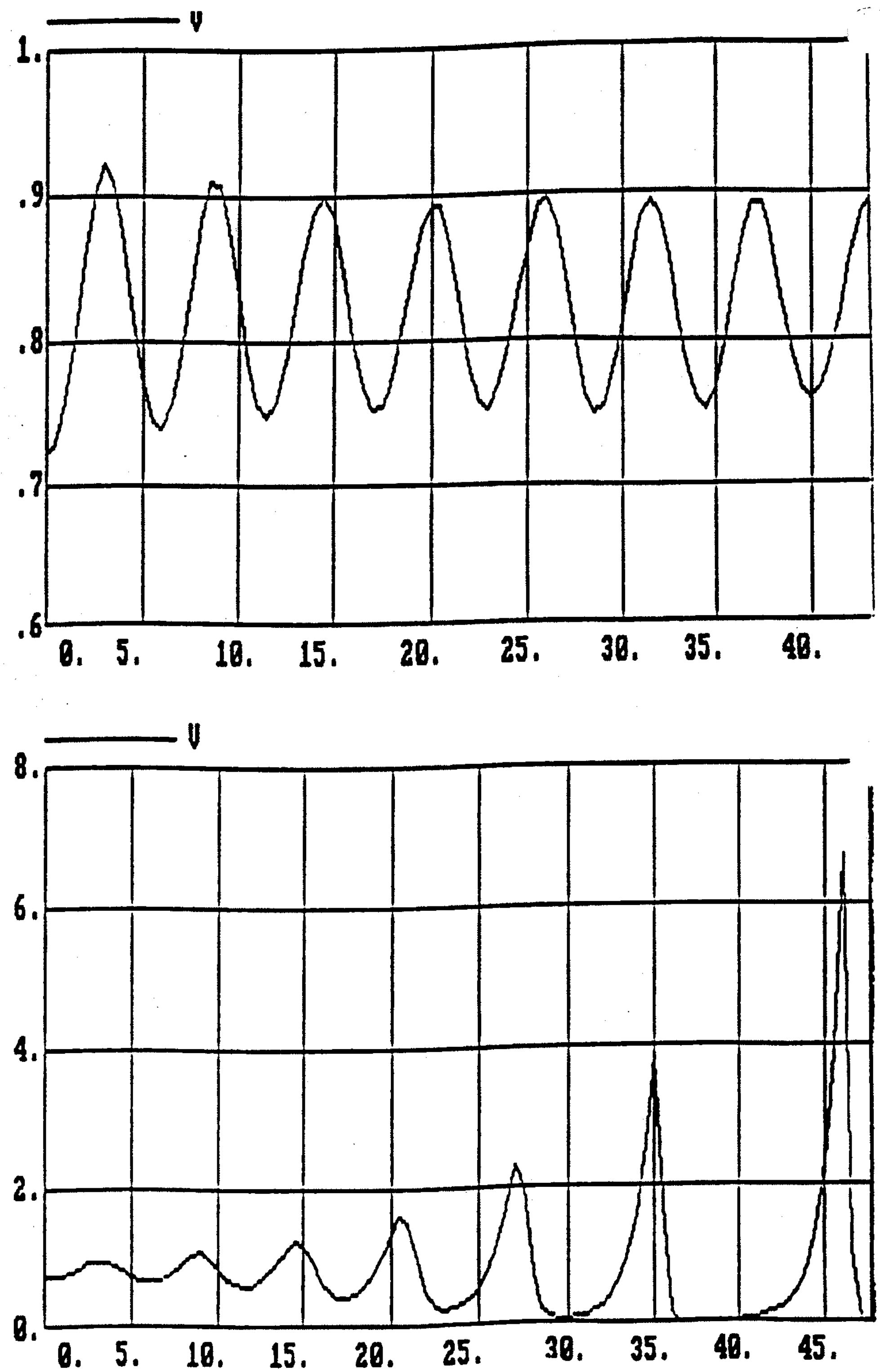

Figure 1 . Simultaneous bargaining with DEL = 0.1 and with DEL = 0.25 (exploding fluctuations)