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Wage Flexibility and Unemployment: The Keynesian Perspective Revisited*

Mario Amendola[†], Jean-Luc Gaffard[‡], Francesco Saraceno[§]

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Abstract

Keynes' main concern in the *General Theory* is about the capacity of an economy to return to a full employment equilibrium when subject to a (negative) demand shock. He maintains that money wages cuts may not help reabsorb unemployment, as they do not necessarily imply a fall in real wages. On the contrary, wage rigidity may be necessary for avoiding that a cumulative process propels the economy far away the full employment equilibrium. The consideration of co-ordination failures in the investment-saving market is behind this conclusion. However, the analysis is carried out within a static equilibrium framework.

This paper is an attempt to focus on the problems of intertemporal co-ordination arising within the context of a sequential economy. Our analysis of the out-of-equilibrium process of adjustment stirred by a shock of whatever nature allows to generalize the original Keynesian intuition. It shows in fact that unemployment emerges as the result of a lack of co-ordination due to irreversibly constrained choices, and that not only nominal but also real wage flexibility does not necessarily help to restore equilibrium. As a matter of fact, it may even be harmful, by triggering processes that make the economy diverge from equilibrium.

The analysis carried out has important analytical implications as regards the role of market imperfections and the interpretation of the effects of monetary policy.

Keywords: co-ordination, unemployment, wage rigidity, Keynesian economics

JEL codes: D5 E12 E44

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1 Introduction

Neo-classical and new-Keynesian economics alike explain involuntary unemployment as the result of real wage rigidity. The neo-classical analysis also postulates a positive correlation between nominal and real wages (generally confirmed by empirical observations) so that any cut in money wages should result in a cut in real wages. As a consequence, money wage rigidities associated with some specific bargaining arrangements on the labour market would be responsible for involuntary unemployment. According to Keynes instead, the wage bargains between the entrepreneurs and the workers do not determine the real wage, and "there may exist no expedient by which labour as a whole can reduce its *real* wage to a given figure by making revised *money* bargains with the entrepreneurs" (Keynes 1936, p. 13). That means that co-ordination failures at the system level rather than at the labour market level would be responsible for unemployment which will be then involuntary in the strict sense. Recent contributions can be considered as a revival of this line of analysis (Hart 1982, D'Aspremont, Dos Santos Ferreira, and Gérard-Varet 1990). They argue that imperfect competition in the markets for goods would be responsible for the existence of involuntary unemployment even at a level of real wages inferior to the competitive (or Walrasian) one. In this framework co-ordination takes place *ex ante* on a strategic basis and results in a general equilibrium with involuntary unemployment the existence of which is clearly explained by the existence of firms' (and unions) market power. Nevertheless, this unemployment could always be reduced, if not totally reabsorbed, thanks to a cut in real wages.

We share with Keynes the belief that co-ordination is the central issue in economic activity. But we think that it is better tackled by abandoning the equilibrium approach that characterizes Keynes' *General Theory*, and seeing the working of the economy as a sequential out-of-equilibrium process. Involuntary unemployment appears then as the result of a lack of co-ordination which emerges along the way, at each step, and cannot disappear simply by allowing price and wage flexibility. The study of out-of-equilibrium processes, in the Hicksian tradition (Hicks, 1973, Amendola and Gaffard, 1988,1998), allows to switch the focus from the analysis of price systems corresponding to alternative equilibrium states of the economy to the sequence of constrained decisions that describes an economic process taking place in time.

The main results of the Keynesian analysis re-emerge in this different framework. However, our analysis makes it possible to advance farther along this line by extending to real wages Keynes' conclusions as regards money wages (thus challenging the classical inverse relation between real wages and unemployment). We show that *(i)* real as well as nominal rigidities, instead of being an obstacle to the attainment of full employment, may appear as an useful device for preventing an aggravation of unemployment; and hence

that *(ii)* market imperfections may be a factor of stability of the system rather than an obstacle on the way to the optimal equilibrium. Finally, our analysis shifts the focus of monetary policy from its effects on employment via changes in the distribution of income or in the burden of the debt to its effects via the structure of productive capacity.

The outline of the paper is as follows. Section 2 will shortly summarize Leijonhufvud's pioneering argument, that the *General Theory* may be seen as an "Essay on co-ordination", and will mention other 'Keynesian' contributions (Drèze 1997, Stiglitz 1999) along the same line; we shall then underline some deficiencies of these approaches, that in our opinion were crucial in the re-absorption of the Keynesian analysis within the mainstream. Section 3 will describe the approach that we propose along Hicksian lines, based on irreversibilities in the production and in the decision processes, which give a real temporal dimension to the analysis. Then in section 4 we shall show, by means of simulations, how Keynesian results emerge, more robustly, from this new approach. Section 5 concludes with an examination of the similarities and differences between the economics of Keynes and the approach proposed here.

2 Co-ordination Problems and Price Rigidity: From Static to Sequential Analysis

According to Keynes the level of activity and of employment is determined by aggregate demand. This crucially depends on expectations (of the firms, on the marginal efficiency of capital, and of the speculators, on the monetary rate of interest), which affect consumption and investment decisions. 'Wrong' expectations may cause intertemporal co-ordination failures in the investment-saving market. The nominal interest rate that assures the stock equilibrium in the money market L-M may not be such that the full employment flow equilibrium in the I-S market is guaranteed. This co-ordination failure in the capital and money market may yield an insufficient aggregate demand, and hence an equilibrium with involuntary unemployment.

The equilibrium analysis of the IS-LM model only captures part of Keynes' argument, thus leading to interpret Keynes as a fix-price (and hence short run) case of the general Walrasian model. In this framework, unemployment can only stem from nominal rigidities in the relevant market, namely, that for labour. However, as is well known, Keynes denies the efficiency of a decrease in the nominal wages as a means for reducing involuntary unemployment. On the contrary, he argues that convergence to a market clearing real wage cannot be assumed as the effect of a process of repeated money wage bargains, since this process may bring about changes in the overall demand for output that have an adverse effect on real wages. Thus, "if money-wages were to fall without limit whenever there was a tendency

for less than full employment, [...] there would be no resting place below full employment until either the rate of interest was incapable of falling further, or wages were zero. In fact, we must have some factor, the value of which in terms of money is, if not fixed, at least sticky, to give us any stability of values in a monetary system" (Keynes, 1936, p. 303). Keynes reverses the common wisdom on wage rigidity, which helps to avoid the implosion of the system rather than being a source of disequilibrium. However, no sequential framework makes the actual dynamic process clear.

Leijonhufvud (1968) interprets the economics of Keynes as the attempt to see unemployment as a disequilibrium phenomenon linked to the sequential adjustment process following an exogenous disturbance, namely, a change in the marginal efficiency of capital. Co-ordination problems arise in the market for saving and investment, where agents with different time horizons interact. In fact, when the real shock above mentioned occurs, "financial markets are manifestly incapable of providing for the consistency of long-term production and consumption plans...(which) does not insure a 'correct' value for the interest rate" (ibidem, p. 276). Entrepreneurs base their demand of loanable funds on the current rate of interest, while supply is determined on the secondary market by the portfolio choices of speculators who refer to the spread between expected and actual interest rates. A drop in the demand of loanable funds following an exogenous shock (here a fall in the marginal efficiency of capital), will not necessarily affect expectations on the secondary market; consequently, the interest mechanism will fail to recover co-ordination by re-establishing investment at its full employment level. Trade then takes place at a false price, at which ex ante saving and investment are not equated, and it is therefore income that has to change in order to restore the equality. The conclusion, according to Leijonhufvud, is obvious: "It was Keynes' position that it is the failure of the incomplete market mechanism to reconcile the implied values of forward demand and supplies [...] that is the source of the trouble. Unemployment of labor and other resources is a derivative phenomenon" (Leijonhufvud 1968 p. 276). The 'source of the trouble' does not lie in the labour market. Unemployment is the consequence of an intertemporal co-ordination failure: of a missing market where investment and saving decisions should be fully coordinated.

The belief that co-ordination failures cannot be identified with price distortions and hence that price flexibility is not always the way to re-establish co-ordination is also shared by other authors who have revisited the problem of price rigidity in a Keynesian perspective. Thus Drèze (1997), who analyzes the problem within a general equilibrium model with rationing, demand externalities and market power, distinguishes between price distortions and co-ordination failures as different sources of the appearance of supply constraints and of inefficient allocations of resources, and hence writes: "It is not obvious at all that price or wage adjustments susceptible

of removing inefficiencies caused by price distortions would also operate in the right direction, or with any effectiveness, to circumvent co-ordination failures"(ibid. p.1753). The real problem, then, is :"the movement from one supply- constrained equilibrium to another as a topic in dynamics, inviting the study of adjustment processes defined over prices (...), quantities, price expectations and plans"(ibid.). An attempt to investigate the main aspects of these adjustment processes has recently been made by Stiglitz who stresses that "Shocks lead to marked changes in relative prices, and those disturbances in relative prices greatly exacerbate economic fluctuations [...] The risks associated with wage and price adjustments may well be larger that those associated with output adjustments" (Stiglitz, 1999, pp. 75 and 76). These two authors thus implicitly argue that the co-ordination problem is not the problem of a missing market, but must rather be seen in the light of adjustment processes.

We maintain that the essence of adjustment processes are the links between successive periods, mainly related to production and money. In this perspective, a restructuring of productive capacity is the essential aspect of the adjustment process aimed at re-establishing co-ordination. We shall show in fact in the next section that the co-ordination failures, and the misalignment of investment, on which unemployment depends, are associated with a breaking of the intertemporal complementarity of the production process and the appearance of financial constraints. These co-ordination failures, whatever their cause, are thus fossilized in the capital stock, i.e. in the temporal structure of productive capacity, and in financial constraints . The handing over of these real and financial stocks carries the disequilibria down the sequence of periods that makes up the adjustment process.

In an equilibrium perspective, co-ordination results from a choice carried out *ex ante*. Co-ordination failures appear as a consequence of the existence of multiple Pareto ranked equilibria[1]: they are nothing but co-ordination on bad equilibria. Out of equilibrium we have to deal instead with a process sketched out step by step by sequentially interacting disequilibria. Co-ordination problems arise as the result of this process taking place. In this perspective, the problem caused by trading at disequilibrium prices lies not so much in the persistence of these prices (i.e. in the sticky prices), which is theoretically hard to defend, but rather into two features of this trading that are mentioned but not developed by Keynes and Leijonhufvud: the appearance of quantity constraints that at each moment in time affect the agent's plans; and the sequence of suboptimal choices triggered by these constraints, which renders the very notion of an equilibrium price meaningless as the price itself would change continuously along the adjustment process.

What really matters, then, are the effects of the exchanges at disequi-

[1]See Cooper and John (1988) and Silvestre (1993).

librium prices on the stocks of the economy, which are the links of the out-of-equilibrium process that shapes out the adjustment. We shall see that in this light price and wage rigidities, far from witnessing the inability of agents to take advantage of market information, could be seen as the expression of a rational behaviour.

Leijonhufvud and Stiglitz have already dealt with financial stocks, with particular reference to the impact of changes in asset values on the adjustment process. Real stocks, and the interactions with financial stocks in an out-of-equilibrium context, are instead at the centre of the analysis that will be carried out in the following sections.

3 The Model

We appeal to a model based on Hicks (1973) and Amendola and Gaffard (1988, 1998) whose main characteristic is the articulation in time of both the production and the decision processes. In our setting on the one hand production takes time, and hence costs come before revenues; and on the other, decisions are taken step by step given the constraints inherited from the past. Only in such a framework in fact it is possible to properly study the problems of co-ordination over time of economic activity, and the sequence of constrained decisions that make up the out-of-equilibrium process of adjustment mentioned but not fully sketched out by Leijonhufvud, Drèze and Stiglitz.[2]

Consider a sequential economy of a neo-Austrian type which uses a homogeneous labour resource. Labour is inputted for n periods to build the productive capacity, and used for the following N to operate it and obtain a final output. An elementary process of production is defined by input coefficients such that:

$$\begin{aligned} \mathbf{a}^c &= [a_i^c], \quad a_i^c = a^c, \forall i = 1, ..., n \\ \mathbf{a}^u &= [a_i^u], \quad a_i^u = a^u, \forall i = n+1, ..., n+N \end{aligned} \tag{1}$$

and output coefficients

$$\mathbf{b} = [b_i], \quad b_i = b, \forall i = n+1, ..., n+N \tag{2}$$

The productive capacity of the economy is given by the number of processes in use at the moment t, in construction, $\mathbf{x}^c(t)$, and in utilization, $\mathbf{x}^u(t)$:

$$\mathbf{x}(t) = [\mathbf{x}^c(t), \mathbf{x}^u(t)] \tag{3}$$

[2]Saraceno (2003) shows that to yield meaningful disequilibrium dynamics, we need *both* adaptive expectations and the articulation in time of production.

This capacity is subject to ageing and to modifications due to investment and scrapping. The economy enters each period with a given productive capacity, and a set of prices for labour ($w(t)$) and for final output ($p(t)$). These prices only change at the junction between periods, while *within* the period market disequilibria result in supply or demand rationing. In other words, this is a *fix-price* model (Hicks 1956).

At the beginning of the period, firms choose how much to produce and how much to invest, subject to a number of constraints. Desired supply is determined adaptively[3] from demand observed in the previous period:

$$\hat{s}(t) = d^e(t) = [1 + g_d^e(t)]d(t-1) \tag{4}$$

$$g_d^e(t) = (1-\lambda)\sum_{i=1}^{\tau} \lambda^{i-1} g_d(t-i) \tag{5}$$

with hats denoting desired quantities. The expected growth rate of demand, $g_d^e(t)$ is a weighted average of τ past values of the growth rate g_d[4]. Desired supply may be greater or smaller than the sum of productive capacity and the unsold stocks carried over by previous periods which are put back in the market. In the first case, the firm will be constrained and hence produce at its maximum capacity. Otherwise, it will be forced to partially utilize (or equivalently to scrap) some processes.

$$\begin{aligned} &\hat{s}(t) \geq \mathbf{b}\mathbf{x}^u(t) + o(t-1) \Rightarrow \tilde{s}(t) = \mathbf{b}\mathbf{x}^u(t) + o(t-1) \\ &\hat{s}(t) < \mathbf{b}\mathbf{x}^u(t) + o(t-1) \Rightarrow \tilde{q}(t) = \mathbf{b}\tilde{\mathbf{x}}^u(t) = \hat{s}(t) - o(t-1) \end{aligned} \tag{6}$$

where the tildes denote constrained quantities, $q(t)$ and $o(t-1)$ are production and the stock of goods previously accumulated respectively.

While they form demand expectations on a day-by-day basis, firms recognize that investment is an inherently long term phenomenon, and hence do not alter their behaviour in response to short term disequilibria. Investment (i.e. construction) decisions are always taken such as to maintain a balanced structure of productive capacity: the planned number of new processes is the one consistent with the steady state (long run) position of the economy:

$$\hat{x}_1(t) = (1+g^*)^n x_n(t) \tag{7}$$

where g^* is the steady state growth rate of the economy.

Firm's planned production and investment decisions are constrained by available financial or human resources: The total of wages that they plan to pay is

[3]Backward looking behaviour may be seen as the most rational (in terms of costs) choice by boundedly rational agents facing a complex environment.

[4]If $\lambda = 1$, we have static expectations ($d^e(t) = d(t-1)$); while $\tau = 1$ is the standard adaptive expectations case: $d^e(t) = [1 + \psi g_d(t-1)]d(t-1)$

$$\hat{\omega}(t) = w(t)L^d(t) = w(t)[a_1^c\hat{x}_1(t) + \sum_{i=2}^{n} a_i^c x_i(t) + \mathbf{a}^u\tilde{\mathbf{x}}^u(t)] = \hat{\omega}^c(t) + \hat{\omega}^u(t) \quad (8)$$

where L^d is the total demand for labour and w is the wage rate. Firms demand external financial resources to pay whatever of this wage fund is not covered by internal resources:

$$f^d(t) = \hat{\omega}(t) - m(t-1) - h^f(t-1) + c(t) + h_d^f(t) \quad (9)$$

Internal resources are revenues (m), plus money balances (h^f), carried over from the previous period, minus the take-out (c), and whatever firms desire to hoard in the current period (h_d^f). The take-out, $c(t)$, defined as the fraction of available financial resources not spent on production processes (which might stand for private and/or social consumption) is such that $c(t) = \mu m(t-1)$. The difference between the total of wages that firms plan to pay and the available internal resources gives the demand for external money resources $f^d(t)$.

External money demand is matched with money supply f^s, exogenously determined by the monetary authority choosing among alternative monetary policies:

$$f^s(t) = f^s(t-1)\left\{(1-\zeta)(1+g^*) + \zeta\left[1 + \xi g_{f^d} - (1-\xi)g_p(t-1)\right]\right\} \quad (10)$$

where g_{f^d} is the growth rate of the money demand which may be higher than g^*, and g_p is the expected growth rate of the price level. ζ is an indicator function. When it takes the value $\zeta = 0$ a Friedman rule is applied while with $\zeta = 1$, broadly speaking, a Taylor rule prevails. In the latter case ξ and $1-\xi$ are the weights of growth and inflation objectives respectively.

There is no interest rate in the model. It is implicitly considered as a charge that contributes to determine the available financial resources at each moment. In fact, the behaviour of the banking system is not explicitly modelled.

It may be the case, if $f^d(t) > f^s(t)$, that firms incur in a financial constraint. Consequently they will not be able to carry on their investment as planned:

$$\tilde{\omega}(t) = \hat{\omega}(t) - \left[f^d(t) - f^s(t)\right] \quad (11)$$

This financial constraint is endogenous insofar as it results from the previous market disequilibria and of the way these disequilibria have been dealt with in the past. Indeed, as we shall see, inappropriate changes in the wage rate will trigger changes in the structure of productive capacity that will result in an endogenously determined financial constraint.

The resources to be used in utilization and in construction will be reduced by the financial constraint:

$$\begin{aligned} \tilde{\omega}^u &= \min(\hat{\omega}^u, \tilde{\omega}) \\ \tilde{\omega}^c &= \max(\tilde{\omega} - \hat{\omega}^u, 0) \end{aligned} \tag{12}$$

Equations (12) model a rational behaviour by firms, that tend to preserve older processes which will be profitable sooner: in the first place will be reduced the resources devoted to investment/construction, and then those devoted to production/utilization.

The lack of resources will cause the scrapping of production processes. For some i then, we shall have[5]

$$\tilde{x}_i(t) < \hat{x}_i(t) \tag{13}$$

In some sense, the scrapping of production processes reveals the existence of bankruptcy issues.

The firm may also be limited by the amount of labour available on the market (we assume that the labour market opens after the financial market). Labour supply evolves as follows:

$$L^s(t) = L^s(t-1)(1+g_{pop})[1+g_w(t-1)] \tag{14}$$

where g_{pop} is the exogenous population growth rate, and $g_w(t-1)$ is the growth rate of wages. Labour demand on the other hand is given by

$$L^d(t) = a_1^c \tilde{x}_1(t) + \sum_{i=2}^{n} a_i^c \tilde{x}_i(t) + \mathbf{a}^u \tilde{\mathbf{x}}^u(t) \tag{15}$$

If firms incur in a human resource constraint ($L^d > L^s$), they will be forced to cumulate money stocks (h^f) and further scrap processes, while if the contrary holds, unemployment will appear.

Once the two constraints are taken into account, the number of processes and the wage fund can be determined

$$\begin{aligned} x_i(t) &\leq \tilde{x}_i(t) \leq \hat{x}_i(t) \\ \omega(t) &\leq \tilde{\omega}(t) \leq \hat{\omega}(t) \end{aligned} \tag{16}$$

where the second inequality of each equation holds if the financial constraint is binding, while the first holds if the human resources constraint is binding (one or more equal signs will imply the lack of constraints).

[5] Again, the rational behaviour will be modelled in the simulations below by assuming that younger processes (lower i) are scrapped first.

Final demand depends on the wage fund - there is no saving from wage earners - the social consumption and the past idle balances of households $h^h(t-1)$:

$$d(t) = \frac{\omega(t) + c(t) + h^h(t-1)}{p(t)} \tag{17}$$

The last market to open is the market for final output, where demand and supply are matched. In case of market disequilibria we can have involuntary accumulation of real stocks (o) by firms or monetary stocks (h^h) by households:

$$o(t) = \max\left[0, s(t) - d(t)\right], \tag{18}$$

or:

$$h^h(t) = p(t)\max\left[0, d(t) - s(t)\right] \tag{19}$$

Internal finance constraints derive from these market disequilibria:

$$m(t) = p(t)\min\left[s(t), d(t)\right] \tag{20}$$

This marks the end of the period. At the junction between periods wages and prices change in response to disequilibria in the goods and labour markets:

$$\begin{aligned} g_p(t+1) &= \kappa\frac{d(t) - s(t)}{s(t)} \\ g_w(t+1) &= \nu\frac{L^d(t) - L^s(t)}{L^s(t)} \end{aligned} \tag{21}$$

where g_p and g_w are the rates of change of the price and the wage rate, respectively. Between periods we also have ageing of productive capacity:

$$x_{i+1}(t) = x_i(t-1), \quad \forall i = 1...n + N - 1 \tag{22}$$

In equilibrium this model behaves as a standard exogenous growth model. All variables grow at the population growth rate, and per capita income and consumption are constant. Expectations are fulfilled, co-ordination between construction and utilization is attained. This implies a given ratio of construction to utilization production processes to sustain a constantly growing flow of final output and the investment required to maintain this flow. When this is so, it is easy to see, investment and saving and supply and demand of final output are also harmonized. No constraints appear, and no stocks cumulate.

The characteristic of this model is nevertheless that it allows to analyze behaviours outside equilibrium, a field in which mainstream theory has little to say. Successive disequilibria between aggregate demand and aggregate supply arise out of the failure of intertemporal co-ordination between saving and investment. This co-ordination failure, we have just seen, results in

turn from a misalignment between production processes in the construction and in the utilization phases (necessary outcome of a shock of whatever kind), and prevents demand and supply to be adjusted at each moment of time. The force that drives the evolution of the economy is therefore the changes in the temporal structure of productive capacity, which no longer sustains a steady state. But, of course, in a world characterized by rational expectations, which means that agents maintain the required structure of productive capacity and do not revise their plans in reaction to current market disequilibria, considered as pure random events, the sequential dimension of the economic process would be cancelled and the structure of productive capacity would go back into the shade. It is therefore the joint effect of technical irreversibilities and adaptive expectations that causes a meaningful out-of-equilibrium dynamics, and hence allows to investigate the properties of our sequential economy.

We shall see that the out-of-equilibrium path followed by the economy as the result of a shock may lead to cumulative processes, and, in particular, that price stickiness may in that case be necessary to avoid the implosion of the system.

4 The Simulation Analysis

Numerical simulations allow to explore how our model behaves out of equilibrium. In particular, the simulation analysis carried out confirms Keynes' results that money wage flexibility may not be enough to eliminate unemployment, as its explanation is not confined to the labour market. The path followed by the economy is the result of a process where prices interact with quantities at the system level, and aggregate demand determines prices and real wages. However, our analysis goes beyond that, by extending to real wages Keynes' conclusions as regards money wages (thus challenging the classical inverse relation between real wages and unemployment also upheld by Keynes). The main result of our analysis, though, concerns the co-ordination failure between consumption and investment that both Keynes and Leijonhufvud indicate as the real source of the chain of effects leading to the above conclusions. The focus that we put on a breaking of the intertemporal complementarity of the phases of construction and utilization of productive capacity as the result of a shock of whatever nature hitting the economy deepens in fact the understanding of the saving-investment co-ordination failure by throwing light on its structural source and stressing its intertemporal character. A breaking of the intertemporal complementarity of the production process brings about co-ordination problems that may stir cumulative processes resulting in a threat to the viability of the adjustment path followed by the economy. Among other things, price stickiness may in that case be necessary to avoid the implosion of the system. The simulation

analysis investigates the effects of a shock on the economy described by our model, originally assumed to be in equilibrium, under different degrees of price and wage flexibility, and different monetary policies.

Demand or supply shocks may be at the origin of out-of-equilibrium adjustment processes. Here shocks matter only because they trigger adjustment processes. Our main focus is on the loss of co-ordination following the shocks, and on the role of different institutions (price and wage setting mechanisms, monetary policies) in helping or hampering the recovery of co-ordination. The essential role of these co-ordination mechanisms is attested, as we shall see, by the result that the same normative conclusions are obtained whatever the nature of the shock considered.

Let us start by describing in detail the effects of a demand shock. Consider an economy in a steady-state (at a rate $g^* = 0$), and assume that after thirty periods, a lack of confidence in the existing state of affairs induces firms to hoard a fraction ρ of their current revenues:

$$h_d^f(t) = \rho\,[m(t-1) - c(t)] \tag{23}$$

The shock stirs an out-of-equilibrium process which, given the behaviour of the control variable $f(t)$, mainly depends on the prevailing price and wage regimes. The case of fixed prices and wages is depicted in figure 1. Hoarding by firms reduces the wage fund: $\omega(30) = (1-\rho)\,[m(29) + f(30) - c(30)]$; consequently, the income perceived by the workers and their demand are reduced. An excess supply appears in the market for final output, and undesired stocks cumulate ($o(30) > 0$). In the following period, desired supply drops (because of adaptive expectations on the firms side), and stocks are put back on the market. As a consequence the desired production is lower than productive capacity, and the firms scrap some processes in the utilization phase. On the other hand, as we assume that the shock only lasts one period, money balances from previous periods are put back on the market. Thus we have excess demand on the market for final output (and, hence, undesired monetary stocks accumulated by households); the excess supply on the labour market persists, as production drops.

Due to the excess demand for final output the desired supply increases in the next period. However, as the available revenues from the previous periods are lower than they would be in the original steady-state, the external financial resources should increase at a higher rate to finance desired production and investment. If this is not the case, as we assume in the simulation of figure 1 ($\zeta = 0$), firms will be unable to invest as much as they want. The wage fund is thus reduced, demand becomes the short side of the market and firms cumulate real stocks.

The simulation shows an alternation of excesses of supply and demand which are gradually reduced as the adjustment process goes on. Each time the level of activity will drop, until a point where the wage fund will stop

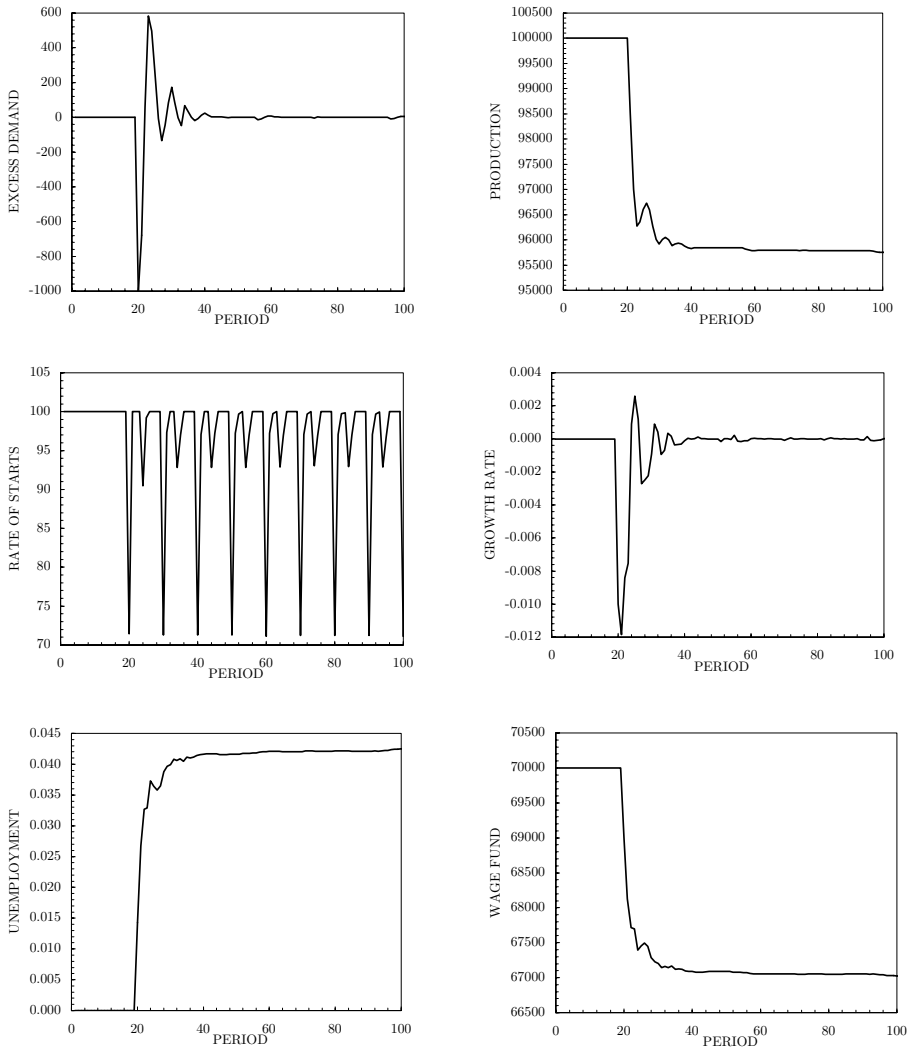

Figure 1: Time series. Aggregate demand shock with fixed price and wage ($\kappa = \nu = 0$) and tight monetary policy.

falling, and the demand will not further decrease. This will happen when expected and realized demand coincide. In the new situation, on the one hand financial constraints result in recurrent fluctuations in the rate of starts, which cannot be maintained at its previous equilibrium level. On the other hand supply and demand for final output are equal at a level which implies underutilization of labour. Summing up, the system settles on an pseudo-equilibrium characterized by a lower level of activity and positive unemployment: all plans are realized, except for the labour supply. This corresponds to the standard Keynesian equilibrium. This first simulation

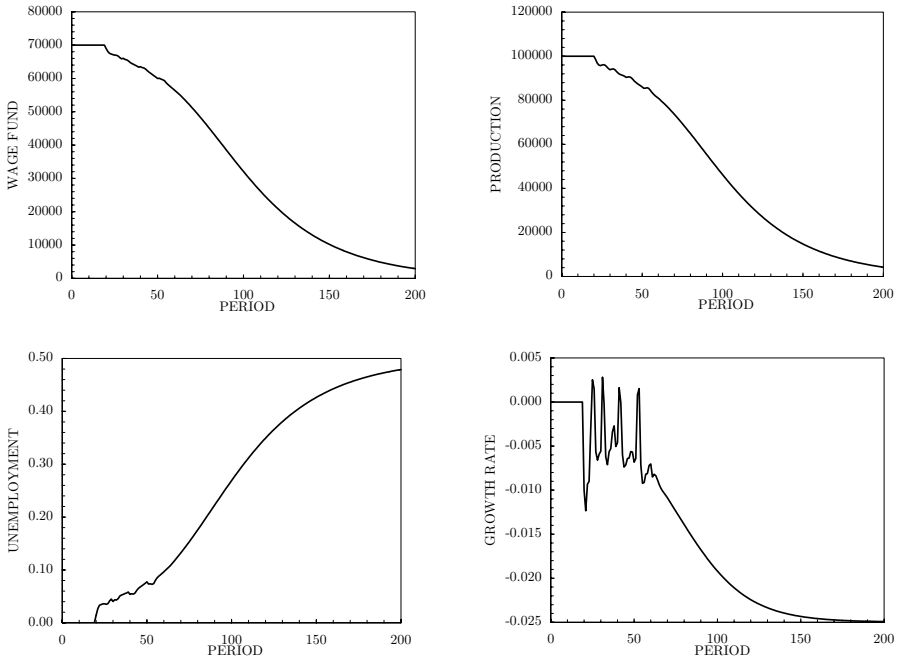

Figure 2: Time series. Aggregate demand shock with fixed price ($\kappa = 0$), flexible wage ($\nu = 0.05$) and tight monetary policy.

highlights the crucial role of wages as a component of demand. The decrease of the wage fund feeds back into the value of demand, which in turn causes scrapping and a further decrease of the wage fund. One may think that this 'Keynesian' effect is caused by the hypothesis of fixed prices, and that by allowing sufficient flexibility, the variation of prices and wages should bring the system back to equilibrium. This is what was checked next.

By allowing the money wage rate, and hence the real wage rate, to change ($\kappa = 0$ and $\nu = 0.05$), as in figure 2, the shock is not reabsorbed, and the system collapses. We said above that with fixed prices and wages the decrease of demand happens at a decreasing rate, so that desired supply sooner or later catches up. In this case instead, the mechanism described by Keynes develops: The wage deflation (due to the recurrent excess labour supply),

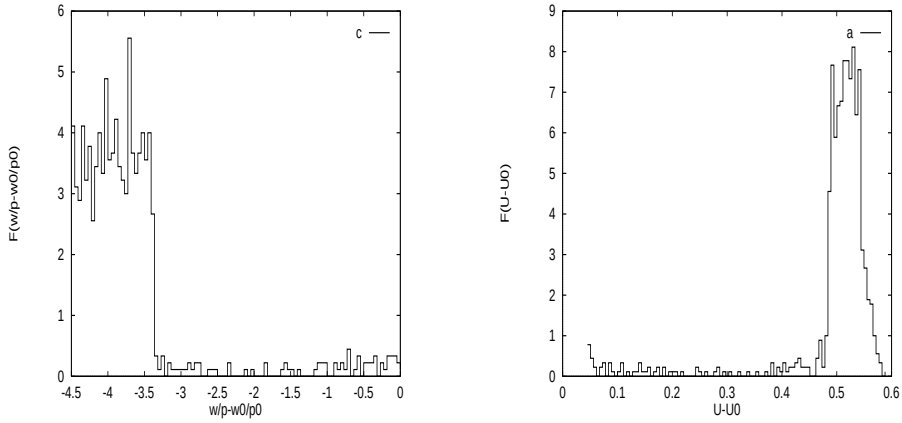

Figure 3: Histograms for a set of 900 simulations. Aggregate demand shock with fixed price ($\kappa = 0$), tight monetary policy, and a wage reaction coefficient randomly chosen in the interval $\nu \in [0, 0.5]$.

keeps negatively affecting aggregate demand by progressively reducing the wage fund. The process continues until production comes to a halt, and the system collapses. In other words, wage flexibility sets the system on a cumulative deflationary path, the same process envisioned by Keynes in a different context (see the quote of page 3 above). As a matter of fact only a positive demand shock, that is sustaining final demand, would allow to reverse the process.

The result suggested by the analysis of a particular time series is confirmed by a Monte Carlo experiment on a set of 900 simulations corresponding to different wage reaction coefficients randomly chosen in a given interval $[0, 0.5]$, with fixed price, by means of the Monte-Carlo method. For all these simulations unemployment has increased and real wages have decreased at the end of the run (figure 3).

The conjecture that it is wage behaviour that hampers the viability is confirmed by making prices flexible, while wages are kept constant. Figure 4 shows the same Monte-Carlo experiment, but having the price coefficient randomly chosen, while the wage rate is fixed. In most cases unemployment has slightly increased and real wages have slightly decreased at the end of the run, that is a new equilibrium has been reached. The effect of price flexibility is not as disruptive, because price drops affect at the same time demand and supply.

We can now summarize the results of this first set of simulations: *(i)* A shock entails a loss of intertemporal coordination, by disrupting the balance between construction/investment and utilization/production. *(ii)* This coordination failure affects the labour market, through changes in the wage fund and hence in aggregate demand. *(iii)* Wage flexibility does not help

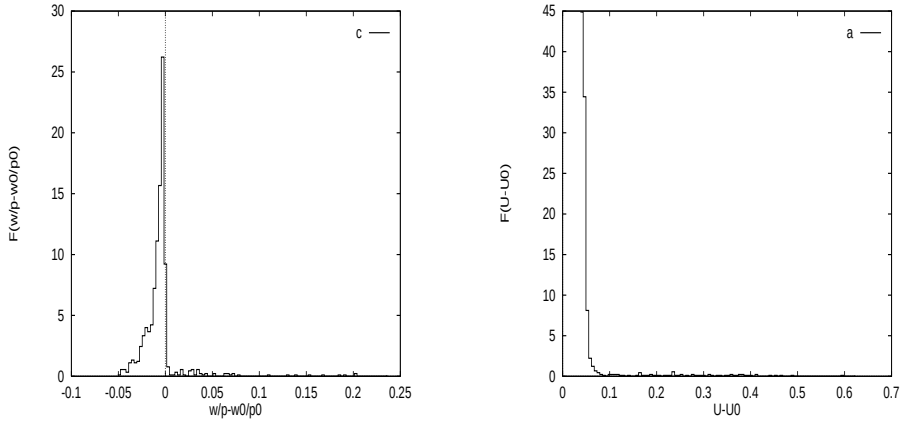

Figure 4: Histograms for a set of 900 simulations. Aggregate demand shock with fixed wage ($\nu = 0$), tight monetary policy, and a price reaction coefficient randomly chosen in the interval $\kappa \in [0, 0.5]$.

solve the problem because, as in Leijonhufvud, 'the source of the problem' does not lie within the labour market. Rather, it may trigger a cumulative deflationary process.

Now suppose that the same economy as before is hit by a different (and positive) type of shock: the introduction of a superior technology characterized by an increase in construction costs more than compensated by the reduction of costs in the following phase of utilization of the new productive capacity[6]. With fixed prices and wages, and if the supply of money follows the original steady-state growth rate of the economy, the aggregate supply shock results in a new equilibrium characterized by a persistent unemployment (figure 5). With a flexible wage rate ($\kappa = 0, \nu = 0.05$), co-ordination problems, resulting in distortion of productive capacity[7] bring about increasing levels of unemployment, and decreasing real wages (figure 6). In neither case the gains from the superior technique show in productivity figures; but wage flexibility increases the instability of the system. A lower flexibility of wages (up to $\nu = 0.01$, the figure is available upon request), may cause the system to settle down for a period, but the implosion will eventually occur. Price and wage rigidities may only delay a cumulative recession. For the productivity gains to be appropriated by the system monetary policy has to remove the liquidity constraints faced by firms. Figures 5 and 6 showed that fluctuations could not be adequately dealt with by firms, because any

[6]In the simulations we used $a^c = a^u = 8$, for the old technology, while for the new we have $a^c = 10$ and $a^u = 5$. The new technology is on average labour saving, but involves a larger effort in construction. The effects of technological shocks in the Hicksian framework have been extensively studied in Amendola and Gaffard (1998).

[7]We define the distortion of productive capacity as the ratio between the sum of the processes in utilization and the sum of the processes in construction.

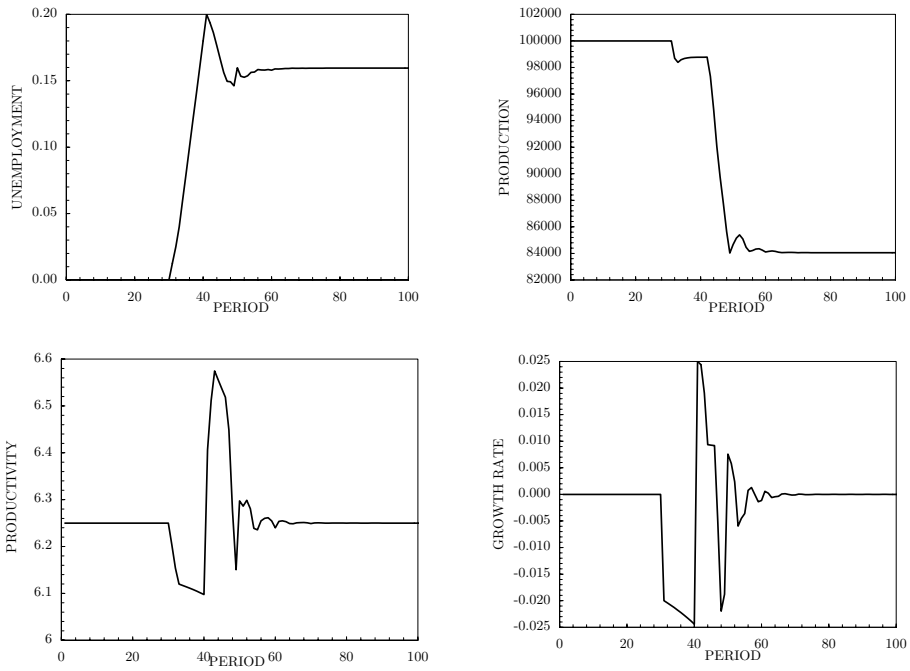

Figure 5: Time series. Supply shock with fixed prices and wages ($\kappa = \nu = 0$) and tight monetary policy.

attempt to invest and to bring productive capacity to its full employment level was frustrated by the lack of financial means. If we assume (as in figure 7, where $\zeta = \xi = 1$) a completely accommodating monetary policy on the part of the central bank (or equivalently a perfectly efficient financial market), investment is not constrained, the distortion of productive capacity is only temporary, and the shock does not result in permanent unemployment. In other words, the new and more productive technology is successfully incorporated into the system.[8]

The reader will have noticed that the qualitative behaviour, in the cases of supply and demand shocks, is extremely similar; this confirms our claim that the shock is only a trigger; the policy conclusion is then that the design of institutions suited to facilitate the recovery of co-ordination has to be independent of the type of shock.

To summarize the results, price and (especially) wage variability are unable to act as co-ordinating devices as is the case in the Neoclassical model; we share this conclusion with Keynes. Furthermore, we believe, with

[8]Notice that an accommodating monetary policy would have a role, even if less important, in case of a demand shock as well (figures available upon request). In fact, the demand drop reduces sales and hence internal funds; an accommodating monetary policy would allow firms to maintain a balanced structure of productive capacity, and hence avoid permanent effects of the demand shock.

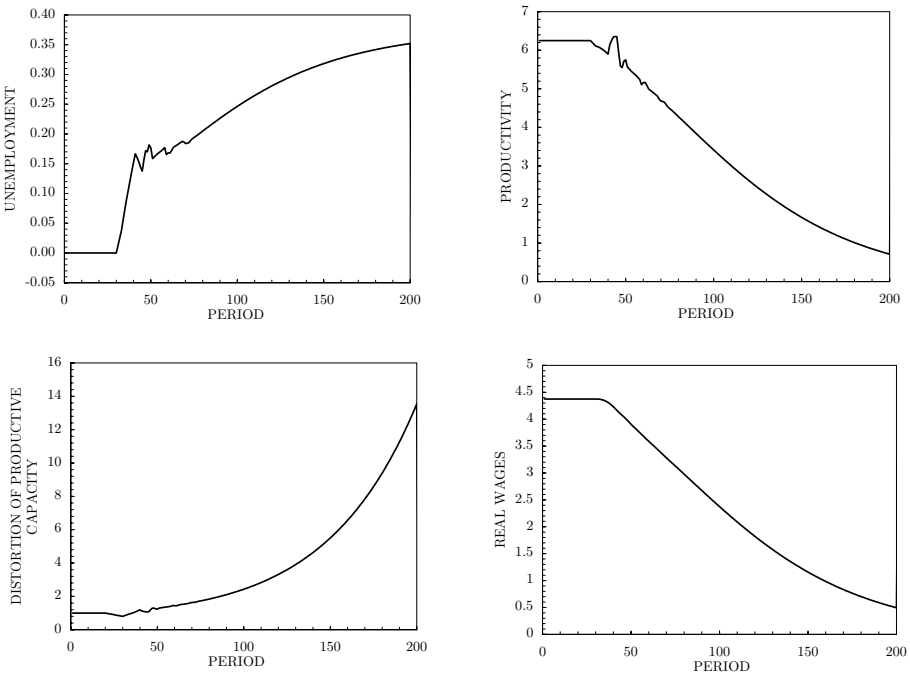

Figure 6: Time series. Supply shock with fixed prices ($\kappa = 0$) flexible wages ($\nu = 0.05$) and tight monetary policy.

him, that monetary policy has an essential role in reabsorbing the shock; but in both cases, as we shall see in the next section, the underlying reasons are different.

Notice in conclusion that the simulations clarify the analytical difference between perfect flexibility and strong variability of prices and wages. The very concept of flexibility relies on a tautology if by perfectly flexible we mean that prices and wages are at every instant at the value that equates supplies and demands. Not to be trapped into the tautology, flexibility must rather be conceived as strong price variability within the context of non clearing markets. The relation between employment and flexibility appears then under a completely different light. We just saw that it will be in fact the result of a complex adjustment process, and will depend on how this process actually evolves. Trading at false prices creates constraints and incentives that induce firms to take wrong production and investment decisions. And what happens sequentially to productive capacity is the reason of co-ordination problems which arise during adjustment processes. Thus the problem lies not so much in the persistence of a wrong price than in the effects on the structure of productive of an excessive volatility.

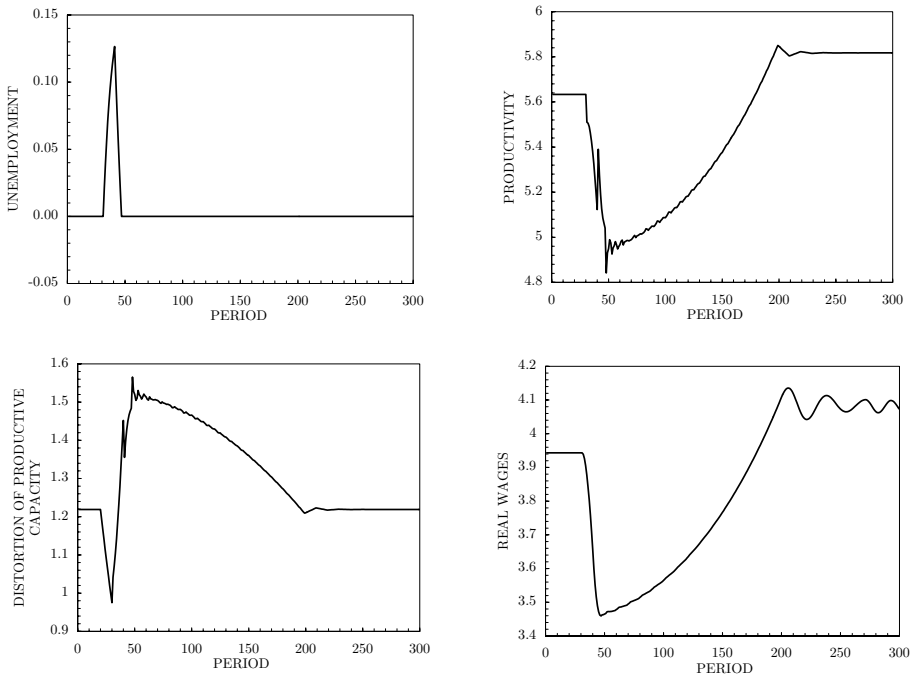

Figure 7: Time series. Supply shock with flexible wages and prices ($\nu = \kappa = 0.05$) and accommodating monetary policy.

5 Similarities and Differences

In our as well as in Keynes' model wage flexibility is not enough in order to eliminate unemployment. This is so because employment depends not only on what happens on the labour market but on a complex process where, among other things, changes in demand for output play a crucial role. But, this must again be stressed, we underline that this complex process is stirred by a breaking of intertemporal co-ordination that is seen at a deeper and more dynamic level than by Keynes and Leijonhufvud. The focus on the time structure of the production process deepens in fact the understanding of the origins of a co-ordination failure between saving and investment. While the problem of the 'right' or 'wrong' value of the interest rate (which is the determinant of the co-ordination failure of saving and investment in both Keynes and Leijonhufvud) can be treated within a short run equilibrium context, the focus on intertemporal complementarity problems evokes more properly a sequential disequilibrium process, stressing the links that shape its evolution and the conditions required for its viability. This has consequences both on the relation between real wages and employment and on the nature of economic policy. This is the way in which the essential Keynesian co-ordination problem is revisited here.

The fundamental issue raised by Keynes is whether an economy hit by a (negative) demand shock is able to return to a full employment equilibrium. One of the major results that he obtains is that money wage flexibility is not a good means for re-establishing this equilibrium, as it would not "have the effect of reducing real wages and might even have the effect of increasing them, through its adverse influence on the volume of output" (Keynes 1936, p. 269). Furthermore, resistance to money wages cuts is not necessarily a cause of persistent unemployment. On the contrary, it may be considered as a necessary condition for avoiding that a cumulative process propels the economy far away the full employment equilibrium. The emphasis on real wage effects also shows a distinguishing feature (and in our opinion a limit) of Keynes' unemployment theory, namely that it remains an essentially static theory, still firmly rooted into the classical inverse relation between real wage and employment. However, as Patinkin puts it "once we throw off the restrictions of static equilibrium analysis, we also free ourselves of the necessity of assuming wage rigidity as a necessary precondition of involuntary unemployment. For, during any given period of time, the dynamic workings of the system may well keep the workers at a point *off their supply curve.* In this departure from the supply curve lies the *involuntariness* of unemployment. The important point is that this situation can exist regardless of the shape of supply curve; that is, even if wages are not rigid" (Patinkin 1972 p. 30).

The model we presented avoids the limits of Keynes' static approach. As a consequence, there is no longer an inverse relation between real wage and employment. Decreasing nominal wages may have the effect of reducing real wages. But, in this case, unemployment, instead of being re-absorbed, may still be increasing. A major result of our sequential analysis of out-of-equilibrium processes, is that wage flexibility does not necessarily help to restore equilibrium face to an exogenous shock, whatever the nature of the shock; more than that, it may be harmful, by triggering processes that bring the economy farther and farther from equilibrium; this confirms the conclusions of Keynes as regards money wages flexibility, but extends this conclusion also to real wages flexibility. The reason for this result is that when adjustment is not instantaneous (both in the agent's decision processes and in the technological structure), and actions are irreversible, a frictionless system may become extremely unstable, while what are generally seen as 'market imperfections' contribute to smooth the effects of 'wrong' actions, and hence help maintaining the system viable. In a world characterized by adaptive behaviours, and by a temporally articulated production structure, the conventional wisdom is reversed: *market imperfections may be a factor of stability of the system rather than an obstacle on the way to fully optimal equilibria.* More specifically, given the characteristics of the system, the rigidity of wages is necessary to keep the system itself viable, and, as such, may be considered as the expression of a rational behaviour.

We stressed, on the other hand, that Keynes does not succeed in developing a dynamic framework, and hence has to rely on short run distortions in the price mechanism hard to defend when considering the long run. In our framework this result obtains because of intrinsic characteristics of the system (the existence of irreversibilities) and hence problems of co-ordination appear both in the long and short run.

Another point of contact between our analysis and the Keynesian approach is the importance of monetary policy. As stressed by Keynes, "while a flexible wage policy and a flexible money policy come, analytically, to the same thing, inasmuch as they are alternative means of changing the quantity of money in terms of wage units, in other respects there is, of course, a world of difference between them" (Keynes 1936, p. 267).

The 'world of difference' between these two instruments, in Keynes, in the neoclassical synthesis of Patinkin (1965), and more recently in Stiglitz (1999), is mainly distributional, concerning the burden of the adjustment. By focusing on the problems of co-ordination faced by a perturbed economy, our numerical experiments suggest another difference, namely the opposite effects of these policies on employment via the structure of productive capacity. A flexible or accommodating monetary policy allows to smooth liquidity constraints while the effect of flexible wages is to aggravate the distortions in the structure of productive capacity. In our analysis there is no analytical equivalence between monetary policy and wage flexibility, and hence the difference between the two instruments may not be reduced to a problem of 'social opportunity'.

To conclude, we believe that both Keynes (in the works that have been done after the Treatise and before the General Theory) and Leijonhufvud had the right intuition, when they put the problem of co-ordination at the centre of the analysis of involuntary unemployment. This problem was nevertheless treated within a static framework, in which the whole issue of co-ordination was reduced to a problem of Pareto inferior equilibria. This paper represents an attempt to focus on the problems of intertemporal co-ordination posed by a sequential economy within an out-of-equilibrium dynamic context. Our results support the Keynesian intuition, and unemployment emerges as the result of a lack of co-ordination, which is hampered by irreversible constrained choices. We believe that in doing so we succeed in strengthening Keynes' analysis, and in freeing his policy prescriptions from the fate of short run tools.

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