A note on Keynes' conjecture[1]

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"I shall argue that the postulates of the classical theory are applicable to a special case only and not to the general case, the situation which it assumes being a limiting point of the possible positions of equilibrium" (Keynes, General Theory, p. 3).

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Provisionary and incomplete version

Abstract. *General competitive equilibrium is refractory to the integration of involuntary unemployment as an equilibrium phenomenon. The purpose of this note is to put forward the conditions under which the existence of involuntary unemployment equilibria under perfect competition with correctly flexible perceived prices and wages are conceivable. We propose here a simple example of a competitive economy with persistent rationing in the labour market. Introducing supply constraint on the labour market, a continuum of equilibria with involuntary unemployment at flexible prices arises. Moreover, when expectations are not perfect, the efficiency of a wage decrease to cure unemployment depends critically on the value of price expectations with respect to current wages.*

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1. Introduction

Keynes' *General Theory* contains a conjecture relative to the existence of competitive equilibria with involuntary unemployment at flexible prices and non rigid wages. Three features may be noted. First, a Keynesian equilibrium is a state in which all markets are cleared except the labour market which presents a persistent excess supply. Involuntary unemployment is thus an equilibrium phenomenon. Second, wage rigidity can be exonerated as the cause of involuntary rationing. Third, wage cuts cannot generally cure the unemployment so the demand activation is the appropriate remedy. Under this perspective, Keynes' *General Theory* may be viewed as an essay of comparative static in which it is shown that underemployment equilibria with involuntary unemployment may persist despite wage variations.

[1] This paper is a first version of a research devoted to the logical foundations of involuntary unemployment in competitive market economies. A more advance and satisfactory version is in progress.

The purpose of this note is to determine the logical conditions under which the existence of involuntary unemployment equilibria under perfect competition with correctly flexible perceived prices and wages are conceivable. We consider two departures from the general competitive equilibrium theory. The first is that the labour market presents a supply constraint. According to Keynes views in chapter 2, the level of employment is determined by firms (Keynes' objection to the second postulate of classical theory). This idea has been initially developed by Clower (1965), Glustoff (1968) and more recently revived by Cartelier (1996). The first departure is associated with partial Walras' law and leads to a continuum of involuntary underemployment equilibria under flexible prices and given wages[2]. The second is the adoption of a temporary equilibrium structure without endowing the agents with rational expectations. This makes more precise the conditions under which the rationing equilibria of the current period can be persistent. We propose to use Hicks' concept of elasticity of expectation as developed in *Value and Capital* (1939). The efficiency of a fall in wages to cure unemployment depends then critically on the value of the elasticity of price expectations with respect to current wages[3]. We propose a simple example to illustrate such ideas. We see that there exists a continuum of involuntary unemployment equilibria under perfect foresight. In such a case the cause of involuntary rationing is wage rigidity. Second, we assume a regular expectation function and show that the effects of prices adjustments are limited by the value of the elasticity of wage expectation.

There is a vast literature on the subject in a general equilibrium. Nevertheless, the conjecture as defined previously has not been yet demonstrated. The main reason is the failure of the theory to make the concept of involuntary unemployment compatible with the logic of competitive equilibrium at flexible prices and wages (De Vroey (2004), Howitt (1990)). It is well known since Patinkin (1965) that, according to the real balance effect, involuntary unemployment is a temporary phenomenon occurring in disequilibrium. Three major lines of research have thus been developed. The first line is price-wage ridities (Bénassy (1993), Drèze (1975), Citanna and *alii* (2001)). The second puts forward the role of imperfect competition (d'Aspremont and alii (1990), Hart (1982), Grandmont and Laroque (1976)). The third is coordination failures approach (Diamond (1982), Heller (1986), Howitt (1990) and Roberts (1987)). In the latter approach, agents are always on their individual labour supply curves so there exist only underemployment equilibria without rationing, except in Roberts (1987).

The paper is organised as follows. In section 2 we present the economy. In section 3 we see that a reducing in wages under perfect foresight leads to lower unemployment. In section 3, we introduce an expectation function in order to study the effects of wage variations on unemployment. The results are not univocal. In section 4 we conclude.

2. The economy

Consider a two period private ownership economy with a large number of identical firms and identical consumers[4]. There are two commodities: one consumption good is produced in the future and the other (labour) is used as an input in the production process. The market system is incomplete so the agents have to make expectations regarding the value of the price of the good produced. We denote p_{t+1}^e the expected price which is assumed to be the same for all agents. The nominal wage is w_t. The economy is assumed to be perfectly competitive.

Firms. Each firm produces a good in period *t+1* in quantity x_{t+1} with labour used in quantity n_t, according to the following technology $x_{t+1} = (1/\alpha)n_t^\alpha$, with $\alpha \in (0,1)$. In order to finance their future plans, each firm issue bonds in quantity b_t. This financial asset is a promise to deliver one unit of money tomorrow for whom buy it today. We note $q_t = 1/(1+r_t)$ the price of bonds where r_t the nominal interest rate. The finance constraint of the firm writes $w_t n_t = q_t b_t$,. The program of the representative firm is denoted (P1) and can be written:

[2] Partial Walras' law may be viewed as an asymmetry between firms and consumers/workers (see Cartelier (1996)) or in terms of a supply constraint which applies only on the labour market.
[3] A similar view under imperfect competition is developed by R. Dos Santos Ferreira (1999).
[4] There is a large number of identical firms and consumers.

$$\underset{\{l_t, x_{t+1}\}}{Max} \frac{1}{1+r_t} p_{t+1}^e x_{t+1} - w_t n_t$$
$$s.t. \;\; x_{t+1} = (1/\alpha) n_t^{\alpha}$$
$$n_t \geq 0, x_{t+1} \geq 0$$

We deduce the labour demand and supply functions:

$$n_t = \left(\frac{1}{1+i_t}\right)^{\frac{1}{1-\alpha}} \tag{2.1}$$

$$x_{t+1} = \frac{1}{\alpha}\left(\frac{1}{1+i_t}\right)^{\frac{\alpha}{1-\alpha}} \tag{2.2}$$

These functions depend on the real interest rate $1+i_t = (1+r_t)/(w_t \,/\, p_{t+1}^e)$ and are continuous and homogeneous of degree zero. The profit function $\Pi_{t+1}/(1+r_t) = \alpha(1-\alpha)^{-1}(1/(1+i_t))^{\alpha/1-\alpha}$ is continuous and homogeneous of degree one. Moreover, $\partial n_t / \partial(1+i_t) < 0$, $\partial^2 n_t / \partial(1+i_t)^2 > 0$. Then $\partial x_{t+1} / \partial(1+i_t) < 0$, $\partial^2 x_{t+1} / \partial(1+i_t)^2 > 0$.

Consumers. Each consumer has the utility function $U^H = \frac{1}{1-\sigma} c_{t+1}^{1-\sigma} - \frac{1}{1+\varepsilon} l_t^{1+\varepsilon}$, with $\sigma, \varepsilon > 0$ .The program (P2) of the representative consumer is:

$$\underset{\{c_{t+1}, l_t\}}{Max} U = \frac{1}{1-\sigma} c_{t+1}^{1-\sigma} - \frac{1}{1+\varepsilon} l_t^{1+\varepsilon}$$
$$s.t. \qquad \frac{b_t^H}{1+r_t} \leq w_t \min(l_t, n_t)$$
$$p_{t+1}^e c_{t+1} \leq b_t^H + \Pi_{t+1}$$
$$l_t \geq 0, c_{t+1} \geq 0$$

1. In the case $l_t = n_t$, the supply function of labour and the demands for bonds and consumption functions are respectively:

$$l_t = (1+i_t)^{\frac{1-\sigma}{\varepsilon+\sigma}} \tag{2.3}$$

$$b_t = w_t (1+r_t)(1+i_t)^{\frac{1-\sigma}{\varepsilon+\sigma}} \tag{2.4}$$

$$c_{t+1} = (1+i_t)^{\frac{1-\sigma}{\varepsilon+\sigma}} \tag{2.5}$$

2. In the case $l_t > n_t$ the plans of consumers are constrained by the expenditures of firms:

$$b_t^H = w_t (1+r_t)\left(\frac{1}{1+i_t}\right)^{\frac{1}{1-\alpha}} \tag{2.6}$$

$$c_{t+1} = (1+i_t)^{\frac{1\alpha}{\varepsilon+\sigma}} + \left(\frac{1-\alpha}{\alpha}\right)\left(\frac{1}{1+i_t}\right)^{\frac{1}{1-\alpha}} \tag{2.7}$$

These functions have the desired properties.

3. Equilibria with perfect foresight and wage variation

Definition 1. A Walrasian temporary equilibrium with perfect foresight is a vector $\{w_t, r_t^*, p_{t+1}^*\}$ *and an allocation* $A^W = \{(x_{t+1}^*, n_t^*, b_t^*), (c_{t+1}^*, b_t^*, l_t^*)\}$ *such that the following three conditions are simultaneously satisfied:*

(i) the vector $\{w_t, r_t^*, p_{t+1}^*\}$ *clears all markets, i.e.,* $b_t = b_t^H$, $l_t = n_t$, , $x_{t+1} = c_{t+1}$,

(ii) at $\{w_t, r_t^*, p_{t+1}^*\}$ *the allocation* A^W *solves simultaneously (P1) and (P2),*

(iii) $p_{t+1}^e = p_{t+1}$.

Definition 2. A Keynesian equilibrium with perfect foresight is given by a vector of prices $\{w_t, \tilde{r}_t, \tilde{p}_t\}$ *and an allocation* $A^W = \{(\tilde{x}_{t+1}, \tilde{n}_t, \tilde{b}_t), (\tilde{c}_{t+1}, \tilde{b}_t)\}$ *such that the following three conditions are simultaneously satisfied:*

(i) the vector $\{w_t, \tilde{r}_t, \tilde{p}_{t+1}\}$ *clears the commodity market except the labour market which presents an excess supply, i.e.* $b_t = b_t^H$, $x_{t+1} = c_{t+1}$ *and* $U_t = l_t - \min\{l_t, n_t\}$,

(ii) at $\{w_t, \tilde{r}_t, \tilde{p}_{t+1}\}$, *the allocation* $A^K = \{\tilde{x}_{t+1}, \tilde{c}_{t+1}, \tilde{n}_t, \tilde{b}_t\}$ *solve (P1).*

(iii) $p_{t+1}^e = p_{t+1}$.

Result 1. *There exists a continuum of equilibria with perfect foresight; one is Walrasian, the other are Keynesian.*

Proof. In order to prove this proposition, consider first that the Walras' law holds. Secondly, we will show that its restriction is implied by the supply constraint assumption.

Step 1. We use the *Intermediate Value Theorem*[5]. We refer to the properties required on the utility function and the production function to deduce the properties on individual supply and demand functions on the labor market (continuity, limiting behavior at extreme values of the real wage rate):

H1: $(1-l_t)(w_t / p_{t+1}, (1-q_t)/q_t))$ and $N^d(w_t / p_{t+1}, (1-q_t)/q_t)$ are continuous.

H2: For $(w_t / p_{t+1}) = 0$, $(1-l_t)(0) = 1$ so $l_t = 0$. Moreover, since $\alpha \in (0,1)$, we have $n_t(0) \to \infty$.

H3: For $(w_t / p_{t+1}) = (\bar{w}_t / p_{t+1})$, i.e. $(\bar{w}_t / p_{t+1}) \approx \infty$, $(1-l_t)(\bar{w}_t / p_{t+1}) < 1$ and $n_t(\bar{w} / p_{t+1}) \to 0$.

Denote finally the market excess supply function for labour/leisure as $U(w_t / p_{t+1}, (1-q_t)/q_t) = 1 - (1-l_t)(w_t / p_{t+1}, (1-q_t)/q_t) - n_t(w_t / p_{t+1}, (1-q_t)/q_t)$. Here $U(0) < 0$ and $U(\bar{w}_t / p_{t+1}, (1-q_t)/q_t) > 0$, where $U(w_t / p_{t+1}, (1-q_t)/q_t)$ is continuous. By the Intermediate Value Theorem, we can find $(w_t / p_{t+1})^*$: $0 < (w_t / p_{t+1})^* < (\bar{w}_t / p_{t+1})$ so that $U((w_t / p_{t+1})^*) = 0$. Walras' law implies that $x_{t+1} = c_{t+1}$ at $(w_t / p_{t+1})^*$. This establishes $(w_t / p_{t+1})^*$ as a Walrasian equilibrium real wage.

Step 2. Consider now that the Walras' law is restricted to the output and bond markets. We have to show that this implies a continuum of involuntary unemployment equilibria in the bonds markets. First, we verify that the supply constraint is sufficient to produce a continuum of equilibria. Second, we show that partial Walras' law is a necessary condition.

Under supply constraint assumption we have the two equations which characterizes a Keynesian equilibrium $b_t(1/(1+i_t)) = b_t((1/1+i_t), U_t)$ and $U_t = l_t(1/(1+i_t)) - n_t(1/(1+i_t)) > 0$. They determine the real interest $(1/(1+i_t))^*$ and the level of unemployment U_t .When $0 < U_t \le U_{t,\max}$, where $U_{t,\max}$ is associated with $n_t = 0$, we have a continuum of equilibria parametered by the level of unemployment. Monetary prices p_{t+1} and r_t are flexible because they depend on U_t . The real interest rate decreases with the size of the rationing in the labour market.

We show now that the supply constraint implies the restriction of Walras' law. Aggregating all budget constraints over all agents gives $q_t b_t^H + w_t n_t = q_t b_t + w n_t$. This yields to $q_t(b_t^H - b_t) = 0$. *QED.*

Comments.

1. The restriction of Walras' law makes a disequilibrium in the labour market compatible with a general equilibrium in another markets (see Cartelier (1996)).

2. We can verify that the equilibria are Pareto ordered by the level of unemployment. These equilibria may be interpreted as coordination failures.

[5] "Let $[a,b]$ be a closed interval in IR and f a continuous real-valued function on $[a,b]$ so that $f(a) < f(b)$. Then for any real c so that $f(a) < c < f(b)$ there is $c \in [a,b]$ so that $f(x) = c$.

An example. Consider the following parameters values: $\alpha = 1/2, \sigma = \varepsilon = 1/3$. In the Walrasian case, we find $w_t / p_{t+1} = 1$, $(1+i_t)^* = 1$, $l_t = n_t = 1$, $x_{t+1} = c_{t+1} = 2$, $b_t = 1$. At a Keynesian equilibrium we find $(1+i_t)^* = 1+\tau$, $n_t = (1+\tau)^{-2}$, $x_{t+1} = 2(1+\tau)^{-1}$, $c_{t+1} = 2(1+\tau)^{-1}$ and $b_t = (1+\tau)^{-1}$, with $0 < \tau < 1$. We can verify that $U_t = 0$ when $\tau = 0$.

Result 2. *Under perfect foresight a reduction of wage decreases unemployment.*

Proof. We make a comparative static exercise. Consider a Keynesian with perfect foresight equilibrium in the continuum for a given wage. We suppose that the equilibria are stable. We want to know if a cut in wages reduces unemployment (the economy tends toward another K-equilibrium which is topologically nearer of the Walrasian equilibrium than the preceding). Consider the following system of equations of excess supply at a Keynesian equilibrium:

$$\begin{aligned} &\varphi^1(w_t, r_t, p_{t+1}, U_t) = 0 \\ &\varphi^2(w_t, r_t, p_{t+1}, U_t) = 0 \\ &\varphi^3(w_t, r_t, p_{t+1}, U_t) = 0 \end{aligned} \tag{2.8}$$

The functions φ^j, *j=1,2,3* all have continuous partial derivatives with respect to all the endogenous variables and exogenous variable. From the implicit function theorem, we will see that there exists a neighborhood of the Keynesian equilibrium in which the endogenous variables $\{\tilde{r}_t, \tilde{p}_{t+1}, U_t\}$ are functions of w_t in the neighborhood of a Keynesian equilibrium. These functions are regular (they have continuous partial derivatives) with respect to w_t. Differentiating this system with respect to the wage rate with $r_t = r_t(w_t)$, $p_{t+1} = p_{t+1}(w_t)$ and $U_t = U_t(w_t)$ and putting it in matrix form we find:

$$\begin{pmatrix} \dfrac{\partial \varphi^1}{\partial r_t} & \dfrac{\partial \varphi^1}{\partial p_{t+1}} & \dfrac{\partial \varphi^1}{\partial U_t} \\ \dfrac{\partial \varphi^2}{\partial r_t} & \dfrac{\partial \varphi^2}{\partial p_{t+1}} & -1 \\ \dfrac{\partial \varphi^3}{\partial r_t} & \dfrac{\partial \varphi^3}{\partial p_{t+1}} & \dfrac{\partial \varphi^3}{\partial U_t} \end{pmatrix} \begin{pmatrix} \dfrac{dr_t}{dw_t} \\ \dfrac{dp_{t+1}}{dw_t} \\ \dfrac{dU}{dw_t} \end{pmatrix} = - \begin{pmatrix} \dfrac{d\varphi^1}{dw_t} \\ \dfrac{d\varphi^2}{dw_t} \\ \dfrac{d\varphi^3}{dw_t} \end{pmatrix} \tag{2.9}$$

According to Walras' Law, some little algebra leads to the following equation:

$$\frac{dU_t}{dw_t} = \frac{\partial \varphi^3}{\partial r_t}\frac{dr_t}{dw_t} + \frac{\partial \varphi^3}{\partial p_{t+1}}\frac{dp_{t+1}}{dw_t} + \frac{\partial \varphi^3}{\partial w_t}. \tag{2.10}$$

This gives, under reasonable computation ($\alpha = 1/2$ and $\sigma = \varepsilon = 1/3$):

$$\frac{dU_t}{dw_t} = (1+3\tau)(1+\tau)^2 - 1 > 0. \tag{2.11}$$

QED.

4. Temporary competitive equilibria and wage variation

Under the imperfect expectation case, we have to endow the agents with some expectation function. Let us consider the following specification and with the reasonable values $p^e_{t+1} = \phi(w_t)$, with $\phi(0) = 0$, $\phi'(w_t) > 0$ and $(\phi / w_t)(\infty) = 0$ (see Grandmont [1983]). Then wage variations depend on the value associated with the elasticity of price expectations with current wages[6].

Definition 3. A Walrasian temporary equilibrium is a vector $\{w_t, r_t^*\}$ *and an allocation* $A^W = \{(n_t^*, b_t^*), (b_t^*, l_t^*)\}$ *such that the following two conditions are simultaneously satisfied:*

(i) the vector $\{w_t, r_t^*\}$ *clears all markets, i.e.,* $b_t = b_t^H$, $l_t = n_t$ *and,*

(ii) at $\{w_t, r_t^*, p_{t+1}^*\}$ *the allocation* A^W *solves simultaneously (P1) and (P2),*

[6] The wage rate is a parameter which can take different values. In order to simplify, we have not considered a spot market for the good produced. Otherwise we would have written $p^e_{t+1} = \phi(p_t)$.

Definition 4. A Keynesian equilibrium with perfect foresight is given by a vector of prices $\{w_t, \tilde{r}_t\}$ and an allocation $A^W = \{(\tilde{n}_t, \tilde{b}_t), (\tilde{b}_t)\}$ such that the following two conditions are simultaneously satisfied:

(i) the vector $\{w_t, \tilde{r}_t\}$ clears the commodity market except the labour market which presents an excess supply, i.e. $b_t = b_t^H$ and $U_t = l_t - n_t > 0$,

(ii) at $\{w_t, \tilde{r}_t\}$, the allocation $A^K = \{\tilde{n}_t, \tilde{b}_t\}$ solves (P1).

Result 3. *There exists a continuum of temporary equilibria; one is Walrasian, the other are Keynesian (to prove; in progress).*

See for example Grandmont [1983] or Hool [1976] in the context pf pure exchange economies.

Result 4. *When the value of the elasticity of price expectations with respect to the variations of current wages is less than one, then the wage decrease reduces unemployment. The converse is true for other values.*

Proof. We suppose the *tâtonnement* converges. We rewrite once more the matrix used in establishing the proof of result 2 and take into account of the learning procedure:

$$\begin{pmatrix} \dfrac{\partial \varphi^1}{\partial r_t} & \dfrac{\partial \varphi^1}{\partial p^e_{t+1}} & \dfrac{\partial \varphi^1}{\partial U_t} \\ \dfrac{\partial \varphi^2}{\partial r_t} & \dfrac{\partial \varphi^2}{\partial p^e_{t+1}} & -1 \end{pmatrix} \begin{pmatrix} \dfrac{dr_t}{dw_t} \\ \eta \dfrac{\phi}{w_t} \\ \dfrac{dU_t}{dw_t} \end{pmatrix} = - \begin{pmatrix} \dfrac{d\varphi^1}{dw_t} \\ \dfrac{\partial \varphi^2}{dw_t} \end{pmatrix} \tag{2.12}$$

Computing at the Keynesian equilibrium we find:

$$\frac{dU_t}{dw_t} = \frac{1}{1+\tau} \left\{ -[2 + (3+4\tau)(1+\tau)^2]\eta + 1 + (3+4\tau)(1+\tau)^2 \right\} \tag{2.13}$$

We must have $dU_t / dw_t > 0$, which is equivalent to:

$$\eta < \frac{1 + (3+4\tau)(1+\tau)^2}{2 + (3+4\tau)(1+\tau)^2} . \tag{2.14}$$

Remarks. First, we remark that $\eta < 1$ which is the condition for the existence of temporary equilibria. Second, when we approach the Walrasian temporary equilibrium $\eta \approx 5/6$ whereas the value of η must be sufficiently great in order to decrease the real interest rate.

The interpretation of Result 4 is the following (see also the interpretation of Leijonhufvud (1968)). The level of employment depends negatively on the real of interest. Since, the real interest is bounded below, the adjustment cannot be based on an increase in the price of bonds q_t, but merely on a less decrease of the expected price. The formation of expectations is here critical. When wages are decreased, the level of future prices increase only if the variations of expected prices are not too sensitive, if the value of price expectations with respect to current wages is less than one. The conclusion is reversed in the case for high values of η.

4. Conclusion

The logical foundations for the existence of competitive equilibria with involuntary unemployment are the supply constraint in the labour market which leads to partial Walras' law and the imperfection of expectations. Clower's intuition according to which "Either Walras' law is incompatible with Keynesian economics or Keynes has nothing fundamentally new to add to orthodox economic theory" is founded. The second ingredient is the Hicksian concept of elasticity of price expectations and its role in the market adjustment process.

The basic economy must be developed in order to integrate the cause of unemployment. There is no explanation here for the origin of involuntary unemployment.

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