







Università di Roma "La Sapienza"

# Technological unemployment: a discussion

Andrea Attar



Copyright © MMIII ARACNE EDITRICE S.R.L.  
00173 Roma, via Raffaele Garofalo, 133 A/B  
tel. (06) 72672222 telefax (06) 72672233

[www.aracne-editrice.it](http://www.aracne-editrice.it)  
[info@aracne-editrice.it](mailto:info@aracne-editrice.it)

ISBN 88-7999-561-8

*I diritti di traduzione, di memorizzazione elettronica,  
di riproduzione e di adattamento anche parziale,  
con qualsiasi mezzo, sono riservati per tutti i Paesi.*

I edizione: settembre 2003

# Technological unemployment: a discussion

Andrea Attar\*

University of Roma, La Sapienza and Catholic University of Louvain

## 1 Introduction

The objective of this work is to provide a critical assessment of the basic methodology advanced in current macroeconomic theories to understand the relationship between technological progress and unemployment.

The standard reference will be the so called *natural unemployment* schemes, that in what follows will be fully identified with *equilibrium unemployment theories*<sup>1</sup>.

Our conviction is that unemployment theories abandoned the representation of technological unemployment as a phenomenon with a definite temporal dimension, where it is possible to distinguish *over time* the phase of ejection from the phase of reabsorption of workers. This traditional way of thinking<sup>2</sup>, shared by authors like Wicksell, Marshall and Pigou, survived up to the eighty's<sup>3</sup>. The recent adoption of intertemporal equilibrium constructions definitively identified the notion of technological unemployment to the *logical* comparison of alternative equilibrium paths associated to different productivity parameters. The equilibrium nature of this comparison imposes to focus on economies which instantaneously adapt to the technique in use.

This work suggests an alternative research perspective where capital ac-

---

\*This work has been written when I was visiting IDEFI-CNRS. I want to thank J.L. Gaffard for his suggestions and encouragements, J. Joseph for useful comments, E. Campioni and M. Franchi for their collaboration in the simulative work. Usual disclaimer applies.

<sup>1</sup>Several authors (e.g. Nickell and Layard, 1999) insisted on the distinction between the general class of *Nairu* (non accelerating inflation rate of unemployment) schemes and the *natural rate* ones which define a subset of *Nairu* constructions where monetary policy is not able to affect the level of economic activity. This distinction can potentially offer some useful insights on the role of multiple equilibria or on the effects of staggered prices. However, our interest is to stress how current unemployment theories share the reference to a dynamic general equilibrium methodology, and makes the previous distinction not essential at this stage.

<sup>2</sup>That is, what Classical economists defined the *compensation theory*.

<sup>3</sup>A very articulated synthesis of the traditional way of characterizing technological unemployment in neoclassical theories is proposed in Gourvitch (1940), while the evolution of this notion in the postwar era is well surveyed in Vivarelli (1995).

cumulation has the role to ensure technological change to become *effective*, i.e. economically sustainable for the system. The pivotal element of such an approach is the belief that *complementarity*, rather than *substitutability* relationships are suited to characterize phenomena directly related to the temporal evolution of economic activity. We stress the role of two complementarity relationships: the first is induced by the expectations revision mechanism, and the second comes from the temporal structure of the production process.

Inside this perspective, the evolution of employment is studied as an *out-of-equilibrium* dynamics driven by such complementarity relationships. As a consequence, the unemployment induced by a structural technological change will be *involuntary* in a proper sense, that is, it will reflect a substantial impossibility of realizing individual plans.

The paper is organized in three sections. The first one presents the most recent equilibrium unemployment constructions. It aims at showing how these schemes unified the numerous research directions that had sprung from the seminal work by Phelps (1970). The synthesis is provided by an infinite horizon optimal growth framework embedding several forms of labor market imperfections. The section is self-contained and it can also be read as a critical survey work.

The last two sections develop a sequential economy along the lines of Amendola and Gaffard (1998) and try to compare the main predictions of this apparatus with some of those implied by natural unemployment schemes. In the view we suggest, the role of institutions turns out to be to sustain the innovation process all along the transition phase of adopting new techniques. The task for policy interventions becomes to guarantee the intertemporal coordination of economic activity, that is to reduce the fundamental distortions of productive capacity following the introduction of a structural change.

## 2 Market Imperfections and Equilibrium Unemployment

This section provides an overview of the alternative constructions recently suggested to provide a theoretical foundation to the natural unemployment notion and their relationships with technological progress.

The final step of these researches resulted in an extended predictive power of both unemployment theories and growth theories. Natural unemployment schemes are finally conceived as dynamic general equilibrium constructions; at the same time, traditional growth theories have come to embed non market clearing features, allowing for positive equilibrium unemployment.

As a consequence, natural unemployment has to be directly related with the variables *defining* economic growth, namely demographic factors and the pace of technological advance<sup>4</sup>.

---

<sup>4</sup>More general foundations have been provided in the recent generation of endogenous growth models with positive unemployment. See, among others, Aghion and Howitt (1994), Erikson (1997), Daveri and Tabellini (2000), Bean and Pissarides (1993).

## 2.1 Imperfect Competition and Information: Layard, Nickell and Jackman

The basic feature of the framework suggested by Layard, Nickell and Jackman (LNJ) (1991) is the emphasis on labor market imperfections as fundamental sources of equilibrium unemployment. The most recent contributions<sup>5</sup> to this stream of research share the belief that changes in factor productivity levels *do not* systematically affect the unemployment rate, with the main consequence that the only determinants of unemployment become behaviors and institutions that are *specific* to the labor market<sup>6</sup>. The determination of the equilibrium employment level results from the interaction of two aggregate relationships, the *Price Setting (PS)* and *Wage Setting (WS)* schedules. Such schedules may embed several forms of market imperfections and asymmetric information as determinants of the overall activity level<sup>7</sup>.

LNJ is the most representative *PS-WS* model, both for the huge empirical evidence proposed, and for the variety of analytical techniques employed.

They assume the existence of a finite number  $m$  of firms living in an imperfectly competitive environment, each endowed with a Cobb-Douglas technology

$$Y_i = \Lambda N_i^a K_i^{1-a} \quad i = 1, \dots, m \quad (1)$$

where  $\Lambda$  is a productivity parameter. The market demand for firm's  $i$  product is

$$Y_i = (P_i)^{-\eta} Y_{d_i} \quad i = 1, \dots, m \quad (2)$$

where  $P_i$  is the price of  $i$ -th output,  $Y_{d_i}$  is a demand index and  $\eta$  denotes the elasticity of demand. For a given nominal wage  $W_i$ , firm  $i$  sets the labor demand  $N_i$  and the price of her product in order to maximize her profits  $\Pi_i = P_i Y_i - W_i N_i$  under the constraints (1) and (2). As a consequence, we have that<sup>8</sup>:

$$N_i/K_i = [W_i/(P_i a \theta)]^{-1/(1-a)} \quad (3)$$

where  $\theta \equiv 1 - 1/\eta$  is a measure of market power. The other side of the labor market, that is the wage setting decisions, is studied assuming that

---

<sup>5</sup>Bean (1994), Blanchard and Katz (1997), Lindbeck (1993), Phelps (1992), Woodford (1994) and many others.

<sup>6</sup>Such a claim is apparently justified by empirical evidence: "Unemployment rates viewed over the very long run – for example, over the past century- appear to be un-trended in most nations, despite tremendous increases in productivity. Thus, any model should satisfy the condition that there is no long run effect of the level of productivity on the natural rate of unemployment" (Blanchard and Katz, 1997 p.11).

<sup>7</sup>The PS schedule is usually derived in monopolistic competition frameworks (Blanchard and Kiyotaki, 1987). Behind the WS schedule we usually find wage bargaining models or *efficiency wages* schemes *à la* Shapiro and Stiglitz (1984).

<sup>8</sup>See LNJ, p.102.

for each firm there is a separate wage union<sup>9</sup>, and that the wage rate is the outcome of a Nash (asymmetric) bargaining between this union and the firm. Given that  $V_i$  is the  $i$ -th union's payoff<sup>10</sup> and that starred values stay for reservation utilities, the wage rate is the outcome of the following problem:

$$W_i = \arg \max(V_i - V^*)^\beta (\Pi_i - \Pi^*) \quad (4)$$

Solving (4) and focusing on the symmetric macroeconomic equilibrium allocation<sup>11</sup> we are able to define the *Price Setting* and *Wage Setting* aggregate relationships. The equilibrium unemployment rate will be<sup>12</sup>:

$$u^* = \frac{1 - \alpha\theta}{(1 - b)(\varepsilon_{sn} + \alpha\theta/\beta)} \quad (5)$$

where  $B/W \equiv b$ . Hence, the productive technique in use (namely, the capital-labor ratio) *does not matter* in determining the unemployment rate; nor it is relevant the (average or marginal) factor productivity  $\Lambda$ . It seems then reasonable to claim that “[...]Unemployment in the long run is independent of capital accumulation and technical progress” (LNJ, p.107). Furthermore, having excluded persistent effects of capital accumulation or of technological advances on equilibrium unemployment, *structural malfunctioning* of the labor market becomes the only cause of a low level of activity.

In other words, LNJ work are suggesting a reformulated partial equilibrium approach to labor market.

It is also important to remark that their main prediction crucially relies on very strict conditions. In particular, Rowthorn (1999) has recently shown how the introduction of a production function with elasticity of substitution  $\sigma < 1$  may allow for a labor augmenting technical progress to positively affect equilibrium unemployment. Under a Cobb-Douglas technology, with unitary elasticity of substitution, the equilibrium distribution of output is independent of capital intensity; as a matter of fact, in the LNJ economy distribution is only affected by the coefficient  $a$  and the elasticity of demand  $\eta$ . The introduction a CES technology with  $\sigma < 1$ , enables to state that

<sup>9</sup>The aim is to reproduce a typical feature of UK labor market. Moreover, the authors argue that the extreme case of full decentralization is strictly superior, with respect to the employment outcome, to any form of partial decentralization.

<sup>10</sup>We remark that the  $i$ -th union target is the maximization of the insiders' income. If  $S_i$  is the proportion of insiders and  $A$  the outside option for the workers who lose their job, then insiders' income is given by  $V_i = S_i W_i + (1 - S_i)A$ .

Also notice that  $A \equiv (1 - \phi u)W + \phi uB$ , where  $W$  is the average wage rate,  $B$  is the unemployment benefit and  $\phi$  is a constant.

<sup>11</sup>That is, we consider the allocation  $W_i = W$ ,  $P_i = 1$ ,  $S_i = S$ ,  $N_i = N/m$ ,  $Y_i = Y/m$ , and  $K_i = K/m$ , where the absence of subscripts denote that we refer to aggregate variables.

<sup>12</sup>See LNJ (pp. 106, 107).

The aggregate *WS* schedule is defined by  $\frac{W - B}{W} = \frac{1 - \alpha\theta}{(\varepsilon_{sn} + \alpha\theta/\beta)\varphi u}$ , whereas the *PS* is  $W = \alpha\theta\left(\frac{K/N}{1 - u}\right)^{1-a}$ . Notice that  $\varepsilon_{sn}$  is the elasticity of the number of insiders with respect to employment.



the equilibrium share of wages positively depends on the capital-ratio output expressed in efficiency units:  $\pi \equiv \Lambda_K K / \Lambda_N N$ . Equilibrium analysis will then imply<sup>13</sup>

$$\frac{d(\Pi/y)}{d(\Lambda_k k / \Lambda_l l)} < 0, \quad \frac{du^*}{d(\Lambda_k k / \Lambda_l l)} < 0 \quad (6)$$

Now, a reduction in  $\pi$ , induced for example by an Harrod-neutral technological progress<sup>14</sup>, leads to a lower share of wages at equilibrium. Then, a higher unemployment rate is required to keep unchanged the union's reservation utility. As a by-product, the main policy implications should significantly differ from the LNJ ones: “[...] Growth in the labor supply or technical progress with a labor augmenting bias will cause a permanent rise in unemployment unless they are offset by additional investment. The policy implication is that measures to stimulate investment may have an important role in reducing unemployment. Moreover, measures to improve the quantity or quality of the labor force will lead to a higher unemployment rate unless they are accompanied by more investment in physical capital”<sup>15</sup>.

An even more disruptive critique of LNJ approach focuses on the absence of any intertemporal substitution mechanism. Manning (1992) shows that LNJ are not able to account for a distinction between changes in the *level* of factor productivity within a certain growth regime, and changes reflecting a modified growth rate. That is, they don't distinguish neutrality from *super-neutrality*, namely the invariance of equilibrium unemployment with respect to productivity growth. A proper dynamic analysis requires to consider productivity growth *within* the bargaining scheme. This in turn should imply a direct reference to an intertemporal equilibrium setup where the paths of natural unemployment and capital accumulation are endogenously determined.

This is the direction attempted by Phelps (1994).

## 2.2 Phelps in *Structural Slumps*

The various set of constructions advanced in Phelps (1994) explicitly consider intertemporal individual decisions together with a multiplicity of markets working simultaneously. *Structural Slumps* has the declared ambition of introducing “A modern paradigm of market equilibrium to challenge the competitive equilibrium of neoclassical theory” (from the *Preface*); this is done by allowing for the working of capital market, and by suitably characterizing the role of wealth effects in the price and wage setting decisions. Phelps presents

<sup>13</sup>Rowthorn (1999), p. 420.

The CES production function used by Rowthorn is:

$$Y_i = \left[ (1-a)\Lambda_K K_i^{(\sigma-1)/\sigma} + a\Lambda_N N_i^{(\sigma-1)/\sigma} \right]^{\sigma/(\sigma-1)}$$

Whenever  $\Lambda_K/\Lambda_N$  raises, then technological progress has a capital saving bias.

<sup>14</sup>An Harrod neutral technological progress is associated to progressive reductions in  $\Lambda_K/\Lambda_N$ . Notice that a reduction in  $\pi$  can be also induced by a contraction in the level of investment.

<sup>15</sup>Rowthorn (1999), p. 414.