

CRENOS
CENTRO RICERCHE
ECONOMICHE NORD SUD
Università di Cagliari
Università di Sassari

**GROWTH AND EMPLOYMENT:
A SURVEY ON THE DEMAND SIDE OF THE LABOUR MARKET**

Maria Gabriela Ladu

WORKING PAPERS



2005/07

Growth and Employment: A survey on the Demand Side of the Labour Market*

Maria Gabriela Ladu[†]

Università degli Studi di Cagliari and CRENoS

July 2005

Abstract

Until recently, the neoclassical growth theory and the neoclassical labour market theory have independently evolved over time without communicating to each other. The neoclassical growth theory (Solow, 1956), born after the second world war, assumes full employment. On the other hand, the unemployment theory (Friedman, 1968) turned the attention to the problem of inflation, ignoring that one of growth. In this paper I present recent contributions suggesting that such a sharp division may be unjustified from a theoretical viewpoint.

Keywords: Growth, Embodied and Disembodied Technological change, Employment

JEL Classification: E24, J64, O40

*This paper is mainly based on Chapter 1 of my PhD dissertation at the University of Cagliari.

[†]Address for correspondence: gabriela.ladu@crenos.it

1 Introduction

Until recently, the neoclassical growth theory and the neoclassical labour market theory have independently evolved over time without communicating to each other. The neoclassical growth theory (Solow, 1956), born after the second world war, assumes full employment. On the other hand, the unemployment theory (Friedman, 1968) turned the attention to the problem of inflation, ignoring that one of growth. However, some recent contributions have suggested that such a sharp division may be unjustified from a theoretical viewpoint.

The starting point of this survey is a brief description of the dichotomy between growth and employment. Then, after analysing the problems of this approach, I survey the new "growth and employment" literature. The first attempt to drop the dichotomy above-mentioned is represented by the contribution of Pissarides (1990). He finds a negative relationship between growth and unemployment: at higher growth rate, wages and vacancies are higher and unemployment lower. This effect of growth is called the "capitalization effect". At faster rate of technological progress all future income flows are discounted at a lower rate. Because the cost of creating a vacancy is borne now, whereas the profits from it accrue in the future, the lower discount rate increases job creation.

On the other hand, "Schumpeterian" models of growth (Aghion and Howitt, 1998) go in the opposite direction. The increased growth is likely to produce an increased rate of job-turnover, and the search theories of Lucas and Prescott (1974) and Pissarides (1990, 2000) imply that an increased rate of job-turnover will result in a higher natural rate of unemployment. The analysis of Aghion and Howitt uncovers two competing effects of growth on unemployment. The first is the "capitalization effect", whereby an increase in growth raises the rate at which the returns from creating a firm will grow, and hence increases the capitalized value of those returns. The second effect is the "creative destruction", according to which an increase in growth

may reduce the duration of a job match, which raises the equilibrium level of unemployment both directly, by raising the job-separation rate, and indirectly, by discouraging the creation of job vacancies and hence reducing the job-finding rate. Mortensen and Pissarides (1998) solve the apparent inconsistency between these point of view. They use a matching model to show that both types of effects ("capitalization" and "creative destruction") can be obtained, depending on the particular technological assumptions adopted.

Postel-Vinay (2002) claims that, while the short-run behavior of the conventional matching model is quite well known, not much has been said so far about the short-run behavior of unemployment in a creative destruction context. He compares the short-run and long-run effects of technological progress on employment developing a simple model of frictional unemployment that capture the negative creative destruction effects of technological change on employment. In the long-run, faster technological change accelerates job obsolescence, but in the short-run it has positive and potentially important effects on employment.

This paper provides an extensive review of the theoretical and empirical literature on "growth and employment" on the demand-side of the labour market.¹ This survey draws on some recent literature reviews as Aghion-Howitt (1998) and Pugno (1998). It also presents the new more recent contributions in the field.

2 Dichotomy

The neoclassical growth theory does not consider the monetary aspects which play a central role in the labour market analysis. Furthermore, it assumes perfect competition in the labour market and inelasticity of the labour supply with respect to real wage. These assumptions exclude the existence of

¹See Aricò (2003) for an analysis of some recent contributions about the problem of growth and unemployment on the supply-side of the labour market.

unemployment. Nevertheless, if elasticity of the labour supply with respect to real wage was positive, we could not have steady state economic growth with constant and positive unemployment.

Pugno (1998) introduces the labour market into the Solow growth model. The start point is the following production function :

$$Y = AN^\alpha K^{1-\alpha} \quad (1)$$

where $0 < \alpha < 1$ and Y , N , K are the output, the labour and the capital used in the economy, respectively. The growth rate is constant and exogenous:

$$\dot{A} = \bar{A} \quad (2)$$

The accumulation function is:

$$\dot{K} = s \frac{Y}{K} \quad (3)$$

where s is the propensity to save.

The equilibrium in the labour market is given by:

$$\dot{N} = n + \eta \dot{w} \quad (4)$$

where $0 < \eta < \infty$, n is the constant and exogenous growth of the population and η is the labour supply elasticity.

The steady state growth is given by:

$$g = \dot{Y} = n + \bar{A} \frac{1 + \eta}{\alpha} = s \frac{Y}{K} \quad (5)$$

If $\bar{A} > 0$, the wage in steady state grows because $\dot{w} = \frac{\dot{A}}{\alpha} > 0$ and the unemployment goes down at the rate $n - \dot{N} = -\eta \frac{\dot{A}}{\alpha}$.² But this result is not

²To obtain this result we first calculate the steady state growth $\dot{Y} = \dot{N} + \frac{\dot{A}}{\alpha}$ using equations (1) and (2). Then we substitute in the equation $\dot{w} = \dot{Y} - \dot{N}$ obtained by

consistent for a steady state solution. This is the “Solow problem”. In his most famous model, Solow assumed $\eta = 0$ and $\bar{A} > 0$, obtaining the solution $\dot{Y} = n + \frac{\bar{A}}{\alpha}$, where $\frac{\bar{A}}{\alpha} = \dot{\pi}$ is the technological progress Harrod-neutral. Later, he extended the labour supply function as in (4), but he imposed $\bar{A} = 0$, obtaining $\dot{Y} = n = \dot{N}$ and $\dot{w} = 0$. In this case, the unemployment is positive and constant, but there is no role for technological progress.

Another dichotomist approach between growth and unemployment is that of Layard, Nickell and Jackman (1991). The authors provide micro-foundations for their macroeconomic views. They do not consider the economic growth in their analysis of the labor market and they only marginally consider changes in capital and productivity. Wage bargaining and unemployment are modelled within a stochastic framework, using a combination of cooperative and non-cooperative game theory. The model generates powerful results. Suppose that unemployment benefits are always raised or lowered in line with wages, so as to keep the replacement ratio constant. Then, according to Layard, Nickell and Jackman, (1991), the equilibrium unemployment rate (NAIRU) is completely unaffected by variations in aggregate capital stock, aggregate labour supply or technical progress. If there is investment in new physical capital, trade unions will respond by forcing wages up to the point where the loss of jobs on existing equipment is exactly equal to the extra jobs created on the new equipment. If the labour supply is increased through population growth or higher labour force participation, then bargainers will adjust wages downwards to ensure that enough additional workers are absorbed into employment to keep the unemployment rate constant. The same is true if there is technical progress.

This approach solves the “Solow problem” because growth also takes place when unemployment rate is constant and positive.³

differentiation of the wage equation $w = \alpha \frac{Y}{N}$.

³Gordon (1995) repropose the dichotomy also showing that shocks in the labour supply, which affect unemployment, do not affect the growth rate, at least in the long-run.

3 New Theoretical Contributions

3.1 Complementarity between Capital and Employment

Despite the dichotomy between growth and unemployment has a strong tradition, some theoretical developments show that it is based on unrealistic assumptions.

Rowthorn (1999) argues that the literature on European unemployment has focused on labour market issues, such as wage fixing institutions, the role of welfare benefits, and the quality and motivation of the workforce.

Other potentially important issues, such as the impact of capital formation on employment, have been rather neglected. Indeed, many economists believe that investment has little or no long-run effect on employment. This is the view taken in the highly influential work of Layard, Nickell and Jackman (1991).

Rowthorn argues that the model used by Layard, Nickell and Jackman (1991) suffers from a potential weakness: it is assumed that labour and physical capital are close substitutes, so that variations in wages have a large effect on employment. This helps to explain why investment in new capital stock leads to no net job creation in the Layard, Nickell and Jackman (1991) model. Because the demand for labour is very elastic, the wage increase, generated by investment in new capital stock, leads to a loss of employment on existing equipment, which is enough to offset entirely the extra jobs created on new equipment.

Production functions in the Layard, Nickell and Jackman (1991) model are of the Cobb-Douglas variety in which σ , the elasticity of substitution between labour and capital, is equal to unity.

Rowthorn argues that this is an unrealistic assumption. If it is replaced by the more realistic assumption that σ is well below unity, then none of the major conclusion of the Layard, Nickell and Jackman (1991) model with regard to unemployment is valid. In this case, capital investment does cre-

ate employment even where benefits are indexed to wages; while growth in the labour supply, or technical progress with a labour augmenting bias will cause a permanent rise in unemployment unless they are offset by additional investment.

To derive this results, Rowthorn uses a version of the Layard, Nickell and Jackman (1991) model which has been modified in three respects. Firstly, the elasticity of substitution σ is less than unity. Secondly, demand functions facing individual firms are non-stochastic, unlike Layard, Nickell and Jackman (1991) model. Finally, the Rowthorn model specifically allows for technical progress, which plays an important role in his approach. His model shows that there is no dichotomy between economic growth and employment and he finds a negative relationship between the two variables.

3.2 Exogenous Growth and Employment

Another way to drop the dichotomy between growth and unemployment (employment) is by introducing search costs in the labour market. These results are obtained by models that are very different the one from the other.

3.2.1 The negative relationship

The Pissarides model (1990, 2000) is the first attempt in the literature to drop the dichotomy between economic growth and unemployment.

The central idea of the model is that trade in the labour market is an economic activity. It is uncoordinated, time-consuming, and costly for both firms and workers.

The number of jobs formed at any moment in time and the number of firms looking for workers are given by a well behaved matching function:

$$XL = X(uL, vL) \tag{6}$$

where L is the number of workers, u denote the unemployment rate and v

is the number of vacant jobs as a fraction of the labour force. Only the uL unemployed workers and the vL job vacancies engage in matching.

The matching function is assumed to be increasing in both arguments, concave and homogeneous of degree 1. Homogeneity, or constant returns to scale, is an important property: it is the only assumption that can ensure a constant unemployment rate along the balanced-growth path.

For convenience Pissarides introduces the v/u ratio as a separate variable, denoted by θ and he writes the rate at which vacant jobs become filled as:

$$q(\theta) = x\left(\frac{u}{v}, 1\right) \quad (7)$$

Unemployed workers move into employment according to a Poisson process with rate $x\left(\frac{uL, vL}{uL}\right)$. Using θ notation, this rate is equal to $\theta q(\theta)$.

θ is an appropriate measure of the tightness of the labour market. The dependence of the functions $q(\theta)$ and $\theta q(\theta)$ on the relative number of traders (tightness) is an example of a trading externality that will play a central role in Pissarides analysis. The trading externality arise because, in the trading sector of the economy, price is not the only allocative mechanism. There is a stochastic rationing, which cannot be eliminated by price adjustments. But it can be made better or worse for the representative traders by adjustments in the relative number of traders in the market. If the ratio of hiring firms to searching workers increases, the probability of rationing is higher for the average firm and lower for the average worker and conversely.

The flow into unemployment results from job specific shocks that effect occupied at rate s . Without growth or turnover in the labour force, the mean number of workers who enter unemployment during a small time interval is $s(1 - u)L\delta t$ and the mean number who leave unemployment is $XL\delta t$. Rewriting the latter as $u\theta q(\theta)L\delta t$, the mean rate of unemployment in the steady state is:

$$s(1 - u) = \theta q(\theta)u \quad (8)$$

Pissarides assume that the market is large enough so that deviations from the mean can be ignored and we can rewrite the equation above as an equation determining unemployment:

$$u = \frac{s}{s + \theta q(\theta)} \quad (9)$$

This is the first key equation of the model. Given s , and θ there is a unique equilibrium unemployment rate. s is a parameter of the model. θ is an unknown.

Firms Firms are small and each has one job that is either vacant or occupied by a worker. When the job is occupied the firm rents capital k at a rental r and produces output $f(k)$. When it is vacant, the firm is actively engaged in hiring at a fixed cost γ_0 per unit time.

Let J be the present-discounted value of expected profit from an occupied job and V the present-discounted value of expected profit from a vacant job. With a perfect capital market, V satisfies:

$$rV = -\gamma_0 + q(\theta)(J - V) \quad (10)$$

In equilibrium all profit opportunities from new job are exploited. Therefore, the equilibrium condition for the supply of job is $V = 0$, implying:

$$J = \frac{\gamma_0}{q(\theta)} \quad (11)$$

For an individual firm $\frac{1}{q(\theta)}$ is the expected duration of a vacancy, so equation (11) states that in equilibrium the number of jobs is such that the expected profit from a filled job is exactly equal to the expected cost of a vacant job.

In the labour market the job yields net return $f(k) - \delta k - w$, where $f(k)$ is real output, δk is capital depreciation and w is the cost of labour.

J is determined by the condition:

$$r(J + k) = f(k) - \delta k - w - sJ \quad (12)$$

where s is an adverse shock.

Maximizing J respect to k , we derive the equilibrium condition for the firm's capital stock:

$$f'(k) = r + \delta \quad (13)$$

The marginal product of capital is equal to the marginal cost of capital, the rental plus the depreciation rate. Using equation (12) to substitute J out of the equilibrium condition (11), we derive the key equation,

$$f(k) - (r + \delta)k - w - \frac{(r + s)\gamma_0}{q(\theta)} = 0 \quad (14)$$

This equation corresponds to a marginal condition for the demand for labour under constant returns to scale. $\frac{(r+s)\gamma_0}{q(\theta)}$ is the expected capitalized value of the firm's hiring cost.

Workers Workers have only an indirect influence on unemployment in this simple model, through their influence on wages. A typical worker earn w when employed and searches for a job when unemployed. During search the workers enjoys some real return z . Let U and E denote the present-discounted value of the expected income stream of, respectively, an unemployed and an employed worker.

Wages Let w_i be the wage rate negotiated between a firm and a worker when they meet. The wage derived from the Nash Bargaining solution is the w_i

that maximizes the weighted product of the worker's and the firm's net

return from the job:

$$(E_i - U)^\beta (J_i - V)^{(1-\beta)} \quad 0 \leq \beta \leq 1 \quad (15)$$

In symmetric situations β is equal to 1/2. More generally, there may be plausible bargaining situations that imply a different β , in which β may be interpreted as a relative measure of labour's bargaining strength. Pissarides treats β as a constant parameter strictly between 0 and 1.

The wage equation of the model is:

$$w = (1 - \beta)z + \beta[f(k) - (r + \delta)]k + \theta\gamma_0 \quad (16)$$

So the four equations determining equilibrium are:

$$u = \frac{s}{s + \theta q(\theta)} \quad (17)$$

$$f(k) - (r + \delta)k - w - \frac{(r + s)\gamma_0}{q(\theta)} = 0 \quad (18)$$

$$w = (1 - \beta)z + \beta[f(k) - (r + \delta)k] + \theta\gamma_0 \quad (19)$$

$$f'(k) = (r + \delta) \quad (20)$$

The equilibrium system is recursive. Given the interest rate, equation (20) determines the capital stock; with k determined, the set (18) and (19) determines wages and labour-market tightness; and with θ determined, equation (17) determines unemployment. The system may be further simplified by substituting wages from (19) into (18). Then 18 becomes:

$$(1 - \beta)[f(k) - (r + \delta)k - z] - \frac{r + s + \beta\theta q(\theta)}{q(\theta)}\gamma_0 = 0 \quad (21)$$

The equilibrium can be illustrated by the figure (1)

Trade equilibrium is represented by equation (17), the condition that

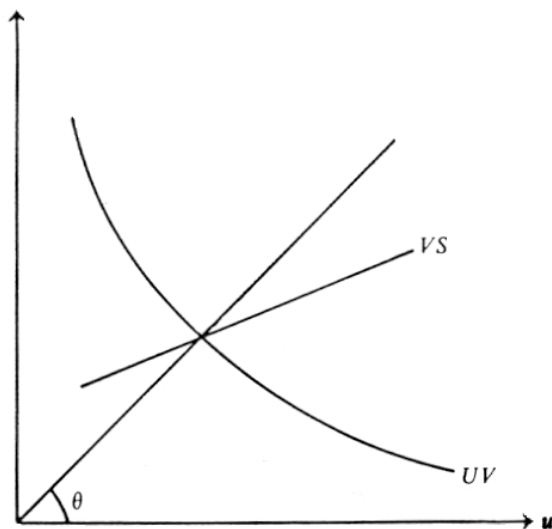


Figure 1: Vacancies, unemployment, and labour market tightness

equates flow into unemployment with flows out of it. In the $u - v$ space, the equation (17) corresponds to what is often called UV , or Beveridge curve.

The second curve drawn describes the equilibrium in production. Equilibrium in production is derived from the block (18) and (19). The intersection of this line with the UV curve determines equilibrium vacancies and unemployment.

To extend the static labour-market model to a model of balanced growth, Pissarides (1990, 2000) introduces growth in the labour-force and labour-augmenting technical progress. He changes the specification of two elements of the model: the hiring cost and the value of time of the employed worker.

Let $F(K_i, N_i)$ be a constant returns to scale production function, where K_i is the capital of firm i and N_i is the employment of firm i .

Let L denote the labour force and suppose that it grows at the rate n . The flow into unemployment consists of workers who have lost their jobs, $s(1 - u)L$, and of new entrants to the labour force, nL . The flow out of

unemployment consists of workers who find jobs, $q(\theta)\theta uL$. In the steady state inflows must exceed outflows by nuL , since unemployment must grow at the rate n . Hence, in equilibrium:

$$s(1 - u)L + nL - q(\theta)\theta uL = nuL \quad (22)$$

The equilibrium unemployment rate is:

$$u = \frac{s + n}{s + n + q(\theta)\theta} \quad (23)$$

The effect of growth in the labour force on the steady state condition for unemployment is the same as the effect of higher structural change in the economy. Unemployment goes up, given the labour market tightness, because more workers now join the unemployment pool. Nothing else changes in the system. The wage bargain is still the same. So θ is unaffected by labour force growth. The aggregate capital stock, employment, unemployment, and the number of job vacancies all grow at the same rate n .

Growth in the labour force shifts the UV curve to the right, see figure (2):

Since in equilibrium the $\frac{u}{v}$ ratio is unaffected, growth shifts also the VS curve up and to the left, such that the intersection of the new UV and VS curves is on the original line through the origin. Thus, growth in the labour force raises both unemployment and vacancies. Unemployment goes up because the new labour force entrants first enter the unemployment pool.

Suppose now that there is labour-augmenting technical progress at rate $g < r$; the production function changes to:

$$F = F(K_i, e^{gt} N_i) \quad (24)$$

The interest rate is assumed to be exogenous and the supply of capital is infinite, an assumption that it is extreme in a model of long-run growth but

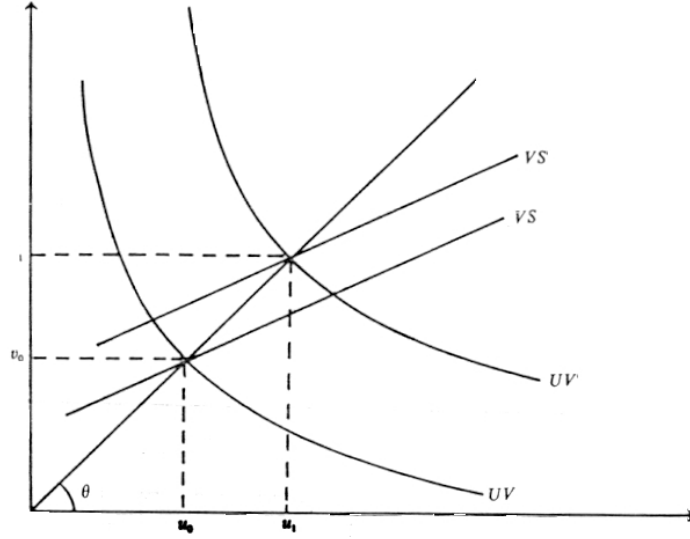


Figure 2: The effects of labour-force growth on equilibrium vacancies and unemployment

helpful in the analysis of unemployment.

As in the standard neoclassical model, technological progress is “disembodied”, in the sense that all existing and new jobs benefit from the higher labour productivity without the need to replace their capital stock.

Defining k as the ratio of the aggregate capital stock to the “efficiency units” of labour, and $f(k)$ as the product for each efficiency unit of labour, $f(k)$ and the marginal products of capital and labour satisfy:

$$f(k) = \frac{1}{e^{gt}N} F(K, e^{gt}N) = F\left(\frac{K}{e^{gt}N}, 1\right) \quad (25)$$

$$F_k = f'(k) \quad (26)$$

$$F_n = e^{gt}[f(k) - kf'(k)] \quad (27)$$

By constant returns to scale each firm will have the same ratio k as in ag-

gregate. So:

$$f'(k) - r - \delta = 0 \tag{28}$$

Since k is defined in terms of efficiency units of labour, the aggregate capital stock grows at the rate of growth of the efficiency units of labour, $n + g$.

k is constant in the steady state, so given θ , wages grow at the rate of technical progress g . The rate of technical progress influences equilibrium labour market tightness. Pissarides finds that at higher g , θ is higher. With higher θ , wages and vacancies are both higher and unemployment lower. This happens because the firm incurs in some hiring costs, in order to acquire workers who will yield some profit in the future. If the firm knows that in the steady state hiring costs rise at the same rate as profits, it can economize on future hiring costs by bringing forward some hiring. So at higher rates of growth, it goes into the market with more vacancies.

The effect of growth derived above is the “capitalization effect”. At faster rate of technological progress all future income flows are discounted at a lower rate. Because the cost of creating a vacancy is borne now, whereas the profits from it accrue in the future, the lower discount rate increases job creation.

3.2.2 The positive relationship

The theoretical work of Aghion and Howitt (1998) is as important as that one of Pissarides but it goes in the opposite direction. The main consideration that leads the authors to think that the question about the relationship between growth and unemployment in the long run is interesting has to do with the re-allocative aspect of growth. Faster economic growth must come from a faster increase in knowledge. If the advancement of knowledge is embodied in industrial innovations it is likely to raise the job destruction rate, through automation, skill obsolescence, and the bankruptcy associated with the process of creative destruction. So the increased growth is likely to produce an increased rate of job-turnover, and the search theories of Lucas and Prescott (1974) and Pissarides (1990, 2000) imply that an increased rate

of job-turnover will result in a higher natural rate of unemployment.

The analysis of Aghion and Howitt uncovers two competing effects of growth on unemployment. The first is the “capitalization effect”, whereby an increase in growth raises the rate at which the returns from creating a firm will grow, and hence increases the capitalized value of those returns. The “capitalization effect” encourages more firms to enter. This raises the number of job openings in the steady state equilibrium, as in Pissarides’s analysis, thereby reducing the equilibrium rate of unemployment by increasing the job-finding rate.

The second effect is the “creative destruction”, according to which an increase in growth may reduce the duration of a job match, which raises the equilibrium level of unemployment both directly, by raising the job-separation rate, and indirectly, by discouraging the creation of job vacancies and hence reducing the job-finding rate.⁴

The model The economy is composed of a continuum of agents, infinitely-lived. Each individual is endowed with a flow of one unit of labour services and a stock of X units of human capital. The utility function is given by:

$$U(c) = E_0 \int_0^{\infty} c_t e^{-rt} dt \quad (29)$$

where $r > 0$ is the subjective rate of time preference, and c_t is the individual’s consumption of a final good at time t . There is a continuum of firms, infinitely-lived. Each firm should be thought as a research facility for producing new knowledge. Let D_t be the sunk cost of setting-up a research facility at date t . Each firm generates a stream of innovations according to a Poisson process with a parameter λ .

⁴See Mortensen and Pissarides (1998) for a clear explanation about the different conclusions of Aghion-Howitt model and Pissarides model.

The output flow of a production unit at time s is equal to:

$$y_s = A_t \Psi(x_s - a) \quad (30)$$

where $a > 0$ is the minimum human capital input representing overhead costs; Ψ is regular production function, $A_t = A_0 e^{gt}$ is the unit's productivity parameter. Aghion and Howitt in this model assume that growth of the leading technology A_t depends upon an exogenous invention process, taking the growth rate g as given.

The source of unemployment in the model is labour re-allocation across firms. The aggregate flow of new matches is a function of the mass of searching workers and the mass of vacancies. In this model the whole labour force is involved in the matching process. So the rate of matching will be $m(1, v)$, where v is the number of vacancies in the economy. A firm spends the amount of time $1/q$ searching before its machine is matched with an appropriate worker and a worker must wait $1/p$ units of time before being successfully matched with a machine. Whenever $\frac{1}{p(v)} > S$ (S is the life time of a production unit), there will be a positive amount of (involuntary) unemployment in the economy.

The flow of workers into unemployment is $(1 - u)\frac{1}{S}$, where u is the unemployment rate; the flow out of unemployment is the job-finding rate $p(v)$. So the unemployment equation is:

$$u = 1 - Sp(v) \quad (31)$$

The “direct creative destruction” effect of growth on unemployment derives from the fact that any production unit has to incur a fixed overhead cost in human capital whose price in terms of final consumption rises at the economy-wide rate of growth. Thus a production unit with fixed technology becomes unable to produce enough to cover its fixed cost. The faster the price of human capital grows, the sooner the production units will hit the zero-profit

bound. So, there is an inverse relationship between the growth rate g and the duration of a match S .

Aghion and Howitt have found other two opposing effects of growth rate on the firm's incentive to enter and therefore on the equilibrium rate of vacancy creation v . First, it will reduce the net discount rate at which firms capitalize their expected income, which increases the present benefit of entry. This is the "capitalization effect", which increases the equilibrium level of vacancies v and hence decreases unemployment. Second, an increase in growth reduces the life time of production units and induces a faster decline of profits. So, an increase in growth reduces the value of each innovation and tends to reduce the firm's incentive to enter and create vacancies. This is the "indirect creative destruction" effect.

So, Aghion and Howitt have found three effects of growth on unemployment: the "direct creative destruction" effect, which increases u ; the "indirect creative destruction" effect, which also increases u and the "capitalization" effect, which reduces u .

Whether the overall effect will be to raise or reduce u will depend upon the relative strength of these effects. The numerical example made by the authors suggest that the unique (steady state) equilibrium unemployment rate $u^*(g)$ can be represented as an inverted U -shaped function of g , whenever the entry cost is positive but sufficiently small. For high growth rates the "capitalization" effect dominates.

Following Aghion and Howitt (1998), Pissarides (2000) analysis the "creative destruction" effect of growth on unemployment. He supposes that technology is embodied in new capital investment. Instead of the disembodied technology of the preceding model (1990), which benefited all existing jobs, new technology now can benefit only jobs that explicitly invest in new equipment. In this case, higher rate of growth implies lower θ . This result contrasts with those derived for the case of disembodied technological progress, where for a given r market tightness is higher at the higher rate of technological

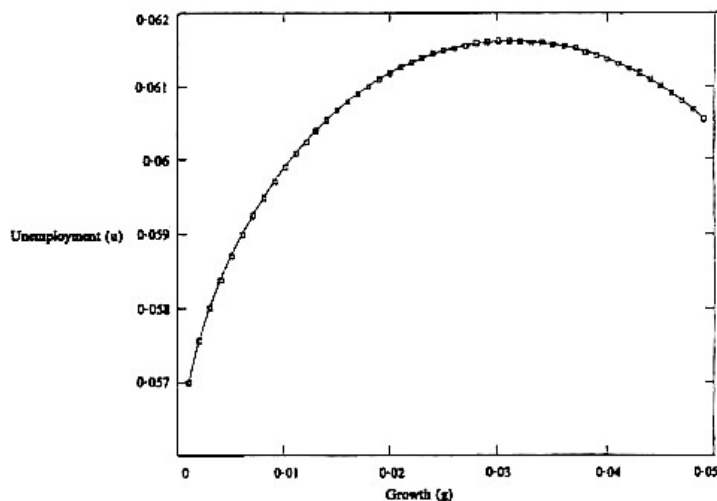


Figure 3: Growth and Unemployment relationship

progress. The reason is that whereas in the case of disembodied progress both revenues and costs rise faster when there is more technological progress, in the case of embodied progress only costs rise in existing jobs.

Thus the “capitalization” effect in the latter case works against jobs creation, since revenues are received at a flat rate but costs are paid at an increasing rate.

Anyway, the apparent inconsistency between Pissarides and Aghion and Howitt points of view is simply resolved by Mortensen and Pissarides (1998). They show that both types of results (“capitalization” effect and “creative destruction” effect) can be obtained, depending on the particular technological assumptions adopted. The “capitalization” effect rests on the assumption that technology is disembodied, as in the Solow model. This implies that firms are able to update continuously their technology, without costs and no obsolescence. The “creative destruction”, instead, rests on the assumptions that technology is embodied. This implies that only new jobs can take

advantage from technological improvement and existing jobs cannot benefit from it.

Pissarides and Vallanti (2004) propose a new equilibrium model which shows that the net impact of Total Factor Productivity growth on employment is negative when new technology is embodied in new jobs but positive when it is disembodied. This model draws heavily on models with frictions and quasi-rents by Pissarides (2000), Aghion and Howitt (1998), Mortensen and Pissarides (1998) and others.

To derive the growth effects Pissarides and Vallanti assume that job creation requires some investment on the part of the firm, which may be a set-up cost or a hiring cost. Growth influences job creation through capitalization effects and job destruction through obsolescence. The precise influence on each depends on whether new technology can be introduced into ongoing job relationships, or whether it needs to be embodied in new job creation. Both types of results can be obtained, depending on the particular technological assumptions adopted. Following Mortensen and Pissarides (1998), Pissarides and Vallanti assume that there are two types of technology. One, denoted by A_1 , can be applied in existing jobs as well as new ones: this is the disembodied technological progress, as in Solow model, and existing jobs can take full advantage of new technological improvements. The other, denoted by A_2 , can only be applied in new jobs: this is the “Schumpeterian” assumption of embodied technology. Let the rate of growth of A_1 be λa and the rate of growth of A_2 be $(1 - \lambda)a$, with $0 \leq \lambda \leq 1$, so the total rate of growth of technology is a . The parameter λ measures the extent to which technology is disembodied. If $\lambda = 0$, this implies the extreme “Schumpeterian” assumption of embodied technology and if $\lambda = 1$ we have the Solow disembodied case. The parameter a is the rate of growth of TFP in the steady state and is observable while the parameter λ is unobservable by the econometrician, but Pissarides and Vallanti calculate an approximate value for it from the empirical estimates of their model.

3.2.3 Growth, wealth and the natural rate

Hoon and Phelps (1997) study the effect of faster technical progress using a general-equilibrium incentive-wage model of the natural rate of unemployment. In its closed economy version, the model implies that, in the limit, as the steady-growth rate is approached, the increase in the rate of progress is neutral for the natural unemployment rate. Its effects are completely offset by the equal increase in the rate of interest (r) it induces. In the open economy, however, the increase of the productivity growth rate (λ) reduces the net-of growth interest rate, $r - \lambda$. An increase in this interest rate has a substitution effect: it encourages employees not to quit now, but later when wages will be lower. A reduction of this net interest rate from faster wage growth put the substitution effect into reverse: quit now, not later when wages will be higher and also the opportunity cost of quitting. However, it may be that there is little substitutability between present and future consumption, and likewise, little substitutability between present enjoyments on the job and future ones. So, the substitution effect may be small.

3.3 Endogenous Growth and Unemployment

In the models so far considered the economic growth was originated by an exogenous increase of the productivity or an exogenous capital accumulation. In this section we will introduce models in which the economic growth is endogenous.

3.3.1 Endogenous innovations

Aghion and Howitt (1998) extended their basic model, coming closer to endogenous growth models by assuming that innovations are the unique source of growth. More specifically, if λ denotes the arrival rate of innovations in each firm, γ is the size of technological improvements, and f is the total

number of innovating firms in the economy, we have:

$$g = \lambda f \ln \gamma \quad (32)$$

In steady state equilibrium, the flow of new plants must be equal to the flow of all plants that become obsolete. The former is λf ; the latter is the same as the flow of workers into unemployment, $(1 - u)\frac{g}{\Gamma}$.⁵

So we have:

$$\lambda f = (1 - u)\frac{g}{\Gamma} \quad (33)$$

From (32) and (33) we get:

$$g = (1 - u)\frac{g}{\Gamma} \ln \gamma \quad (34)$$

The effect of the two sources of growth, namely the frequency and the size of innovations, on unemployment is unambiguous. Consider first the effect of an increase in the frequency parameter λ . Using (32) and (33) we have:

$$1 = (1 - u)\frac{\ln \gamma}{\Gamma} \quad (35)$$

hence $\frac{du}{d\lambda} = 0$; an increase in the frequency of innovations has no effect on unemployment since it increases both the flow of new plants and the flow of old plants which become obsolete in the same proportions. On the other hand, an increase in the size of innovation speeds up the obsolescence process without affecting the job creation rate directly and unemployment will increase.

3.3.2 Endogenous growth and search costs

In the models so far considered causality runs from growth to unemployment. But the existence of causality links working in the opposite direction,

⁵ $\frac{g}{\Gamma}$ is the rate of plant obsolescence and $(1 - u)$ is the number of plants using any given technological vintage.

i.e. from unemployment to growth, seems very likely. Bean and Pissarides underline one of the possible channels through which unemployment may affect long run growth, combining an endogenous growth model of the Arrow-Romer type with a matching model of the labour market.⁶

The technology is given by:

$$Y_t = F(\bar{K}_t, N_t K_t) = K_t f(n_t) \quad (36)$$

where Y_t is the output in period t , N_t is employment, K_t is the capital stock at the beginning of period t and $n_t = \bar{K}_t N_t / K_t$.⁷

The labour market is characterized by matching frictions. Potential workers and employers have to search for each other. All matches last one period and the matching technology for aggregate employment is given by:

$$\bar{N}_t = m(\bar{J}_t; L_t) \quad (37)$$

where \bar{J}_t is the aggregate number of jobs opened at the start of period t and L_t is the number of young households.

Householders become capitalists in the second period of their lives. Profits are:

$$\Pi_t = K_t f(n_t) - w_t N_t - q_t J_t \quad (38)$$

where w_t is the wage and q_t is the cost of opening up a job slot. Bean and Pissarides assume that $q_t = \chi \bar{K}_t$.⁸

Because of the matching frictions, there are rents to be shared from a successful match between the firm and a potential worker. Bean and Pissarides assume that the wage is determined as the outcome of a Nash bargain between the firm and the individual worker. The authors describe household preferences by a linearly homogeneous utility function, $U(C_1^t, C_2^t)$, where C_1^t

⁶Modified to allow for an overlapping generation structure.

⁷A bar over a variable indicates an economy-wide quantity.

⁸Hiring costs rise with the state of technical progress

is the consumption in youth and C_2^t is the consumption in old age. In that case maximum utility is given by:

$$\max_{C_1^t, C_2^t} U_t = V\left(\frac{1}{R_{t+1}}\right) y_t \quad (39)$$

where R_{t+1} is the return on savings between period t and period $t + 1$, and y_t is income.

The wage satisfies:

$$w_t = \arg \max [V(\frac{1}{R_{t+1}})(w_t - t_t) - V(\frac{1}{R_{t+1}})z_t]^\beta [\bar{K}_t f'(n_t) - w_t]^{1-\beta} \quad (40)$$

where t_t is a per capita tax paid by workers and z_t is an unemployed worker's income. Bean and Pissarides assume that taxes and unemployment income rise with the state of technology so that $t_t = \tau \bar{K}_t$ and $z_t = \xi \bar{K}_t$. The parameter β provides an index of relative bargaining strength. The wage is just a weighted average of the marginal revenue product and the opportunity cost of working:

$$w_t = [\beta f'(n_t) + (1 - \beta)(\xi + \tau)] \bar{K}_t \quad (41)$$

The labour market equilibrium is described by:

$$f'(N_t) - g(N_t) = \xi + \tau \quad (42)$$

where $g(N_t) = [\chi \frac{m^{-1}(N_t)}{N_t} + \beta N_t f''(N_t)](1 - \beta)$.

The first component in $g(N_t)$ reflects the additional cost of bringing capital and labour together, which tends to reduce employment relative to the frictionless economy. The second component captures the strategic use of employment by the firm to affect the outcome of the wage bargain; because higher employment lowers the marginal product and thus also the wage, this tends to raise employment above that in a frictionless economy. The authors

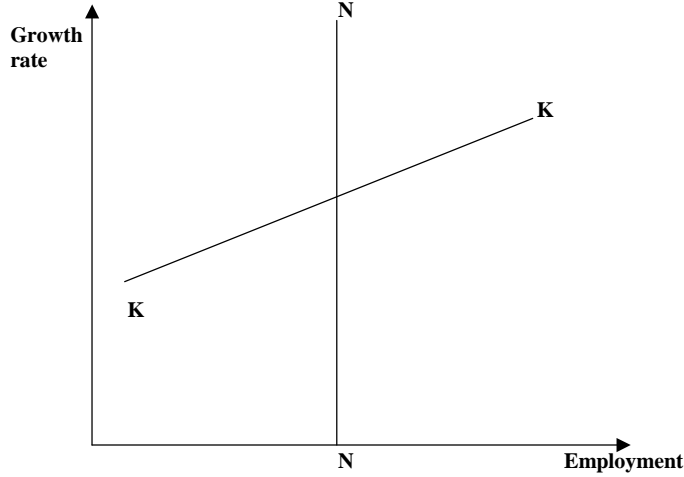


Figure 4: Determination of Equilibrium

make the assumption that $f''(N_t) < g'(N_t)$, so the overall effect is to reduce N_t .

The evolution of the capital stock is described by the following equation:

$$\frac{K_{t+1}}{K_t} = s(R_{t+1})[(w_t - t_t)N_t + z_t(1 - N_t)]/K_t \quad (43)$$

The determination of the equilibrium can be shown in the diagram in figure (4).

NN is the labour market equilibrium schedule, while KK is the capital market equilibrium schedule. Along a balanced growth path with a constant employment rate, the rate of growth of output is just $\frac{K_{t+1}}{K_t} - 1$.

Bean and Pissarides make some interesting comparative static exercises. First, they consider a reduction in hiring cost. This shifts the NN schedule out, raising both employment and the rate of capital accumulation and growth. Second an increase in taxes, τ has the opposite effect, shifting the NN schedule in and KK schedule down. Finally, an increase in the propen-

sity to consume shifts the KK schedule down, lowering the rate of growth but leaving employment untouched.

A more interesting result is the effect of increasing the relative bargaining strength of workers, β . The effect on growth is ambiguous. On the one hand the increase in bargaining strength shifts income entrepreneurs to workers. Since in this model it is the workers who do the saving, Bean and Pissarides get a sort of anti-Kaldorian result. This is not the only effect because, provided the “strategic effect” is not too strong, unemployment will rise which, by reducing the available pool of savings, tends to reduce the growth rate. The overall effect on the growth rate depends on which effect dominates.

Bean and Pissarides extend their model in one in which consumption and investment goods are now distinct. They analyze the mechanism through which an increase in the propensity to consume raise both output and investment. This mechanism relies not on the traditional Keynesian accelerator, but rather on a “new Keynesian” story of imperfect competition in the consumption good sector.

3.3.3 Trade-off between growth and employment

Eriksson (1997) investigates how unemployment and the long run growth influence each other in the steady state. The work is built on Pissarides but Ramsey preferences are introduced, influencing the interest rate.

One main finding (subject to the qualification that consumers’ intertemporal elasticity of substitution is small) is that there is a trade-off between successful growth and high unemployment, if one considers exogenous change in the growth rate, or in the productivity parameter in the production function when there is endogenous growth. On the other hand, when growth is affected in indirect ways (i.e. when growth is endogenously changing in response to variations in parameters such as the capital tax rate or the unemployment benefit) variations in exogenous parameters that decrease unemployment also make growth more successful. Since such variations can arise

anywhere in the economy, the author finds not only that growth conditions affect unemployment, but also that labour market conditions affect growth.

3.3.4 Endogenous capital accumulation

Postel-Vinay (1998) takes the standard search model of Pissarides (1990) and allows for endogenous capital accumulation and for unbounded endogenous growth by means of a production externality implying non-decreasing returns to capital. The model shows the existence and uniqueness of a balanced growth path. The economy is basically the same as that of Pissarides (1990). Time is continuous, and all variables are indexed by time. All agents have perfect foresight. One good is produced by a large (fixed) number of identical firms, using labour and capital as inputs. The production technology is the following:

$$Y_t = f(K_t, \bar{K}_t l_t) \quad (44)$$

where Y_t is the representative firm's output, K_t is the stock of capital in that firm, and l_t is the quantity of labour it employs. \bar{K}_t denotes the aggregate stock of capital, which appears here as a Romer style externality to make unbounded endogenous growth possible.

Jobs are determined at same exogenous rate of “structural change” μ , so that employment in the representative firm evolves according to:

$$\dot{l}_t = q(\bar{\theta}_t)v_t - \mu l_t \quad (45)$$

θ is the usual tightness parameter, $q(\bar{\theta}_t)$ is the hiring rate.

$$\bar{\theta}_t = \bar{v}_t / \bar{u}_t \quad (46)$$

where \bar{u}_t is the number of unemployed workers, \bar{v}_t is the number of vacant jobs at same date t .

The dynamic equation for the tightness parameter is:

$$\eta_{\theta,t}^q \frac{\dot{\theta}_t}{\theta_t} = f'_1(1, l_t) + \mu \frac{q(\theta_t)}{\gamma_t} [K_t f'_2(1, l_t) - w_t] - \frac{\dot{\gamma}_t}{\gamma_t} \quad (47)$$

where $\eta_{\theta,t}^q > 0$ denotes the elasticity of the hiring rate q , γ_t is the real cost of a vacancy per unit time.

Finally, the author assumes that labour is supplied inelastically, and that the amount of labour available is normalized to one. This normalization implies that $u_t = 1 - l_t$. This allows to rewrite the equation (40) in terms of (θ_t, l_t) :

$$\dot{l}_t = \theta_t q(\theta_t)(1 - l_t) - \mu l_t \quad (48)$$

Households They supply labour without disutility. They work, consume and lend capital to the firms. They are endowed with a C.E.S. function, with intertemporal elasticity of substitution σ , and a discount factor ρ . If c_t is the consumption, it evolves according to the Keynes-Ramsey rule:

$$\frac{\dot{c}_t}{c_t} = \sigma(r_t - \rho) \quad (49)$$

Comparative statics The comparative statics made by the author suggests that the sign of the relationship between the long run rate of growth and the steady state level of employment is not totally clear-cut. In particular, the only effect of a stronger bargaining power of the worker, like that of more generous unemployment compensation or heavier hiring costs, in this simple model is to raise the cost of labour, thus lowering employment. Unlike Bean and Pissarides 1993), in this model there is not an “anti-Kaldorian” effect of a rise in the earnings of workers, since Postel-Vinay does not assume different saving behaviors of workers and capitalists.

From an empirical perspective, if one believes that the observed dispersion in labour market performances stems from different degrees of rigidity in

labour market institutions, then the model predicts a negative cross-sectional relationship between growth and unemployment.

3.3.5 Growth, Unemployment and Labor Market Policy

Mortensen (2004) studies an economy characterized by the Schumpeterian model of endogenous growth as developed and studied in Grossman and Helpman (1991) and Aghion and Howitt (1998). The single consumption good is produced with a variety of intermediate goods and services. A new more productive or higher quality version of each intermediate input arrives from time to time at a rate endogenously determined by collective R&D investment. Labor is the only factor used to produce intermediate goods and services and it can also be used to provide research effort. The rate at which unemployed workers are matched with firms is determined by a function of unemployed workers and vacancies, denoted $M(u, v)$. By assumption the matching function is increasing, concave and homogenous of degree one in its arguments, vacancies v and unemployment u . The wage is determined as the outcome of bilateral bargaining problem. The free entry condition, the equality of the expected cost of innovation with the expected present value of the future rents attributable to an innovation, requires that a negative relationship holds between market tightness and the rate of creative destruction. New firms with job vacancies flow into the stock of potential entrants at the rate of creative destruction and out of the stock at the rate at which firms with vacancies are matched with production workers. The steady state condition, which requires the equality of these two flows, and the labor force identity, which implies that the available labor force must be divided into between those who are employed in production, employed in research, and unemployed, requires that a positive relationship holds between market tightness and the rate of creative destruction. An equilibrium solution to the model is a creative-destruction rate and a labor market tightness ratio that satisfy both these conditions. Unemployment is determined by the labor

market steady state conditions, while the growth rate is the product of the rate of creative destruction and the log of quality step size.

In the model, unemployment and the aggregate growth rate are simultaneously determined. As a consequence there is no clear prediction about how the two should be correlated across countries and time. Therefore, the model suggests a list of joint determinants of the two variables. So, an increase in the bargaining power of workers increases the worker's share of the profit earned by a producing firm. The rate of creative destruction and market tightness both fall with bargaining power and the unemployment rate rises. Labor force shocks identify the positive relationship between unemployment and growth implied by the free entry condition while interest shocks identify the negative relationship implied by the labor market steady state condition and the employment identity. Finally, R&D productivity increases the equilibrium growth rate but the net effects on labor market tightness and unemployment are unclear.

The model shows the effect of labor market policy on unemployment and growth. An increase in the unemployment compensation or the payroll tax increases the cost of labor and the market tightness is adversely affected. The demand for labor decreases with tax and unemployment benefit. Therefore more workers are available for employment in R&D. Unemployment increases but the net effect on the rate of creative destruction is ambiguous.

Finally, the model shows that employment protection policy reduces the return to job creation through innovation and entry, the growth rate is adversely affected by employment protection.

3.4 Unemployment and Technology

Postel-Vinay (2002) shows the short-run behavior of unemployment in a creative destruction *context*. He supposes the “correct” model is that of “Schumpeterian” inspiration and the economy leaves no space for any form of capitalization effect, so that a speedup in growth eventually leads to a fall

in long-run employment. Postel-Vinay shows that the short-run behavior of unemployment in response to a sudden change in the rate of technological progress is in some sense “perverse”, since it goes in the opposite direction to its own long-run tendency. In the long-run, faster technological progress accelerates job obsolescence, which reduces equilibrium level of employment. But in the short-run it has a positive and potentially important effects on employment. The intuition behind this result is the following. Creative destruction entails a drop in the present value of new jobs. Firms offer less jobs because they anticipate the drop in profitability and, as a consequence, the available number of new jobs decreases. This makes existing jobs more valuable. Indeed, by cutting the opportunity costs of older matches, faster technological change postpones their destruction and because of the decreasing of the job destruction rate, the level of employment rises. The dynamic behavior of unemployment exhibits one essential feature: whatever is the sign of the technological shock, it causes unemployment to start a motion in a direction that contradicts its final long-run variation. Therefore, the prediction of Aghion and Howitt (1998) and Mortensen and Pissarides (1998) that a speedup in technological progress would worsen long-run unemployment should come with the restriction that the short-run predictions of this kind of models are exactly the opposite. Postel-Vinay (2002) argues that this restriction is important since it may help the "Schumpeterian" model to fit the data.

The subsequent dynamics are characterized by a phenomenon known in the vintage capital literature as *echo effects*. Technologies become obsolete after a certain period of time, say T . A job created at some date t will be destroyed when reaching age T . As a results, everything happening at t on the side of job creations echoes at $t + T$ on the side of job destructions. This implies that the initial adjustment of unemployment is periodically reverberated in the dynamics, leading to a non-monotonic convergence of unemployment towards its steady state value. Furthermore, the dynamic behavior of un-

employment in the model is asymmetric. In fact, a slowdown in technical change produces a faster, and more important in magnitude, short-run rise in unemployment than the short-run drop coming after a speedup in technical change. These features are usually respectively referred to as *steepness asymmetry* and *deepness asymmetry* in the empirical literature.

Summarizing, Postel-Vinay (2002) shows that faster (slower) technological change has a positive (negative), and potentially important short-run influence on the level of employment by causing a short-run drop (surge) in job destruction.

Those results seem to reconcile the "Schumpeterian" view with the observed data. For instance, those results tend to partially reconcile the "Schumpeterian" view of the effects of technological change on labor markets with the response of unemployment rates in most OECD countries to the 1970s productivity slowdown.

4 Empirical contributions

This section illustrates some empirical contributions that try to shed light on the relationship between growth and employment. It is worth emphasizing the fact that empirical studies in this field are still few with respect to the theoretical contributions. Furthermore, there is no consensus regarding the sign of the correlation between growth and employment either across countries or across long periods of time in the same country.

Bean and Pissarides (1993) study the simple correlation between unemployment rate and measures of productivity growth across OECD countries over the periods 1955-1965, 1965-1975 and 1975-1985. In particular, they study the simple correlation between unemployment rate and labor productivity growth, and between unemployment rate and Total Factor Productivity growth. Their results show that there is mild evidence of a negative relationship between the two variables over the full sample but this is primarily

a consequence of the fact that the 1975-1985 period was one of both lower productivity growth and higher unemployment than the two earlier periods.

Caballero (1993) organizes a few very preliminary empirical application of Bean and Pissarides model. The data are quarterly from 1966 to 1989 for U.S.A. and UK. Since the main concern of Bean and Pissarides paper is with medium/long-run issues, Caballero filters out the high frequency components of the data.⁹ In the first experiment Caballero studies the comovement of unemployment and per capita growth, through a reduction in hiring costs. He finds a positive correlation at the medium/low frequency for both countries, while it is positive for UK but zero or even negative for USA at very low frequencies. This evidence suggests that the correlation between growth and unemployment is all but clear. However, if one must pick a sign, positive seems more appropriate than negative.

In the second experiment, an increase in the bargaining power of workers, he finds that the correlation between growth and labour share -controlling for unemployment- is essentially zero for USA and very negative for UK.¹⁰

The third experiment consists in analyzing what happens if the marginal propensity to consume increases. Caballero uses corporate profits data (filtered) for the USA, to proxy for medium/low frequency variations in the degree of competitiveness. Then he tests if the product of these measures and the consumption/income ratio (as a proxy for the marginal propensity to consume) are positively correlated with growth, controlling for unemployment. Caballero finds that the conditional correlation is positive and very significant.

Hoon and Phelps (1997) report a strong positive correlation between the change in unemployment and the extent of the slow down in productivity

⁹Caballero presents two sets of results: the first one leaves only the very low frequency component of the data, while the second one only removes the very high frequency component.

¹⁰The results must be taken with some caution since conventional t-statistics are inappropriate when data are filtered.

growth over the same time period analyzed by Bean and Pissarides (1993) across the G7 countries. Among those countries, it appears that Japan is an outlier maybe because of firing inhibitions or an increased undercount of the unemployment.

Postel-Vinay (2002) reports results of numerical simulations of his theoretical model that I discussed in the previous section. The numerical values of the exogenous parameters are more or less arbitrarily chosen to have “plausible” steady state values of the endogenous variables. The matching technology adopted is a Cobb-Douglas: $m(u, v) = u^{0.4}v^{0.6}$. Postel-Vinay (2002) considers two values for the rate of technological progress: 3 and 4 percent. The simulated dynamics follow a jump at date $t_0 = 0$ either from $g = 3$ percent to $g' = 4$ percent, or from $g = 4$ percent to $g' = 3$ percent.

Postel-Vinay (2002) shows the presence of a large, quasi-periodic, non-monotonic fluctuations, phenomenon known as “echo effect” in the vintage capital literature. The intuition behind this result is simple: anything happening at any given date $t \geq t_0$ on the “job creation side” of the model is reflected T^* periods later on the “job destruction side”.

The short-run adjustment of unemployment goes in the “wrong way” with regard to its long-run variation. This initial adjustment is of potentially great magnitude. In the numerical example shown by Postel-Vinay (2002), a 1 percent rise in the growth rate causes unemployment to rise by 1.6 percent in the long-term, and to drop by a bit over 3 percent in the short run. On the contrary, a 1 percent drop in g induces a 1.6 percent drop in long-term unemployment that has to be compared to a four and a half times more important short-run rise of about 7.2 percent.

Those results seem to reconcile the Schumpeterian view with the observed data. For instance, the general productivity slowdown of the 1970s came with a sharp rise in the unemployment rates of all OECD countries, a picture of which the Schumpeterian model now seems to be able to give a replica.

Another interesting work is that of Mauro and Carmeci (2000). They

propose a model of endogenous growth with inefficiencies in the production of human capital due to unemployment. The rationale of this model can be found in the observation that youngsters need to acquire firm-specific knowledge by working for schooling human capital to become productive. The model implies a negative long-run relationship between growth and equilibrium unemployment. It is estimated using an unbalanced panel data of 15 OECD countries covering the period 1965-1995. The estimation method is GMM. The data support the theory. They find that youth unemployment influences negatively and significantly the growth of output and more importantly its inclusion renders the effect of the schooling investment significant and positive.

Fagerberg, Verspagen and Caniëls (1997) explore the relationship between technology, growth and employment growth across European regions. The sample consists of 64 regions from four different countries: (West) Germany, France, Italy and Spain. They find a negative correlation between growth and unemployment and they explain this result through the negative impact of unemployment on inward migration. In fact, net inward migration was found to have a strong, positive impact on growth. Unemployment acts as a factor that limits net inward migration and, hence, growth.

A more recent empirical contribution is that one of Pissarides and Val-lanti (2004). They develop a new equilibrium model for employment and estimate it with an annual panel data for the United States, Japan and Europe. The structural model is estimated by a three stage least squares. The period examined goes from 1965 to 1997. Results are inconsistent with the Schumpeterian assumption of embodied technology and creative destruction. On the contrary they find support for the Solow assumption of disembodied technology. They show that the effects of faster Total Factor Productivity on employment are positive and significant, after an initial period of not more than one year. Furthermore, they use their empirical estimates to obtain a prediction of the extent to which exogenous Total Factor Productivity growth

can account for the observed change in the rate of employment. The estimates do a good job in attributing the rise and fall in trend unemployment in the USA to the 1970s productivity slowdown, but productivity changes are generally less successful in explaining the dynamics of European unemployment.

5 Final Remarks

In this paper I have presented and discussed the theoretical and empirical contributions that try to shed light on the relationship between growth and employment. First, the theoretical contributions have been discussed. After a brief description of the dichotomic approach between growth and employment and having analyzed its issues in section 2, I have discussed the recent contributions that drop the dichotomy between the two variables in section 3. These contributions are very diversified in hypothesis, methods and conclusions. I have analyzed in detail the contribution of Pissarides (1990), which is the first attempt in the literature to drop the dichotomy between growth and employment. Then, I have presented the contribution of Aghion and Howitt (1998), which goes in the opposite direction with respect to that one of Pissarides (1990). We have seen that this apparent inconsistency between these two points of view is simply resolved by Mortensen and Pissarides (1998).

After discussing the contributions in which economic growth is treated as exogenous, I have introduced models in which the economic growth is endogenous. I have also presented a recent model proposed by Postel-Vinay (2002) in which the short-run behavior of unemployment in a creative destruction context is considered. Finally, I have discussed some empirical contributions and I think it is worth emphasising the fact that the empirical contributions are still few with respect to the scope and the importance of the theoretical debate.

However, more work need to be done, both theoretical and empirical, and

an interesting avenue for future research might be the attempt to link the demand-side of the labor market to the supply-side factors.

References

- [1] Aghion, P. and P. Howitt (1991), "Unemployment. A Symptom of Stagnation or a side-effect of Growth?," *European Economic Review* vol. **35**, 535-41.
- [2] Aghion, P. and P. Howitt (1992), "A Model of Growth through Creative Destruction," *Econometrica* vol. **60**, 323-51.
- [3] Aghion, P. and P. Howitt (1994), "Growth and Unemployment," *Review of Economic Studies* vol. **61**, 477-94.
- [4] Aghion, P. and P. Howitt (1998), "Endogenous Growth Theory", MIT Press: Cambridge, Massachusetts.
- [5] Aghion, P. and G. Saint-Paul (1991), "On the Virtue of Bad Times", Discussion Paper n. 578, Centre for Economic Policy Research, *mimeo*.
- [6] Aricò, F. (2003), "Growth and Unemployment: Towards a Theoretical Integration", *Journal of Economic Surveys*, vol. 17, 419-459.
- [7] Ball, L. and R. Moffitt (2002), "Productivity Growth and the Phillips Curve. In the Roaring Nineties: Can Full Employment be Sustained?", edited by A.B. Krueger and R. Solow, New York: Russel Sage Foundation.
- [8] Barro, R., and X. Sala-i-Martin (1995), "Economic Growth", New York, McGraw-Hill.
- [9] Bean, C. and C. Pissarides (1993), "Unemployment, Consumption and Growth," *European Economic Review* vol. **37**, 837-54.

- [10] Birchenall, J.A. (2002), "Growth and Unemployment (without market frictions)", University of Chicago, *mimeo*.
- [11] Boeri, T. (1996), "Is Job Turnover Countercyclical?", *Journal of Labor Economics*, vol. **14**, 603-25.
- [12] Caballero, R. (1993), "Comments on Bean and Pissarides," *European Economic Review* vol. **37**, 855-59.
- [13] Cristini, A. (1999), " Unemployment and Primary Commodities Prices", Mcmillan Press LTD.
- [14] Davis, S. and J. Haltiwanger (1993), "Gross Job Creation, Destruction and Employment Reallocation," *Quarterly Journal of Economics* vol. **107**, pp. 819-64.
- [15] Davis, S., J. Haltiwanger and S. Shuh (1996), "Job Creation and Destruction", MIT Press, Cambridge, MA.
- [16] Eriksson, C. (1997), "Is There a Trade-off between Employment and Growth?," *Oxford Economic Papers* vol. **49**, 77-88.
- [17] Fagerberg, J., B. Verspagen and M. Caniëls (1997), "Technology, Growth and Unemployment across European Regions," *Journal of the Regional Studies Association* vol. **31**, 457-66.
- [18] Friedman, M. (1968), "The Role of Monetary Policy," *American Economic Review* vol. **58**, 1-17.
- [19] Gordon, R.J. (1995), "Is There a Trade-off between Unemployment and Productivity Growth," *NBER Working Paper* n. **5081**.
- [20] Hoon, H.T. and E. Phelps (1997), "Growth, Wealth and the Natural Rate: Is Europe's Job Crisis a Growth Crisis?," *European Economic Review* vol. **41**, 549-57.

- [21] Layard, R., S. Nickell and R. Jackman (1991), *Unemployment. Macroeconomic Performance and the Labour Market*, Oxford University Press.
- [22] Lucas, R.E. (1988), "On The Mechanics of Economic Development", *Journal of Monetary Economics*, vol. **22**, 3-42.
- [23] Mauro, L. and G. Carmeci (2000), "Long Run Growth and Investment in Education: Does Youth Unemployment Matter?," University of Trieste Di.S.E.S.Working Papers n. **69**.
- [24] Mortensen, D. T. and C. Pissarides (1998), "Technological Progress, Job Creation and Job Destruction," *Review of Economic Dynamics* vol. **1**, 733-753.
- [25] Mortensen, D. T. (2004), "Growth, Unemployment, and Labor Market Policy", Northwestern University, *mimeo*.
- [26] Nickell, S., L. Nunziata, W. Ochel and G. Quintini (2001), "The Beveridge Curve, Unemployment and Wages in the OECD from 1960s to the 1990s", Discussion Paper n. 502, Centre for Economic Performance, LSE, *mimeo*.
- [27] Paci, R., F. Pigliaru and M. Pugno (2001), "Disparities in Economic Growth and Unemployment Across The European Regions: A Sectoral Perspective", Working Paper, Contributi di ricerca Crenos, Università di Cagliari
- [28] Phelps, E.S. (1994), "Structural Slumps, the Modern Equilibrium Theory of Unemployment, Interests and Assets", Cambridge MA, Harvard University Press.
- [29] Pissarides, C. (1990), *Equilibrium Unemployment Theory*, Oxford, Blackwell.

- [30] Pissarides, C. (2000), *Equilibrium Unemployment Theory*, second edition, Cambridge, MA: MIT Press.
- [31] Pissarides, C., and G. Vallanti (2004), "Productivity Growth and Employment: Theory and Panel Estimates, *Centre for Economic Performance*, Discussion Paper series, forthcoming.
- [32] Postel-Vinay, F. (1998), "Transitional Dynamics of the Search Model with Endogenous Growth," *Journal of Economic Dynamics and Control* vol. **22**, 1091-115.
- [33] Postel-Vinay, F. (2002), "The Dynamic of Technological Unemployment", *International Economic Review* vol.**43**, 737-60.
- [34] Pugno, M. (1998), "Economic Growth and Unemployment: Recent Theoretical Developments", *Economia Politica*, n.1
- [35] Romer, P. (1986), "Increasing Returns and Long-run Growth", *Journal of Political Economy*, vol. **94**, 1002-36.
- [36] Romer, P. (1990), "Endogenous Technological Change", *Journal of Political Economy*, vol. **98**, 71-102.
- [37] Rowthorn, R. (1999), "Unemployment, Wage Bargaining and Capital-Labour Substitution," *Cambridge Journal of Economics* vol. **23**, 413-25.
- [38] Solow, R.M. (1956), "A Contribution to the Theory of Economic Growth", *Quarterly Journal of Economics* vol. **70**, 65-95.
- [39] Solow, R. (1957), "Technical Change and Aggregate Production Function", *Review of Economics and Statistics*, vol. **39**, 312-20.