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EMPLOYMENT, CAPITAL OPERATING TIME AND EFFICIENCY WAGES HYPOTHESIS: IS THERE ANY ROOM FOR WORKSHARING?

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EMPLOYMENT, CAPITAL OPERATING TIME AND EFFICIENCY WAGES HYPOTHESIS: IS THERE ANY ROOM FOR WORKSHARING?*

Antonio Garofalo♦ and Concetto Paolo Vinci♣

Abstract

Our main objective in this paper is to shed some light on the existing relation between employment and work-week duration. As stressed by Cahuc and d'Autume (1997) some of the main factors that regulate this relation are respectively linked on one hand to the productivity gains following variations in working time obtained by firms, on the other to the possibility of gaining, or otherwise, wage compensation and finally to the amount of fixed costs associated to labour input. It is therefore necessary in dealing with work-sharing to take into account that working time reductions and their effect on employment must not be considered within a framework which explicitly evaluates the effects of firms' profits and wage determination. In this light, under the hypothesis of a production function embodying, amongst other things, Capital Operating Time, the following analysis will be referred to models based on the efficiency wage hypothesis, whose common objective is to give a more convincing explanation of why firms do not find it profitable to lower wages even in the presence of unemployment. In order to evaluate the effectiveness of work-sharing policies we will use two different macroeconomic approaches: a Keynesian and a Neo-classical one. In the former we will operate in a context with unemployment due to demand-side constraints, while in the latter, employment is determined by the labour demand.

JEL classification codes: J22,J23,J41

Keywords: Hour reduction, Working-time, Work-sharing, Efficiency wages, Capital Operating Time

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Section 1: Introduction

The unemployment picture is bleak: the unemployment rate has raisen from 2.6 percent in 1970 to nearly 11 percent in 1996 in the European OECD countries: what dramatically emerges is the substantial increase in the share of the long-term unemployment rate (0.9 percent in 1979 compared to 6.6 percent in 1994) [Siebert, 1997]. As Cameron [1999] pointed out, "*…there once was a time, not long ago, when Europe was close to full employment. In the 1960s and early 1970s, in the halcyon days after the completion of the recoveries from the devastation of World War II and before the rise of oil prices and the demise of the Bretton Woods exchange rate regime, unemployment rates throughout Europe were generally in the range of two to three per cent…. Now, some three decades later and in the wake of the major recessions of the 1974-75, 1980-84, and 1991-94, Europe is afflicted with enduring high levels of unemployment. Throughout the 1990s, for example, the fifteen member states of the European Union experienced an average rate of unemployment of 10.3 percent. Even some five years after the end of the last major European recession, and after sustained recovery since then in much of Europe, the rate of unemployment remains in double digits - a sure sign that much of the unemployment is structural in nature rather than cyclical…what makes the long-term deterioration in employment in Europe especially notable, of course, is the fact that it has been far more severe than in other advanced economies…*".

In the various attempts made to search for policies able to tackle unemployment, worksharing has increasingly played a leading role as a tool to deal with the unemployment dilemma. As P. Cahuc & P. Granier (1997) pointed out, "*a reduction in working time is often seen as a way of sharing the available numbers of jobs and increasing employment*".

The debate on working time has undergone considerable changes in the last 40 years. In the 1950s and 1960s, during the phase of steady economic growth, working hours were reduced in most developed countries. From the 1970s onwards, working time has become a far more controversial issue between social groups: on one side, trade unions demand substantial working-time reductions as a remedy against increasing unemployment; on the other, employers reject working time reductions as a remedy against increasing unemployment, seeking more working-time flexibility instead. Depending on the economic situation, the existing regulatory framework and the industrial relations system, working hours have been reduced and flexibilised to very different degrees in different countries.

The issue of worksharing has attracted considerable interest in recent years especially in the European Community, where unemployment rates, as seen, have soared to double figures. The employment effects of shorter working hours have been widely discussed within and outside the academic community [to quote some: R. Hart 1987, 1988; V. Valli 1988; G. Bosch, P. Dawkins & F. Michon 1993; M. Andrews & Simmons 1994, 1997; R. Paterno' & L.Prosperetti 1997; R. Marimon & F. Zilibotti 1999].

However, despite the abundance of literature in this area, several important questions have not been wholly solved; notwithstanding the growing interest in worksharing and theoretical analyses of some of the issues involved, there are few studies which explicitly consider the possibility of Capital Operating Time (COT) and shift working.

The economic debate on the development of COT and shift-work has changed over time. In the first period, steady economic growth from the early post World War II period up to the first oil-crisis, the main attention of researchers was on the long-term sources of growth (Denison, 1962, 1967; Jorgenson & Griliches 1967; Kendrick 1961). At the same time, a controversy on the role of capital and its utilisation in economic growth broke out: researchers argued for the inclusion of COT in the models instead of merely capital stock.

Murray Foss (1963) stressed in the early 1960s that operating hours had been considerably prolonged since the 1920s and showed that this lengthening of COT made an important contribution to economic growth during this period. During the 1970s a series of papers analysed the microeconomic fundamentals of shift work and capital utilisation (Marris, 1964; Wintson & McCoy 1974; Betancourt & Clague 1981; Bosworth & Westaway 1984; Cette 1990). The main focus in the 1970s was on the sources of long-term variations in productivity and the adjustment of capacity utilisation and factor use to the business cycle. Several studies showed that labour productivity varied cyclically, decreasing considerably in the downturns and increasing as business activity picked up. This pro-cyclical behaviour surprised most economists inclined to believe in decreasing returns to labour. Econometric estimates of short-run employment functions (Nadiri, 1968) found output elasticities with respect to labour to be above one; results confirmed later by various production function estimates (Craine, 1973; Feldstein, 1967; Tatom, 1980). Among the explanations proposed there was the one linked to the possibility of a specification error in the production functions and the absence of the degree of utilisation on the production factors. The idea was that the omission of capital utilisation would lead to an upward bias in the estimation of labour contribution, giving the impression of increasing returns to this factor. What finally emerged was that the pro-cyclical behaviour of labour productivity disappears when variations in capital utilisation are taken into account. As noted by Tatom (1980) "*…accounting for the cyclical variation of utilisation of the capital stock in a Cobb-Douglas specification reconciles the apparent inconsistency of the diminishing returns to labour hypothesis and the observed pro-cyclical movements of labour productivity and real wages*".

Nowadays more than in the past, production not only requires capital as well as labour but also depends on varied and complex forms of work organisation, which tie more or less closely to one another the uses of the two main factors. In industry and services labour needs many allocations of capital for efficient production, some of which is required on a long-term basis, some in the short-run. Many production processes, even using the most modern equipment, cannot function well without constant guidance or control by human labour. The cost of interrupting some industrial processes is so high as to impose continuous operation. Statistical information and economic analysis often neglect, because of its complexity, such a complex interplay. Very little is known about capital operating time: the data in question usually concern the volumes of the two main productive factors and the working times of employees.

Bearing in mind these hypotheses, our main objective in this paper is to examine the existing relation between employment and working week duration. As already stressed by P. Cahuc & A. d'Autume (1997) some of the main factors that regulate this relation are respectively linked on the one hand to the productivity gains following variations in working time obtained by the firms, on the other to the possibility of having wage compensation or otherwise, and finally to the amount of fixed costs associated to labour input. It is therefore necessary in dealing with worksharing that working time reductions and their effects on employment should not be developed out of a framework which explicitly consider the effects on firm's profits and wage determination. In this light, the following analysis will be referred to models based on the efficiency wages hypothesis; these models, whose common objective is to give a more convincing explanation of why firms do not find it profitable to lower wages even in the presence of unemployment, have as a natural benchmark the Solow (1979) model, which mainly derives from introducing in the firm's objective function an increasing worker effort function as regards wages. According to Solow, the traditional Marshallian scheme, concerning the pure operating mechanism of demand and supply on the single market, is incomplete if applied to labour market. This incompleteness emerges because wage rates and jobs have peculiar characteristics with respect to prices and quantities available on other markets. In fact: "*they are much more deeply involved in the way people see themselves, think about their social status, and evaluate whether they are getting a fair shake out of society*" (Solow 1990, p. 22).

It is on the relation between effort and wage, through the functional form $e = e(w)$ that Solow builds the first efficiency wage based model, which, as is widely known, corresponds to the wage level which minimises labour costs per efficiency units. Starting from this pioneering work, efficiency wage based models thereafter individualise different motivations concerning why firms are willing to pay a higher wage compared to the Walrasian one, with the consequence of refusing to accept those workers who offer themselves at a lower wage: gift exchange between workers and firms (Akerlof, 1982) and other recent contributions which partly confirmed the validity of some hypotheses proposed by Akerlof (1982): Fehr, Cachter and Kirchsteiger (1997), Cachter and Falk (1997), Bewley (1995); reduction of the natural propensity to a scarce workers utilisation (Shapiro & Stiglitz, 1984; Rey & Stiglitz, 1994); turnover rate reduction and attenuation of the firms' information asymmetry problem concerning workers' qualities (Weiss 1980).

In the effort function we are going to adopt we will take into account the effects of effort working time reduction. Indeed also K. Marx emphasised the consequences of the effect of a work week reduction; he asserted that a work week reduction: "*…gives an immense impetus to the development of productivity….It imposes on the worker an increased expenditure of labour…and a closer filling-up of the pores of the working day…which can only be attained within the limits of the shortened working day…The denser hour of the ten-hour working day contains more labour, i.e. expended labour power, than the more porous hour of the twelve-hour working day*" (Marx, 1976 p.534).

The effects of variation in hours on the worker effectiveness and effort is twofold: on the one hand, the dead times occurring during the working day (such as pauses, for example) play the role of fixed costs with the consequence of implying an unreserved effect on the duration of the working day on workers' effort. On the other hand, the effects due to the workers' tiring out suggest an inverse relation. After all, it is thus possible to hypothesise the existence of a bell shaped effort function as regards the standard working day variations. Empirical evidence indeed has been quite ambiguous on this matter: Feldestein (1967) and Craine (1973) emphasised how standard working week reductions are inclined to reduce workers' productivity; contrasting results were obtained by Merchand and others (1983); Leslie and Wise (1980) found no significant functional relation.

In our analysis, as in Cahuc and d'Autume (1997) from which this work stems, we have privileged the *a priori* favourable hypothesis of a working hour reduction. We hypothesised that we were operating along the decreasing pull tail of the relation between effort and working hours.

If it is clear that a working week reduction brings about a workers' effort intensification, which should allow for higher production in a shorter time, on the other hand, as underlined by Cette & Taddei (1994) and Cahuc and d'Autume (1997), the working week reduction is combined with a work reorganisation which tends to modify the number of *equipes*, workers as well as the capital utilisation and its productivity. Once again (as already stressed in Garofalo and Vinci 2000), it is clear that a worksharing policy does not only affects the labour inputs used by employers. Based on this latter hypothesis, in our analysis, as in Cahuc and d'Autume (1997), we will adopt a production function which also embodies the capital operating time which in turn is linked to hours worked

In what follows it will be hypothesised that the work reorganisation emerging when a standard working week reduction is adopted, tends to increase the number of workers' *equipes* and hence capital operating time. This relation takes stems from various contributions (Borlange and ...1990; Anxo and ...1995) which underlined the existence of a negative correlation between labour and capital input duration. In order to evaluate the effectiveness of a worksharing policy, we will use two different macroeconomic approaches: Keynesian and Neo-classical. In the former we will assume operation in a context characterised by an unemployment margin due to the demand side constraint, while in the latter we will consider a situation in which employment is merely determined by labour demand; in such a context labour costs will play a crucial role in employment determination.

The main difference of this paper with respect the one by Cahuc and d'Autume (1997) lies in having considered an efficiency wage effort hypothesis; in what follows it will be preliminary analysed the case in which the effort function is linked to wages and consequently the case when it is linked respectively to wages and hours.

The paper is organised as follows: section 2 will be devoted to introducing the production function utilised; section 3 and 4 illustrate respectively the case when effort depends on wages and on both hours and wages; section 5 concludes.

Section 2: Assumptions and basic concepts

It represents the product between the instantaneous flow production, given by $F(K, en)$, and $T=\lambda h$, the capital operating time.

As in Cahuc and d'Autumne (1997), the instantaneous production flow depends on the amount of capital stock K and on the number of available jobs n which set the number of employees in a given instant. In general, capital operating time depends directly on work duration; when reorganisation does not occur, the operating time is proportionate to that of work; it decreases when the working duration decreases. Nevertheless, the working hours reduction is likely to bring about working reorganisation. Under some circumstances the reorganisation can be such that the reduction in the working week duration can be linked to an increase in equipment. Such a phenomenon is likely to occur in those sectors where the utilisation of subsequent workers' *equipes* is possible. The reduction in the working week duration may give rise to an increase in the number of *equipes*, and in the duration of machine use.

Empirically, the relation between work and capital duration is not well known. Econometric analyses have usually found a negative relation between work duration and subsequent workers' *equipe*; which seems to suggest the existence of reorganisation when work duration varies (Bourlange and others, 1990, Anxo and others, 1995).

In what follows we will assume the existence of constant returns to scale, with respect to capital input and employment expressed in efficiency units, according to which we can consequently relate the production level to the flow of services, and write:

$$Y=F(TK, eL)$$

where T represents the duration of capital utilisation and L the total numbers of hours worked.

An important question to be addressed is whether the reduction in the working week can be achieved, keeping constant the duration of capital utilisation, through the adoption of a variable hours schedule and the extension of the work in *equipes*. If this is the case, then it is convenient to write the relation between production Y and the level of employment N in the following way:

$$Y=F(TK, ehN)$$

If, however, the reduction in the working week is linked to that of a reduction in the duration of capital use, parameter λ represents the number of *equipes* remaining constant. The production function can be expressed as follows:

$$Y=hF(\lambda K, eN)$$

We will adopt, however, the general case, where the reduction of the working duration is accompanied by a certain extent of hours reorganisation. Therefore we assume the existence of a decreasing relation for $\lambda(h)$ between the weekly duration of the *equipe* number. Analytically this can be written as:

$$Y = \lambda(h)hF\left(K; \frac{eN}{\lambda(h)}\right)$$

This latter general form of production function will be the one adopted in order to explore the basic mechanisms operating when a reduction in working duration is undertaken. In what follows we will consider two different effort functions: one uniquely linked to the wage and the other related to wages and hours.

Section 3: Working week reduction employment and effort: the case of e=e(w)

Let us start by considering the case in which we will use an effort function exclusively linked to the hourly wage perceived by workers, namely $e = e(w)$. Preliminary let us define α the elasticity of the production function Y with respect to labour input expressed in physical units N[1] and with ε_w and ε_λ respectively the elasticity of effort with respect to the wage and the elasticity of the reorganisation function λ with respect to the hours of work h. Let us

[1] We consider N in place of eN because our aim is to detect the employment effect of a working week reduction and not, as in firms based approach, the employment in efficiency units.

further assume a positive and smaller than unity value for α, and a negative value for ε_λ contained within the interval [-1, 0]. As regards ε_w, it will be equal to 1, due to the well known Solow condition.

From now on we will assume *K* as given and consequently the weekly production will result depending on *h*, *N* and *w*; the related total differential will be:

$$dY = dN\left(\frac{\lambda hF^{'}e}{\lambda}\right) + dh\left[\lambda hF^{'}\left(\frac{-\lambda_h eN}{\lambda^2}\right) + F(\lambda_h h + \lambda)\right] + dw\left(\frac{\lambda hF^{'}e_w N}{\lambda}\right)$$

that, once we consider the case of $\alpha = \frac{hF^{'}eN}{Y}$, with some simple manipulations, becomes:

$$\frac{dY}{Y} = \alpha\frac{dN}{N} + \beta\frac{dh}{h} + \gamma\frac{dw}{w} \qquad (1)$$

where $\beta = \varepsilon_\lambda(1-\alpha)+1, \quad \gamma = \alpha\varepsilon_w$ and consequently $\gamma = \alpha$.

Let us consider the parameter β, which captures the impact of hours variation on the total amount of production. Various possibilities emerge. First we should consider the case in which the number of workers' teams (or labour groups) are totally independent with respect to the hours worked; this will be the case in which $\varepsilon_\lambda=0$ and so $\beta=1$. In such a case the reduction in the working week, maintaining constant the level of workers employed, will cause a proportional reduction in the production level. A second case is the one in which a reduction in working hours will be followed by a proportional increase in the number of teams so as to leave unchanged the capital operating time. Consequently, $\varepsilon_\lambda=-1$, and hence $\beta=\alpha$, and so hours and workers are perfect substitutes. Finally for any value of ε_λ in the interval [-1, 0] we will have a positive value for β lower than unity but lower than α; this means that a reduction in the working hour will determine less than proportional increase in the production level. From condition (1) we can see that for a given level of production a reduction in *h* will produce a positive impact on employment, hence:

$$\frac{dN}{N} = -\frac{\beta}{\alpha}\frac{dh}{h}$$

In order to consider productivity effects, the existing relation between a working week reduction and a possible variation in the employment level, will be analysed first under a Keynesian-based economic system and then on a Neo-classical based one with and without fixed production costs. Before the presence of wage compensation, that could emerge from the relation existing between hourly wage w and the amount of hours worked h, is non-existent. Let us recall that the wage, obtained are those which arise from a cost minimisation process for efficiency units, and are subsequently totally independent of the amount of hours worked.

3.a) Keynesian unemployment framework

Let us consider the case of an economy with fixed prices and wages; the consumption demand is supposed to depend on wages and other exogenous demand components. The consumption propensity of those who earn profits is supposed to be equal to zero. Therefore:

$$Y^D = Y = cWN + D \qquad (2)$$

where c is the share of labour income consumed, D the autonomous demand and W (which is equal to wh) the real weekly wage, this according to the assumption of unity prices. Having already underlined that the wage compensation is absent since the hourly wage, the efficiency one, is independent with respect to hours worked, we will obtain the following:

$$\frac{dW}{W} = \frac{dh}{h}.$$

In what follows we will consider the case of a generalised hours reduction; for this purpose let us define $\hat{\alpha} = \frac{whN}{Y}$ as the production share going to labour input expressed in physical units. In a competitive market framework such a share is equal to the value of the output elasticity with respect to labour input α, while in a keynesian unemployment contest $\hat{\alpha}$ is greater than α.

By totally differentiating (2), and with simple manipulations the following expression follows:

$$\frac{dY}{Y} = \left[\frac{dc}{c} + \frac{dw}{w} + \frac{dh}{h} + \frac{dN}{N}\right]\frac{cwhN}{Y} + \frac{dD}{D}\frac{D}{Y}$$

Since $\frac{dc}{c}=0$ and $\frac{D}{Y}=1-c\hat{\alpha}$[2] we can write:

$$\frac{dY}{Y}=c\hat{\alpha}\left[\frac{dw}{w}+\frac{dh}{h}+\frac{dN}{N}\right]+(1-c\hat{\alpha})\frac{dD}{D} \tag{3}$$

Equating demand and supply we obtain:

$$\alpha\frac{dN}{N}+\beta\frac{dh}{h}+\gamma\frac{dw}{w}=c\hat{\alpha}\left[\frac{dw}{w}+\frac{dh}{h}+\frac{dN}{N}\right]+(1-c\hat{\alpha})\frac{dD}{D} \tag{4}$$

so as to get:

$$\frac{dN}{N}=\frac{dw}{w}\left[\frac{c\hat{\alpha}-\gamma}{\alpha-c\hat{\alpha}}\right]+\frac{dh}{h}\left[\frac{c\hat{\alpha}-\beta}{\alpha-c\hat{\alpha}}\right] \tag{5}$$

Since the efficiency wage is independent with respect to the hours worked and in the absence of wage compensation, equation (5) may be written as:

$$\frac{dN}{N}=\frac{dh}{h}\left(\frac{c\hat{\alpha}-\beta}{\alpha-c\hat{\alpha}}\right) \tag{6}$$

from which it follows that: $\frac{dN}{N}\Big/\frac{dh}{h}<0$[3].

Sic rebus stantibus, the adoption of a worksharing policy will bring about a more than proportional increase of the employed people. Out of efficiency wages mechanism and in condition of full wage compensation mechanism, so as to leave unchanged the worker's weekly wage, we would have had $\frac{dw}{w}=-\frac{dh}{h}$ and consequently condition (5) could have been written as :

[2] It is known that $\frac{D}{Y}=\frac{D}{cwhN+D}=\frac{\frac{D}{Y}}{\frac{cwhN}{Y}+\frac{D}{Y}}$ which can be written as $1=\frac{1}{\frac{cwhN}{Y}+\frac{D}{Y}}$ and consequently $1=\frac{1}{c\hat{\alpha}+\frac{D}{Y}}$ and finally $\frac{D}{Y}=1-c\hat{\alpha}$.

[3] It is well known that $\beta\geq\alpha>c\hat{\alpha}$ and consequently: $\frac{dN}{N}\Big/\frac{dh}{h}<-1$.

$$\frac{dN}{N}=\frac{dh}{h}\left[\frac{\gamma-\beta}{(\alpha-c\hat{\alpha}}\right] \tag{7}$$

hence: $\frac{dN}{N}\Big/\frac{dh}{h}\leq 0$[4].

In this case too we observe an employment increase as a consequence of working hours, with the exception of the case in which the elasticity coefficient ε_{λ} is equal to the limit value –1.

Let us now turn our attention to non wage income (from now on called profits), defined as π. From the national income equation, $\pi + whN = Y$, we derive:

$$\frac{dY}{Y}=\frac{d\pi}{\pi}(1-\hat{\alpha})+\hat{\alpha}\left[\frac{dw}{w}+\frac{dh}{h}+\frac{dN}{N}\right] \tag{8}$$[5]

which taking account of (1), again with simple mathematical manipulations becomes:

$$\frac{d\pi}{\pi}=\frac{dN}{N}\left(\frac{\alpha-\hat{\alpha}}{1-\hat{\alpha}}\right)+\frac{dh}{h}\left(\frac{\beta-\hat{\alpha}}{1-\hat{\alpha}}\right)+\frac{dw}{w}\left(\frac{\gamma-\hat{\alpha}}{1-\hat{\alpha}}\right) \tag{9}$$

In the case of independence of w on hours, or $\frac{dw}{w}=0$, equation (9) may be written as:

$$\frac{d\pi}{\pi}=\frac{dh}{h}\left[\frac{\alpha(1-\hat{c})(\beta-\alpha)}{(1-\hat{\alpha})(\alpha-c\hat{\alpha})}\right] \tag{10}$$

4 By distinguishing as before three cases we can write:

1) *if* $\varepsilon_{\lambda}=0\Rightarrow\beta=1$ *and* $\frac{dN}{N}\Big/\frac{dh}{h}<0$

2) *if* $\varepsilon_{\lambda}=0\Rightarrow\beta=\alpha$ *and* $\frac{dN}{N}\Big/\frac{dh}{h}=0$

3) *if* $-1<\varepsilon_{\lambda}<0\Rightarrow\beta>\alpha$ *we will have* $\frac{dN}{N}\Big/\frac{dh}{h}<0$.

5 Recall that $\hat{\alpha}=\frac{whN}{Y}$ and consequently $\frac{\pi}{Y}=\frac{Y-whN}{Y}=(1-\hat{\alpha})$

from which it follows: $\frac{d\pi/\pi}{dh/h} > 0$.

Overall although a reduction in working hours may have an expansive effect on employment, it will reduce profits. Analogous results could be obtained with wages at *efficiency levels* and with the adoption of full wage compensation; if this were the case, $\frac{dw}{w} = -\frac{dh}{h}$, equation (9), after simple manipulations, could be written as equation (10).

In spite of its incompleteness the analysis allows us to grasp the employment and firm's profits effects of a worksharing policy in an economic framework characterised by Keynesian unemployment. Being interested to the effects of a reduction from 39 (this representing nowadays the European average weekly working week) to 35 weekly hours, roughly a 10% standard working week reduction, in what follows, as in Cahuc and d'Autume (1997), we will propose a simple numerical example. We assume for the relevant parameters the following numerical values, namely:

$$\alpha = 0.7 \quad \hat{\alpha} = 0.6 \quad and \quad c = 0.7$$

distinguishing five cases, as shown below:

Table 1

	ε_λ	β
Case 1	0	1
Case 2	-0.25	0.925
Case 3	-0.5	0.85
Case 4	-0.75	0.775
Case 5	-1	0.7

Case 1 and 5 are the extreme ones examined previously where the elasticity coefficient ε_λ proves to be respectively equal to 0 and –1; β varies between 1 and 0.7 (which in turn is equal to α); those from 2 to 4 are intermediate ones in which ε_λ assumes a decreasing trend and the same for β which is always greater than α.

The main results are summarised in Table 1 and Table 2[6]. This latter considers the consequences of a 10% working week reduction in the five cases described in Table 1, namely efficiency wages and no wage compensation, while Table 3 analyses the consequences in the case of wage compensation.

Table 2

	Employment	Total hours worked	Profits
Case 1	20.7%	10.7%	-4.8%
Case 2	18.0%	8.0%	-3.6%
Case 3	15.3%	5.3%	-2.4%
Case 4	12.7%	2.7%	-1.2%
Case5	10.0%	0.0%	0.0%

Table 3

	Employment	Total hours worked	Profits
Case 1	10.7%	0.7%	-4.8%
Case 2	8.0%	-2.0%	-3.6%
Case 3	5.3%	-4.7%	-2.4%
Case 4	2.7%	-7.3%	-1.2%
Case5	0.0%	-10.0%	0.0%

It is worth to emphasise that, in an economic framework characterised by the presence of Keynesian unemployment, hours reduction, although with decreasing profits, is likely to produce increasing effects on employment[7]. Comparison between the two resulting tables suggest, as expected, that when compensation does not occur, employment effects are larger.

[6] For a given value of the elasticity ε_{λ} =-0,25 there will be a corresponding value for β =0,95, and it is for these values that we will get in the two tables $\frac{d\pi}{\pi}$.

[7] Of course the conclusion stems on the assumption of *D* independence.

3.b) Neo-classical unemployment framework

We now proceed to analyse an economic system ruled by Neo-classical unemployment and where employment is determined uniquely by the labour demand. In a context in which labour costs play a crucial rule let us start by considering the case of absence of fixed costs. For a given capital level, representative firm's profits will be:

$$\pi = \lambda(h)hF\left(K, \frac{e(w)N}{\lambda(h)}\right) - whN$$

The labour demand results from equalisation of the marginal productivity of labour input to the wage (the efficiency one):

$$F'\left(K, \frac{e(w)N}{\lambda(h)}\right)e = w$$

Defining σ_F the elasticity of substitution between capital and labour, we will have:

$$\sigma_F = \frac{d(K/N)/K/N}{d(wh/h)/wh/h}$$

The latter can also be written as $\sigma_F = \dfrac{\frac{dK}{K} - \frac{dN}{N}}{\frac{dw}{w} + \frac{dh}{h} - \frac{dr}{r}}$; with simple substitutions it is possible to express labour demand as a rate of variation and obtain[8]:

$$\frac{dN}{N} = \varepsilon_\lambda\left(\frac{dh}{h}\right) \tag{11}$$

hence: $\frac{dN}{N}\Big/\frac{dh}{h}$<0; except for the case in which elasticity ε_λ is equal to –1, this is the case when a cut in hours worked will be matched by less than proportional increase in employment.

In a situation of full wage compensation, we would obtain:

$$\frac{dN}{N} = (\varepsilon_\lambda - 1)\left(\frac{dh}{h}\right) \tag{12}$$

[8] For an analytical derivation see Appendix A.

from which it emerges that $\frac{dN}{N} \Big/ \frac{dh}{h} < 0$ with a more than proportional increasing effect of a working hour reduction.

Returning to the national income distribution between wages and profits, it is possible to write:

$$\frac{dY}{Y} = \frac{d\pi}{\pi}(1-\alpha) + \left(\frac{dw}{w} + \frac{dh}{h} + \frac{dN}{N}\right)\alpha \qquad (13)^{9}$$

using (1) with simple algebraic manipulations we get:

$$\frac{d\pi}{\pi} = \frac{dh}{h}\left[\frac{(\beta-\alpha)}{(1-\alpha)}\right] + \frac{dw}{w}\left(\frac{\gamma-\alpha}{1-\alpha}\right)$$

Since $\gamma=\alpha$ we can write:

$$\frac{d\pi}{\pi} = \frac{dh}{h}\left[\frac{(\beta-\alpha)}{(1-\alpha)}\right] \qquad (14)$$

Condition (14) is useful both in the case considered, namely absence of wage compensation, and when full compensation occurs. Once again from the latter condition, it emerges that a working hours reduction negatively affects profits except in the case when the elasticity ε_{λ} is equal to –1.

As in the previous case (economic setting characterised by the Keynesian approach) let us consider a shift from 39 to 35 hours under the hypothesis of almost 10% hours reduction. We will summarise, in what follows, using the same numerical values, the main simulation results.

Table 4 refers to the case of absence of compensation, full compensation will be the case in Table 5.

Table 4

	Employment	Total hours	Profits
Case 1	0,0 %	-10,0 %	-10,0 %
Case 2	2,5 %	-7,5 %	-7,5 %
Case 3	5,0 %	-5,0 %	-5,0 %
Case 4	7,5 %	-2,5 %	-2,5 %
Case 5	10,0 %	0,0 %	0,0 %

[9] The analitical derivation is similar to the one followed for condition (8). In this case we have to remember that: $\alpha = \frac{whN}{Y}$ and hence: $(1-\alpha) = \frac{\pi}{Y}$.

Table 5

	Employment	Total hours	Profits
Case 1	10,0 %	0,0 %	-10,0 %
Case 2	12,5 %	2,5 %	-7,5 %
Case 3	15,0 %	5,0 %	-5,0 %
Case 4	17,5 %	7,5 %	-2,5 %
Case 5	20,0 %	10,0 %	0,0 %

Now consider the case with fixed costs associated to employment. It is clear that the existence of such costs can in some way stop the possibility for workers and hours worked from being easily substituted. If we put employer's labour costs for any employed worker equal to $wh+v$, with w representing the hourly wage, h actual worked hours and v fixed costs, by totally differentiating labour demand:

$$F'\left(K, \frac{e(w)N}{\lambda(h)}\right)eh = wh + v$$

we obtain:

$$\frac{dN}{N} = \frac{dh}{h}\left[\frac{\sigma_F v}{(wh+v)(1-\alpha)} - \varepsilon_\lambda\right] \qquad (15)^{10}$$

from which it follows that $\frac{dN}{N}\Big/\frac{dh}{h}$>0. Unlike the previous case, this time fixed costs operate so as to eliminate any possibility of substitution between hours and workers; a reduction in working hours will have, in fact, a disastrous effect on employment thresholds. This, however, will be the case even when full compensation is assumed; in this former case we have:

$$\frac{dN}{N} = \frac{dh}{h}\left[\frac{(1-\alpha)(wh+v)}{(1-\alpha)\left[wh-(wh+v)\varepsilon_\lambda\right]+\sigma_F v} - \varepsilon_\lambda\right] \qquad (16)$$

that once again implies $\frac{dN}{N}\Big/\frac{dh}{h}$>0.

[10] For the analytical derivation of this condition see Appendix B.

Lastly profits analysis will be similar to that seen previously, except for the circumstance according to which they are lower due to the presence of fixed costs.

Section 4: Working week reduction, employment and effort: the case of e=e(w,h)

In this section we will consider the case of an workers' effort function functionally related, in a direct way, to the hourly wages earned by employed people, and also influenced by weekly hours worked. The impact of hours worked on effort is twofold: dead times of a working day play the role of fixed costs, entailing a positive impact of an increase in *h* on effort; at the same time it must be underlined that the fatiguing workers' effect increases as the working day increases. After all, as well underlined by Cahuc & d'Atumne (1997) it is possible to assume a bell-shaped effort function as hours increase; initially the first effect, the positive one, prevails while subsequently, the fatiguing effect will prevail.

Empirical evidence for such effects is ambiguous; Feldstein (1967) and Craine (1973) estimated a positive effect in between hours and effort, Marchand and others (1983) have obtained negative results. Below we will favour the second hypothesis; in so doing we will assume operation along the decreasing part of the effort-hours function. The effort function may be written as:

$$e = e(w,h) \quad with\ e_w > 0,\ e_{ww} < 0$$
$$e_h < 0,\ e_{hh} > 0,\ e_{hw} < 0$$

Once again, α represents the elasticity of the production function with respect to the labour input, with ε_w and ε_λ respectively the elasticity of effort with respect to wages and hours[11]; as regards ε_h, namely the elasticity of effort with respect to hours, also in accordance with what has been stated so far, it will be contained in the interval [-1; 0].

By totally differentiating the production function, and under the hypothesis of constant capital, we obtain:

$$dY = dN\left(\frac{\lambda hF'e}{\lambda}\right) + dh\left\{\left[\lambda h\left(\frac{e_h N\lambda - eN\lambda_h}{\lambda^2}\right)\right] + F\left(h\lambda_h + \lambda\right)\right\} + dw\left(\frac{\lambda hF'e_w N}{\lambda}\right)$$

[11] As above, also in this case -1<α<0, ε_w =1 and –1< ε_λ <0.

where, recalling that $\alpha = \frac{hF^{'}eN}{Y}$, after simple analytical manipulations we obtain:

$$\frac{dY}{Y} = \alpha \frac{dN}{N} + \hat{\beta} \frac{dh}{h} + \alpha \frac{dw}{w} \tag{17}$$

with $\hat{\beta} = \alpha\varepsilon_h + \varepsilon_\lambda(1-\alpha) + 1$.

The analysis of the β parameter will allow us also this time to distinguish different cases. First consider the case where workers' effort and workers' team numbers are independent of working hours. That is $\varepsilon_\lambda = \varepsilon_h = 0$, with the consequence of $\hat{\beta} = 1$. Once again the working week reduction, keeping the employment level fixed, will produce a proportional decrease of the output level. A second case is the one in which effort is considered constant but a decrease in hours will be matched by an increase in the number of the workers teams so as to leave unchanged the capital operating time. This is the case of $\varepsilon_\lambda = -1$, that is with a value of $\varepsilon_h = 0$, it follows that $\hat{\beta} = \alpha$. Finally, we will consider the case in which $-1 < \varepsilon_\lambda,\ \varepsilon_h < 0$, with positive values of β[12].

From condition (17) emerges that for a given production level, the effect of a working hours reduction on employment will depend on the variations undergone by wages[13].

Hence:

$$\frac{dN}{N} = -\frac{\beta}{\alpha}\frac{dh}{h} - \frac{dw}{w} \tag{18}$$

Since from the efficiency wage we get: $\frac{dw}{w} = \frac{dh}{h}\left[\varepsilon_h(1-m_w)\right]$[14] with $m_w = \frac{e_{hw}w}{e_h}$, equation (18) can be rewritten in the following way:

[12] From our analysis are excluded those cases in which $\varepsilon_h = -1$ and $\varepsilon_\lambda = 0$, or $\varepsilon_h = -1$ and $\varepsilon_\lambda = -1$ because in these cases $\hat{\beta} = 0$. We will not consider the case in which we have $\hat{\beta} < 0$, situation this occurring when $-1 < \varepsilon_h < \varepsilon_\lambda < 0$. $\beta\beta$

[13] In this case we will have that hours' variation will influence wages too.

[14] For a derivation of this condition see Appendix C.

$$\frac{dN}{N}=\frac{dh}{h}\left[-\frac{\beta}{\alpha}-\varepsilon_h(1-m_w)\right] \qquad (19)$$

It is further interesting to note that, unlike the previous case in which we operated in the absence of wage compensation, this time we will have the possibility of acting both without compensation, this occurring when $m_w=1$, and in the presence of compensation, though partial, the latter occurring when $0<m_w<1$. It is worth considering that when $m_w>1$ firms will react to a reduction in working hours with a wage reduction .

In this case too, in order to consider productivity effects, the variation between working hours and employment variation will be taken into account both referring to an economic system characterised by Keynesian unemployment and a system in which unemployment is strictly Neo-classical, the latter with and without fixed costs of production.

4.a) Keynesian unemployment framework

As in the previous section let us suppose to operate in an economy characterised by fixed prices and a Keynesian unemployment margin. As before, we start from the condition relative to the income distribution between profits and wages given from the following expression: $Y^D=Y=cwhN+D$; by setting $\hat{\alpha}=\frac{whN}{Y}$[15] we can derive condition (5) again:

$$\frac{dN}{N}=-\frac{dw}{w}+\frac{dh}{h}\left[\frac{c\hat{\alpha}-\beta}{\alpha-c\hat{\alpha}}\right] \qquad (5).$$

As shown in Appendix C, a worksharing policy will affect efficiency wages too, since workers' effort also depends on *w* and *h*. Consequently, bearing this in mind we obtain:

$$\frac{dN}{N}=\frac{dh}{h}\left[\frac{-\varepsilon_h(1-m_w)(\alpha-c\hat{\alpha})+c\hat{\alpha}-\beta}{\alpha-c\hat{\alpha}}\right] \qquad (19)$$

In order to evaluate the employment effect three different cases must be distinguished, namely:

[15] Where $\hat{\alpha}<\alpha$; while for a framework to be a perfectly competitive, we should have had $\hat{\alpha}=\alpha$.

$$a)\ m_w < 1 \qquad \text{with} \qquad -1 < \frac{\frac{dw}{w}}{\frac{dh}{h}} < 0$$

$$b)\ m_w > 1 \qquad \text{with} \qquad \frac{\frac{dw}{w}}{\frac{dh}{h}} > 0$$

$$c)\ m_w = 1 \qquad \text{with} \qquad \frac{\frac{dw}{w}}{\frac{dh}{h}} = 0$$

where we know that: $\frac{\frac{dw}{w}}{\frac{dh}{h}} = \varepsilon_h(1 - m_w)$.

By considering case a), with simple algebraic manipulations it will be possible to obtain:

$$\frac{\frac{dN}{N}}{\frac{dh}{h}} \lesseqgtr 0 \text{ if } \beta \gtreqless \theta^a$$

where $\theta^a = c\hat{\alpha} - \varepsilon_h(1 - m_w)(\alpha - c\alpha)$,

for case b) and proceeding in the same way as before, we can write:

$$\frac{\frac{dN}{N}}{\frac{dh}{h}} \lesseqgtr 0 \text{ if } \beta \gtreqless \theta^b$$

where $\theta^b = c\hat{\alpha} - \varepsilon_h(1 - m_w)(\alpha - c\alpha)$.

Finally in case c) we will have a total absence of wage compensation:

$$\frac{\frac{dN}{N}}{\frac{dh}{h}} \lesseqgtr 0 \text{ if } \beta \gtreqless c\hat{\alpha}$$ [16]

[16] It can be easily shown that: $\theta^a > c\hat{\alpha} > \theta^b$.

If once again we had full wage compensation, or in other words $\frac{dw}{w} = -\frac{dh}{h}$, condition (5) would have produced:

$$\frac{dN}{N} = \frac{dh}{h}\left[\frac{\alpha - \beta}{c\hat{\alpha} - \beta}\right] \qquad (20)$$

from which it emerges that $\frac{dN/N}{dh/h} \gtreqless 0$ if $\beta \lesseqgtr \alpha$.

On the profits side, we know that:

$$\frac{d\pi}{\pi} = \frac{dN}{N}\left[\frac{\alpha - \hat{\alpha}}{1 - \hat{\alpha}}\right] + \frac{dh}{h}\left[\frac{\hat{\beta} - \hat{\alpha}}{1 - \hat{\alpha}}\right] + \frac{dw}{w}\left[\frac{\alpha - \hat{\alpha}}{1 - \hat{\alpha}}\right]$$

from which it emerges that:

$$\frac{d\pi}{\pi} = \frac{dh}{h}\left[\frac{\hat{\alpha}(\hat{\beta} - \hat{\alpha})(1 - c)}{(1 - \hat{\alpha})(\alpha - c\hat{\alpha})}\right] \qquad (21)$$

and hence: $\frac{d\pi/\pi}{dh/h} \lesseqgtr 0$ if $\beta \lesseqgtr \alpha$[17].

Let us proceed now to consider, as above, the case of a shift from 39 to 35 hours, under the hypothesis, once again, of a 10% reduction in the standard working week. As in the previous case, we will consider a simple numerical example with the same values attributed to the parameters $\alpha, \hat{\alpha}$ and c (which are respectively equal to 0.7, 0.6 and 0.7) by distinguishing different cases as reported in Table 6.

[17] We have not taken into account the possibility of full wage compensation where the results are similar to those analysed above.

Table 6

	ε_λ	ε_h	β
Case 1	0	0	1
Case 2	-0.25	-0.05	0.89
Case 3	-0.5	-0.25	0.675
Case 4	-0.75	-0.5	0.425
Case 5	-1	0	0.7

The first and last cases represent two extreme cases with ε_λ equal to zero and –1 respectively, and with ε_h equal to zero in both cases and where β assumes respective values of 1 and 0.7 (the latter being the value of α too). Cases 2, 3 and 4 are intermediate ones in which ε_λ assumes decreasing values over time and in which numerical values corresponding to ε_h are attributed ad *hoc*.

The results of this simple numerical simulation are reported in the following tables. Table 7 reports the employment consequences of a 10% workweek reduction in relation to case (a) of $m_w < 1$. We will consider three different numerical values for parameter m_w, namely 0.9, 0.5 and 0. In Table 8, case b ($m_w > 1$), we will consider the following values for m_w: 2, 1.5 and 1.2. For the very last case, $m_w = 1$, we refer back to the previous section. Finally, in Table 9, we report the effects on profits.

Table 7

	$m_w = 0.9$		$m_w = 0.5$		$m_w = 0$	
	Employment	Tot. Hours	Employment	Tot. Hours	Employment	Tot. Hours
Case 1	20.71%	10.71%	20.71%	10.71%	20.71%	10.71%
Case 2	16.73%	6.73%	16.53%	6.53%	17.28%	7.28%
Case 3	8.8%	-1.2%	7.8%	-2.2%	11.6%	1.6%
Case 4	-0.32%	-10.32%	-2.3%	-12.3%	-4.8%	-14.8%
Case 5	10%	0%	10%	0%	10%	0%

Table 8

	$m_w = 2$		$m_w = 1.5$		$m_w = 1.2$	
	Employment	Tot. hours	Employment	Tot. Hours	Employment	Tot. Hours
Case 1	20.71%	10.71%	20.71%	10.71%	20.71%	10.71%
Case 2	17.28%	7.28%	17.04%	7.04%	16.88%	6.88%
Case 3	11.61%	1.61%	10.36%	0.36%	9.61%	-0.39%
Case 4	5.18%	-4.82%	2.68%	-7.32%	1.18%	-8.82%
Case 5	10%	0%	10%	0%	10%	0%

Table 9

	Profits
Case 1	-4.82%
Case 2	-3.05%
Case 3	0.4%
Case 4	4.42%
Case 5	0%

4.b) Neo-Classical unemployment framework

Let us now consider the case of an economic setting in which classical unemployment is the rule, or in other words where the employment level is determined uniquely by labour demand. By starting with the case of no fixed costs, under the hypothesis of fixed capital, using the results of the previous analysis, we start straightaway from the condition obtained in Appendix A, namely:

$$\frac{dw}{w} = \varepsilon_\lambda \frac{dh}{h} - \frac{dN}{N}$$

also in this case with simple mathematical tricks and recalling that the efficiency wage is influenced by variations in working hours, we obtain the following condition:

$$\frac{dN}{N} = \frac{dh}{h}\left[\varepsilon_\lambda - \varepsilon_h (1 - m_w)\right] \tag{22}$$

By referring to case a), where $m_w < 1$ (and consequently with $-1 < \frac{dw/w}{dh/h} < 0$) we obtain the following: $\frac{dN/N}{dh/h} \gtreqless 0$ if $\varepsilon_\lambda \gtreqless \varepsilon_h (1 - m_w)$. Concerning the second case (b) with $m_w > 1$ and $\frac{dw/w}{dh/h} > 0$ we obtain $\frac{dN/N}{dh/h}$<0. Finally in case c) where $m_w = 1$, this time condition (22) will become:

$$\frac{dN}{N} = \frac{dh}{h}\varepsilon_\lambda \tag{23}$$

and consequently will always be $\frac{dN/N}{dh/h}$<0.

Unlike the case in which effort proves dependent only on wages in the case in which a worksharing policy has expansive effects on employment, the latter will be less then proportionate.

Let us now turn to consider profits. Once again we take into account the national income distribution between profits and wages. As above, we will obtain with simple substitutions, condition (8) that combined with condition (1) gives:

$$\frac{d\pi}{\pi} = \frac{dh}{h}\left[\frac{\beta}{(1-\alpha}\right], \text{where } \frac{\beta}{(1-\alpha)} > 0$$

As above in tables 10, 11 and 12 we proceed with a numerical simulation in order to evaluate the employment and profits effects of a 10% reduction in the working week.

Table 10

	$m_w = 0.9$		$m_w = 0.5$		$m_w = 0$	
	Employment	Tot. Hours	Employment	Tot. hours	Employment	Tot. Hours
Case 1	0.0 %	-10.0%	0.0 %	-10.0 %	0.0 %	-10.0 %
Case 2	2.0 %	-8.0 %	2.225 %	-7.77 %	2.45 %	-7.55 %
Case 3	2.5 %	-7.5 %	3.75 %	-6.25%	4.75 %	-5.25 %
Case 4	2.5 %	-7.5 %	5.0 %	-5.0 %	7.0 %	-3.0 %
Case 5	10 %	0.0 %	10%	0.0%	10.0 %	0%

Table 11

	$m_w = 1.2$		$m_w = 1.5$		$m_w = 2$	
	Employment	Tot. Hours	Employment	Tot. hours	Employment	Tot. Hours
Case 1	0.0 %	10.0 %	0.0 %	-10.0 %	0.0 %	-10.0 %
Case 2	2.6 %	-7.4 %	2.75%	-725 %	3.0 %	-7.0 %
Case 3	5.5 %	-4.5 %	6.25 %	-3.75%	7.5 %	-2.5 %
Case 4	8.5 %	-1.5 %	10.0%	0.0 %	12.5 %	2.5 %
Case 5	10 %	0.0 %	10.0%	0.0%	10.0%	0.0%

Table 12

	Profits
Case 1	-33.3 %
Case 2	-29.6 %
Case 3	-22.5 %
Case 4	-14.5 %
Case 5	-23.3 %

Let us now consider the case where we have fixed costs associated to employment. Fixed labour costs also supported by the representative employer are given by: $N(wh+v)$, where v represents once again the fixed costs for each employee. From the efficiency wage, which is given in this case by $w = \frac{e}{e_w} - \frac{v}{h}$, with simple manipulations we will get:

$$\frac{dw}{w} = \frac{dh}{h}\left\{\frac{1}{w}\left[w(\varepsilon_h - m_h) + \frac{v}{h}(\varepsilon_h - m_h + 1)\right]\right\}$$ [18]

the above combined with the following expression obtained by Appendix B:

$$wh(1-\alpha)\frac{dw}{w} = \frac{dh}{h}\left[\sigma_F v - (wh+v)(1-\alpha)\varepsilon_\lambda\right] - \frac{dN}{N}(wh+v)(1-\alpha)$$

we get the following expression:

[18] For an analytical derivation refer back to Appendix D.

$$\frac{dN}{N}=\frac{dh}{h}\left\{\frac{-h(1-\alpha)\left[w(\varepsilon_h-m_h)+\frac{v}{h}(\varepsilon_h-m_h+1)\right]+\sigma_F v-(wh+v)\varepsilon_\lambda(1-\alpha)}{(wh+v)(1-\alpha)}\right\} \quad (24)$$

Let us consider now the three cases mentioned in Appendix D:

$$m_w>\varepsilon_h+\frac{v}{v+wh} \quad \text{con} \quad \frac{dw/w}{dh/h}<0$$

$$m_w<\varepsilon_h+\frac{v}{v+wh} \quad \text{con} \quad \frac{dw/w}{dh/h}>0$$

$$m_w=\varepsilon_h+\frac{v}{v+wh} \quad \text{con} \quad \frac{dw/w}{dh/h}=0$$

The latter case (c) is the one in which there is the absence of wage compensation. In case a) we have $\left(\frac{dN/N}{dh/h}\right)>0$, while in case b) it will result that:

$$\frac{dN/N}{dh/h}\gtreqless 0 \ \text{ if } \ m_h\gtreqless\varepsilon_h+\frac{v}{v+wh}-\frac{\sigma_F v}{(1-\alpha)(wh+v)}+\varepsilon_\lambda$$

finally in case c)we have $\frac{dN/N}{dh/h}>0$.

It is worth noting that in this case a worksharing policy might not be effective, because firms for "efficiency" reasons will be driven to decrease employment. For the profits case the analysis is identical to the previous case $\left(\frac{d\pi/\pi}{dh/h}\right)>0$.

Section 5: Concluding remarks

The most interesting results of this paper may be summarised as follows: under the hypothesis of wages determined according to the standard efficiency wages model (Solow, 1979), independent of other variables such as the unemployment rate or the outside workers' wage, both in a Keynesian and in a neoclassical framework without fixed costs associated to the labour input, an increase in the employment rate will always correspond to a reduction in the working week. The above result will be overturned if we allow for the introduction, within a neoclassical framework, of fixed labour costs; when the latter is the case, a generalised reduction of the standard working week will be matched by an employment fall. However, it should be stressed that in all the cases considered we always end up with a considerable profit decrease. Moving on to the second case, where we consider in the effort function, in addition to wages, also the amount of hours worked, a reduction of the standard working week in a Keynesian framework will produce a likely increase in employment. If, on the other hand, we hypothesise a framework strictly related to a typical neoclassical economic behaviour, a reduction in the working time will determine an uncertain employment trend, if we hypothesise to work with full wage compensation[19], and a clearly growing employment level if wages do not undergo changes according to variations in the working hours[20]; in this case too, profits will always be decreasing. If also in this case we consider a classical world in which we take account of the existence of fixed labour costs, corresponding to a decrease in hours worked there will be a decrease both in the employment level and in profits, this occurring with or without wage compensation.

After all it is possible to see that if we retain the assumption of a world acting according to Keynesian schemes, worksharing might be considered as an effective political economy policy aimed to favour employment expansion whereas if the logic is typical of a neoclassical world then the working week reduction has to be considered not always effective; we have seen that, when fixed costs occur, such a policy has negative effects on employment.

Once again we underline how cautious economists must be, and this is even more important for those supporters of the Keynesian approach, before believing that in a situation characterised by high unemployment levels the "only" remedy may be found in a generalised reduction in the standard working hours, because it must be remembered that such a policy undoubtedly has negative effects on firms' profits. The fall in profits is likely to push employers to modify the workers' wage determination mechanism and, on the other hand, to increase prices thereby giving rise to some inflationary costs' side pressure. Furthermore, such a profits reduction could be detrimental to investment and consequently slow down the process of economic growth in the country considered.

It is worth stressing the possibility of investigating further lines of research. First, it would be interesting to extend the model, whilst retaining the dual distinction (Keynesian and neoclassical), to the possibility of all or just some

[19] It is in the interest of firms, respectful to the efficiency wages models, to compensate workers in order to avoid a fall in the effort level.

[20] We considered it needless to consider the effect of hours' reduction on employment in a context in which wages decrease with hours, because such a case is unlikely to occur.

workers having access to overtime premiums, even in a bisectorial framework. Second, it seems worth exploring the effectiveness of worksharing in an economic context which is governed by different mechanism of wage determination.

Appendix A

In order to demonstrate the following identity:

$$\alpha\left[\frac{dwh}{wh}\right]+(1-\alpha)\frac{dr}{r}=0 \qquad (a)$$

we proceed as follows; condition *(a)* can be rewritten as:

$$\alpha\left(\frac{dw}{w}+\frac{dh}{h}\right)=-(1-\alpha)\frac{dr}{r},$$

and again:

$$\alpha rdwh=-(1-\alpha)whdr.$$

Bearing in mind that: $\alpha=\frac{whN}{Y}$ and $(1-\alpha)=\frac{rK}{Y}$, the above condition can be written as: $\frac{rwhN}{Y}dwh=-\frac{rK}{Y}whdr$ from which we obtain:

$$Ndwh=-Kdr \qquad (b).$$

This latter condition can be easily shown; from the production function we have: $dY=F_N dN+F_K dK$, and so $dY=whdN+rdK$. Moreover we know that: $Y=whN+rK$ and consequently:

$$dY=whdN+Ndwh+rdK+Kdr$$

$$whdN+rdK=WhdN+Ndwh+rdK+kdr$$

$$Ndwh=-Kdr \qquad (b).$$

Finally the substitution elasticity may be written as:

$$\sigma_F\left(\frac{dr}{r}-\frac{dwh}{wh}\right)=-\left(\frac{dK}{K}-\frac{dN}{N}\right) \qquad (c);$$

combining conditions *(a)* and *(c)* we have:

$$\frac{dwh}{wh}-\frac{dr}{r}=\frac{1}{\sigma_F}\left(\frac{dK}{K}-\frac{dN}{N}\right)$$

$$\frac{dwh}{wh}\left[1+\frac{\alpha}{(1-\alpha)}\right]=\frac{1}{\sigma_F}\left(\frac{dK}{K}-\frac{dN}{N}\right)$$

$$\frac{dwh}{wh}=-\frac{(1-\alpha)}{\sigma_F}\left(\frac{dN}{N}-\frac{dK}{K}\right)$$

$$\frac{dw}{w}+\frac{dh}{h}=-\frac{(1-\alpha)}{\sigma_F}\left(\frac{dN}{N}-\frac{dK}{K}\right) \qquad (d)$$

If we now consider the labour demand: $w=F'\left(K,\frac{eN}{\lambda}\right)e$, by differentiating we obtain: $dw=dw\left[e_wF'+\frac{eF''Ne_w}{\lambda}\right]-dh\left[\frac{e^2F''N\lambda_h}{\lambda^2}\right]+dN\left[\frac{e^2F''}{\lambda}\right]$.

However, recalling that: $\varepsilon_\lambda=\frac{\lambda_h h}{\lambda}$, $1=\frac{e_w w}{e}$, $\alpha=\frac{hF'eN}{Y}$, and from the above condition

(d) that: $\frac{dwh}{dN}=-\frac{(1-\alpha)wh}{N\sigma_F}$, and so: $\frac{hF''e^2}{\lambda}=-\frac{(1-\alpha)wh}{N\sigma_F}$ and then: $\frac{F''e^2}{\lambda}=-\frac{(1-\alpha)w}{N\sigma_F}$, we have:

$$dw=dw\left[\frac{e}{w}\left(F'+\frac{eF''N}{\lambda}\right)\right]+\frac{dh}{h}\left[-\frac{e^2F''N\varepsilon_\lambda}{\lambda}\right]+dN\left[\frac{e^2F''}{\lambda}\right]$$

$$dw=dw\left[e\left(\frac{1}{e}-\frac{(1-\alpha)}{e\sigma_F}\right)\right]+\frac{dh}{h}\left[\frac{w\varepsilon_\lambda(1-\alpha)}{\sigma_F}\right]-\frac{dN}{N}\left[\frac{(1-\alpha)}{\sigma_F}\right]$$

$$dw\left[\frac{(1-\alpha)}{\sigma_F}\right]=+\frac{dh}{h}\left[\frac{\varepsilon_\lambda(1-\alpha)}{\sigma_F}\right]-\frac{dN}{N}\left[\frac{(1-\alpha)}{\sigma_F}\right]$$

$$\frac{dw}{w}=\frac{dh}{h}\varepsilon_\lambda-\frac{dN}{N}$$

With no wage compensation we have:

$$\frac{dN}{N}=\frac{dh}{h}\varepsilon_\lambda,$$

while with wage compensation we will have:

$$\frac{dN}{N}=\frac{dh}{h}(\varepsilon_\lambda-1).$$

Appendix B

First of all, we have to demonstrate the following identity

$$\alpha\left[\frac{d(wh+v)}{wh+v}\right]+(1-\alpha)\frac{dr}{r}=0 \quad (a')$$

The above condition can be rewritten as follows:

$$\alpha r d(wh+v)=-(1-\alpha)(wh+v)dr .$$

Remembering that: $\alpha=\frac{N(wh+v)}{Y}$ and: $(1-\alpha)=\frac{rK}{Y}$, the condition *(a')* will become: $\frac{r(wh+v)N}{Y}d(wh+v)=-\frac{rK}{Y}(wh+v)dr$ and so:

$$Nd(wh+v)=-Kdr . \quad (b')$$

Condition *(b')* can be easily demonstrated. From the production function we know that: $dY=F_N dN+F_K dK$ and so: $dY=(wh+v)dN+rdK$. Moreover, we know that: $Y=(wh+v)N+rK$ and then:

$$dY=Nd(wh+v)+(wh+v)dN+rdK+Kdr$$

and finally:

$$Nd(wh+v)=-Kdr . \quad (b')$$

However, the substitution elasticity can be written in the following way:

$$\sigma_F\left(\frac{dr}{r}-\frac{d(wh+v)}{wh+v}\right)=-\left(\frac{dK}{K}-\frac{dN}{N}\right) \quad (c');$$

combining conditions *(a')* and *(c')* we have:

$$\frac{d(wh+v)}{wh+v}-\frac{dr}{r}=\frac{1}{\sigma_F}\left(\frac{dK}{K}-\frac{dN}{N}\right)$$

$$\frac{d(wh+v)}{wh+v}\left[1+\frac{\alpha}{(1-\alpha)}\right]=\frac{1}{\sigma_F}\left(\frac{dK}{K}-\frac{dN}{N}\right)$$

$$\frac{d(wh+v)}{wh+v}=-\frac{(1-\alpha)}{\sigma_F}\left(\frac{dN}{N}-\frac{dK}{K}\right) \quad (d')$$

We know that: $\frac{d(wh+v)}{wh+v}=\frac{dwh}{wh}\left[\frac{wh}{wh+v}\right]+\frac{dv}{v}\left[\frac{v}{wh+v}\right]$ and if we suppose: $f=\frac{v}{wh+v}$, it is possible to write the following expression: $\left(\frac{dw}{w}+\frac{dh}{h}\right)(1-f)+f\frac{dv}{v}=\frac{d(wh+v)}{wh+v}$.

If we now consider the labour demand: $wh+v=F'\left(K,\frac{eN}{\lambda}\right)eh$* by differentiating it we obtain:

$$hdw+wdh+dv=dw\left[e_wF'h+\frac{ehF''Ne_w}{\lambda}\right]+dh\left[eF+ehF'\left(-\frac{eN\lambda_h}{\lambda^2}\right)\right]+dN\left[\frac{e^2hF''}{\lambda}\right].$$

Moreover, bearing in mind that: $\varepsilon_\lambda=\frac{\lambda_h h}{\lambda}$, $1=\frac{he}{e_w(wh+v)}$, $\alpha=\frac{(wh+v)N}{Y}=\frac{hF'eN}{Y}$, from condition *(d')* we obtain $\frac{d(wh+v)}{dN}=-\frac{(1-\alpha)(wh+v)}{N\sigma_F}$ and hence $\frac{hF''e^2}{\lambda}=-\frac{(1-\alpha)(wh+v)}{N\sigma_F}$.

Coming back to the total differential we have:

$$hdw+wdh=dw\left[e_w\left(F'h+\frac{ehF''N}{\lambda}\right)\right]+dh\left[eF'+ehF'\left(-\frac{eN\lambda_h}{\lambda^2}\right)\right]-\frac{dN}{N}\left[\frac{(1-\alpha)(wh+v)}{\sigma_F}\right],$$

$$hdw+wdh=dw\left[\frac{h}{wh+v}\left(hF'e+\frac{eF''Nhe}{\lambda}\right)\right]+\frac{dh}{h}\left[eF'h-\frac{ehF'eNh\lambda_h}{h\lambda^2}\right]-\frac{dN}{N}\left[\frac{(1-\alpha)(wh+v)}{\sigma_F}\right]$$

$$hdw+wdh=dw\left[\frac{h}{wh+v}\left((wh+v)+\frac{(1-\alpha)(wh+v)}{\sigma_F}\right)\right]+\frac{dh}{h}\left[\left((wh+v)+\frac{(1-\alpha)(wh+v)}{\sigma_F}\right)\varepsilon_\lambda\right]+$$

$$-\frac{dN}{N}\left[\frac{(1-\alpha)(wh+v)}{\sigma_F}\right]$$

* In this case the efficiency wage derives from the following condition: $\frac{eh}{e_w}=wh+v$ which gives us the following value: $w=\frac{e}{e_w}-\frac{v}{h}$. The modified Solow condition is now: $1=\frac{he}{(wh+v)e_w}$.

and again we obtain:

$$hdw + wdh = dw\left[h - \left(\frac{(1-\alpha)h}{\sigma_F}\right)\right] + \frac{dh}{h}(wh+v)\left[1 - \frac{(1-\alpha)\varepsilon_\lambda}{\sigma_F}\right] - \frac{dN}{N}\left[\frac{(1-\alpha)(wh+v)}{\sigma_F}\right],$$

$$dw\left[\frac{(1-\alpha)}{\sigma_F}\right] = -wdh + \frac{dh}{h}(wh+v)\left[1 - \frac{(1-\alpha)\varepsilon_\lambda}{\sigma_F}\right] - \frac{dN}{N}\left[\frac{(1-\alpha)(wh+v)}{\sigma_F}\right],$$

$$wh\frac{dw}{w}\left[\frac{(1-\alpha)}{\sigma_F}\right] = \frac{dh}{h}(wh+v)\left[v - \frac{(wh+v)(1-\alpha)\varepsilon_\lambda}{\sigma_F}\right] - \frac{dN}{N}\left[\frac{(1-\alpha)(wh+v)}{\sigma_F}\right],$$

$$\frac{dw}{w}(1-\alpha)wh = \frac{dh}{h}\left[\sigma_F v - (wh+v)(1-\alpha)\varepsilon_\lambda\right] - \frac{dN}{N}(1-\alpha)(wh+v).$$

From analysis of the above condition we can derive that in the case of no wage compensation we obtain that:

$$\frac{dN/N}{dh/h} = \frac{\sigma_F v}{(wh+v)(1-\alpha)} - \varepsilon_\lambda,$$

if total wage compensation is the case, then we will have:

$$\frac{dh}{h}\left[wh(1-\alpha) + \sigma_F v - (wh+v)(1-\alpha)\varepsilon_\lambda\right] = (wh+v)(1-\alpha)\frac{dN}{N}$$

from which we can easily derive the following expression:

$$\frac{dN/N}{dh/h} = \frac{wh(1-\alpha) + \sigma_F v - (1-\alpha)(wh+v)\varepsilon_\lambda}{(1-\alpha)(wh+v)}.$$

Appendix C

We already know that $w = \frac{e(w,h)}{e_w(w,h)}$, from which we can obtain the following identity: $w_h = \frac{e_h e_w - e_{wh} e}{(e_w)^2}$ and consequently:

$$\frac{dw}{w} = \frac{dh}{h}\left[\frac{h}{w}\left(\frac{e_h e_w - ee_{wh}}{(e_w)^2}\right)\right]$$

$$\frac{dw}{w} = \frac{dh}{h}\left[\frac{he_h}{we_w} - \frac{he_{wh}}{e_w}\right].$$

Because $e_{wh} = e_{hw}$, and defining $\frac{e_{hw} w}{e_h} = m_w$ as the elasticity of e_h with respect to w, and in the light of the mentioned Solow Condition, we will have: $\frac{dw}{w} = \frac{dh}{h}\left[\frac{he_h}{e}\left(\frac{e}{we_w} - \frac{ee_{hw}}{e_h e_w}\right)\right]$ and again $\frac{dw}{w} = \frac{dh}{h}\left[\frac{he_h}{e}\left(1 - \frac{we_{hw}}{e_h}\right)\right]$; the above condition can be rewritten as follows:

$$\frac{dw}{w} = \frac{dh}{h}\left[\varepsilon_h (1 - m_w)\right] \quad \text{where: } m_w > 0 \text{ and } -1 < \varepsilon_h < 0.$$

From the analysis of the above condition three cases may be distinguished:

$$m_w < 1 \text{ with: } -1 < \frac{dw/w}{dh/h} < 0;$$

$$m_w > 1 \text{ with: } \frac{dw/w}{dh/h} > 0;$$

$$m_w = 1 \text{ with: } \frac{dw/w}{dh/h} = 0 \text{ (This is the case of no wage compensation).}$$

It is worth noting that in case b) a reduction in hours will push firms to reduce efficient wages.

Appendix D

In this case the modified Solow Condition is given by $1 = \frac{he}{(wh+v)e_w}$, and the corresponding efficiency wage will be $w = \frac{e}{e_w} - \frac{v}{h}$ from which we can easily derive the following expression: $w_h = \frac{e_h e_w - e_{wh} e}{(e_w)^2} + \frac{v}{h^2}$ and hence: $w_h = \frac{h^2 e_h e_w - h^2 e e_{wh} + v(e_w)^2}{h^2 (e_w)^2}$. We are now in a position of determining:

$$\frac{dw}{w} = \frac{dh}{h}\left[\frac{h}{w}\left(\frac{he_h}{we_w} - \frac{hee_{wh}}{w(e_w)^2} + \frac{v}{h^2}\right)\right]$$

$$\frac{dw}{w} = \frac{dh}{h}\left[\frac{1}{w}\left(\frac{he_h}{e_w} - \frac{hee_{wh}}{(e_w)^2} + \frac{v}{h}\right)\right].$$

Recalling the Solow Condition the above can be rewritten as:

$$\frac{dw}{w} = \frac{dh}{h}\left[\frac{1}{w}\left(\frac{\varepsilon_h e}{e_w} - \frac{m_h e}{e_w} + \frac{v}{h}\right)\right]$$

where m_h measures the elasticity of e_w with respect to h. Finally remembering that: $\frac{e}{e_w} = w + \frac{v}{h}$ we have the following:

$$\frac{dw}{w} = \frac{dh}{h}\left\{\frac{1}{w}\left[(\varepsilon_h - m_h)\left(w + \frac{v}{h}\right) + \frac{v}{h}\right]\right\}$$

$$\frac{dw}{w} = \frac{dh}{h}\left\{\frac{1}{w}\left[w(\varepsilon_h - m_h) + \frac{v}{h}(\varepsilon_h - m_h + 1)\right]\right\}.$$

From the analysis of the above condition three following cases may be distinguished:

a) If $m_w > \varepsilon_h + \frac{v}{v+wh}$ it will be: $\frac{dw/w}{dh/h} < 0$;

b) if $m_w < \varepsilon_h + \frac{v}{v+wh}$ it will be: $\frac{dw/w}{dh/h} > 0$;

c) if $m_w = \varepsilon_h + \frac{v}{v+wh}$ it will be: $\frac{dw/w}{dh/h} = 0$ (This is the case of no wage compensation).

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