Reduction of working time and employment

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Abstract

This paper analyzes the consequences of compulsory reductions in working time on employment. The first part of the paper is devoted to the analysis of labor demand when the firm chooses the number of jobs and hours. This framework allows us to show that compulsory reductions in standard hours can increase employment only if wage compensation is sufficiently low. Then, the second part of the paper looks at the determinants of wages, hours and employment in different frameworks: perfect competition, collective bargaining, monopsony. It is shown that regulation of hours is justified and can even increase employment when competition is imperfect. However, compulsory reductions in working hours cannot systematically improve employment and welfare.

1 Introduction

Worksharing through reductions of working hours per week, per month or per year has often emerged as a potential instrument for reducing unemployment. In some countries this instrument had not only been potential during the last twenty years. In Germany, reductions in standard hours have been negotiated between unions and employers in the eighties and the nineties to induce worksharing. In France, large scale compulsory reductions in standard hours have been implemented in order to increase employment. The basic theory that motivates worksharing policies relies on a simple rule of three. For a constant level of production, reductions of working time increase the number of jobs. This simple reasoning can make sense in a keynesian world in which the production of firms is determined by aggregate demand. However, it is now well established that the keynesian conception of economics neglects many determinants of employment, especially in the long run. In the long run, labor costs and productivity are the main determinants of employment. Therefore, reductions in working time can benefit to employment only if they entail changes in productivity and labor cost that favor employment. Obviously, labor cost and productivity are themselves influenced by a large number of institutional features which interact with standard hours and which have to be taken into account to understand the consequences of compulsory reductions in working hours.

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From this point of view, economic analysis shows that compulsory reductions in standard hours can increase employment, but in very special circumstances that are far from being often met in the real world. In particular, it is generally not possible to increase employment thanks to reductions in working hours accompanied by full wage compensation. In other words, drops in weekly working hours have to go hand in hand with drops in weekly earnings to be able to favor employment. The magnitude of the required drops in weekly earnings depends on the productivity changes induced by working time reductions. If reductions in working time is accompanied by raises in the productivity of each hour worked, it is possible to increase the number of jobs with small drops in weekly earnings. However, if productivity of hours remains constant, large drops in weekly wages are required.

These results indicate clearly that the impact of compulsory reductions in working hours on employment hinges on the reaction of wages. Wages themselves are determined by preferences, technology and markets mechanisms. The analysis of these mechanisms in different contexts, including perfect competition, collective bargaining and monopsony, allows us to shed light on the choices over working hours and the consequences of reductions in working time when wages are endogenous. It appears that working hours depend on features such as the preference for leisure and non market production, the wage bargaining structure, the market power of firms and the regulations of working conditions. Moreover, when competition is imperfect, choices over working hours are not efficient. Therefore, regulations of working time are needed. Nevertheless, compulsory reductions in working hours cannot systematically improve employment and welfare.

The paper is organized as follows: section 2 is devoted to the analysis of labor demand when the firm chooses the number of jobs and hours. The interactions between choices of employers and workers over hours, employment and wages are studied in section 3. Section 4 provides some concluding comments.

2 Labor demand and working time

In order to grasp the determinants of the tradeoff between jobs and hours, it is necessary to distinguish the contributions of these two elements to the production process, and to differentiate between the costs arising from an increase in the number of employees and those that arise from a change in the number of hours worked by each employee. Assuming that the hourly wage remains constant, one can then study the "pure" effects of reductions in the working time. But reductions in working time with constant hourly wages means drops in weekly and monthly wages. Workers are probably not ready to accept such drops and will probably ask for higher hourly wages in order to try to keep unchanged their puchasing power. This could have an impact on the consequences of compulsory working time reductions.

2.1 The effects of reductions in working time when the hourly wage is constant

The production process

Firms produce output with capital and labor services. Both labor and capital services are influenced by the duration of work. The working time of each worker determines the number of units of labor services that he provides. A priori, an increase in working time raises the number of units of labor services that each employee produces. However, it is important to stress that this relation might be quite complex, for set up costs might imply that a minimum number of hours is required to get positive returns form labor services, then, once this number is passed, the efficiency labor services should increase rapidly with the number of hours. The effects of fatigue as the hours pass should also cause marginal efficiency to decrease for large values of working time.

Likewise, the duration of capital utilization may depend on the working time. One should expect the duration of capital utilization to increase with the duration of work. However, it can be the case that the duration of capital utilization is independent of the individual duration of work, or even decreases with the duration of work if there are reorganizations of the production process associated with changes in working time.

These brief remarks merely indicate that a firm that keeps its number of employees constant lowers its level of production when working hours and the duration of capital utilization shrink.

The cost of labor

The cost of labor does not depend in a simple way on its duration because workers and hours are distinct outputs. This distinction is important for at least two reasons (Rosen, 1968, Hart, 1987).

In the first place, for each employed person there are fixed costs that do not depend on the duration of work, principally the costs of hiring and firing, training costs, and certain social security contributions. These fixed costs are influenced by the institutional environment: for instance, they are higher in countries in which job protection is more stringent. They also depend on the unemployment rate: when the unemployment rate is higher, hiring costs are lower because it takes less time to find unemployed workers.

In the second place, in many countries there exists a legal or standard work duration, and every overtime hour worked past that limit is remunerated at a higher rate than regular or standard hours. For example, in the United States the 'Fair Labor Standards Act', signed in 1938, defines the standard work week as 40 hours and lays down an overtime rate 50% higher for hours worked past that limit. Let us use T to designate the standard work week, W to designate the wage for a normal hour, Z to designate the fixed costs, and x to designate the overtime premium. Then the labor cost is written:

$$C = \begin{cases} [WT + (1+x)W(H-T) + Z\,]\,N & \text{if } H > T \\ (WH + Z)\,N & \text{if } H \leq T \end{cases} \tag{1}$$

The choice of capital, hours and jobs

Let us designate by R the unit cost of capital utilization, then the total cost of production is equal to $C + RK$. For each firm, its optimal choice of capital, jobs and hours is deduced from the minimization of this total cost, made of labor costs C plus capital costs RK. The expression (1) of the labor costs C indicates that labor demand, here the number of persons employed and hours worked, should depend on the comparison between the value of the variable labor costs — determined by W, T and x — and that of the fixed costs of labor represented by Z. Intuition suggests that a reduction in fixed labor costs gives firms an incentive to substitute workers for hours, and thus ought to favor employment. Conversely, a reduction in variable costs ought to increase the number of hours worked, to the detriment of employment. The demand for workers and the demand for hours may thus vary in inverse directions.

The influence of standard hours on hours and jobs

Changes in standard hours have contrasting effects according to whether or not the firm makes use of overtime. Imagine that the level of standard hours is high relatively to what the firm needs. Then the optimal number of hours is lower than standard hours and obviously, changes in standard hours have no effect, neither on employment nor on hours actually worked. However, things are different in other cases.

If the optimal number of hours just corresponds to the standard hours the effects of changes in standard hours on the duration of work are trivial: reductions in standard hours evidently lead to drops in the number of hours actually worked. But the consequence on the number of jobs is a priori ambiguous. On one hand, the expression (1) of total labor cost shows that a reduction in standard hours amounts to a reduction in the cost of each worker (equal to $WT + Z$), which tends to increase employment, but on the other hand, it also means that the efficiency of labor is decreased, which may give the firm an incentive to lower its employment level.

Imagine now that the level of standard hours is low relatively to what the firm needs. Then the optimal number of hours is higher than standard hours and firms will make use of overtime hours. Looking at the definition of the labor cost (1), it appears that decreases in standard hours increase the marginal cost of each job (equal to C/N) but do not change the marginal cost of overtime hours (equal to $(1 + x)W$). Therefore, the ratio between the cost of an additionnal worker and the cost of an additionnal hour has increased which incites firms to increase work duration at the expense of the number of jobs when standard hours drop (see Rosen, 1968, and Calmfors and Hoel, 1988). In that case, reductions in standard hours have the counter-intuitive effect of raising the number of hours worked by all employees. In other words, reductions in standard hours increase working hours by causing the number of overtime hours to rise. This result seems at first sight to run counter to the

H^*	η_x^H	η_T^H	η_x^N	η_T^N
$0.9 \times T$	0	0	0	0
T	0	1	0	-0.96
$1.04 \times T$	-2.23	-2	2.00	1.86

Table 1: Values of elasticities of hours and employment. Source: Cahuc and Zylberberg (2004, table 4.2, p. 203).

purpose of reductions in standard hours, which is precisely to bring down the actual number of hours worked by every individual so as to increase the number of jobs.

According to these brief remarks, economic theory indicates that the employment effects of reductions in standard hours are a priori ambiguous: when the hourly wage is taken as given, reductions in standard hours should decrease employment in firms in which actual working hours are larger than standard hours and have the opposite effect when actual hours are equal to standard hours.

Some quantitative results

In order to shed some light on the potential impact of reductions in standard hours on employment, it is useful to consider a simple case in which the production function is a Cobb Douglas, assuming that the share of the cost of labor in the total cost is equal to 0.7 and that the elasticity of substitution between capital and labor is equal to one. Empirical studies suggest that such values are relevant for an "aggregate" production function that represents the technology of the economy as a whole. We assume further that the elasticity of labor efficiency with respect to hours worked is equal to 0.9.[1]

We distinguish three types of firm according to the relative level of their fixed costs compared to their variable costs in order to have three different behaviors for the choice of optimal hours. In our calibration, firms with small relative fixed cost has optimal hours equal to 90% of standard hours ($H^* = 0.9 \times T$), firms with medium relative fixed cost have optimal hours just equal to standard hours ($H^* = T$), and firms with high relative fixed cost have optimal hours equal to 104% of standard hours ($H^* = 1.04 \times T$). Assuming that the overtime premium x is equal to 30%, table 1 gives the values for the elasticities of optimal hours and employment, with respect to overtime premium (η_x^H and η_x^N) and legal duration (η_T^H and η_T^N).

Table 1 shows that variations in standard hours have very different effects on employment, since elasticity η_T^N runs from -0.96 to 1.86 when the only source of heterogeneity in firms is the extent of the relative fixed costs of labor. The same remark applies to overtime premium. A reduction in the number of hours worked allows employment to be significantly increased (at a given hourly wage) when the actual number of hours is the same as the standard one, but has a very strong negative effects on employment in firms that make use of overtime.

[1] Formally, the production function takes the form $AK^{0.3}[H^{0.9}L]^{0.7}$ where A is a positive constant.

Changes in: (percentage)	Case 1	Case 2	Case 3
Employment	+13	-17	-5
Production	+6	-22	-16
Profits	+12	-33	-8

Table 2: The effects of a 10 percent decrease in standard hours. Case 1: No wage compensation, 5 percent decrease in weekly labor productivity and no decrease in the duration of capital utilization. Case 2: Full wage compensation, 10 percent decrease in weekly productivity and 10 percent decrease in the duration of capital utilization. Case 3: Full wage compensation, 6.66 percent decrease in weekly labor productivity and no decrease in the duration of capital utilization.

2.2 Compensating for the global wage reduction

It is important to emphasize that what we have done is to look at the impact of variations in standard hours and the overtime premium, while taking the hourly wage as given. Now there are good reasons to think that the hourly wage is influenced by these two variables, because reductions in time worked entail reduction in monthly earnings when hourly wages remain constant. We can well imagine that wage-earners would resist such income drops by demanding higher hourly wages. The German and French past experiments show that it is indeed the case (see Hunt, 1999, and Cahuc, 2001). According to any standard model of labor demand such rises in the cost of labor would end up with lower employment. But this is not the end of the story, because reductions in standard hours can also have at least two beneficial effects on employment that run counter increases in labor costs.

A first beneficial effect that we have already mentioned is that average labor productivity is higher when the duration of work is shorter (the effects of fatigue as the hours pass should cause marginal efficiency to decrease for larger values of hours). In other words, labor is more intensive when it is spread on shorter durations and, as a general rule, rises in the average labor productivity will favor employment. A second beneficial effect concerns the reorganization of the production process. Reductions in standard hours followed by reductions in the duration of capital utilization will have an adverse impact of firms profitability and therefore on employment. Notwithstanding, reductions in standard hours may induce significant reorganization in the production process leading to more intensive capital utilization and thus to higher employment.

The final impact of a reduction in standard hours will depend upon the magnitude of all these effects. We use a model of labor demand similar to the preceding one to evaluate the impact of a 10% reduction in standard hours under three different alternatives[2]. Table 2 displays the results of these three alternatives.

The most favorable case for employment is scenario 1. It assumes no compensation for the global wage (the weekly wage decreases by 10 percent), the production process is reorganized in order to

[2]For more details see the appendix on the labor demand elasticities.

Employers subsidies necessary to keep unchanged	Case 1	Case 2	Case 3
Employment	-8	10	3
Profits	-5	14	7

Table 3: Minimum level of employment subsidies (in percentage of initial labor cost) necessary to maintain employment and profits when standard hours are decreased by 10 percent

keep the same duration of capital utilization and the average productivity of an hour of work increases by 5 percent which implies that the productivity of labor over the week is decreased by 5 percent. Under this scenario a 10 percent reduction in standard hours leads to a rise in employment by 13 percent (firms profits are increased by 6 percent and output gains 6 percent). Case 2 is the worst for employment. It assumes a decrease in capital utilization, full wage compensation (the weekly wage does not change) and no gain in hourly productivity. The main results are a 17 percent decrease in employment with even greater drops in production and profits. Cases 1 and 2 represent two polar cases and any intermediary case ought to be considered as possible according to the values of the wage compensation, the gain in hourly productivity and the change in capital utilization. Case 3 represents such an intermediary situation where the wage compensation is complete, hourly labor productivity increases by 3.33 percent[3] and capital utilization remains unchanged. In that case, employment decreases by 5 percent and total output and firms profits also decrease significantly.

These results highlight the importance of wage compensation. Reductions in standard hours with full wage compensation appear to be detrimental to employment even if the productivity gains are huge[4]. Moreover, it turns out that reductions in working time can have strong negative effects on profits, especially for firms in which there are low productivity gains and where there is strong wage compensation. From this point of view, reductions of working time policies may accelerate the destruction rate of some firms.

These results suggest that policies that aim at reducing standard hours without too much damages on the global wage and on profits should be linked with subsidies accruing to firms. This is actually the kind of strategy that has been implemented in France, where the reduction in working time to 35 hours has been accompanied by important employment subsidies in order to favor job creation. Table 3 displays the level of subsidies (expressed as a percentage of ex ante labor cost) that are necessary to maintain employment and firms profits under the three cases considered in Table 2.

Except in the unreasonable alternative described by case 1 where the global wage is reduced by 10 percent, Table 3 tells us that reductions in standard hours with full wage compensation must be actually subsidized if one wishes simply to maintain the employment level and profitability. Even in

[3]Estimates of the relation between hours and labor productivity yield very heterogenous results. Using French date Gianella and Lagarde (1999) do not find any productivity gain following a reduction in working time. However, Crépon et al. (2004) find large productivity gains associated with the "Aubry" reductions in working time in 2000 in France. It should be noticed that the "Aubry" reductions have been accompanied by important changes in the regulation of working conditions, which allow the employer to use more flexible hours.

[4]See the discussion in the appendix on the labor demand elasticities.

the favorable case 3 where labor productivity increases dramatically, firms faced with a 10 percent reduction in standard hours need subsidies that amount to 3 percent of total labor cost in order to keep the level of employment unchanged (the subsidy must reach 7 percent of total labor cost to keep the profits unchanged). Two significant lessons emerge from these results.

First, reductions in weekly working time cannot increase employment if weekly labor costs remain constant. For workers paid at the minimum wage, this means that governements cannot increase employment thanks to reductions in working that are not accompanied by drops in labor costs. Labor costs can be reduced thanks to lower weekly earnings of employees. But such a scenario is generally not wished. It is also possible to accompany reductions in working hours by job subsidies. However, it turns out that job subsidies create more jobs when working hours are not reduced as long as the weekly earnings of employees remain the same.

Second, as the employment effects of compulsory reductions in working time are conditioned to a large extent by the reaction of wages, it is essential to know more about the impact of reductions in working hours on wages to be able to understand the employment effects of working time reductions.

3 Working time, wages and employment

The competitive model of the labor market is a useful point of departure to begin to analyze the consequences of reductions in working time on wages and employment. We are going to see that this model delivers a very deceptive conclusion: it shows that compulsory reductions in standard hours cannot improve welfare and are likely to destroy jobs. However, real economies are not perfectly competitive. From this point of view, it is worth looking at models of imperfect competition to fully understand the consequences of reductions in working time on employment when the reactions of wages are taken into account. The conclusions obtained when imperfect competition is accounted for help us to understand the usefulness of regulations of working hours. Moreover, they show that small compulsory reductions in hours can, in certain circumstances, increase employment.

3.1 Perfect competition

In a perfectly competitive economy, compulsory reductions in standard hours cannot improve welfare because they introduce constraints in a context in which the allocation of resources is efficient. Generally, the inefficiency of compulsory reductions in hours implies that such reductions are bad for employment. However, interactions of labor supply decisions within households implies that aggregate employment can increase when (inefficient) compulsory reductions in working hours are introduced.

The choice of hours and wages

Economic analysis shows that perfect competition in the labor markets ought to lead to a wage heterogeneity that results purely from the fact that the working conditions of some jobs are harder

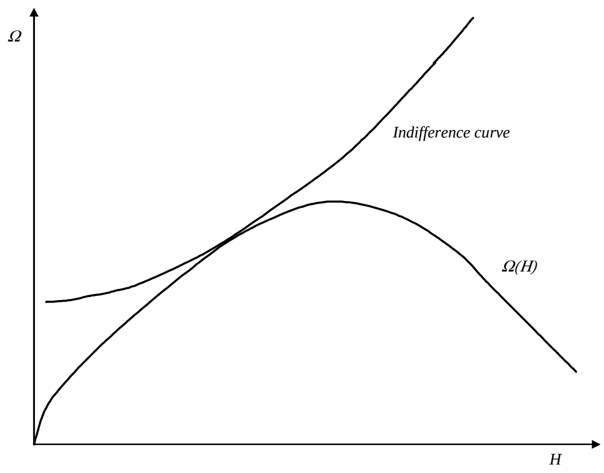

Figure 1: Hours and wage in the economy with perfect competition

than others, and some suppliers of labor are more competent than others. Differences arising from working conditions are explained by the hedonic theory of wages, the premises of which were sketeched by Adam Smith at the end of the eighteenth century and have more recently been formalized by Rosen (1974, 1986). From the perspective of the hedonic theory, wage heterogeneity reflects compensating differentials: employees who work more hours per week should get higher earnings because they work more. But the hedonic theory of wages yields more precise results: it shows that weekly earnings and weekly working hours hinge on preferences and technology. Such results can be illustrated in a simple framework where preferences are represented by a utility function $v(\Omega, H_0 - H)$, where Ω denotes weekly earnings, H_0 the time allocation and H the working hours per week. Between firm competition implies zero profits and wages equal to marginal productivity. This process leads to define the weekly earnings as a function of weekly hours, denoted by $\Omega(H)$. The slope of this function depends on the technology. It ought to be increasing when working hours are sufficiently small, but may become decreasing when hours are very long because fatigue may reduce labor productivity beyond a certain threshold. The function that each worker faces may also be discontinuous, because his activities may need to be coordinated with those of other workers. In this context, each worker chooses the working hours that maximize his utility subject to the weekly earnings function $\Omega(H)$. The solution is displayed on figure 1. It turns out that workers choose working hours such that the marginal rate of substitution between earnings and hours equals the marginal returns $\Omega'(H)$ of working hours.

This solution highlights that the choice of hours hinges on both preferences and technology. In particular, individuals may choose lower working hours if they have stronger preferences for home production. As stressed by Becker (1965), individuals may prefer to eat a meal prepared by themselves rather than working to be able to go to restaurant. Therefore, working hours ought to be lower in economies in which there is more home production. From this perspective, Freeman and Shettkat

(2005) have shown that working hours are shorter in Europe than in the US, but individuals, and especially women, devote more hours to home production in Europe than in the US. It is however not clear whether this phenomenon arises from differences in preferences, rooted in different cultures or in differences in taxes (Blanchard, 2004, Algan and Cahuc, 2006, Pissarides et al. 2004, Rogerson, 2003). The competitive model can also explain how technological changes can induce changes in working hours (Greenwood et al.? 2005).

Reductions in working time

What are the consequences of compulsory reductions in working time when hours and wages are determined by a competitive mechanism? Is it possible to foster job creation in European countries by accelerating the decline in working hours observed in those countries as suggested by some observers?

Unfortunately, the perfect competitive model suggests, at first sight, that reductions in working hours cannot increase employment. At best, such reductions have no effect on employment because the adjustement of the hourly wage rate can crowd out the impact of reductions in standard hours on labor costs. More precisely, as suggested by Hamermesh and Trejo (2000), reductions in standard hours can lead to decrease hourly wage rates because the number of hours worked that benefit from overtime premium is increased when standard hours are decreased. Accordingly, when standard hours drop, there are more overtime hours, but each hour of work is paid a lower wage such that both weekly wages and hours of work remain unchanged.

However, reductions in the upper limit of hours worked can change employment because they change the scope of contracts that can be bargained over. In order to grasp the employment effects of such changes, it is necessary to explain how employment is determined in our competitive model. Employment is determined by the labor market participation decisions of individuals. More precisely, an idle person whose non market income is equal to R reaches a utility level given by $v(R, H_0)$. Thus, only the individuals for whom $v(R, H_0) < v(\Omega, H_0 - H)$ accept jobs with earnings Ω and working hours H. In this context, as shown by Figure 2, the scope of contracts being smaller when the upper limit of hours worked is reduced, this leads to a decrease in the maximum utility derived from waged work which diminishes labor market participation. It can be seen on Figure 2 that the equilibrium goes from point A to B where the number of hours is lower and where the individuals achieve an indifference curve that corresponds to a lower level of utility. Therefore, in this context, reductions in working time cannot improve employment and efficiency.

Labor supply interactions within the family

For many individuals, labor supply decisions are influenced by other people through family interactions. From this point of view, economic analysis shows that constraints on the labor supply on certain members of a household can induce the other members to increase their own labor supply

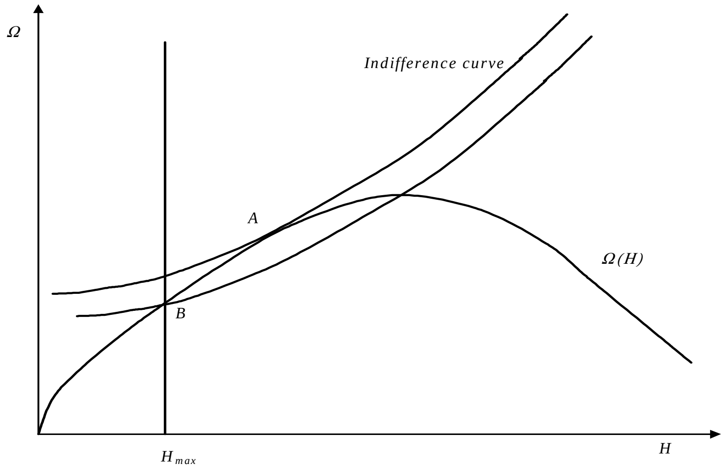

Figure 2: Reduction in working hours in the economy with perfect competition.

(Chiappori, 1992, Blundel and MaCurdy, 1999). This is the well known worker added effect: if someone losses his jobs and becomes unemployed, the other members of his family who are inactive may be induced to try to find a job. The effects of contraints on worked hours can be similar: if reductions in working hours lead to drops in the earnings of individuals who work less, other individuals may be induced to enter in the labor market with an aim at maintaining the income of the household. This process can increase employment. In particular, it may induce increases in female employment because women may raise their labor supply when there are compulsory reductions in the working time of their husband. Nevertheless, as such reductions in working time add restrictions on the set of choices of all the members of the household, they cannot be welfare improving. Therefore, they cannot be recommended even if they can lead to increases in female employment.

The contribution of Gersbach and Haller (2005) sheds a somewhat different light on this issue. They consider a context where household members differ in individual preferences and enjoy positive leisure-dependent externalities. The presence of "workaholic" member exerts negative externalities which can be limited by compulsory reductions in working hours. Therefore, restrictions on the number of hours an individual is allowed to work can benefit all workers and favor employment. Gersbach and Haller show simply that the introduction of externalities allows us to depart from the conclusions of the competitive case. In the same spirit, Alesina et al. (2005) argue that European labor market regulations, advocated by unions in declining European industries who argued "work less, work all" explain the bulk of the difference between the U.S. and Europe. They also argue that these policies may have had a more society-wide influence on leisure patterns because of a social multiplier where the returns to leisure increase as more people are taking longer vacations. In the presence of externalities, a very hard question to answer is whether labor regulation introduce distortions that reduce welfare or whether they are a way of coordinating on a more desirable equilibrium with fewer hours worked

(Cahuc and Postel-Vinay, 2005). On needs to know much more on these externalities to be able to yield some relevant answers to this type of questions.

3.2 Collective bargaining

In the previous section we pointed out that the impact of reductions in the standard work week on employment is conditioned by the response of wages. In this regard collective bargaining models are particulary useful to study the impact of reduction of working time since collective bargaining coverages are high in most European countries in which work sharing policies have been discussed or implemented. For instance, according to OECD, collective bargaining coverage is above 90% in Austria, Denmark, Finland, France, Sweden, and above 80 in Italy and the Netherlands. Collective bargaining models (see Booth and Ravaillon, 1993, and Contensou and Vranceanu, 2000) help us understanding the influence of the institutional context on the choice of working hours and on the efficiency of reduction of working time. It appears that the results depend on a series of features such as the preference for leisure of workers, the bargaining power of employees, the relative weight of employment versus wages in trade union objectives, the degree of coordination of wage bargaining and the regulation of working conditions. In order to show these results, we first describe the main features of a simple collective bargaining model which includes bargaining on hours (formal details are given in appendix).

A simple collective bargaining model

We consider a framework in which a trade-union bargains with a firm over wages and hours. The outcome of the bargaining process is represented by the generalized Nash bargaining solution where the relative bargaining power of the union is denoted by γ $\alpha \in [0,1]$. We assume further that a legal constraint imposes an upper limit, denoted by $\bar{H}$, on the number of hours worked. In reality, the standard duration should be distinguished from the upper limit for the hours worked above the standard duration are remunerated at a higher rate. To simplify the exposition we will neglect the distinction between the standard duration and the upper limit. We will also assume that the firm keeps the "right to manage" that signifies that employment is chosen by the firm, once hours and wages have been negotiated.

The union's objective is to maximize a function that depends on employment, denoted by L, and on the net utility gains of employees. The net utility gains is defined as the difference between the utility of an employee and an unemployed worker. The utility of an employee amounts to $v(\Omega, H_0 - H)$, where Ω, H_0 and H designate respectively income, the time allocation, and actual hours worked and the utility of unemployed workers; $v(\cdot)$ is a utility function increasing with respect to both arguments. The utility of an unemployed workers amounts to $v(b, H_0)$, where b stands for the income of unemployed workers. For the sake of simplicity, we assume that $v(\Omega, H_0 - H)$ is a Cobb-Douglas function that takes the form $\Omega^{\mu}(H_0 - H)^{1-\mu}$, where $\mu \in (0,1)$ measures the relative weight of income with respect to leisure in workers preferences. A higher value of μ corresponds to stronger preferences for income with respect for leisure. The relative weight of employment in trade-union's objective is denoted by $\beta \in (0,1)$. Accordingly, the objective of trade-union reads $L^{\beta}\left[v(\Omega, H_0 - H) - v(b, H_0)\right]^{1-\beta}$

The production of the firm depends on the number L of workers hired and the hours of work H. The efficiency of the hours worked by each employee is assumed to be an increasing function with constant elasticity denoted by ε, hence $e(H) = H^{\varepsilon}$. For the sake of simplicity, we assume that the revenue of the firm is also described by an iso-elastic function taking the form $R[e(H)L] = [e(H)L]^{\alpha}/\alpha$, with $\alpha \in (0,1)$. Therefore, the profit of the firm reads $R[e(H)L] - \Omega L$.

The outcome of the bargaining determines, together with the choice of employment by the firm, the wage, the working hours and the number of jobs.

The choice of hours

Let us first consider the case where the upper limit $\bar{H}$ on working hours is not binding. It can be shown that the negotiated number H_b of working hours is a fraction, denoted by ρ, of the time allocation H_0, which depends on the bargaining power of the trade-union (γ), on the preference for income versus leisure (μ), on the weight of employment in union's objective (β) and on technological parameters such as the elasticity of the revenue function of the firm (α) and the elasticity of the efficiency of hours (ε). The signs of the variations of the negotiated number of working hours is described by (see equation (B8) in the appendix):

$$H_b = \rho(\underset{-}{\gamma}, \underset{+}{\mu}, \underset{+}{\beta}, \underset{+}{\alpha}, \underset{+}{\varepsilon})H_0 \tag{2}$$

When the elasticity (ε) of the efficiency of labor services with respect to working hours is high, working hours are also high because reductions in working hours imply large production drops. In other words, it is more interesting to work longer hours when the marginal efficiency of hours is high. If the workers attach more and more importance to income with respect to leisure, they will work longer hours. Thus, H_b is an increasing function of the parameter μ like in the competitive model.

Bargaining power, market power and working hours

The model shows that increases in union's bargaining power (γ) lead to lower working hours. Indeed, a stronger union can bargain higher utility levels for is employees. Thus, as far as leisure is a normal good, whose consumption increases with income, higher level of utilities are associated with more leisure and less working hours.

It is interesting to notice that the negotiated level of the working hours is also influenced by the elasticity (α) of the revenue function of the firm with respect to the services of labor $e(H)L$. This elasticity can reflect two features. First, the monopoly power of the firm on its product market; this elasticity being lower when the firm has strong market power. Second, the degree of centralization of negotiations. When negotiations are centralized, at the industry or the national level, the elasticity of the revenue function is lower because the substitution effects across the goods that are produced by each firm cancel out. Accordingly, strong monopoly power on the product market and highly centralized wage bargaining should lead to low elasticity of the revenue function. It can be shown that negotiated working hours increase with the elasticity of the revenue function. This implies that economies with less competition on the product market and with higher degree of centralization of wage bargaining should display lower working hours.

More jobs with longer working hours!

It turns out that stronger weights (β) on employment in union's objective is conducive to higher hours. When the trade union puts more emphasis on employment, the solution of the negotiations entails more employees, but with a lower level of utility for each employee. Accordingly, working hours increase: each employee works more hours and gets lower weekly wage. This mechanism is exactly the opposite of the so-called work sharing mechanims in which less working hours increase the number of jobs. Here, when the union puts more emphasis on employment, the negotiation process gives rise to more jobs, but at the expenses of the employees who are forced to accept utility losses, through lower weekly wage and higher hours, to foster job creation.

It is worth noticing that this result is compatible with Hunt's (1999) conclusions of her meticulous empirical study of reductions in working time in Germany in the eighties and the nineties. Hunt concludes her paper by the following statement: "Germany's work-sharinng experiment has thus allowed those who remained employed to enjoy lower hours at a higher hourly wage, but likely at the price of lower overall employment". Interpreting this conclusion under the light of our collective bargaining model, it can be argued that it was actually a lower weight of employment in unions' objective that led to German's reductions in working time and to employment drops in the eighties and the nineties.

All these results assume that the negotiated working hours H_b given by equation (2) are not higher than the authorized upper limit $\bar{H}$. Conversely, if $H_b > \bar{H}$, working time per individual will be equal to $\bar{H}$. Let us examine this case now.

The consequences of reductions in standard hours

The case where $H_b > \bar{H}$ is interesting for it may help to understand whether it is possible to force workers and employers to share employment more widely by imposing a maximum number of hours to be worked.

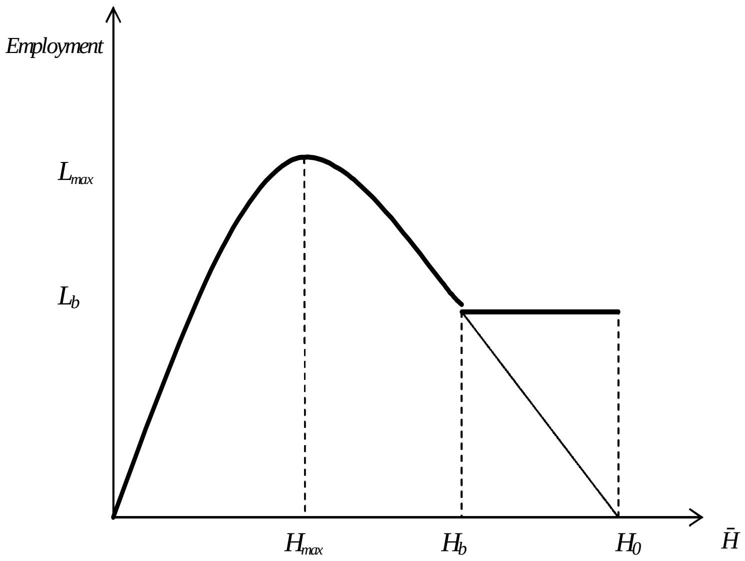

Figure 3: Employment in the collective bargaining model

With a simple model of labor demand, we have shown in the previous section that the impact of reductions in standard hours on employment hinges on the reaction of wages. In our simple model of wage bargaining, the elasticity of the weekly wage with respect to hours worked (which are equal to $\bar{H}$) depends on the number of hours worked[5]. This elasticity is positive, hence reductions in standard hours decrease weekly wages. Moreover, this elasticity increases with $\bar{H}$, which means that reductions in the weekly wage entailed by standard hours drops are larger if the number of hours worked is high. This suggests that it is easier to increase employment throught mandatory reductions in working time when working time is high rather than low. It also turns out that the elasticity of the weekly wage with respect to working hours is larger when the preference for leisure is stronger. Therefore, it should be easier to increase employment throught reduction in working time when individuals have stronger preferences for leisure.

The knowledge of the wage elasticity with respect to hours allows us to determine the impact of reductions in hours on employment taking into account the wage response. The relation between employment and standard hours (equivalent in this framework to the upper limit $\bar{H}$) is displayed by the bold curve on figure 3.

If the upper limit on hours $\bar{H}$ is above the negotiated level H_b, the constraint on the upper limit for hours is not binding and the individual duration of work reaches the value H_b and the employment level is equal to L_b. If $\bar{H}$ is smaller than H_b, the constraint on the upper limit for hours is binding, the individual duration of work equals $\bar{H}$ and the level of employment is given by the bold curve in

[5]It is shown in the appendix that this elasticity amounts to $\bar{H}(1-\mu)/\mu(H_0-\bar{H})$.

figure 3 located at the left of point (H_b, L_b). One sees that employment reaches its maximum for a duration of work denoted by $H_{\max}$.

Figure 3 indicates that reductions in hours worked are favorable to employment if and only if the number of hours worked is above the threshold value $H_{\max}$. Below this value, the elasticity of the weekly wage with respect to hours becomes too small to allow reductions in working hours to create jobs. In other words, below this value, the hourly wage increases too much when working time is decreased so that working time reductions become bad for employment.

It is shown in the appendix that $H_{\max}$ is equal to the number of hours negotiated H_b when the union disposes of all the bargaining power ($\gamma = 1$). Hence, its properties are described by equation (2) where $\gamma = 1$. Therefore, $H_{\max}$ decreases with the preference for leisure, the market power of the firm and the degree of centralization of wage bargaining. These results mean that it is possible to increase employment throught mandatory working time reductions for lower values of working hours in economies in which workers display a strong preference for leisure, where unions' bargaining power is strong, where collective bargaining is highly centralized and firms have strong market power.

Reductions in working time and working conditions

The impact of reductions in working time on employment is also influenced by interactions between working conditions and working time. This influence appears when one notices that the threshold value $H_{\max}$ increases with the elasticity ε of labor services with respect to hours. At this point, it should be noticed that the elasticity of labor services with respect to hours is influenced by the possibility to reorganize production when working time is decreased. This elasticity ought to be smaller for mandatory reductions in working time when firms have more possibilities to reorganize production. The reorganization of production could be considered as endogenous as in the contributions of Askenazy (2004) and d'Autume (2001) who provide bargaining models that analyze the connections between working time, hours flexibility, and labor effort. These models show that in return for higher hourly wages, trade unions consent to greater management-controlled hours flexibility. Hours flexibility, in turn, leads to a deterioration in working conditions, including an intensification of labor effort. In this type of model, shorter working time may increase work effort and deteriorate working conditions.

From this point of view, stringent regulations of working conditions, which hinder the reorganization of work, lead to high elasticities of labor services with respect to working hours in case of compulsory reductions in working time. Therefore, compulsory reductions in working time are less likely to create jobs when there are stringent regulations on working conditions.

In sum, models of bargaining over the number of hours to be worked show that union power should exert downward pressure on these hours. It also turns out that forcible reductions in the number of hours worked have a more favorable impact on employment when union bargaining power is slight. More generally, reductions in working time can increase employment if trade unions do not get all bargaining power. Moreover, in this context, compulsory reductions in working time increase the utility of the trade-union, because the utility of employees remains unchanged when working time is reduced whereas the number of jobs increase. Obviously, this process makes sense only for small enough reductions in working hours such that the number of hours worked remains above a certain limit that depends on the preferences of individuals and on the technology. From this point of view, monopsony models of the labor market deliver the same type of result.

3.3 Monopsony power

Marimon and Zilibotti (2000), Contensou and Vranceanu (2002) and Rocheteau (2002) have shown, in matching models à la Pissarides (2000), that starting from a *laissez-faire* economy in which firms have some monoposony power, small reductions in working time result in increases in the equilibrium employment while large reductions reduce employment. Moreover, it appears that small reductions in working hours can improve the welfare of employees. Manning (2001) gets the same type of results in pure monopsony models where it is shown that compulsory restrictions on hours or working condition can improve workers' welfare.

A simple framework

This type of result can be illustrated in a simple framework in which the preferences of the individuals over income and hours are still represented by the utility function $v(WH, H_0 - H) = (WH)^{\mu} (H_0 - H)^{1-\mu}$ where W and H respectively represent the hourly wage and the numbers of hours worked. For the sake of simplicity, it is assumed that each hour of work produces a constant quantity of good denoted by y, so that profits per employee read $(y - W) H$. Moreover, it is assumed that individuals are heterogenous with respect to the level of utility that they get when they do not work. More precisely, we assume that the non market incomes of the idle persons are described by a cumulative distribution function denoted by $G(\cdot)$. An idle person whose non market income is equal to R reaches a utility level given by $R^{\mu} {H_0}^{1-\mu}$. Thus, only the individuals for whom $R^{\mu} {H_0}^{1-\mu} < (WH)^{\mu} (H_0 - H)^{1-\mu}$ accept jobs with a wage W and working hours H. If working age population is normalized to one, labor supply is simply $G(WH \left[(H_0 - H)/H_0\right]^{\frac{1-\mu}{\mu}})$.

The equilibrium with perfect competition is characterized by a zero profit condition for firms. The competitive equilibrium hourly wage is thus equal to the productivity of an hour of labor, i.e. $W_C = y$. Given this wage, individuals work a number of hours, denoted by H_C, that maximizes their utility, and employment attains the level L_C given by $G(yH_C \left[(H_0 - H_C)/H_0\right]^{\frac{1-\mu}{\mu}})$.

The choice of wage and hours

Let us now consider the case of monopsony. By definition, a firm in such a position offers contracts over wage W and hours H knowing that the labor supply is then $G(WH \left[(H_0 - H)/H_0\right]^{\frac{1-\mu}{\mu}})$. If there

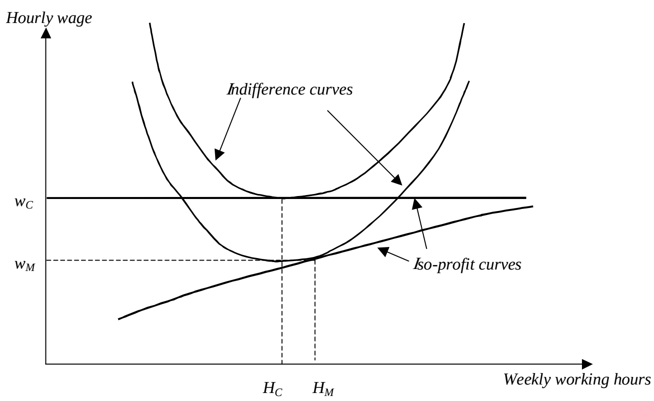

Figure 4: Hours and wages in the monopsony model. W_C and H_C stand for the hourly wage and the working hours in the competitive equilibrium. Subscript M designates the monopsony solution.

is no legal upper limit on hours worked, it is shown in the appendix that a monopsony that seeks to maximize its profits subject to the labor supply constraint will choose a wage W_M smaller than the competitive wage W_C and a work duration H_M larger than the competitive work duration. The results are displayed on figure 4 which shows that the monopsony chooses a contract with a lower hourly wage and higher hours than in the competitive situation. Therefore, workers get lower utility than in the competitive equilibrium, which implies that employment is lower than in the competitive equilibrium.

Compulsory reductions in working hours

Let us now assume that there is an upper limit $\bar{H}$ on hours worked. The results are displayed on figure 5 (see the model in the appendix for the calculations). This figure represents employment as a function of the upper limit on hours $\bar{H}$. If $\bar{H}$ is larger than H_M, the monopsony is not constrained on its decisions, the individual duration of work reaches the value H_M and the employment level is equal to L_M. If $\bar{H}$ is smaller than H_M, the monopsony is constrained to set working hours to $\bar{H}$ and the level of employment is given by the bold curve in figure 5. One sees that compulsory reductions in working time increase employment as long as working time is above the competitive level H_C. Conversely, reductions in working time $\bar{H}$ decrease employment when $\bar{H}$ is below the competitive level.

These results are strikingly reminiscent of the effects of the minimum wage as analyzed by Stigler (1946) who showed that the relationship between employment and the minimum wage is not monotonic but increasing for low values of the minimum wage and decreasing for higher ones when the labor market is monopsonistic.

Figure 5 also shows that the maximum employment attainable by a monopsony happens for $\bar{H} = H_C$, i.e. when the law obliges the monopsony to set its individual working time at the competitive level.

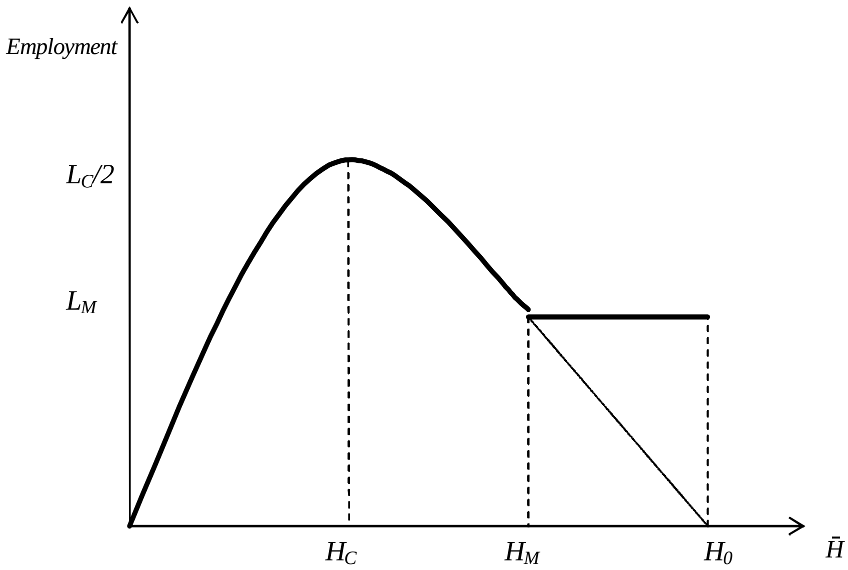

Figure 5: Employment in a monopsony model with a constraint on hours worked.

Nothwithstanding, in this latter case employment is less than the competitive level of employment because the firms sets a wage smaller than in the competitive case. Hence, regulations of working hours can improve employment and welfare but cannot alone reach the first best situation. For this, it is necessary to have a second instrument in form of a minimum wage. Imposing a minimum wage higher than the monopsony wage and reducing the working time improves the welfare of workers (see the appendix for details).

In sum, monopsony and bargaining models show that regulation of working hours can improve employment and welfare of workers. However, these models also show that compulsory reductions in hours are not likely to improve systematically employment and welfare. Indeed, heterogeneity in preferences and in individual productivities implies heterogeneous choices in worked hours that cannot be efficiently regulated by a single constraint on working time which does not account for the diversity of people.

4 Conclusion

5 References

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Appendix

A Labor demand elasticities

The working time of each worker determines the number of units of labor services that he provides. This number can be represented by an increasing function of working time, H, denoted $e(H)$. If N designates the number of persons employed in the firm, then labor services are expressed by the product $Ne(H)$, assuming, for the sake of simplicity, that all employees work the same amount of hours.

Denoting by $d(H)$ the duration of capital utilizatin, capital services are expressed by the product $Kd(H)$ where K designates the stock of capital. One should expect the function $d(H)$ to increase with the duration of work. Finally the output Y produced by a firm is a function of K, N and H that can be written as $Y = F[Kd(H), Ne(H)]$.

Let us consider a firm whose profits read

$$\Pi = F[Kd(H), Ne(H)] - \Omega N$$

where F is a production function with constant returns to scale. Let us denote by σ the elasticity of substitution between capital and labor and by R the user cost of capital. Log-differentiation of the first-order condition

$$\frac{e(H)F_2(d(H)K, e(H)N)}{d(H)F_1(d(H)K, e(H)N)} = \frac{\Omega}{R}$$

with respect to K and N yields

$$\delta K \left(\frac{F_{21}d}{F_2} - \frac{F_{11}d}{F_1} \right) + \delta N \left(\frac{F_{22}e}{F_2} - \frac{F_{12}e}{F_1} \right) = \frac{\delta\Omega}{\Omega} - \frac{\delta R}{R}$$

Noticing that the homogeneity of degree one of the production function implies that $F_1Kd + eNF_2 = F$, $F_{11}Kd = -F_{12}eN$ and $F_{22}eN = -F_{12}Kd$, the last equation reads

$$\left(\frac{\delta K}{K} - \frac{\delta N}{N} \right) = \frac{F_1F_2}{F_{12}F} \left(\frac{\delta\Omega}{\Omega} - \frac{\delta R}{R} \right)$$

which is equivalent to

$$\sigma = \frac{F_1F_2}{F_{12}F} = \frac{-d(H)KF_1F_2}{e(H)NFF_{22}} \tag{A1}$$

Now, let us consider that the capital stock is given. The first-order condition with respect to employment reads

$$e(H)F_2(d(H)K, e(H)N) = \Omega$$

Log differentiation of this first-order condition yields

$$\frac{\delta H}{H} \left(\eta_H^e + \frac{F_{21}Kd(H)}{F_2}\eta_H^d + \frac{F_{22}Ne(H)}{F_2}\eta_H^e \right) + \frac{\delta N}{N} \left(\frac{e(H)NF_{22}}{F_2} \right) = \frac{\delta\Omega}{\Omega}$$

where η_H^x, denote the elasticity of function $x = e, d$, with respect to hours.

Using equation (A1) and the definition of the share of capital costs at the optimum, which reads $\alpha = d(H)F_1/F$, one gets the elasticity of employment with respect to hours:

$$\eta_H^N = \eta_H^d + \left(\frac{\sigma - \alpha}{\alpha}\right)\eta_H^e - \frac{\sigma}{\alpha}\eta_H^\Omega \tag{A2}$$

where η_H^Ω stands for the elasticity of the weekly wage with respect to hours. Equation (A2) shows that reductions in working time decrease employment when there is full wage compensation ($\eta_H^\Omega = 0$) if $\eta_H^d \geq 0, \eta_H^e \geq 0$ and the elasticity of substitution between capital and labor services σ is larger than the share of capital in total costs α. These conditions, which are very weak, are generally satisfied.

The results given in tables 2 and 3 assume that $\alpha = 0.3$ and $\sigma = 0.5$.

B The collective bargaining model

B.1 The Nash criterion

The union's objective reads:

$$\mathcal{V}_s = \ell^\beta \left[v(\Omega, H_0 - H) - v(\overline{w}, H_0)\right]^{1-\beta} \quad , \quad \ell = \text{Min}(1, L/N)$$

In this expression, N designates the (exogeneous) size of the union. When employment is equal to L and each employee supplies H hours, the firm's profit takes the following form:

$$\Pi = \frac{1}{\alpha}[e(H)L]^\alpha - \Omega L \tag{B3}$$

We assume that the firm retains the right-to-manage. Here, this hypothesis signifies that the employer decides on the size of his or her workforce after bargaining over the hourly wage w and the number H of hours to be worked has been completed. In these conditions, labor demand, denoted by $L(\Omega, H)$, is found by maximizing profit, with Ω and H taken as given. Setting the derivative of (B3) to zero with respect to L, we get:

$$L(\Omega, H) = [e(H)]^{\frac{\alpha}{1-\alpha}}\Omega^{\frac{1}{\alpha-1}} \tag{B4}$$

When this value of labor demand does not exceed the size N of the union, the profit of the firm is expressed thus:

$$\Pi(\Omega, H) = \left(\frac{1-\alpha}{\alpha}\right)\left[\frac{e(H)}{\Omega}\right]^{\frac{\alpha}{1-\alpha}}$$

Assuming that if there is failure to reach agreement the firm obtains zero profit, the issues of bargaining corresponds to the solutions of the maximization of the following Nash criteria:

$$\underset{\{\Omega, H\}}{\text{Max}} \left[\frac{L(\Omega, H)}{N}\right]^{\beta\gamma} \left[v(\Omega, H_0 - H) - v(\overline{w}, H_0)\right]^{\gamma(1-\beta)} \left[\Pi(\Omega, H)\right]^{1-\gamma}$$

subject to:

$$L(\Omega, H) \leq N \quad \text{and} \quad H \leq \bar{H}$$

B.2 The optimal number of hours worked

Interior solutions

For an interior solution, the derivatives of the logarithm of the Nash criterion with respect to Ω and H yield the first-order conditions. They are written:

$$\frac{(1-\beta)\gamma v_1(\Omega, H_0 - H)}{v(\Omega, H_0 - H) - v(\overline{w}, H_0)} = \frac{\alpha(1-\gamma)+\gamma}{(1-\alpha)\Omega} \tag{B5}$$

$$\frac{(1-\beta)\gamma v_2(\Omega, H_0 - H)}{v(\Omega, H_0 - H) - v(\overline{w}, H_0)} = \frac{\alpha\varepsilon(\beta\gamma+1-\gamma)}{(1-\alpha)\,H} \tag{B6}$$

Dividing these last two relations member to member, we get:

$$\frac{v_1(\Omega, H_0 - H)}{v_2(\Omega, H_0 - H)} = \frac{H}{\Omega}\frac{\alpha(1-\gamma)+\beta\gamma}{\alpha\varepsilon(\beta\gamma+1-\gamma)} \tag{B7}$$

This last equation defines the marginal rate of substitution between income and leisure as a function of the hourly wage $W = \Omega/H$ and the elasticity ε of individual productivity with respect to hours. The general study of the system formed by equations (B5) and (B6) is possible, but we will arrive at the main results more rapidly by assuming that the utility of each member of the union is a function of the Cobb-Douglas type $v(\Omega, H_0 - H) = \Omega^{\mu}(H_0 - H)^{1-\mu}$, with $\mu \in]0,1[$. In particular, equation (B7) then immediately gives us the number of hours worked:

$$H_b = \frac{\varepsilon\mu\alpha\,[1-\gamma(1-\beta)]}{(1-\mu)[\gamma\beta+\alpha(1-\gamma)]+\varepsilon\mu\alpha\,[1-\gamma(1-\beta)]}H_0 \tag{B8}$$

The parameter μ is interpreted as a measure of the importance of income with respect to leisure for each worker. Equation (B8) shows that the optimal number of hours worked is an increasing function of this parameter, and of elasticity ε. In consequence, constraint $H_b \leq \bar{H}$ is less likely to be binding if this elasticity is weaker, or if workers attach less importance to income than they do to leisure.

Constrained solutions

Let us now assume that there is a compulsory number of hours, $\bar{H}$, lower than the number arrived at through bargaining, defined by equation (B8). The negotiated wage is then given by equation (B5) with $H = \bar{H}$. Assuming, as above, that preferences are of the Cobb-Douglas type, this equation implicitly defines the negotiated wage as follows:

$$\Omega^{\mu}(H_0 - \bar{H})^{1-\mu} = \frac{\alpha(1-\gamma)+\gamma\beta}{\alpha(1-\gamma)+\gamma\beta-\gamma\mu(1-\beta)(1-\alpha)}v(\overline{w}, H_0) \tag{B9}$$

with $\alpha(1-\gamma)+\gamma\beta-\gamma\mu(1-\beta)(1-\alpha) > 0$.

Since the right-hand side of this equation does not depend on hours, we deduce from it the elasticity η_H^Ω of the weekly wage with respect to hours $\bar{H}$. We thus arrive at $\eta_H^\Omega = \bar{H}(1-\mu)/\mu(H_0 - \bar{H})$.

When $H = \bar{H}$, equation (B4) defining labor demand gives the employment level which is thus equal to $L(\Omega, \bar{H})$. As the negotiated global wage Ω depends also on $\bar{H}$ – see equation (B9) –, the employment level $L(\Omega, \bar{H})$ can be considered as a function of $\bar{H}$. Deriving this function with respect to $\bar{H}$, one sees that the employment level reaches a maximum when $\bar{H}$ is equal to $H_{\max}$ defined by:

$$H_{\max} \equiv \frac{\varepsilon\mu\alpha}{(1-\mu) + \varepsilon\mu\alpha} H_0 \tag{B10}$$

Comparison of equations (B8) and (B10) indicates that $H_{\max}$ is equal to the number of hours negotiated H_b when the union disposes of all the bargaining power ($\gamma = 1$). Since the negotiated number of hours H_b decreases with the bargaining power γ of the workers, one always has $H_b > H_{\max}$ for $0 < \gamma < 1$. Finally, noticing that $H_{\max}$ does not depend on $\bar{H}$, one obtains Figure 3 that represents the employment level as a function of $\bar{H}$.

C The monopsony model with hours

The equilibrium with perfect competition is characterized by a zero profit condition for firms. The competitive equilibrium hourly wage is thus equal to the productivity of an hour of work, i.e. $W_C = y$. Given this wage, the utility level of a worker is given by $(yH)^\mu (H_0 - H)^{1-\mu}$. Maximizing this last expression with respect to H yields the competitive individual labor supply denoted by H_C. One gets $H_C = \mu H_0$. Employment corresponds to aggregate labor supply that reads $G(yH_C \left[(H_0 - H_C)/H_0\right]^{\frac{1-\mu}{\mu}})$. For the sake of simplicity, it is assumed in the sequel that G is uniform over the interval $[0, R_u]$, $R_u > y$, thus $G(R) = (R/R_u)$ and the competitive equilibrium is finally described by:

$$W_C = y,\ H_C = \mu H_0,\ L_C = \frac{y}{R_u} H_C \left(\frac{H_0 - H_C}{H_0}\right)^{\frac{1-\mu}{\mu}} \tag{C11}$$

For any wage and hours (W, H), the profit of the monopsony is equal to $(y - W)\, HG\left[WH\left(\frac{H_0-H}{H_0}\right)^{\frac{1-\mu}{\mu}}\right]$. When $G(R) = (R/R_u)$, neglecting exogenous parameters the monopsonist problem reads

$$\max_{(W,H)} (y - W)\, WH^2 (H_0 - H)^{\frac{1-\mu}{\mu}}$$

subject to:

$$H \leq \bar{H} \tag{C12}$$

This problem is separable in W and H. The interior solutions are given by:

$$W_M = \frac{y}{2},\ H_M = \frac{2\mu}{1+\mu} H_0,\ L_M = \frac{y}{2R_u} H_M \left(\frac{H_0 - H_M}{H_0}\right)^{\frac{1-\mu}{\mu}}$$

One sees that $W_M < W_C$, $H_M > H_C$ and $L_M < L_C$.

When $H_M > \bar{H}$, the solutions of the monopsony are given by:

$$\bar{W}_M = \frac{y}{2},\ \bar{H}_M = \bar{H},\ \bar{L}_M = \frac{y}{2R_u}\bar{H}\left(\frac{H_0 - \bar{H}}{H_0}\right)^{\frac{1-\mu}{\mu}} \tag{C13}$$

On figure 4 we have drawn the function $L(\bar{H}) = \frac{y}{2R_u}\bar{H}\left(\frac{H_0-\bar{H}}{H_0}\right)^{\frac{1-\mu}{\mu}}$ that reaches its maximum at $\bar{H} = H_C$. When $\bar{H}$ varies from 0 to H_0, the solutions of the monopsony are represented by the bold curve in figure 4. It is worth noticing that the highest employment level attainable by the monopsony is obtained when it is constrained to accept the competitive level of hours, i.e. when $\bar{H} = H_C$. In that case, (C11) and (C13) show that the monopsony sets employment to the level $L_C/2$ which is of course smaller than the competitive level L_C. These results prove that regulating a monopsony by means of the duration of work can improve employment (see the comments in the main text) but cannot reach the first best optimum. For this it is also necessary to impose a minimum wage greater than the wage set by the monopsony. In this simple model, the minimum wage should be set equal to y (the level of the competitive wage) which is greater than the monospsony wage equal to $y/2$.