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Should we tax overtime, subsidize the wage or subsidize employment?

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Should we tax overtime, subsidize the wage or subsidize employment?

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Summary: This paper compares the macroeconomic implications of taxing overtime and using two kinds of subsidies, an employment and a wage subsidy, in a model where team work and commuting costs subject to congestion are key determinants of the choice of the workweek. To obtain reliable estimates, I calibrate the model to the substitutability between the workweek and employment using business cycle information. I find that subsidizing employment can achieve the same employment increase than taxing overtime but at a lower cost in terms of output, productivity, wages and welfare. The wage subsidy that achieves the same employment increase turns out to be very costly from a fiscal point of view, 12.7% of output versus 4.57% of output in the employment subsidy experiment.

Keywords: Overtime taxes, Employment Subsidies, Wage Subsidies, Workweek, Labor Policy, Macroeconomic effects, Team Work, Commuting costs.

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1 Introduction

Employment policies like reducing the workweek, subsidizing the wage or subsidizing employment have been proposed in some countries as a way to increase employment. In France a 35 hour workweek has been introduced and, in other countries like Germany, unions have imposed similar measures in some sectors. In Spain, permanent contracts are promoted through wage subsidies and in other European countries a number of different subsidy schemes are in place. In the academic literature Fitzgerald (1996), Fitzgerald (1998), and Marimón and Zilibotti (2000) amongst others have studied the implications of imposing legal restrictions on the number of hours worked. Mortensen and Pissarides (2003) and Cardullo and van der Linden (2006) have used the search and matching framework to analyze the effect of employment subsidies and Orszag and Snower (2003) have compared the relative effectiveness of hiring and wage subsidies.

In this paper I compare the macroeconomic effects of taxing overtime and using two kinds of subsidies, an employment and a wage subsidy, in a general equilibrium model. Since these policies make employment cheaper relative to hours the results will crucially depend on the degree of substitutability between the workweek length and employment. I use business cycle fluctuations of hours and employment to have a precise measurement of this degree of substitutability. In the model the two margins of labor will be imperfect substitutes due to the following assumptions : *(i)* team-work and *(ii)* additional frictions modelled as commuting costs subject to congestion.

Team-work implies that a plant can only be operated when all its workers are present, and hence, that the length of the workweek is common to every worker in the plant. Consequently, when a plant changes its workweek, the amount of capital available to each worker does not change. On the other hand, when a plant changes the size of its labor force, the amount of capital available to each worker also changes. This implies that workweek length and employment are imperfect substitutes, inducing a form of decreasing returns to employment that do not apply to the workweek. Moreover, it also implies that the wage-rate is a non-linear function of the number of hours worked.

Regarding the frictions that make employment and hours imperfect substitutes, I follow Osuna and Ríos-Rull (2003) and model them as commuting costs subject to congestion. Commuting implies that workers have to use a certain amount of time before they start working. Moreover, commuting costs are assumed to be increasing in aggregate employment, that is, subject to congestion[1]. As in Osuna and Ríos-Rull (2003) this assumption should not be taken literally. The advantage over alternative mechanisms is that it allows the use of the representative agent abstraction. Kydland and Prescott (1991), Cho and Cooley (1994), Bils and Cho (1994) and Cho and Rogerson (1988) use other ways to get adjustment along both margins, hours and bodies[2]. The imperfect substitutability between employment and hours per worker introduces a non convexity in the choice set that I deal with, following Hansen (1985) and Rogerson (1988), by assuming that agents have access to employment lotteries.

Except for those two features, the model economy is a standard business cycle model without overtime taxes or subsidies. I calibrate a baseline model economy so that the average duration of its workweek is 40 hours and so that it mimics the main features of the U.S. economy. In particular, I calibrate the model to the relative volatility of employment and hours per worker to get a reliable estimate of the substitutability between the two margins of labor.[3] Next, I introduce and compare several employment policies. I first report the tax-rate on overtime that reduces the workweek from 40 to 35 hours in steady-state as in Osuna and Ríos-Rull (2003). A 12% tax-rate achieves this end and brings about a 7% increase in steady-state employment, a 10.2% decrease in steady-state output and a 4.2% decrease in steady-state productivity. Then, I look for the employment and wage subsidy that brings about the same increase in steady-state employment. I find that an employment subsidy performs better in terms of output, productivity, wages and welfare. The wage subsidy turns out to be very costly from a fiscal point of view, 12.7% of output versus 4.57% of output in the employment subsidy experiment. In addition, I study the implications of a related and very controversial policy: the recently proposed increase in the legal workweek till 60 hours. Finally, I also compute the transition between steady states of the three model economies in order to measure the welfare costs implied by these policies. I find that these welfare costs are very significant. Specifically, they are at least 0.6% of average consumption on a flow basis, which is a large number as far as welfare calculations go.

On the technical side, this paper make use of the methods developed in Osuna and Ríos-Rull (2003) to compute the equilibria of non–convex business cycle economies where the Second Welfare Theorem does not hold.[4] Computing equilibria directly is burdensome because households must know the wage function in order to compute their decisions in a model where wages are non-linear functions of hours. These wage functions are part of the fixed-point problem that must be solved to compute the equilibrium. These techniques are not easily applied to the characterization of equilibria with all kinds of frictions.

There are some other papers related to this one. I use the distinction between hours and bodies used in Ehrenberg (1971), and later in Kydland and Prescott (1991), Fitzgerald (1995) and Fitzgerald (1998). I also build on the work of Prescott and Townsend (1984), Hansen (1985), Rogerson (1988), Prescott and Ríos-Rull (1992), Kydland and Prescott (1991) and, especially, on Hornstein and Prescott (1993). All these papers use lotteries to get around non-convexities in general equilibrium macroeconomic models.

Section 2 describes the model and the use of lotteries to implement its recursive competitive equilibrium. I also adapt the model to include overtime taxation, wage and employment subsidies. Section 3 describes how to map the model to data. Section 4 reports the results for the baseline model, for several employment policies and the transition. Finally, Section 5 concludes.

2 The model

In Section 2.1 I describe households and preferences and then technology in Section 2.2. In Sections 2.3– 2.3.3 I describe the contracts that agents use and the problems that they solve. In Section 2.4 I go on to define equilibrium recursively in a way that is suited for computation. I then expand the economy to include overtime taxes in Section 2.5, an employment subsidy in Section 2.6 and a wage subsidy in Section 2.7.

2.1 Households and Preferences

There is a continuum of *ex-ante* identical agents of measure one, with preferences given by

$$E\left\{\sum_{t=0}^{\infty} \beta^t \; u(c_t, \ell_t)\right\} \tag{1}$$

where c_t is consumption and ℓ_t is leisure in period t. The instantaneous utility function is strictly concave and satisfies the Inada conditions. Finally, $\beta \in (0,1)$ is the subjective time discount factor.

An individual's time endowment in each period is one. The amount of time that can be allocated to work is $1-\ell-\eta(N)$, where $\eta(N) > 0$ measures the amount of time required for commuting to work every period that the individual is employed, and where N is aggregate employment. I assume that there is congestion which creates a negative externality in employment. In particular, I assume that $\eta(N) > 0$, and $\eta'(N) > 0$. Notice that $\ell(h, N)$ is not a continuous function since if hours worked are zero, no commuting is needed. This introduces a non-convexity. We will see in detail below how agents deal with the non-convexity. For technical reasons I define an underlying consumption possibility set $C = \{[0,\bar{c}], [0,1]\}$, where $\bar{c}$ is an upper bound in consumption that is non-binding.[5]

2.2 Plant's Technology

Production takes place in plants of which there may be a large number. Moreover, new plants can be opened at zero costs. Plants are operated during a number of hours that is *the same* for all workers. Plants also use capital and they are restricted to have one shift.[6] We can write the plant's production function f as

$$f(z,h,k,n) = z\, h^{\xi}\, k^{1-\theta}\, n^{\theta} \tag{2}$$

where h denotes the workweek, n employment in the plant and k the amount of capital in the plant.[7] Variable z represents total factor productivity. I use it to incorporate shocks to productivity. Capital depreciates geometrically at rate δ.

Note that given the workweek, plants are subject to constant returns to scale. When $\xi = \theta$, we have the standard Cobb-Douglas technology where total hours and not its decomposition in hours per worker and employment is what matters. When $\xi = 1$, the technology is linear in hours and we have an extreme case of team production, where workers are not subject to fatigue (an increase in the workers' workweek results in an increase of output of the same proportion).

2.3 Contracts

I assume complete markets. In this economy with non-convexities, there are efficiency gains from the introduction of lotteries.[8] The non-convexities apply only to the labor market, so I only need to specify lotteries for the labor contract. Moreover, rather than having plants buy measures of agents, as for example in Prescott and Ríos-Rull (1992), I find that it is easier to describe the economy by posing an, otherwise irrelevant, insurance firm that contracts in measures with households and that contracts in real quantities with the operators of plants. In the absence of distortionary taxation and the commuting externality, the equilibrium would have been optimal under this market structure.[9]

2.3.1 The firms' problem

To see the nonlinearity of the wage as a function of the workweek, I start fixing the workweek, h, and I use w_h to denote the salary paid to a worker who works for h hours. Then the problem of a firm with an h hour workweek is the following

$$\max_{k,n} \; z\, h^{\xi}\, k^{1-\theta}\, n^{\theta} - k(r+\delta) - n\; w_h \tag{3}$$

where r is the rental rate of capital (the interest rate). There is free entry, which implies that firms have zero profits. Moreover, there are constant returns to scale, so we can normalize the size of a firm to have one employee that works h hours. This means that for any given r, we can solve

$$\max_{k} \; z\, h^{\xi}\, k^{1-\theta} - k(r+\delta) - w_h \tag{4}$$

with solution given by $k(z,h,r)$.

I then determine the salary for workweek h as the value of w_h that satisfies

$$0 = z\, h^{\xi}\, [k(z,h,r)]^{1-\theta} - k(z,h,r)(r+\delta) - w_h \tag{5}$$

using the zero-profit condition.

In fact, we can do this for all h and obtain the wage rate w_h as a function of the interest rate. As we can see from equation (5) this is a non-linear function of h. In sum, plants can be indexed by their workweek and their capital per worker.

To describe the number of existing one-worker plants at any point in time we can use a measure Ψ defined not over C, but just over its second component, the workweeks. Let $\Psi(B)$ be the measure of plants of size one worker that operates a workweek of size $h \in B \subset [0,1]$ for any Borel set B.

Aggregating over firms we get that aggregate output can be written as

$$\int_{[0,1]} z\, h^{\xi}\, k(z,r,h)^{1-\theta}\ \Psi(dh) \tag{6}$$

and aggregate employment, N, can be denoted as

$$N = \int_{[0,1]} \Psi(dh) \tag{7}$$

while aggregate total hours (not per worker) is given by

$$H\, N = \int_{[0,1]} h\ \Psi(dh) \tag{8}$$

2.3.2 Households choices

Let $\mathcal{C}$ be an appropriate family of subsets of C, say, its Borel σ–algebra. Households choose probabilities over $\mathcal{C}$. Let $\mathcal{M}$ be the space of signed measures that includes the probabilities. The per-period consumption possibility set of households is indexed by aggregate employment in the period:

$$\begin{aligned} X(N) = \{x \in \mathcal{M} :\quad & x \text{ is a probability},\ \ i.e.\ x \geq 0,\ \ \text{and}\ \ x(C) = 1, \\ & \text{If}\ \ h \in (0,1],\ \ \text{and}\ x\left([0,\bar{c}],[h,1]\right) > 0,\ \text{then}\ h \leq 1 - \eta(N)\}\,. \end{aligned} \tag{9}$$

where the last condition is the requirement that in no case working hours plus commuting time is greater than the time endowment.

A household that chooses x has indirect instantaneous utility function given by

$$U(x,N) = \int_C u[c, \ell(h,N)] \; dx. \tag{10}$$

Note that function U is linear in x. The price of x is given by a linear function, $\int_C q(c,h) \; dx$, where $q(c,h)$ gives the value of consuming c units and working h hours with probability one. A detailed discussion of q can be found in Section 2.3.3.

Moreover, households own assets a, and choose savings that I denote by a'. Since working does not have dynamic implications (a period later agents with wealth a' are identical regardless of what was the labor situation today) all agents with the same assets choose the same savings independently of the outcome of the lottery. These considerations imply that the budget constraint of the household is

$$\int_C q(c,h) \; dx + a' = (1+r) \; a.$$

I can define an indirect current return function R that takes as given the saving behavior of the household and solves for the optimal x. The static household problem given its saving behavior is to solve

$$R(a,N,q,r,a') = \max_{x \in X(N)} \quad U(x,N) \tag{11}$$

$$\text{s.t.} \quad \int_C q(c,h) \;\; dx + a' = (1+r) \;\; a \tag{12}$$

where both the objective and the constraint are linear. I write $x(a,N,q,r,a')$ as the optimal choice for a household with a assets, that saves a', when aggregate employment is N, and prices are given by functions q and r.

2.3.3 The intermediate insurance companies

These companies have zero profits and their only role is to insure the households. They deal with both households and firms and they choose signed measures $y \in \mathcal{M}$. In exchange of y that sells at price q, these firms acquire the rights to working time that they sell to plants at price w_h and provide to consumers the consumption implied by the lottery. These insurance firms contract with a large number of households which allows a law of large numbers to hold (see Uhlig (1996)), which precludes any aggregate uncertainty over the realizations of the lotteries.

Their problem is to

$$\max_y \int_C q(c,h)\ dy + \int_C w_h\ dy - \int_C c\ dy \tag{13}$$

This problem has only a solution if the pricing function is such that its consumption component only depends on the first moment of the measure y and if the wage is given by the function w_h. This implies that the pricing function q satisfies

$$\int_C q(c,h)\ dx = \int_C c\ x(dc,[0,1])\ - \int_C w_h\ x([0,\bar{c}],dh) \tag{14}$$

and, hence, I can rewrite the households' budget constraint as

$$\int_C c\ x(dc,[0,1])\ + a' = (1+r)\ a + \int_C w_h\ x([0,\bar{c}],dh) \tag{15}$$

Accordingly, I redefine the current return of the household after the static optimization problem described in equation (11) as $R(a,N,w_h,r,a')$ and the lottery choice as $x(a,N,w_h,r,a')$. An important property of $x(a,N,w_h,r,a')$ given the properties of w_h and q is that it has positive mass in at most two points[10], one of which is $\{c,0\}$ where $c \in [0,\bar{c}]$. It is easy to see why this is the case. Strict concavity of function u, and convexity of the choice set for $h > 0$ shows that households prefer to get a point with mass on only one h than another point with mass in more than one point with positive h and the same mean.

So, the solution to the household problem can only be one of the following three possibilities. One, there is positive mass in only one point with $h > 0$; two, there is positive mass only in $h = 0$; and three, there is positive mass in two points, one with $h = 0$ and one with $h > 0$. The use of a production function that satisfies the Inada conditions guarantees that in these economies there is always mass at some $h > 0$. I denote by $h(a,N,w_h,r,a')$ the point with positive mass in $h > 0$ and by $n(a,N,w_h,r,a')$ the mass at that point.

2.4 The recursive problem

Once I have set the within periods contracting problems, I can turn to define equilibrium for the economy. I will do so recursively. I start by defining the aggregate state variables of the economy. These are those variables that are needed to evaluate and forecast all prices. For this economy, they are total factor productivity z and aggregate capital K. The household's individual asset level a is also part of the individual state vector. In order for a household to solve its maximization problem it has to be able to compute the values for $\{r, w_h, K', N\}$. I assume that the household uses functions $\{\phi_r, \phi_{w_h}, G_K, G_N\}$ to do so. These functions map the aggregate state variables into the variables that the household needs to know to solve its maximization problem. The value function in expression (16) is indexed by these functions for clarity. In later expressions I omit the indices.

$$v(z, K, a; \phi, G) = \max_{a'} \; R(a, N, w_h, r, a') + \beta \; E\left\{v(z', k', a'; \phi, G)|z\right\} \tag{16}$$

$$\text{s.t.} \tag{17}$$
$$r = \phi_r(z, K) \tag{18}$$
$$w_h = \phi_w(z, K, h) \tag{19}$$
$$K' = G_K(z, K) \tag{20}$$
$$N = G_N(z, K) \tag{21}$$
$$H = G_H(z, K) \tag{22}$$

Let $a' = g_a(z, K, a; \phi, G)$ denote the solution to this problem. Substitution of this solution in (11) yields $x(z, K, a; \phi, G)$, and given that this problem puts mass in at most two points, it also yields $h = g_h(z, K, a; \phi, G)$ and $n = g_n(z, K, a; \phi, G)$.

Definition 1. A *recursive competitive equilibrium* is a set of decision rules for households $\{g_a, g_h, g_n\}$, a value function v, functions for aggregate variables $\{G_K, G_H, G_N\}$, for the interest rate $\phi_r(z, K)$, a wage schedule function $\phi_w(z, K, h)$, a measure of firms $\Psi(z, K)$, and a capital renting policy of the plants $k(z, r, h)$ such that *i)* the decision rules and value function satisfy (16), *ii)* the agent is representative, i.e. $g_a(z, K, K; \phi, G) = G_K(z, K)$, $g_h(z, K, K; \phi, G) = G_H(z, K)$ and $g_n(z, K, K; \phi, G) = G_N(z, K)$, *iii)* plants choose capital optimally and have zero profits, *i.e.* they solve (4) and (5), *iv)* the labor market clears, *i.e.*, Ψ has mass in only one point with positive hours worked which is given by $G_H(z,K)$ and $\Psi[z,K,G_H(z,K)] = G_N(z,K)$, and *v)* the market for capital clears, $K = \Psi[z,K,G_H(z,K)] = \dot{k}[z,\phi_r(z,K),G_H(z,K)]$.

A steady state for a deterministic version of this economy (a fixed value of total factor productivity $\bar{z}$) is just a number K^* such that, when substituted in the above general definition of recursive equilibrium, satisfies

$$K^* = G_K(\bar{z}, K^*), \tag{23}$$

in addition to all the requirements above.

2.5 Overtime taxation

An overtime tax is a policy $\tau(\bar{h},h)$ such that if $h > \bar{h}$ then firms have to pay $\tau(\bar{h},h)\cdot\hat{w}_h$ to the government, where $\hat{w}_h$ is the total payment that the firm has to incur, $\hat{w}_h = w_h + \tau(\bar{h},h)\cdot\hat{w}_h$. Equation (3) becomes

$$\max_{k,n}\ \ z\,h^{\xi}\,k^{1-\theta}\,n^{\theta} - k(r+\delta) - n[\ w_h + \tau(\bar{h},h)\cdot\hat{w}_h] \tag{24}$$

Equations (4) and (5) also change in a similar fashion. An important feature of the computational procedure is that all the relevant objects that the agent face are differentiable. Therefore, I can use the first derivatives to help characterize the solution. To this end, I use a function τ that is differentiable at $h = \bar{h}$. The properties of this function are that $\tau(\bar{h},h) = 0$ if $h \leq \bar{h}$, $\tau(\bar{h},h) > 0$ if $h > \bar{h}$, $\lim_{h\to 1} = \bar{\tau}$, $\frac{\partial\tau(\bar{h},h)}{\partial h}$ is non decreasing. Note that given these assumptions, for the tax to have any effects, $\bar{h}$ has to be lower than the target of hours worked.[11]

All the proceeds of the overtime tax are redistributed lump sum to the households. This changes equation (12) to

$$\int_C q(c,h)\ \ dx + a' = (1+r)\ \ a + T \tag{25}$$

where T are the transfers.

In addition to the changes in the profit function of firms and in the budget constraint of the household, I have to add a balanced budget condition for the government to the definition of equilibrium. This condition is simply that

$$T(z,K) = \tau[\bar{h}, G_H(z,K)] \tag{26}$$

2.6 Subsidy proportional to n

A subsidy proportional to employment is a policy $n\pi$ such that firms receive π from the government for every worker they hire, where $n(w_h - \pi)$ is the total payment that the firm has to incur. Equation (3) becomes

$$\max_{k,n} \; z\, h^{\xi}\, k^{1-\theta}\, n^{\theta} - k(r+\delta) - n(w_h - \pi) \tag{27}$$

Equations (4) and (5) also change in a similar fashion. Given that x has positive mass in at most two points, for convenience I rewrite the static household problem in a simpler way

$$\max_{c0,c1,n} \; n\, U(c1, 1-h-\eta) + (1-n)\, U(c0, 1) \tag{28}$$

$$\text{s.t.} \;\; n\, c1 + (1-n)\, c0 + a' = (1+r)\, a + w_h\, n - N\, \pi \tag{29}$$

where n denotes individual employment and N denotes aggregate employment, so that $N\,\pi$ stands for a lumpsum tax.

2.7 Subsidy proportional to nw_h

A subsidy proportional to the salary mass is a policy $nw_h\pi$ such that firms receive $w_h\pi$ from the government for every worker they hire, where $n(w_h(1-\pi))$ is the total payment that the firm has to incur. Equation (3) becomes

$$\max_{k,n} \; z\, h^{\xi}\, k^{1-\theta}\, n^{\theta} - k(r+\delta) - n(w_h(1-\pi)) \tag{30}$$

Equations (4) and (5) also change in a similar fashion. The household problem is the same as in the previous section except for the lumpsum tax, which in this case takes the form $N\, W_H\, \pi$, where W_H denotes aggregate salary.

3 Mapping the Model to Data

Except for the team work and the commuting cost assumption, the model is a standard business cycle model. Team work is described by the parameter ξ. I have chosen the economy to be midway between the standard Cobb-Douglas case where $\xi = \theta$ and the strict fatigue-less case where $\xi = 1$[12]. Function $\eta(N)$ describes the commuting cost externality

$$\eta(N) = A_N N^{\lambda} \tag{31}$$

The rest is standard. I have chosen the time period to be a quarter and I have assumed that household preferences can be described by the following standard Cobb-Douglas function in consumption and leisure

$$U(c_t, \ell_t) = \frac{\left[c_t^{\alpha}\ \ell_t^{1-\alpha}\right]^{1-\sigma} - 1}{1-\sigma} \tag{32}$$

where $0 < \alpha < 1$ and $\sigma > 0$. The model has 10 parameters. The measurements of the parameters that characterize the process for the Solow residual, the auto–regressive coefficient ρ and the variance of the shock σ_{ϵ}, are taken from Prescott (1986). Apart from parameter ξ the model has seven additional parameters: θ, δ, β, α, σ, A_N and λ, whose values are shown in Table I. The conditions to set these seven parameters are:

1. A labor share of 64%.
2. A steady state yearly interest rate of 4%.
3. A steady state consumption to output ratio of .75.
4. A steady state fraction of the working-age population who work of 75%. See Kydland and Prescott (1991) for a discussion of this choice.
5. A 40 hour workweek. I assume that out of the 168 hours in each week, 68 of them are devoted either to sleeping or personal care. This implies that workers work 40% of their time. See Cooley and Prescott (1995) for a discussion of this choice.
6. The relative volatility of hours and bodies is .5 as in the U.S. data. See Kydland and Prescott (1991) or Cooley and Prescott (1995).[13]
7. An Average commuting time of five hours a week (30 minutes each way).[14]

Table I: **Baseline Economy Parameters.**

ξ	A_N	λ	α	σ	δ	θ	β
.85	.35	6.75	.33	1.5	.025	.64	.99

4 Main Findings

Section 4.1 reports the steady state implications of imposing an overtime tax policy. Section 4.2 reports the steady state implications of introducing an employment and a wage subsidy and compare these results with those obtained with an overtime tax. Section 4.3 studies the implications of a related and very controversial policy: the recently proposed increase in the legal workweek till 60 hours. Finally, Section 4.4 reports the welfare implications and the transition paths of these three model economies.

4.1 An overtime tax

Table II shows, along the steady state of the baseline economy, the steady state of an economy where the overtime tax policy achieves a reduction in the workweek from 40 to 35 hours. To ease comparisons the table includes the percentage change for each relevant variable (%var), as well as the percentage change relative to the hours per worker percentage change ($\frac{\%var}{\%h}$). A tax rate on overtime of 12% induces households to reduce hours worked by 12.5%, increases employment by 7.04%, and decreases output and productivity by 10.2% and 4.2%, respectively. Note that due to the reduction in productivity, the reduction in the salary is larger than the reduction in hours per worker.

4.2 An employment and a wage subsidy

Table III shows the steady state results of introducing an employment and a wage subsidy. To ease comparison with the overtime tax policy I focus on

Table II: **An overtime tax.**

Economy	$\tau = 0$	$\tau = 0.12$	%var	$\frac{\%var}{\%h}$
Hours per worker	40.0	35.0	-12.5	1
Employment	0.75	0.80	7.04	0.57
Total hours	30.0	28.0	-6.29	-0.50
Output	1.00	0.90	-10.2	-0.82
Productivity	1.00	0.96	-4.19	-0.34
Salary w_h	0.69	0.58	-16.3	-1.30

those subsidies that generate a similar employment increase.

An *employment subsidy* of 0.045 reduces hours worked by 6.3% and increases employment by 7.0% since this policy makes bodies relatively cheaper to hours. Contrary to what happened in the overtime experiment, total hours increase because the reduction in hours per worker is more than compensated by the increase in employment. This implies a smaller decrease in total output, 1.9% versus 10.2%, and also a smaller reduction in productivity, 2.1% versus 4.2%. Still, total output, capital and productivity decrease because, due to the team work assumption, it is more profitable to pay for extra hours than hiring an additional worker. The fact that wages are nonlinear functions of hours and the decrease in the workweek and productivity explain the fall in the salary. However, given the lower decrease in hours per worker and productivity, the reduction in the salary is also lower, 1.8% versus 16.3%, than in the overtime experiment.

The *wage subsidy* that generates the same employment increase implies very different results. Given employment, the subsidy grows more than proportional with hours because of the non-linearity on hours of the wage function. In fact, increasing the subsidy results in increases in both the workweek and employment, so that total hours, the steady state capital and output increase considerably. Productivity increases slightly despite the increase in the workweek and employment. Regarding the salary, it also increases given the increase in the workweek, the nonlinearity of the wage function and the increase in the steady state capital.

Table III: **Employment and wage subsidy**

Type of subsidy	πN			$\pi w_H N$		
Economy	$\pi = 0$	$\pi = 0.045$	$\% var$	$\pi = 0$	$\pi = 0.165$	$\% var$
Hours per worker	40.0	37.5	-6.34	40.0	41.5	3.65
Employment	0.75	0.80	7.01	0.75	0.80	7.02
Total hours	30.0	30.1	0.23	30.0	33.3	11.0
Output	1.00	0.98	-1.86	1.00	1.12	12.2
Productivity	1.00	0.98	-2.09	1.00	1.01	1.16
Salary w_h	0.69	0.68	-1.77	0.69	0.87	25.6

To summarize, I find that subsidizing employment can achieve the same employment increase than taxing overtime but at a lower cost in terms of output, productivity and wages. This is particularly important because of the difficulty in implementing policies that imply downward wage flexibility, as it is the case in the overtime experiment. Of course, there is a trade-off. Subsidizing employment implies a budgetary outlay that has to be financed through higher taxes or debt. These costs have to be confronted with the benefits of having more employment with similar wages and, as result, higher consumption and welfare (see Section 4.4) than in the overtime experiment.

The wage subsidy that achieves the same employment increase turns out to be almost three times costlier than the employment subsidy. Table IV compares the results of two subsidies, a 0.045 employment subsidy and a 0.065 wage subsidy, that cost the same in terms of output. The wage subsidy generates a much lower employment increase, 2.7% versus 7.0%.

4.3 Increasing the legal workweek

The goal of this section is to quantify the implications for productivity and employment of a related and very controversial policy: the recently proposed increase in the legal workweek till 60 hours. For that purpose I need to introduce a new element in the model to induce cross–sectional variation of workweeks across plants such that, subject to a positive plant specific shock, a firm may find it profitable to increase the working week above the legal 48-hours. Increasing the legal workweek will improve the flexibility of

Table IV: **An equal cost employment and wage subsidy**

Type of subsidy	πN			$\pi w_H N$		
Economy	$\pi = 0$	$\pi = 0.045$	$\%var$	$\pi = 0$	$\pi = 0.065$	$\%var$
Hours per worker	40.0	37.5	-6.34	40.0	40.6	1.48
Employment	0.75	0.80	7.01	0.75	0.77	2.65
Total hours	30.0	30.1	0.23	30.0	31.3	4.17
Output	1.00	0.98	-1.86	1.00	1.05	4.67
Productivity	1.00	0.98	-2.09	1.00	1.01	0.47
Salary w_h	0.69	0.68	-1.77	0.69	0.75	9.05

firms to adjust their labor input to temporary changes in productivity (or demand).

To model the importance of plant level flexibility, I assume *i.i.d.* transitory shocks to plant level productivity, revealed after the workers have been hired but before production takes place, and independent from the economy wide productivity shock.[15] Consequently, the only margin that can be used to exploit this additional productivity change is to vary the plant's workweek. The new plant level production function is given by

$$z\, s\, h^{\xi}\, k^{1-\theta}\, n^{\theta} \tag{33}$$

where all variables are as before except for the plant specific shock, s. The shock takes only finitely many values $s \in \{s_1, \cdots, s_{m_s}\}$ and is drawn from probability distribution γ_s.

This change requires the indexation of agents' choices by the possible realizations of the shock, resulting in

$$\begin{aligned} X(N) = \{x_1, \cdots, x_{m_s} :\ x_s \in \mathcal{M} :\quad & x_s \text{ is a probability, } i.e.\ x_s \geq 0,\ x_s(C) = 1, \\ & x_s([0,\bar{c}], \{0\}) \text{ is the same for all } s, \\ & \text{if } \ h \in (0,1], \quad \text{and } x_s([0,\bar{c}], [h,1]) > 0, \text{ then } h \leq 1 - \eta(N)\}\,. \end{aligned} \tag{34}$$

Note that all I am adding is that the employment probability cannot depend on the idiosyncratic shock of the plant. From the point of view of the firm, equation (4) has to be rewritten. I arbitrarily specify a workweek of $h(s)$

hours for $s \in \{s_1, \cdots, s_{m_s}\}$, and I get

$$\max_k \; z\, k^{1-\theta} \sum_s \gamma_s \; s \; h(s)^{\xi} \; - \; k(r+\delta) - w_{\{h(s)\}} \tag{35}$$

with solution given by $k(z, \{h(s)\}, r)$. The zero profit condition requires that for each vector $\{h(s)\}$, the salary $w_{\{h(s)\}}$ satisfies

$$0 = z\,[k(z, \{h(s)\}, r)]^{1-\theta} \sum_s \gamma_s \; s \; h(s)^{\xi} \; - \; k(z, \{h(s)\}, r)(r+\delta) - w_{\{h(s)\}} \tag{36}$$

The rest of the changes to adapt the model to the case with idiosyncratic shocks to firms is a tedious minor variation of the equations described above and I omit them for brevity.

4.3.1 Mapping the heterogeneous workweeks economy to data

To parameterize the model I use an equal probability three-valued i.i.d shock. These means that I have three new parameters to set and three new statistics to match. I take these statistics from the cross-sectional distribution of workweeks of individuals as reported by the European Commission in "Employment in Europe Report 2007". One third of workers work between 35-39 hours a week, another third work 40-44 hours, and the remaining third work 45-55 hours. These are the three statistics to replicate and the associated parameters to be determined are the values of the shocks.

The other targets of the model remain the same as in Section 3 except for the average number of hours worked and the employment rate. The average number of hours worked by men in their main job in the EU-15 in 2005 is 40.7 and the men employment rate in the same period is 71.4%. Concerning the parameters, the two that change values are σ and α.

4.3.2 Findings

I next perform the following experiment. I look for the tax on overtime such that in steady state the maximum amount of hours worked is the legal 48 hours. Then I reduce the tax so that the maximum amount of hours worked

Table V: **New economy parameters**

ξ	A_N	λ	α	σ	δ	θ	β
.85	.35	6.75	.3	1.1	.025	.64	.99

turns out to be approximately 60 hours in steady state. This tax reduction can be assimilated to the recently proposed increase in the legal workweek till 60 hours. From this exercise we can learn about the productivity losses and employment gains of maintaining the actual legislation.

Table VI shows that a 12.5% reduction in the overtime tax induces households to increase mean hours worked by 10.2% (from 40.7 to 45). This is a large number since the tax does not affect everybody , only those firms that need to exploit the positive productivity change by increasing the workweek. In addition, the policy reduces employment by 7%, and increases output and productivity by 6.7% and 4%, respectively. Note that due to the increase in productivity, the increase in the salary is larger than the increase in hours per worker.

I also computed the standard deviation of hours to see the implications of the policy for the intensive margin. The increase in the volatility of hours turns out to be 39%. This is not surprising since the tax punishes in the margin only the plants with long workweeks. I fact, the policy changes the cross-sectional distribution from 48.5, 39.8 and 34.0 hours per week to 54.6, 45.9 and 34.3 hours.

4.4 The transition

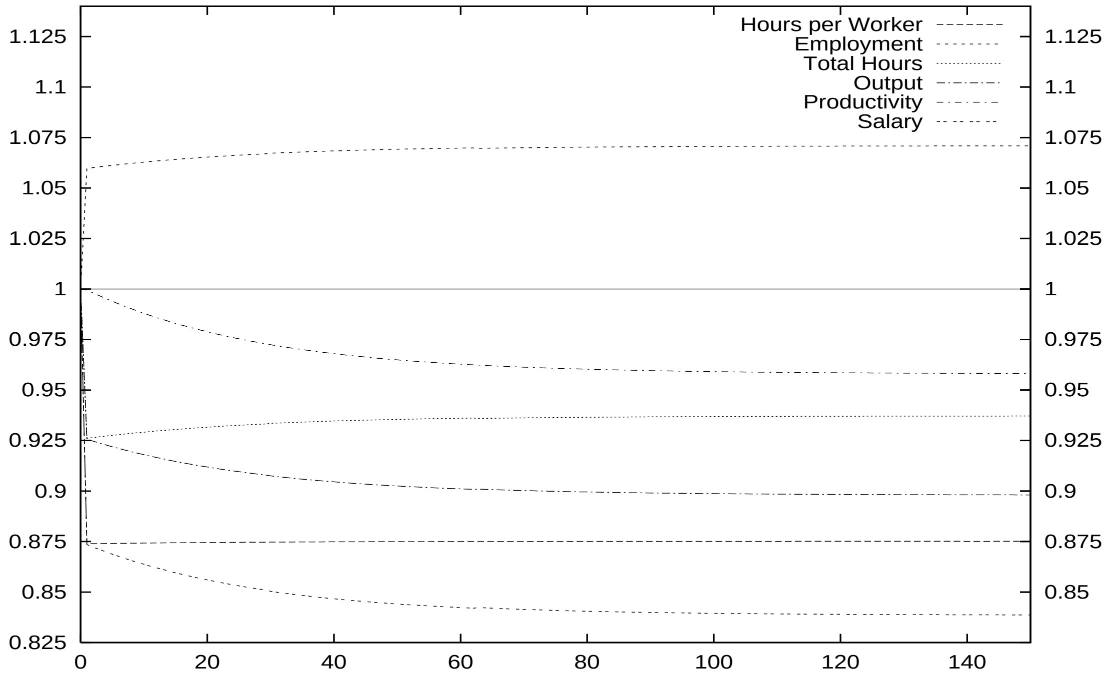
An assessment of a policy cannot be carried out based on steady state comparisons since the economies under consideration have different initial conditions. In order to assess the implications of a policy, I take the steady state of the economy without taxation or subsidies and impose a policy at a time.

Table VI: **Increase in the legal workweek**

Economy	$\tau = 0.125$	$\tau = 0$	%var	$\frac{\%var}{\%h}$
Average hours	40.7	45.0	10.2	1
Employment	71.4	66.5	-6.9	-0.67
Total hours	26.7	26.0	-2.7	-0.26
Output	1.00	1.07	6.7	0.65
Productivity	1.00	1.04	3.9	0.38
Salary	0.63	0.72	14.6	1.42

Figure 1 shows the transition paths for the main aggregate variables that I am interested in for an economy in which I impose the 12.0% overtime tax (as in Section 4.1). To make the picture clearer, I normalize all variables so that in the steady state of an economy without taxes their value is one. The first thing to note is that the adjustment of most variables is very fast. Indeed, hours and employment immediately jump to almost their final value. Only capital adjusts slowly as there is deccumulation, and output and the salary go down slowly following the path of capital. The consumptions of both the employed and the unemployed also fall and so does the utility of the representative agent because, apart from the consumption decrease, the ex-ante probability of ending up working is higher. For the same reason, the utility of the representative agent is also lower in the economy with a 0.045 employment subsidy. On the contrary, in the .165 wage subsidy economy consumption is higher than in the baseline, both for the employed and the non-employed, since hours, employment, capital and, therefore, output are higher. However, the utility of the representative consumer is also lower than in the baseline because the negative effect of having a higher ex-ante probability of ending up working more than compensate the increase in consumption.

The computation of the transition allows the computation of the welfare cost of a policy. I compute the welfare cost as the proportional decrease in consumption (both for the employed and the unemployed) with respect to the steady state without the policy that would leave agents indifferent to implementing the policy. Before reporting the number I state a major caveat which has to do with the type of friction that I use to measure the



Hours per Worker
Employment
Total Hours
Output
Productivity
Salary
1.125
1.1
1.075
1.05
1.025
1
0.975
0.95
0.925
0.9
0.875
0.85
0.825
0
20
40
60
80
100
120
140

Figure 1:

substitutability between hours per worker and employment. Recall that in the model there is an externality based commuting cost. As a result, the increase in aggregate employment increases the commuting time and reduces utility. If I had modelled the economy with a different type of friction, the utility cost of the policy would have been very different, and probably much smaller, as the friction does not need to have utility costs as large as those imposed by the externality. Henceforth, the welfare cost that I compute is likely to overstate the actual welfare costs of the policy. The drop in average consumption that makes agents indifferent between the previous situation and the implementation of the policy ranges from 8.0% in the economy with the 12% overtime tax and the 0.165 wage subsidy to 8.5% in the economy with the 0.045 employment subsidy. Because of the above considerations regarding the friction, I also computed the welfare costs that would come up if I do not take into account the changes in commuting time that are imposed by the externality. In this case, the welfare costs are of a smaller order of magnitude, 1.0% of average consumption in the overtime tax economy and 0.6% in the economy with the employment subsidy[16]. I think these last numbers provide a better assessment of the welfare costs of these policies because they are likely to be more in line with what would have resulted from modelling the frictions in the labor market differently. I want to make the point that welfare calculations usually yield very small numbers due to the concavity of the utility function, and therefore even 0.6% of average consumption is a large welfare cost.

5 Conclusion

In this paper, I have compared the macroeconomic implications of taxing overtime, subsidizing the wage and subsidizing employment in a dynamic general equilibrium model where hours and bodies are imperfect substitutes due to team work and an externality–based commuting cost. For ease of comparison I have looked for policies that generate the same employment increase and I have compared the implications of those policies for the workweek, output, productivity and wages. Having a correct measurement of the degree of substitutability between hours per worker and employment has been crucial to give an accurate assessment of the employment gains since these policies change the relative price of employment and hours. I have used business cycles observations to pin down this relative substitutability.

In the baseline model economy, I found that a 12% tax on overtime decreases the workweek from 40 to 35 hours, increases employment by 7% and decreases productivity by 4.2%. Then, I looked for the employment and wage subsidy that generated the same increase in steady-state employment and compared the changes in hours per worker, output, wages and productivity. I found that an employment subsidy performs better in terms of output, productivity and wages. This is particularly important because of the difficulty in implementing policies that imply downward wage flexibility, as it is the case in the overtime experiment. Of course, there is a trade-off. Subsidizing employment implies a budgetary outlay that has to be financed through higher taxes or debt. These costs have to be confronted with the benefits of having more employment with similar wages and, as result, higher consumption and welfare than in the overtime experiment. The wage subsidy that achieved the same employment increase turned out to be very costly from a fiscal point of view.

I also studied the implications of a related and very controversial policy, the recently proposed increase in the legal workweek till 60 hours, to learn about the productivity losses and employment gains of maintaining the actual legislation. For that purpose I introduced a new element in the model to induce cross–sectional variation of workweeks across plants such that, subject to a positive plant specific shock, a firm may found it profitable to increase the working week above the legal 48-hours. The increase in the legal workweek increased mean hours worked substantially (from 40.7 to 45). This is a large number since the tax does not affect everybody, only those firms that need to exploit the positive productivity change by increasing the workweek. The policy also reduced employment by 7%, and increased output and productivity by 6.7% and 4%, respectively.

Finally, I computed the transition between steady states of the three model economies in order to measure the welfare costs implied by these policies. I found that these welfare costs are at least 0.6% of average consumption, which is a large number as far as welfare calculations go.

There are some caveats to these findings. The first one arises from having used commuting costs subject to congestion as the friction that stands in for a variety of adjustment costs that are difficult to model appropriately. The second caveat has to do with the use of business cycle properties to calibrate the extent of the frictions that determine the relative substitutability between hours per worker and employment. There is no doubt that these findings are affected by these assumptions. In a different paper (Osuna and Ríos-Rull (2003)) I performed some robustness exercises to give a sense of the range of possible values for the main variables that I am looking at. I found that the answers encountered under these alternative assumptions are not very different from those that arise in the baseline model economy. Another major caveat which has to do with the fact that there are not distributional effects. That is, every agent, workers and non-workers, is worst after these policies, not only ex-ante because everybody has a higher probability of ending up working, but also ex-post. The lack of distributional issues in the model makes the implementation of these policies at least puzzling, since they are welfare reducing. The inclusion of some form of market incompleteness would have given an insurance role to these policies and a rationale to its implementation.

I see this contribution as an example of how to use this methodological benchmark to accurately compare several employment policies in terms of i) the trade-offs between employment and hours, output, productivity and wages, ii) the budgetary outlays and iii) the welfare costs. This benchmark could also be used to study the effects of reducing child care costs or promoting part-time work for the women employment rate, or to study the effects of delaying or anticipating the age of retirement. I see the role of this paper as an initial, not as a final formal discussion of the macroeconomic implications of these kind of policies. Moreover, the model can be extended to include additional aspects that may be currently missing.

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Footnotes

1. See Section 5.3 in Osuna and Ríos-Rull (2003) where they show the relevance of this externality assumption.

2. See Section 1 in Osuna and Ríos-Rull (2003) for a review of this literature.

3. In Section 3 Osuna and Ríos-Rull (2003) discuss why this calibration seems reasonable by comparing these estimates with those in direct empirical studies. They also compare with Cho and Cooley (1994) results (that use PSID data at a steady state frequency), and showed that they are extremely similar, what lends support to their measurements.

4. Osuna and Ríos-Rull (2003) describe in detail the computational method used to solve this problem in their Appendix A.

5. See Prescott and Ríos-Rull (1992) for a detailed explanation of why we impose this upper bound and for why it is irrelevant.

6. While some advocates of workweek reduction policies might have in mind gains in employment due to increases in the number of shifts, I think that team–work is a more important feature in actual plants (see Beers (2000) for a discussion of both, shift work and flexible schedules, in recent U.S. data).

7. In a sense, this form of writing the plant production function is a reduced form. I could redefine h to be the hours worked by the worker that works the least. However, given constant returns in bodies and capital, the plants can split at no costs into units where all workers work the same number of hours.

8. See Hansen (1985), Rogerson (1988) and Prescott and Ríos-Rull (1992) for earlier applications of lotteries to labor contracts.

9. Obviously, the actual details of what types of firms buy and sell these lotteries do not matter. I could have chosen other arrangements without changing the equilibrium allocations (see Prescott and Ríos-Rull (1992)).

10. Actually this is a property derived from a standard result in linear programming, see Hornstein and Prescott (1993).

11. See Appendix B and Fig.B1 in Osuna and Ríos-Rull (2003) for details of the tax function.

12. Osuna and Ríos-Rull (2003) explore alternative choices for this parameter as a robustness check.

13. A natural question in this context is to what extent can business cycles variation be informative about the substitutability between hours and employment, and how does it relate to alternative measurement procedures that draw on microeconomic observations to calibrate. See Section 3 in Osuna and Ríos-Rull (2003) for this discussion.

14. Osuna and Ríos-Rull (2003) explore alternative choices for the commuting cost as a robustness check.

15. A more theoretically consistent way to describe this would be to say that it exists a time to hire restriction. The nature of the timing is not dissimilar to that in Burnside, Eichenbaum and Rebelo (1990), although, in that paper hours cannot adjust. This shock could be interpreted as a demand shock, but it is simpler to specify it as a plant specific productivity shock.

16. It does not make any sense to compute this number for the economy with the 0.165 wage subsidy because the policy is welfare improving.