IFAU – OFFICE OF LABOUR
MARKET POLICY EVALUATION

The effects of working time reductions on wages, actual hours and equilibrium unemployment

Oskar Nordström Skans

WORKING PAPER 2001:8

The effects of working time reductions on wages, actual hours and equilibrium unemployment*

by

Oskar Nordström Skans✉

July 12, 2001

Abstract

This paper extends a general equilibrium model of unemployment and working hours and evaluates the model on a 5 percent working time reduction for shift workers in Sweden. Panel data from firms' payroll records are used to examine the relationship between standard hours, actual hours and hourly wages. The main results are: i) Actual hours only decreased by 40 percent of the reduction in standard hours. ii) Hourly wages for shift workers rose relative to wages for daytime workers. iii) The wage increase was more pronounced for workers who received a larger reduction of actual hours. The conclusion is that working time reductions that allow for discretion on lower levels of bargaining do not necessarily reduce actual hours. Furthermore, working time reductions may result in an increase in wage pressure, causing unemployment to rise.

Keywords: Work sharing, working hours, unemployment, wage pressure
JEL classification: E24, J22, J23, J51

* Helpful comments where given by Dominique Anxo, Erling Barth, Mikael Carlsson, Stefan Eriksson, Anders Forslund, Ann-Sofi Kolm, Erik Mellander, Henry Ohlsson and seminar participants at Gothenburg University, Uppsala University and SOFI. Thanks also to SAF and Ari Hietasalo for supplying the data and to Bertil Edin for help with the institutional background.
✉ Office of Labour Market Policy Evaluation (IFAU) and Department of Economics, Uppsala University, Box 513, SE-751 20 Uppsala, Sweden. E-mail: oskar.nordstrom_skans@nek.uu.se.

Table of contents

1 Introduction

Unemployment in the European Union is considered too high by most observers. At the same time, an increasing number of workers wish to work fewer hours (OECD 1998). This has lead unions and policymakers in several European countries to push for working time reductions. Partly, this has been motivated as a policy for reducing unemployment, “work sharing”. The assumption behind this proposal is that a fixed number of working hours is demanded in the economy, and that more workers could find employment if hours per worker are reduced. Theoretical and empirical work by economists have lent little support to this idea. The main theoretical objection has been that total demand for labour services will be reduced due to substitution from labour to capital and reduced production (a recent survey is Kapteyn et al, 2000).

This paper will take as a starting point an equilibrium model of the labour market that accounts for the stylised fact that unemployment is independent of the state of technology. The model shows that a general working time reduction will tend to lower wage pressure and equilibrium unemployment due to a reduction in the cost of forgone leisure when working. This will be the only effect on equilibrium unemployment if the employment elasticity with respect to (hourly) wages is independent of the length of the workweek. A counteracting effect is derived if firms have fixed costs of employment. A shorter workweek will increase the importance of fixed costs, causing the wage pressure and the unemployment rate to rise. Thus, the paper shows that the net effect of a working time reduction on unemployment is ambiguous. Furthermore, it is argued that it is possible to evaluate the effect on the wage pressure by studying the responses of actual hours and hourly wages to a partial reduction in standard working time.

The empirical part of the paper studies a 5 % reduction in standard working hours, as defined in central agreements, for one class of shift workers in the Swedish manufacturing and mining industries. The results show that actual working hours were reduced by only 40 % of the reduction in standard hours. Evidence suggests that one reason for the small effect is that only some workers had their actual hours reduced. Hourly wages were increased as a result of the reduction in standard hours. The rise in hourly wages was sufficient to leave relative monthly earnings constant. Relative wages rose for all workers covered by the standard hours’ reduction, but the rise was most pronounced for the workers that had their actual hours reduced. This suggests that wage pressure increased as a result of the reduction in standard hours and that unemployment may increase as well if standard hours are reduced for all workers.

The major part of the theoretical literature on working hours' regulations was published in the 1980:s when work sharing was frequently discussed as a labour market policy in continental Europe. Examples of models studying the effect of a working time reduction on labour demand are Hart (1987) and papers by Calmfors and Hoel (1988 and 1989) that deal with shift work and overtime. Booth and Ravallion (1993) studies the importance of fixed costs for the partial equilibrium effects on labour demand of a working time reduction. For a survey of bargaining models for working time, see Earl and Pencavel (1990). Theoretical studies of the effect of working time reductions on equilibrium unemployment are less common; exceptions are Houpis (1993) and Marimon and Zilibotti (2000).

Empirical work on Swedish data includes Pencavel and Holmlund (1988) that studies industry level relationships between labour demand, hours and wages. Jacobson and Ohlsson (2000) study aggregate time series data and find an effect from legislated working time on actual hours, but also that employment and working hours are unrelated. Very little empirical work has been done on micro level data; for an international review see Hunt (1998). Examples are Crépon and Kramarz (2000) that study the effects on employment of the French 1982 working time reduction and Hunt (1999) that studies the effects of an industry level working time reduction on hours, wages, and employment in Germany. Hunt finds that hours were reduced by almost the predicted amount, that hourly wages rose to compensate for the loss in earnings and consequently, that employment fell.

This paper adds to the empirical literature in two aspects. First, it supplements Hunt (1999) in giving additional micro-evidence of the effect on actual hours and hourly wages from a partial working time reduction. This paper uses population-wide administrative data on working hours and wages from firms' payroll records while Hunt mainly used survey data and self reported standard hours. Second, it gives evidence on how a central working time reduction is implemented in an environment where it is possible to renegotiate agreements on a local level (see Anxo and O'Reilly 2000).

The paper is structured as follows: *Section 2* discusses predictions from equilibrium theory for the effects of a working time reduction on unemployment and what we may learn about these effects from partial working time reductions. *Section 3* describes the experiment and the data used in the empirical section of this paper. *Section 4* presents evidence of the effect on actual hours worked and *Section 5* presents evidence on hourly wages. *Section 6* concludes.

2 Theory

The simple work sharing argument rests on the assumption that there is a fixed number of working hours demanded in the economy. The demand for labour services may however change with hours worked for several reasons, such as substitution of inputs from labour to capital, changes in total output, and skill match problems. A large part of the literature on work sharing has discussed the importance of these effects in an attempt to determine whether labour demand will increase or decrease as the result of a working time reduction.

Labour demand effects are important for workers in a single firm considering the effects of a shorter workweek. They are also of interest for the welfare implications of a general working time reduction. However, they will not be of prime interest for a study of how equilibrium unemployment responds to a working time reduction, i.e. to an evaluation of work sharing as a policy. The reason is that changes in labour demand from a working time reduction should not affect equilibrium unemployment for the same reason that expansions in product demand, or increases in productivity due to technological change,[1] does not affect equilibrium unemployment. Increases in labour demand that reduce short run unemployment will simply result in increased wages until unemployment has returned to its initial equilibrium value.[2]

Changes in the length of the workweek may have an effect on equilibrium unemployment through the wage setting process, however. Equilibrium unemployment will be affected if wage demands at a given unemployment level changes due to the working time reduction. There are (at least) two reasons to believe that the wage pressure will be affected by a working time reduction. Houpis' (1993) equilibrium model of unemployment implies that a working time reduction will *decrease* wage pressure and unemployment since the cost of forgone leisure from working is smaller if the workweek is shorter. On the

[1] Note that there is an important correspondence between a working time reduction and technical change. The direct effect of a working time reduction is decreased production per employee whereas technical change increases production per employee.
[2] See Layard et al (1991) for a further discussion of this point.

other hand, fixed costs per employee (e.g. search[3] or hiring costs) that are not related to hours of work may become more important if the workweek is shortened. This will reduce the wage sensitivity of employment and thus lead to an *increase* in wage pressure and equilibrium unemployment.

The model presented in the following sections follow Houpis (1993), both in structure and in allowing for effects through the value of leisure. The contributions are twofold: First, the choice of functional forms generates an unemployment rate that is independent of technical change and thus, removes all short run effects through shifts in labour demand. Second, the model allows for equilibrium effects of firms' fixed costs of employment. It is shown that the net effect on unemployment from a working time reduction depends on the relative importance of firms' fixed costs and workers' value of leisure. The sign of the net effect is in general indeterminate. Furthermore, it is shown that the response of hourly wages to a partial working time reduction will contain evidence on whether the wage pressure, and thus the equilibrium unemployment rate, will decrease or not from a general working time reduction.

2.1 The model

For simplicity it is assumed that the unions unilaterally set hourly straight-time wages ($\tilde{w}$).[4] Given these wages firms set employment (*N*) to maximise profits. Actual hours (*h*) are assumed to be equal to, or greater than, standard hours (h_s). An overtime premium ($p\tilde{w}$) is paid for each overtime hour. Hence, we may define average hourly earnings (*w*) as

$$w \equiv \tilde{w}\frac{h_s + (1+p)(h-h_s)}{h} \tag{1}$$

Actual hours are assumed to be a function of standard hours, but independent of wages, $h = \Psi(h_s)$. This assumption is convenient since it allows us to conduct the analysis in terms of actual hours (*h*) and hourly earnings (*w*) first, and later proceed to study the exact relationship between standard and actual hours. One obvious special case is when we do not allow for overtime and ac-

[3] See Pissarides (2000), ch. 7.
[4] Bargaining over wages in a "right to manage" framework will not change the main results.

tual hours are equal to standard hours. Some further justifications for the assumption that hours are independent of wages are presented in *Section 2.3*.

Denote employment by N, hours by h, and the state of technology by A; and assume that the production function is Cobb-Douglas, $A\left(Nh^{b}\right)^{a}$, with decreasing marginal productivity of labour $(a < 1)$. Marginal productivity may be decreasing more rapidly if hours are increased than if employment is increased, implying $b < 1$.[5] Costs are equal to wage costs (*whN*) plus a fixed cost per employee (*AcN*). The fixed cost is assumed to be proportional to the technology parameter (*A*) to ensure that the unemployment rate is independent of technological progress.[6] Thus, the problem for firm *i* is:

$$\max_{N_i} p = A\left(N_i h^{b}\right)^{a} - w_i h N_i - AcN_i \,.$$

The first order condition for a maximum is:

$$N_i^{*} = \left[\left(w_i h + Ac\right)^{-1} h^{ab} A a\right]^{\frac{1}{1-a}} \,. \qquad (2)$$

Differentiate to get the elasticity of employment with respect to hourly wages:

$$e_{Nw_i} \equiv -\frac{dN_i^{*}}{dw_i}\frac{w_i}{N_i^{*}} = \frac{1}{1-a}\frac{w_i h}{w_i h + Ac} \,. \qquad (3)$$

Wages in each firm are set by a monopoly union (with fixed membership *M*), trading off the benefits of higher wages against the risk of reduced employment. The union's objective is the maximisation of a representative member's utility. For the unemployment rate to be independent of the state of technology it is necessary that the utility function is isoelastic in earnings.[7] The util-

[5] The rate of decline in the marginal productivity of hours will not be important for the qualitative results of the analysis. For a more elaborated analysis of the importance of hourly productivity in a partial equilibrium monopoly union model, see Booth and Ravallion (1993).

[6] Holmlund (2000) presents a motivation for why "vacancy costs" should be indexed to the state of technology, but not to hours.

[7] Assuming that the value of leisure is the value of home production and that home productivity is proportional to market productivity will allow for a wider class of utility functions. Such an assumption may remove the leisure effect derived here.

ity of leisure is some general function $f(T\!-\!h)$ (with f'>0 and f''<0) of the total time endowment (T) minus working hours. The unions objective is to maximise the weighted average of the utility for the employed, $\frac{(w_i h)^s}{s} f(T-h)$, and the expected utility for workers loosing their jobs, V^u, where the outside option is taken to be exogenous during wage setting.

Thus, union i will solve the problem:

$$\max_w \Omega = \frac{N_i}{M}\left[\frac{(w_i h)^s}{s} f(T-h)\right] + \frac{(M-N_i)}{M} V^u , \qquad (4)$$
$$s.t.\ N_{\mathrm{i}} = N_i^*(w_i)$$

and the first order condition is:[8]

$$\frac{(w_i h)^s}{s} f(T-h) = \frac{e_{Nw_i}}{e_{Nw_i} - s} V^u . \qquad (5)$$

The first order condition (5) is the partial equilibrium wage equation that, together with the equation for the employment elasticity (3), will determine the wage level at a particular firm. To get equilibrium unemployment we need to endogenously determine the utility of unemployed union members. To this end, we assume that all firms and unions are identical and drop the index i. Assume further, in accordance with standard assumptions, that the outside option is the weighted average of the utility of the employed and the unemployed with the probability of the respective states given by the unemployment rate (u). Unemployment benefits are assumed to be indexed to the average income in the economy, the replacement ratio being denoted by b. This gives the outside option:

$$V^u = u\frac{(bwh)^s}{s} f(T) + (1-u)\frac{(wh)^s}{s} f(T-h) . \qquad (6)$$

[8] This requires that the employment elasticity (e_{Nw}) is larger than s .

Rewriting (5) under this assumption and solving for unemployment gives:

$$u = \frac{s}{e_{Nw}} \frac{1}{1-\tilde{b}(h)} \qquad (7)$$

Where $\tilde{b}(h) \equiv b^s \frac{f(T)}{f(T-h)}$ is the "effective" replacement rate, i.e. the replacement rate adjusted to take account of the relative leisure cost of working. From (7) we see that we may have two effects on equilibrium unemployment, one through the employment elasticity and one through changes in the effective replacement ratio.

2.1.1 Case 1: No fixed costs

We know from the firms profit maximisation problem and equation (3) that the employment elasticity is a constant in the case with no fixed costs (i.e. when $c = 0$). Differentiating (7) under this assumption, and noting that $\tilde{b}(h) < 1$ (or all workers would prefer to be unemployed), we see that unemployment is increasing in working hours:

$$e_{uh}\big|_{c=0} = \left(h \frac{f'(T-h)}{f(T-h)} \right) \frac{\tilde{b}(h)}{1-\tilde{b}(h)} > 0 \, . \qquad (8)$$

Hence, a working time reduction will lower the unemployment rate. This is the prediction of Houpis (1993) restated using the most general explicit utility function that is consistent with the stylised fact that unemployment is independent of the state of technology. This independence of technology has two important implications. The first is that the positive relationship between hours and unemployment is unambiguous. The second implication is that all effects on equilibrium unemployment come through the wage setting process. Shifts in the labour demand equation will not affect the unemployment level.[9] This is important for the study of the partial working time reduction. A shorter workweek will result in reduced earnings for both employed and unemployed work-

[9] Note that the parameter for the productivity of hours (b) does not enter equation (8).

ers, but this will not affect equilibrium unemployment due to the independence of the state of technology (causing independence of the earnings level). The effect on unemployment from a working time reduction is due to the fact that the shorter the workweek is; the lower is the cost of forgone leisure when working and thus the effective replacement ratio $\tilde{b}(h)$.

2.1.2 Case 2: Fixed costs

In the analysis above, and in the equilibrium analysis in Houpis (1993), it is assumed that the elasticity of employment with respect to wages is independent of working hours. This assumption is violated if there are fixed costs of employment.[10] Normalise the (constant) number of firms and the size of the (constant) labour force to 1, implying $N = (1-u)$. Use these normalisations to transform the firms first order condition (2) into a function of the unemployment rate and use (3) to get

$$e_{Nw} = \frac{1}{1-a}\left[1 - \frac{c}{a(1-u)^{a-1}h^{ab}}\right]. \tag{9}$$

Thus, the elasticity of employment is independent of the state of technology, but not independent of working hours if there are fixed costs of employment. Furthermore, it is positively related to both the unemployment rate and to working hours. Thus, there is an offsetting effect on unemployment. Fixed costs will be of increased importance when working time is reduced, resulting in a less sensitive employment elasticity, higher wage pressure and consequently; higher unemployment. The net effect on unemployment is found by differentiating (7), using (9):

[10] It is straightforward to show that the assumption is violated if $d\left(\frac{C''_{Nw}}{F''_{NN} - C''_{NN}}\frac{w}{N}\right)\Big/ dh \neq 0$ in optimum where $p = F(N)-C(N,w)$ is the maximand of the firm; F is the production function, C is total costs and the subscripts denote derivatives. The fixed cost argument is used here since it has a clear economic interpretation, but other similar arguments could easily be made.

$$e_{uh} = \frac{e_{uh}\big|_{c=0} - ab\frac{Ac}{wh}}{1 + \frac{u}{1-u}(1-a)\frac{Ac}{wh}} \tag{10}$$

The sign of the net effect on unemployment is indeterminate. The larger the proportion of fixed cost and the less decreasing the marginal product of hours are, the more likely it is that unemployment will increase if hours are reduced.

This simple model has shown that a working time reduction can affect unemployment even if unemployment is independent of the state of technology. Furthermore, we see that the sign of the effect on unemployment in general is indeterminate. It depends on whether wage pressure is increased (i.e. the fixed cost effect dominates) or decreased (i.e. the leisure effect dominates).

2.2 Interpreting evidence from a partial working time reduction

A partial working time reduction will by definition only affect a limited number of workers and it is reasonable to assume that the outside option (V^u) is independent of the reduction. This implies that a shortening of the workweek for a few workers should result in lower wages, not lower unemployment, if the effect on the utility of working dominates the effect on the employment elasticity.

Restating the partial equilibrium wage equation (5) for convenience:

$$n^e = \frac{(w_i h)^s}{s} f(T-h) = \frac{e_{Nw_i}}{e_{Nw_i} - s} V^u . \tag{11}$$

Differentiating (11) using (3) and solving for the elasticity of wages with respect to hours:

$$e_{wh} = \frac{h\frac{f'(T-h)}{f(T-h)} - (s + Q)}{s + Q} \tag{12}$$

where $Q \equiv \frac{s}{e_{Nw_i} - s}\frac{Ac}{wh + Ac} > 0$ if $c > 0$.

The net effect on wages from a working time reduction is ambiguous according to (12) since Q is positive. A shorter workweek will improve the welfare of the workers causing wage restraint, but it will also increase the importance of fixed costs, causing increased wage demands.

In the absence of fixed costs the right hand side of (11) is a constant implying $Q = 0$. Thus, if individual workers desire a shorter workweek (12) will be positive and we should observe hourly wages falling as the result of a working time reduction.[11] This is, once again, the prediction in Houpis (1993) restated using the utility function needed for an unemployment level that is independent of the state of technology.

Only if there are fixed costs affecting the wage setting and if workers are sufficiently close to optimum will we observe hourly wages rising as a result of a working time reduction. There is some evidence that workers in general prefer to work fewer hours, survey data from 1998 suggest that Swedish full time workers on average preferred to work 6.8 hours less per week (Torp and Barth 2001). This implies that we can interpret a rise in hourly wages in the response to a partial working time reduction as a rise in wage pressure resulting from the presence of fixed costs. It can also be noted that these results are independent the state of technology effects (i.e. of the value of b).

2.3 The determination of actual hours

The model is based on the assumption that actual working time is independent of the wage setting and employment decisions. This assumption is clearly valid if actual hours always equal standard hours. The model does, however, allow for actual hours to be determined endogenously through the use of overtime as long as overtime is determined separately from wages. If overtime is used, actual hours (h) and hourly earnings (w) (defined by equation 1) will be the relevant variables instead of the hourly straight-time wages ($\tilde{w}$) and standard hours (h_s). Some special cases motivating that actual hours may be independent of wages, even if overtime is used, is presented below. It will in all cases be assumed that actual hours are equal to, or greater than, standard hours.

[11] The first order condition for individual optimum is $e_{vh} = s - h\frac{f'(T-h)}{f(T-h)} = 0$, and the second order condition ensures that $e_{vh} < 0$ if the workweek is longer than optimal.

A standard result in the work sharing literature is that actual hours may increase when standard hours are reduced if firms determine hours and the overtime premium is linear ($p\tilde{w}$). Following Houpis (1993) we can show this result by assuming that firms use a positive amount of overtime due to the existence of a fixed *wage* cost ($q\,\tilde{w}$) per worker. The assumption that this cost is proportional to wages has the effect that the employment elasticity with respect to wages remains constant if standard hours are changed. The firm maximises profits by choosing hours and employment:

$$\max_{N,h} p = A\left(Nh^{b}\right)^{a} - whN - q\tilde{w}N \,. \qquad (13)$$

For a non-trivial solution, assume that firms use a positive amount of overtime (i.e. $h^{*} > h_{s}$). The first order conditions give

$$h^{*} = \left(\frac{b}{1-b}\right)\left(\frac{1}{1+p}\right)\left(q - ph_{s}\right). \qquad (14)$$

Thus, actual hours will increase if standard hours are reduced.[12] It can be noted that the effect on actual hours may differ between firms due to heterogeneity in the parameters q and b. These parameters do not enter the wage equation (11), and the wage does not enter equation (14). Thus, we may view a larger reduction in actual hours (due to lower q or b) as a larger *exogenous* reduction in hours that should lead to a larger reduction in earnings if $c = 0$.

An alternative case is when individuals choose their own overtime. Assuming once again a constant overtime premium ($p\tilde{w}$) and using the utility function from above (assuming for simplicity $f = \left(T - h\right)^{ls}$) gives a first order condition for an interior solution (i.e. with positive overtime):

$$h^{*} = \frac{T + h_{s} \cdot p/(1+p)}{1+l}. \qquad (15)$$

[12] If hours and wages are bargained over individually, as in the case of a search model, the prediction is that hours (and earnings) are independent of standard hours (Marimon and Zilibotti 2000).

Thus, there is a positive relationship between standard hours and actual hours. It should be noted that this case assumes that workers always are in their individual optimum for hours and that this implies that hourly earnings should be unaffected by changes in standard hours unless there are fixed costs (from equation 12).

It is the change in actual hours that will determine the effect on the wage pressure as long as actual hours are independent of earnings. Hence the empirical part of the paper (*Section 4* and *Section 5*) will study not only the response of wages to a working time reduction but also the response of actual hours, and the interactions between those effects. Actual hours are independent of the wage level in both of the solutions above. This is a convenient result that does not survive if firms choose actual hours and a true fixed cost (*AcN*) is included as in *Section 2.1* and *Section 2.2*. In that case, actual hours will be a function of wages, causing the solution to be complicated beyond the scope of this paper.

2.4 Summary

The model presented above gives a highly stylised picture of the labour market. The main purpose of the model is to highlight the fundamental idea that there might be effects on equilibrium unemployment from changes in standard hours and that these should work through the wage setting process. If the result of a partial working time reduction is *lower* hourly wages; we expect a general working time reduction to result in a lower overall wage level *at a given unemployment level*, and thus, a lower equilibrium unemployment rate. On the other hand, if we observe a *rise* in hourly wages from a partial working time reduction it suggests the presence of fixed costs that may cause the equilibrium unemployment level to increase as the result of a working time reduction. Hence, the response of hourly wages to a partial working time reduction will give evidence on the effect on unemployment from a general reduction in working time. *Figure 1* show the basic structure of the analysis. The direct effects of a partial reduction in standard hours on actual hours and wages, as well as differences in the wage effects between workers with different effects on hours will be studied. The results will be interpreted in the theoretical framework as to give predictions of what effects on equilibrium unemployment we would expect from a general working time reduction.

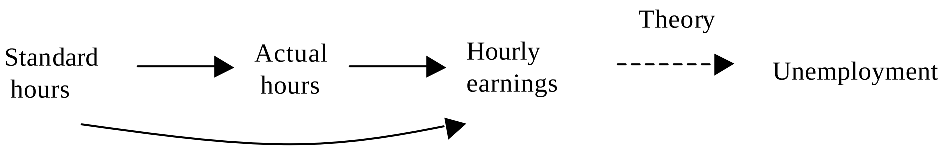

Figure 1. The structure of the analysis

3 The working time reduction

All Swedish blue-collar workers are categorised in one of 5 different shift form categories; daytime, 2-shift, discontinuous 3-shift, continuous 3-shift, and underground (mining etc.).[13] Anxo and Sterner (1995) provide a description of the use of shift work in Sweden from 1968 to 1990. *Figure 2* shows the development over time of standard working hours, as determined in central agreements, for the different shift forms. Between 1983 and 1988 there was a gradual reduction in standard working time for 2-shift workers from 40 to 38 hours per week. The reduction was the result of a series of central agreements between the Swedish Employers Confederation (SAF) and the Swedish Trade Union Confederation (LO).[14] These agreements were implemented at the industry level either as a reduction of working hours on a weekly basis or with increased time off.[15] The intention was to keep monthly wages constant relative to wages for other workers.

[13] 2-shift workers alternate between morning and afternoon shifts on a weekly basis.
Discontinuous 3-shift workers alternate between morning, afternoon and night shifts.
Continuos 3-shift workers are, in addition to working morning, afternoon and night shifts during the workweek, also working weekends.
[14] LO (1988).
[15] Based on readings of industry level agreements.

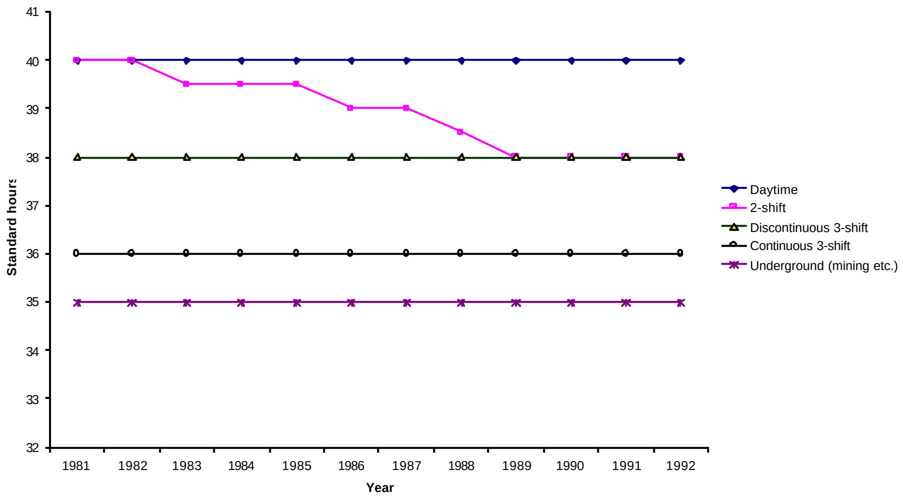

Figure 2. Standard hours by shift form 1981-1992

This paper will study how the actual working time and hourly wages for 2-shift workers changed during this time compared to hours and wages for other workers.

3.1 Data

The study will use individual level panel data collected from private sector firms by the Swedish Employers Confederation (SAF). Data covers earnings and working hours for the second quarter each year on all privately employed workers covered by the central agreements in Sweden. The paper will use data for blue-collar workers from 1981 to 1992. The motivation for this time frame is a labour market conflict in the second quarter of 1980 and a change in the data collection procedure in 1993. In total, the data set consists of on average 400,000 observations per year. It has not been widely used for microeconomic research in the past[16] but it has been used frequently in aggregate form as the base of Statistics Sweden's aggregate data set on working hours and wages. The data should be accurate except for black market (tax evasive) work. It

[16] One example is Petersen et al (1996).

should also be noted that the measure of actual hours used in this paper refer to paid hours, unpaid hours are not recorded.

The working time data and the wage data are decomposed into several parts, such as straight-time hours (wages), overtime hours (-premium), shift compensation, etc. The data set further contains information on industry[17] and municipality as well as size of the firm and the workplace. The firm can however not be identified. Individuals can be followed over time but individual characteristics are not recorded except for age and gender. Standard hours from central agreements are assigned to the observations according to their shift form. See *Appendix A* for further details about the data set, descriptive statistics and applied sample restrictions.

3.2 Identification of the treatment group

SAF did not register 2-shift workers separately from daytime workers before 1988 (i.e. before the final year of the working time reduction). Standard hours can be assigned for the years 1981-82 when standard hours where equal to 40 for both daytime and 2-shift workers, and during 1988-92. These years can be used to identify the effect of the working time reduction if actual hours and wages did not differ between daytime and 2-shift workers before the reduction, or if the shift form status were constant for individuals over time (see further *Section 4.1* below). The identification will, however, be problematic if there were substantial differences between shift-forms before the reduction and workers did change their shift forms.

The solution will be to use a proxy for workers' shift form. This proxy will be constructed using the fraction of shift compensation to total earnings. Henceforth this fraction will be referred to as the *shift compensation share* (SCS). This variable, unfortunately, also includes daytime workers unsociable hours' premium, resulting in measurement errors in the proxy. The period after 1987, for which the true shift-form definition is available, will be used to evaluate the extent of measurement errors. For a more detailed discussion on the identification, see *Appendix B*. The incidence of 2-shift work is much larger in manufacturing and mining than in other sectors. In the other sectors it is more common that daytime workers have shift compensation without formally

[17] The industry classification used refers to union contracts.

being 2-shift workers. Thus, this study will focus on manufacturing and mining to minimise the problems with measurement errors.

In addition to standard hours, *scheduled weekly hours* will be used to study how the implementation varies between 2-shift workers. This variable contains the number of hours that a firm reported that the individual worked during a normal workweek. It was not mandatory for firms to report scheduled hours, the response rate was 55 % (see *Table A2, Appendix A*). The data do not indicate that workers with reported standard hours differ from workers with missing values. Both the direct effects of the agreements on actual hours and wages (the "intention to treat" effect), and the effects on hours and wages for workers that changed their scheduled hours as a result of the agreement (the local average treatment effect, LATE) will be studied.[18] *Table 1* describes the three main variables of interest; standard hours, scheduled weekly hours (for the actual reduction) and the 2-shift dummy for the initial difference between shift forms.

3.3 Empirical strategy

One possible strategy would be to estimate an equation for actual hours and simply include standard hours as a regressor. This might, however, confuse the effect of a change in standard hours with systematic differences in actual hours between shift forms since the only variations in standard hours, except for the reduction for 2-shift workers, are permanent differences between shift forms. This paper is primarily focusing on the effect of a *change* in standard hours and less interested in the permanent differences that may exist between different shift forms. In order to get a clear-cut experiment the paper will only use the information from the years before the reduction (1981-1982) and compare them with the years after the reduction (1989-1992). There are several reasons for this: One reason is that standard hours would have to be assigned using the proxy for the years 1983-1987. Another reason is that it is difficult to assign the standard hours for some years when the central agreements take effect in the middle of the second quarter of the year, which is the period when the data is collected.[19] One advantage of the approach is that the relatively long period between the years before and after the reduction should reduce the influence of

[18] See Imbens and Angrist (1994) for a further description of LATE.

[19] Estimates (not reported) where all years have been used in regressions with both lagged and current standard hours show that the sum of the estimates on current and lagged standard hours is approximately equal to the estimates presented in the paper.

transitionary dynamics on the results. It is an advantage not having to worry about short run issues, such as nominal wage rigidities, since the focus of this paper is on the long run effects of working time reductions

Table 1. Main variables of interest

Variable	Effect	Source	Comments
Standard hours	The direct effect of the agreement ("Intention to treat effect")	Shift form code and central agreements	Daytime and 2-shift workers mixed before 1988. Standard hours were 40 for both groups before 1983.
Scheduled hours	The effect on compliers ("Local average treatment effect")	Scheduled hours as reported	Non-compulsory question: 55% response rate.
2-shift dummy	Permanent (initial) difference between shift forms	Shift compensation share (SCS)	Measurement errors due to false positives and negatives, can be evaluated 1988-1992

4 Evidence on actual hours

All workers do not work full time; furthermore, people switch jobs, take sick leaves and vacations and are absent from work for other reasons such as labour market conflicts. A large portion (about 50 % of the sample, see *Appendix A*) of the workers also work overtime. This results in a distribution of actual hours that exhibits substantial variation. *Figure 3* describes the distribution of actual hours worked during the second quarters of 1982 and 1990.

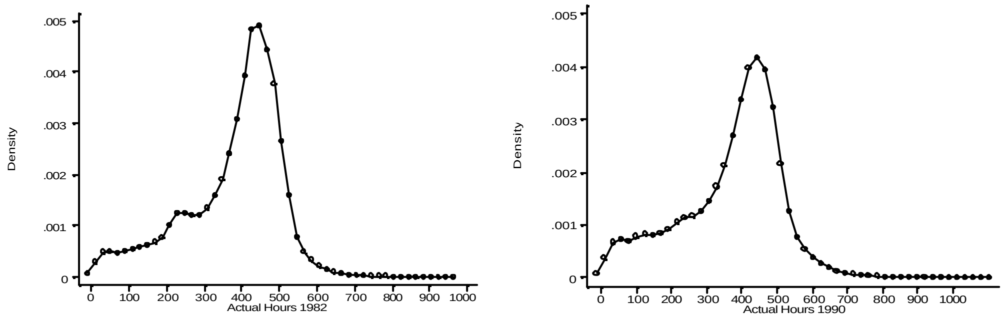

Figure 3. Hours worked in the 2nd quarter in 1982 and 1990

Given that the data cover hours and wages during a quarter each year it is not, in general, possible to separate the differences in total hours that are due to variations in weekly hours from variations in the number of days worked. All workers should in principle be equally affected by the reform (in percentages) if the lower tail in the distribution of actual hours comes from the use of short-term contracts (e.g. seasonal work) labour market churning or worker absenteeism. But changes in the number of days worked that are (possibly spuriously) correlated with shift forms may have a very large impact on the estimates. This motivates the rather restrictive trimming of the sample used. Only workers with more than 320 non-overtime hours (approximately 8 weeks) during the quarter are included in the sample.

4.1 Effects on actual hours for 2-shift workers

The purpose of this section is to investigate how total actual (paid) hours changed for the average 2-shift worker when standard hours were reduced, i.e. the "intention-to-treat-effect". Given available data, it is possible to identify the effect without using a proxy under some partially testable assumptions. Let a_i indicate an individual fixed effect. The parameter b_1 denotes the initial difference in working time between 2-shift workers and daytime workers and γ denotes the effect of the change in (the log of) standard hours (h^s).[20] Denoting the other covariates by X and disregarding the error term, we may write the log of the working time (h) as:

[20] The choice of a logarithmic specification is due to the fact that workers who work different numbers of weeks should be affected by a reform proportionally to the number of hours worked.

$$h_{it} = a_i + b_1 D_{it}^{2-shift} + b_2 X_{it} + g h_{it}^{s} \tag{16}$$

Subtracting individual means (denoted by bars) to remove the individual specific effects:

$$\begin{aligned} h_{it} - \overline{h_i} = {} & b_1 (D_{it}^{2-shift} - \overline{D_i^{2-shift}}) \\ & + b_2 (X_{it} - \overline{X}_i) + g(h_{it}^{s} - \overline{h_i^{s}}) \end{aligned} \tag{17}$$

The effect of the reduction, captured by g, is the change in working time for 2-shift workers relative to daytime workers. The initial difference in working hours, b_1, can not be estimated without using the shift form proxy (see *Section 3.2* and *Appendix B*). We can only identify the effect without using the proxy if one of the following two conditions holds:

1) $b_1 = 0$

2) $D_{it}^{2-shift} = \overline{D_i^{2-shift}} \quad \forall i, t$.

Condition 1) states that there are no differences in working time between shift forms that are independent of standard hours. This should be the case if working time was indeed completely determined by the central agreements. Condition 2) states that those who where 2-shift workers after the reduction where 2-shift workers before the reduction as well. The permanent effect will thus be removed as a part of the individual fixed effects and the change in working time for these workers will be captured by g. Under assumption 1) or 2) we get:

$$h_{it} - \overline{h_i} = b_2 (X_{it} - \overline{X}_i) + g(h_{it}^{s} - \overline{h_i^{s}}) \tag{18}$$

Since standard hours are equal to 40 hours per week for both daytime and 2-shift workers before the reduction we may estimate equation (18) without knowledge of the shift forms before the reduction.

Results are presented in the first column of *Table 2* below. The first column presents results from a regression according to (18) that includes a third order age polynomial as well as year and industry interaction dummies in the *X* matrix to control for differences in the age composition between shift forms and differences in time effects between industries. The result indicates that actual hours where reduced by only 40 % of the reduction in standard hours. The estimate is different from both zero and one at the one percent level of statistical significance. Estimates (not reported) on samples were observations with less than 320 actual hours were included in the regressions find somewhat smaller effects.

Table 2. Elasticities of actual hours with respect to standard hours

Control group	Estimated parameter	Industry and year interactions		Year dummies	Industry, size, municipality and year interactions
		Not controlling for shift form	Controlling for shift form		
Daytime workers	Standard hours	0.403 (0.020)	0.372 (0.021)	0.310 (0.020)	0.324 (0.021)
	2-shift dummy	--	-0.0062 (0.0011)	-0.0072 (0.0011)	-0.0097 (0.0010)
3-shift workers	Standard hours	--	0.376 (0.024)	0.377 (0.021)	0.316 (0.024)

Note: All regressions include individual specific fixed effects and an age cube. Standard errors are in parentheses.

To estimate the effect while relaxing assumptions 1) and 2) we use the proxy (denoted by D_{it}^{SCS-2}) for whether the worker is a 2-shift worker or not. Estimating equation (17) directly we get estimates of both the initial difference in working time (b_1) and the effect of the change in standard hours (g). The results, presented in the second column of *Table 2*, suggest that the initial difference in working time between shift forms is small. The estimate indicate that 2-shift workers worked 0.6 % (approximately 15 minutes per week) less than daytime workers before the working time reduction (note however that the dummy is subject to the attenuation bias discussed in *Appendix B*). Inclusion of the proxy itself does not affect the standard hours' estimate much, the estimate of g is reduced to 0.37 but the difference is not statistically significant. The small effect on the variable of interest from including the 2-shift proxy suggests that the measurement error in the proxy be of little importance for the standard hours' estimate since the correlation between the proxy and the true definition is reasonably high (see *Appendix B*). Nevertheless, the dummy will be included in all regressions in the remainder of this section.

When trying to identify the effect of the change in standard hours on 2-shift workers, daytime workers are used to control for different time effects between industries. The underlying assumption for this identification is that actual hours of other workers were unaffected by the change in standard hours for 2-shift workers. It is, however, conceivable that other workers in firms that employ 2-shift workers demanded a compensation for the improvements for the 2-shift workers. If that compensation were in the form of shorter hours for daytime workers as well, it would bias the estimates of the effect on hours towards zero. To check for this possibility, the last two columns of *Table 2* show estimates of the effect on actual hours when the control variables are varied. The first column only controls for year dummies whereas the second column controls for the interaction of year, industry, municipality, size of the firm (categorised by nine dummies) and size of the work place (categorised by 10 dummies). We should see systematic differences between these models if the other workers were affected indirectly. We expect to see larger estimates when the effect is measured relative to all daytime workers (since that includes daytime workers in firms without 2-shift workers as well) than when measured relative to workers within a small unit. The estimates show little signs of contamination – the hours' estimates are reduced somewhat in both variations of the original model (0.31 and 0.32). Thus, it seems unlikely that contamination should be a major concern.

One possible explanation for the small effect might be a positive trend in working hours for all shift workers. It is possible that working hours for 2-shift workers would have increased relative to daytime workers if there had not been a reduction of standard hours. By using 3-shift workers as an alternative control group we are able to get estimates that are insensitive to such trends. The regressions from above are replicated using 3-shift workers to estimate common year-industry effects for all shift workers.

The model used to compare 2-shift workers with other shift workers includes dummies for each shift form (2-shift, discontinuous 3-shift and continuous 3-shift), capturing constant differences in working times between shift forms. Furthermore, the year effects (with interactions), denoted by X, will be estimated separately for daytime workers and (all) shift workers:

$$h_{it} = a_i + D_{it}^{Shift-form} b_1 + D_{it}^{Daytime} X_{it} b_2 + gh_{it}^{s} + e_{it} \qquad (19)$$

The estimates should be interpreted as the change in working hours for 2-shift workers relative to other shift workers. The results are presented in the bottom row of *Table 2.* These results do not change the impression that the effect of the working time reduction was quite modest. Estimates on total hours and weekly hours calculated from scheduled hours ranges from 0.32 to 0.37. The smallest estimate is from the model with most control variables. This could suggest that 3-shift workers were a contaminated control group since 2-shift workers experienced a larger reduction in hours relative to the average 3-shift worker than relative to 3-shift workers within a smaller unit. The difference in estimates is however reasonably small, suggesting that this problem even if it exists is not of great importance.

4.2 Heterogeneous effects on actual hours

The effect of the working time reduction on actual hours is estimated to be quite small, regardless of comparison group. The elasticity of actual hours with respect to standard hours is in the interval 0.3 to 0.4. This differs substantially from the estimates of German working time reductions in Hunt (1999) that range from 0.85 to 1. One reason for this discrepancy may be that *Section 4.1* studied the direct effect of a central agreement on actual hours whereas Hunt (1999) studies the effect of self-reported standard hours on actual hours, directly and instrumented by standard hours from industry contracts. By using reported scheduled weekly hours, instrumented by standard hours, as the explanatory variable we will get an idea of how the estimates in this paper relates to Hunt (1999). The interpretation of the IV estimates is the effect on actual hours for the workers that changed their weekly scheduled hours due to the change in standard hours, i.e. the local average treatment effect (LATE).

The models estimated in this section are identical to the models in *Section 4.1*; all regressions include year-industry dummies and an age polynomial. The independent variable in *Table 3* is reported weekly scheduled hours. The estimates of the LATE are in the order of 0.80 to 0.85. This is reasonably close to 1 and in the range of the results in Hunt (1999). *Table 3* also show estimates of the elasticity of actual hours with respect to scheduled hours with 3-shift workers as the control group. These estimates are very close to the estimates relative to daytime workers.

Table 3. Elasticities of actual hours with respect to scheduled and standard hours for workers with reported scheduled hours

	Relative to daytime workers		Relative to 3-shift workers
	Not controlling for shift form	Controlling for shift form	
Scheduled hours (IV: standard hours)	0.805 (0.082)	0.856 (0.084)	0.836 (0.091)
2-shift dummy	--	-0.0035 (0.0017)	--
Standard hours (for obs. with reported scheduled hours)	0.342 (0.032)	0.305 (0.033)	0.357 (0.034)
2-shift dummy	--	-0.0083 (0.0017)	--

Note: All regressions include individual specific fixed effects, year and industry interaction dummies and an age cube. Standard errors are in parentheses.

These results show that the workers who did see a change in their scheduled weekly working hours also saw a change in their actual hours without much substitution to overtime. The result is interesting for three reasons. First it indicates that one of the reasons for why the average effect differ so radically from Hunts' (1999) results for Germany may be that she studied the effect of standard hours through self-reported hours (here represented by reported scheduled hours). This paper focuses on the direct effect from standard hours, as defined in central agreements, on actual hours. Second, it is evidence of a heterogeneous impact of the reduction and suggests that it will be interesting to study how the effect on earnings differs between workers with reduced scheduled hours and other 2-shift workers. Third, it suggests that the main cause of the small average effect found above is not substitution to overtime but rather that the actual scheduled workweek remained unchanged for a large part of the workers. This is in line with the French experience: Crépon and Kramarz (2000) report that 20 % of workers did not reduce their hours. The proportion of non-compliers seems much higher for Sweden, which may be explained by the high degree of flexibility in the local level implementation of agreements in Sweden documented by Anxo and O'Reilly (2000).

5 Evidence on wages

The response of hourly wages to a partial working time reduction will indicate whether the wage pressure has increased or decreased due to the shortening of the workweek. From *Section 4.2* we know that the effect on actual hours was heterogeneous, working hours were reduced for some workers but not for others. That leaves us with two interesting questions regarding hourly wages. Did average hourly wages for 2-shift workers rise or fall? And, did the workers whose hours were reduced experience a fall in hourly wages relative to the workers whose hours remained constant?

The purpose of the working time reduction was to reduce hours for 2-shift workers while keeping monthly earnings constant relative to other workers – implying a relative increase in hourly wages. Hence, it would be strong support for the idea of work sharing if hourly earnings for the average 2-shift workers fell relative to other workers wages as a result of the reduction. On the other hand, one would expect hourly earnings for the workers who experienced a reduction of actual hours to see fall relative to the earnings of those who did not receive a reduction of hours. Workers who received the working time reduction should see a relative reduction in hourly earnings as a premium for the reduced hours. It would be strong evidence against the theory of work sharing if this premium was not paid, since it would imply that the wage pressure was not reduced as a result of the working time reduction.

Two possible wage measures can be studied, hourly earnings or the hourly straight-time wage (i.e. hourly earnings excluding the overtime premium). Hourly earnings should be the relevant variable if the interest is in actual outcomes for wages and hours, and it is the variable used in the model in *Section 2*. The hourly straight-time wage, on the other hand, is a better measure of the wage the worker does receive independent of his own choice of hours if he can choose his own overtime hours. Hunt (1999) studies the straight-time wage but since the primary interest in this paper is on actual outcomes, the focus will be on hourly earnings. Hourly earnings is defined as total earnings divided by total hours.

5.1 Effects on hourly earnings for the average 2-shift worker

This section will study how average hourly earnings for 2-shift workers changed relative to hourly earnings for other workers as a result of the reduction. The models used in this section will be similar to the models used for studying the effects on actual hours.

Table 4 below shows estimates of the elasticity of hourly wages with respect to standard hours. The included control variables are an age-polynomial, and year industry interaction dummies. Negative estimates indicate that hourly wages rose as a result of the working time reduction. The estimate of the elasticity of hourly earnings with respect to standard hours is approximately -0.5.

The estimates of the initial difference in hourly wages, as captured by the 2-shift proxy, show that 2-shift workers earned 10 % more than daytime workers. This large difference between shift forms that is independent of the reduction in working hours is of some concern. The problem is twofold; first the measurement errors will bias the 2-shift dummy towards zero and thus give the standard hours estimate a negative bias.[21] Second, the fact that the 2-shift dummy is constructed from an earnings-variable may be of some concern when estimating the effect on earnings. The estimated permanent premium for 2-shift workers is very close to the difference in average shift premium (0.012 for daytime workers and 0.095 for 2-shift workers between 1988 and 1992, see *Table A2*, *Appendix A*).

[21] We get estimates of the effect of a standard hours reduction that are close to zero if the model is estimated without the 2-shift dummy. These results are not presented since they suffer from a serious omitted variable bias.

Table 4. Elasticities of hourly earnings with respect to standard hours

Control group	Estimated parameter	Hourly earnings	Hourly earnings excluding shift premium	
		Controlling for shift form	Not controlling for shift form	Controlling for shift form
Daytime workers	Standard hours	-0.513 (0.011)	-0.355 (0.011)	-0.346 (0.011)
	2-shift dummy	0.092 (0.0006)	--	0.0016 (0.0006)
3-shift workers	Standard hours	-0.716 (0.014)	--	-0.340 (0.013)

Note: All regressions include individual specific fixed effects, year and industry interaction dummies and an age cube. Standard hours are in parentheses.

The second and third columns of *Table 4* show estimates of the effect on earnings where the shift compensation has been subtracted. This should reduce both of the problems discussed above. The estimate of the 2-shift dummy is now close to zero (0.002) and the standard hours' estimates are negative and not affected by whether the 2-shift dummy is included or not. The standard hours estimates are smaller (-0.35) than when shift compensation was included (-0.51). This is expected since measurement errors in the 2-shift dummy should bias the estimate negatively in the latter case. The estimates when the shift compensation is excluded should be unaffected by these measurement errors since the 2-shift estimate is very close to zero. Hence, the size of these estimates should be closer to the true effect and the remaining part of the paper will focus on the effect on earnings minus shift compensation. It can be noted that the elasticity of –0.35 is close to the elasticity of actual hours, implying that monthly earnings remained largely unchanged for 2-shift workers relative to other workers. Thus, there are no signs of a reduced wage drift for 2-shift workers relative to daytime workers. The estimates for the effect on the straight-time wage (not reported) are generally somewhat smaller, but qualitatively the estimates are similar.

The estimates showing an increase in hourly wages for 2-shift workers relative to daytime workers could be an effect of increased wages for shift workers in general. To test the sensitivity of the estimates we may use 3-shift workers as a control group and estimate a model analogous to equation (19) with separate intercept for all shift forms and separate industry-year dummies for daytime workers and shift workers. Results from regressions using this specification are shown in the bottom row of *Table 4*. The effect of the working time reduction as measured relative to 3-shift workers (-0.72) is stronger than the effect relative to daytime workers (-0.51) when studying total earnings. However, when shift compensation has been excluded from wages we get an estimate (-0.34) very close to the effect relative to daytime workers (-0.35).

As explained in *Section 4.1*, it is conceivable that other workers in firms that employ 2-shift workers demanded compensation for the improvements for the 2-shift workers. We found little or no evidence for compensation in terms of hours in *Section 4.1*. If the compensation was in the form of increased wages it would imply wages for 2-shift workers rising less relative to other workers than if the other workers had been truly unaffected and thus give the wage elasticity a positive bias.

Table 5. Elasticities of hourly earnings with respect to standard hours

Control group	Estimated parameter	Year dummies	Industry and year interactions	Industry, size, municipality and year interactions
Daytime workers	Standard hours	-0.316 (0.011)	-0.346 (0.011)	-0.322 (0.011)
	2-shift dummy	0.0021 (0.0006)	0.0016 (0.0006)	0.0054 (0.0005)
3-shift workers	Standard hours	-0.285 (0.012)	-0.340 (0.013)	-0.282 (0.012)

Note: Dependent variable is hourly earnings excluding the shift premium. The middle column is a replication from table 4. All regressions include individual specific fixed effects and an age cube. Standard hours are in parentheses.

Table 5 shows estimates of the effects on earnings (minus shift compensation) when the control variables are varied. The first column only controls for time effects. The second column is a replication from *Table 4* controlling for industry and year interactions. The third column controls for the interaction of year, industry, municipality, size of the firm and size of the work place. If the control groups were contaminated we should see differences between the models. The estimates for standard hours should be closer to zero the more controls are included since wages for 2-shift workers should have risen more relative to the average daytime worker than relative to daytime workers in the same company. The earnings estimates do not show any systematic differences between models, neither relative to daytime workers nor relative to 3-shift workers, suggesting once again that contamination should not be a major concern.

5.2 Hourly wages and the actual working time reduction

Section 4.2 showed that the 2-shift workers that experienced reduced scheduled hours also experienced a corresponding reduction in actual hours. This section will use the reported scheduled weekly hours to deduce how hourly earnings changed for 2-shift workers receiving an actual working time reduction compared to workers not receiving it. The regressions will use scheduled weekly hours as an explanatory variable along with standard hours (capturing the effect on the average 2-shift worker).

We can only use observations with reported scheduled weekly hours. The lower panel in *Table 6* shows that the effect of the standard hours reduction on hourly earnings when estimated on observations with reported scheduled hours (-0.21) is somewhat smaller than the effect estimated on all observations (-0.35) displayed in table 5. This discrepancy imply that the impact of the working time reduction on workers with reported scheduled hours differs somewhat from the impact on workers without reported scheduled hours. Nevertheless, this section will use workers with reported scheduled hours to study heterogeneity among 2-shift workers in the effects of the reform on hourly earnings.

Table 6. Differences in the wage response between 2-shift workers

Estimated parameter	Base sample	Restricted sample
Scheduled hours	-0.154 (0.011)	-0.181 (0.033)
Standard hours	-0.155 (0.018)	-0.141 (0.022)
2-shift dummy	0.0018 (0.0009)	-0.0006 (0.0009)
Standard hours (for observations with reported scheduled hours)	-0.208 (0.017)	-0.207 (0.018)
2-shift dummy	0.0027 (0.0009)	-0.0004 (0.0009)

Note: Dependent variable is hourly earnings excluding the shift premium. All regressions include individual specific fixed effects, year and industry interaction dummies and an age cube. Standard errors are in parentheses. Restricted sample only includes workers with scheduled hours equal to standard hours or 40 hours.

Two different samples are used, one that includes all workers with more than 30 scheduled hours per week, and one where only workers with scheduled hours equal to standard hours, or equal to 40 are included. The first sample allows for wage differences depending on scheduled hours for all workers. The second sample isolates the wage effect for 2-shift workers that had their scheduled hours reduced to 38 compared to the 2-shift workers whose hours remained at 40.

The elasticity with respect to scheduled hours is negative (in the order of –0.15), for both samples. This suggests that hourly wages rose for all 2-shift workers, but that the effect was strongest for the workers that saw a decrease in scheduled hours and thus also in actual hours.

Some caution is warranted when interpreting this result since differences in the implementation between observation can be endogenous to the wage effect. The result does however lend some further support to the finding in *Section 5.1* that a working time reduction increases, rather than decreases, wage pressure.

6 Conclusions

This paper has shown that a general working time reduction may affect equilibrium unemployment through the wage setting process even if the equilibrium unemployment rate is independent of the state of technology. This implies that the response of hourly wages to a partial working time reduction contains evidence on the response of equilibrium unemployment to a general working time reduction, i.e. whether work sharing is feasible.

The empirical part of the paper studies the effects on actual hours and hourly wages of a reduction in standard hours as defined by central agreements. The results show that the effect of the working time reduction was much smaller than intended. On average the reduction is estimated to have only 40 % of the intended effect. Furthermore, the results show that the scheduled weekly hours remained unchanged for many workers. This indicates that far from all workers who were supposed to receive the reduction according to the central agreement actually received it, suggesting that flexible agreements may not be a good way to reduce actual working hours. It also suggests a potential bias in earlier studies that focused on the effects of self reported standard hours on actual hours.

Hourly wages for 2-shift workers did rise as a result of the working time reduction. Wages increased relative to both daytime workers and other shift workers. The wage increase was sufficient to keep monthly earnings constant relative to other workers. Workers receiving a reduction in scheduled hours, and hence also a larger reduction in actual hours, experienced a larger wage increase than other 2-shift workers. Thus, wages rose for all 2-shift workers and more for workers receiving a larger actual reduction. This is taken as evidence of an increase, rather than a decrease, in wage pressure as a result of the working time reduction.

Thus, the paper does not find any empirical support for the hypothesis that work sharing is possible through wage restraint. If the raise in wage pressure from the partial working time reduction was due to fixed costs, the theoretical model predicts that equilibrium unemployment may in fact increase in the response to a general working time reduction.

References

Aigner, D J (1973) “Regressions with a Binary Independent Variable Subject to Errors of Observations” *Journal of Econometrics* 1.

Anxo, D and J O’Reilly (2000) “Working-time regimes and transitions in comparative perspective”. *Working time Changes: Social Integrations through Transitional Labour Market* in O’Reilly et al (eds.) Edward Elgar Publisher.

Anxo, D and T Sterner (1995) “Shiftworking And Capital Operating Time In Swedish Manufacturing”, in Anxo, D et al (eds.), *Work Patterns and Capital Utilisation – An International Comparative Study* Kluwer Academic Publishers, Dordrecht.

Booth, A and M Ravallion (1993) “Employment and Length of the Working Week in a Unionized Economy in which Hours of Work Influence Productivity” *The Economic Record* 69.

Calmfors, L and M Hoel (1988) “Work Sharing and Overtime” *European Economic Review* 90.

Calmfors, L and M Hoel (1989) “Work Sharing, Employment and Shift Work” *Oxford Economic Papers* 41.

Crépon, B and F Kramarz (2000) “Employed 40 Hours or Not Employed 39: Lessons from the 1982 Mandatory Reduction of the Workweek”, Discussion Paper 2358, The Centre for Economic Policy Research.

Earl, J S and J Pencavel (1990), “Hours of Work and Trade Unionism” *Journal of Labor Economics* 8.

Hart, R (1987) *Working Time and Employment*, Allen and Unwin, Boston.

Holmlund, B (2000) “Labor Taxation in Search Equilibrium with Home Production”, Working Paper 2000:1, Department of Economics, Uppsala University.

Houpis, G (1993) “The Effect of Lower Hours of Work on Wages and Employment”, Discussion Paper 131, Centre for Economic Performance, The London School of Economics and Political Science.

Hunt, J (1999) “Has Work Sharing Worked in Germany?” *Quarterly Journal of Economics* 114.

Hunt, J (1998) “Hours Reductions as Work-Sharing” *Brookings Papers on Economic Activity*.

Imbens, G W and Angrist J D (1994) “Identification and estimation of local average treatment effects” *Econometrica*, 62.

Jacobson, T and H Ohlsson (2000) “Working Time, Employment, and Work Sharing: Evidence from Sweden” *Empirical Economics* 25.

Kapteyn, A, A S Kalwij and A Zaidi (2000) “The Myth of Worksharing”, Discussion Paper No. 188, The Institute for the Study of Labor (IZA).

Layard, R, S Nickell and R Jackman (1991) *Unemployment - Macroeconomic Performance and the Labour market*, Oxford University Press, Oxford.

LO (1988). *De centrala överenskommelserna mellan LO och SAF 1952-1987*, Landsorganisationen i Sverige.

Marimon, R and F Zilibotti (2000) “Employment and Distributional Effects of Restricting Working time“ *European Economic Review* 44.

OECD (1998) *The OECD Employment Outlook* June 1998.

Pencavel, J and B Holmlund (1988) “The Determination of Wages, Employment and Work Hours in an Economy with Centralised Wage-Setting: Sweden 1950-1983” *The Economic Journal* 98.

Petersen, T, E M Meyerson and V Snartland (1996) “The Within-Job Gender Wage Gap: The Case of Sweden”, Working Paper 141, The Research Institute of Industrial Economics (IUI).

Pissarides, C (2000) *Equilibrium Unemployment Theory* 2nd Ed. The MIT Press, Cambridge.

Torp H and E Barth (2001) *Actual and preferred working time - Regulations incentives and the present debate on working time in Norway*, Report 3:2001, Institute for social research, Oslo.

Appendix A. The data set

Table A1 show the variables used in the paper. Straight-time wages and hours include piece rate and time rate hours and wages. The size variables are categorical, taking 9 different values for the size of the firm and 10 values for the size of the workplace. A workplace is defined as workers covered by the same agreement within the same firm.

Tabell A1. Variables in the data set

Source	Variables			
	Working time	Wages	Firms	Individuals
SAF	Straight-time hours	Straight-time wages	Industry (agreement)	Fixed effect indicator
	Overtime hours	Piece rate wage	Size of firm	Municipality
	Scheduled weekly hours	Overtime premium	Size of work place	Age
	Shift form	Shift compensation		Gender
		Total earnings		
		Monthly salary		
Central agreements	Standard hours by shift form			

Table A2 shows some descriptive statistics for variables used in the regressions. Only very obvious outliers[22] has been removed from the sample used for

[22] The main restrictions are the exclusion of workers younger than 18 or older than 65, or working zero or more than 600 straight-time hours or 200 overtime hours during the quarter. Observations with nominal hourly earnings are below 20 SEK and above 100 SEK in 1981 are dropped. These numbers are increased by 7.5 % (the estimated time trend in the sample) each year. The number of observation dropped by this procedure is very small.

this table. It can be noted that 55 % of observations had their scheduled hours reported.

Table A2. Descriptive statistics for daytime and 2-shift workers in manufacturing

	Day and 2-shift			Day	2-Shift
	1981-92	1981-82	1983-88	1989-92	1989-92
Number of Observations	4,365,826	775,170	2,242,689	1,100,078	247,889
Number of individuals	929,278	446,767	672,800	438,629	114,754
Fraction Male	0.76	0.76	0.76	0.76	0.76
Age	37.2 (13.1)	38.1 (13.4)	37.1 (13.1)	37.6 (12.9)	34.6 (12.0)
Standard Hours	(38-40)*	40	(38,5-40)*	40	38
Fraction reported scheduled hours	0.55	0.51	0.58	0.51	0.61
Fraction scheduled hours >30	0.51	0.47	0.54	0.46	0.59
Scheduled hours if >30	39.8 (1.35)	39.9 (1.16)	39.8 (1.23)	39.8 (1.65)	39.0 (1.36)
Quarterly actual hours (including overtime)	374.8 (134.4)	370.9 (126.9)	376.7 (134.9)	375.3 (138.3)	367.7 (134.8)
Average overtime (OT) per quarter	9.9 (18.7)	6.4 (15.1)	10.3 (18.8)	10.7 (19.8)	13.7 (21.1)
Fraction OT>0	0.51	0.37	0.53	0.52	0.65
Average OT per quarter if OT>0	19.6 (22.4)	17.0 (20.8)	19.5 (22.2)	20.6 (23.5)	21.2 (23.0)
Quarterly earnings	20,712 (21,537)	13,964 (5,194)	18,962 (27,813)	27,062 (10,863)	29,467 (11,699)
Hourly earnings	55.2 (47.9)	37.6 (12.2)	50.2 (62.1)	72.2 (19.1)	80.3 (18.5)
Hourly earnings minus shift compensation	53.7 (47.4)	36.8 (7.98)	48.9 (61.9)	71.2 (18.7)	72.7 (16.1)
Straight-time hourly wage	54.4 (47.8)	37.3 (12.2)	49.4 (62.1)	71.1 (19.1)	78.7 (18.6)
Average OT-premium	349.2 (767.6)	145.7 (406.2)	330.1 (686.7)	456.8 (937.7)	680.7 (1182)
Hourly OT-premium if OT>0	33.0 (29.7)	21.3 (25.1)	30.1 (28.4)	40.5 (29.7)	48.2 (33.3)
Shift compensation share (SCS)	0.024 (0.051)	0.019 (0.045)	0.024 (0.051)	0.012 (0.041)	0.095 (0.059)
Fraction SCS>7 %	0.152	0.117	0.154	0.058	0.667

Note: Day and 2-shift workers can only be separated from 1988. Standard errors are in parentheses. *Depending on year and shift form.

Some further restrictions have been applied on the data set used in the regressions. Only workers aged 25-55 during the full sample period are included to avoid problems with different age effects between shift forms. For individuals with multiple observations in one year only the observation that had the highest number of hours is used. Dropping these individuals or stacking hours and earnings on the observation with the highest number of hours (for industry etc.) did not change the results. Workers with less than 320 straight-time hours are excluded from the sample to avoid problems with variations in the number of weeks worked (given that data is quarterly). To reduce the number of industry dummies industries that employed less than ten 2-shift workers after the reduction are dropped, as well as industries with less than 100 observations in total. Individuals observed only before or after the reduction are dropped. *Table A3* shows the number of observations dropped at each stage in this procedure. Only the observations from before (1981-82) and after (1989-92) the reduction has been included in the table since the regressions only uses observations for these years.

Table A3. Number of observations remaining after applying restrictions on the sample

	1989-92		1981-82 and 1989-92		
	Day	2-shift	Day and 2-shift	3-shift	Total
Manufacturing	1,100,078	247,889	2,123,137	204,962	2,328,099
Prime aged	451,619	92,537	902,885	92,845	995,730
Highest number of hours/year and individual	446,433	91,214	891,755	90,289	982,044
More than 320 hours worked in the 2nd quarter	347,411	71,518	690,232	71,384	761,616
Large agreements	332,726	71,437	645,462	66,736	712,198
Observations in both periods	195,601	41,092	375,317	50,604	425,921
Reported scheduled hours >30	74,663	15,172	141,305	19,433	160,738

Note: The two bottom rows describes the number of observations in the data sets used in the paper. The data set that only contains observations with reported scheduled hours has been constructed by first dropping observations without (or with less than 30) reported scheduled hours and than applying the other restrictions.

Appendix B. Identification of 2-shift workers

Daytime workers and 2-shift workers where not separated in the data set before 1988 (but the two types of 3-shift workers can be identified). This is not a problem for standard hours since standard hours where the same (40 hours per week) for both daytime and 2-shift workers in 1981 and 1982 (the only two years before 1989 that will be used in the regressions).

Problems will arise if there were differences in actual hours and wages between shift forms before the reduction. The individual fixed effects would however remove this problem if workers did not change their shift form at all between the two time periods (see *Section 4.1*). But if this problem remains after removing the fixed effects, it will bias the estimates of the effect of the working time reduction.

The solution will be to construct a proxy for the shift form of the worker. The proxy will be constructed by using the share of earnings coming from shift compensation. This share will be referred to as the *Shift compensation share* (SCS). This proxy will contain errors since the shift compensation variable also contains daytime workers unsociable hours' premium. The accuracy of the proxy can be evaluated for the years 1988-92 when the true definition is available.

There are two possible misclassification problems in the construction of the proxy. First, some of the workers classified as 2-shift workers are actually daytime workers. Second, some of the workers classified as daytime workers are actually 2-shift workers.

A 7 % cut-off level of the SCS (all workers with a SCS over 7 % are classified as 2-shift workers) will deliver a (local) minimum of the fraction of daytime workers classified as 2-shift workers. There is a monotonic relationship between the cut-off level and the number of 2-shift workers misclassified as daytime workers, but this kind of error is a minor problem. *Table B1* displays the extent of measurement errors during 1989-92; the years used to evaluate the procedure can be evaluated.

Table B1. Classification errors

		SCS-proxy	
		Day (85.3 %)	2-shift (14.7 %)
SAF	Day (82.6 %)	79.8	2.8
	2-shift (17.4 %)	5.5	11.9
Percent errors		6.4	19.2

Note: Results from the 1989-92 data set used to define manufacturing and mining workers as 2-shift workers if they have a shift compensation share (SCS) of more than 7 %. SAF definitions refer to the original definitions in the data set.

One potential problem with the classification procedure is that the percentage of misclassifications may change over time. An estimated linear trend for the SCS of the 20th percentile[23] of *3-shift workers* show only weak signs of a trend for these workers, the SCS increases by 0.2 percentage points each year.[24] The estimated trend for 3-shift workers could in principle be fitted on the cut-off level for 2-shift workers. This will not be done since the trend is small, and there are no signs of a trend for the 20th percentile of 2-shift workers between 1988 and 1992.

The expected attenuation bias (due to measurement errors) of the estimate of the initial difference between daytime and 2-shift workers ($\hat{b}$) is, in the absence of other covariates (Aigner 1973), $\frac{\hat{b}}{b^{TRUE}} = 1-(n+h)$. The parameters n and h denotes the fractions of workers erroneously classified as 2-shift workers and daytime workers. By using the numbers in *Table B1* we get $n = 0.192$ and $h = 0.064$. Thus, one would expect the estimates using the true definition to be 1.3 times the estimate based on the proxy if the 2-shift variable is uncorrelated with other covariates. In principle it is possible to correct for this bias (see Aigner 1973) but the double fixed effects (individuals and industry-years) model makes the implementation difficult.

While noting that the estimates of the initial difference between shift forms will be biased to zero it is still a reasonably good proxy and we may study how

[23] Used since 20 % of two shift workers where misclassified as daytime workers.
[24] It has a minimum of 11.7 % in 1980 and a maximum of 14.4 % in 1991.

the estimates of the effect of the reduction changes if this proxy is included. The measurement errors will not bias the estimates of the effect of the standard hours' reduction if the inclusion of the proxy does not affect the estimates of interest (measurement errors in a variable that *in itself* does not affect the relevant estimate will not be a problem).