Coordination of hours worked, wage differentials and the elasticity of labor supply to tax changes

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Abstract

We consider a framework in which employers gain, to different extents, from coordinating hours worked by employees with heterogeneous preferences over hours. We show that in this framework coordination generates wage differentials, with coordinated firms paying higher wage rates. We then consider the effects of a tax induced change in preferences over hours of one type of workers in a firm. We show that, in coordinated firms, changes to the tax schedule that target one group of workers have spillover effects on hours and wage rates of, otherwise unaffected, coworkers. Using rich data from the Danish matched employer-employee registers, we develop a measure of coordination of hours at the firm level. We thus relate this measure to firm wage premiums derived as the firm component in an AKM regression. In line with our framework, we find that coordinated firms pay higher wage rates. We estimate that coordination can explain up to 25% of the variation in the firm component of wages explained by standard productivity measures. Using the changes to the Danish tax schedule induced by the 2010 tax reform, we then show evidence of sizable spillover effects of tax rate changes across coworkers. We estimate that a raise

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of 1% in the average number of hours worked by the workers targeted by the tax reform leads to an increase of about 1% of hours worked by coworkers not directly affected by the reform. We find evidence of stronger spillover effects in firms that coordinate hours.

JEL Codes: J31, H20, J20

1 Introduction

The traditional labor supply model assumes that workers face exogenous wage rates independent of hours worked. Underlying this model is the assumption that employers are indifferent to the number of hours worked by their employees[1]. Over the years, a number of studies have questioned this assumption[2] (Lewis (1969), Rosen (1986), Siow (1987)). In this study we draw from this literature assuming that employers have, to different extents, interest in coordinating hours worked by their employees. We then assume that coworkers have different preferences over hours. We thus use matched employer-employee data to investigate how coordination affects wage rates and hours worked. In particular we start by focusing on how the coordination of hours contributes to the existence of wage differentials across firms. We then analyze how it affects labor supply responses to tax rate changes.

To guide the empirical analysis, we develop a simple labor supply model that accounts for the coordination of hours at the firm level. The theoretical framework assumes that some but not all of the existing firms gain from having workers with heterogeneous labor supply preferences to work the same number of hours (i.e. coordination of hours worked). If workers can inexpensively move, those firms that coordinate hours will compensate them to work a sub-optimal amount of hours. This generates a wage-hours function for each type of workers.

[1] Alternatively, it needs to be the case that the range of job options that each worker faces is large enough to find the optimal hours job at the wage rate set by the market. In a world with a continuum of workers tastes and finite number of firms, this case can be ruled out.

[2] Lewis (1969) is the first study to consider the possibility that employers are not indifferent to hours worked due to the existence of fixed costs of employment. Barzel (1973) discuss the case of declining marginal productivity at high levels of hours worked. Rosen (1978) and Siow (1987) consider technologies that allow gains from team work or coordination of working schedules. Lewis (1969) and Kinoshita (1987) propose models of wage-hours determination in this type of settings. Those models can be seen as particular cases of the more general hedonic prices (Rosen (1974)) or compensating wage differential (Rosen (1986)) theories.

Firms that coordinate hours thus choose hours worked to maximize profits, taking into account the wage-hours functions of their workers. We show that this results into the formation of wage differentials across firms. Namely, firms that coordinate hours optimally choose a level of hours worked that makes it necessary for them to pay higher wage rates to all employees. We then use the same framework to derive testable predictions on how hours worked and wage rates change in response to tax rate changes that affect only one type of workers. We show that in firms that coordinate hours, a tax rate change that affects only one type of workers moves hours worked and wage rates of all other workers in the same firm. The magnitude of the spillover is greater, the greater is the relative number of workers directly affected by the tax change working in the firm.

We test the predictions of the model using a matched employer-employee panel of the Danish population. The empirical analysis consists of two parts. In the first part we focus on documenting the existing correlation between wage differentials and coordination of hours worked. This is done through a two steps procedure. In the first step we estimate firm fixed effects from a wage regression of the type described in Abowd et al. (1999). The firm fixed effect captures the proportional wage premium (or discount) paid by each firm to all workers. In the second step we then regress the wage premium on a measure of coordination. We measure coordination using the standard deviation of hours worked across skills groups in a firm. We construct such a measure on different definitions of skills. Low standard deviation is interpreted as indicating high coordination. Independently of the definition of skills used, we find a strong association between wage premiums and coordination. We estimate that our measure of coordination can explain up to 25% of the variation in the firm component of wages explained by standard productivity measures such as value added and sales per employee.

In the second part of the empirical analysis we investigate how wages and hours change when tax rates change only for one type of workers in firms that coordinate hours. We base our analysis on the changes to the Danish tax schedule that occurred in 2009 and 2010. These resulted in sizable reductions of the tax rates paid by high income earners, while they left the tax rate faced by low incomes almost unchanged. Our empirical strategy builds on the standard regression model used to evaluate the effect of tax rate changes on taxable income (Gruber and Saez (2002)). We depart from the standard model along two main dimensions. First, we estimate the effects of tax changes on hours worked and wage rates rather than on taxable income. In our setting in fact, a tax change can move hours and wage rates in opposite directions. Second, we add one extra term that captures the average change in the labor supply of coworkers that was induced by the tax change. As it is standard practice in the literature, we deal with the endogenity of the actual tax rates and the changes in hours worked by coworkers using mechanical tax rates produced through a tax simulator[3]. We find strong spillover effects from a tax change on high incomes to hours worked by low income coworkers. We estimate that a raise of 1% in the average number of hours worked by high incomes leads to an increase of about 1% of the hours worked by low incomes in the same firm. We find this effect to be greater in magnitude in firms showing lower standard deviation of hours across skills groups prior to the tax change.

The results of this study are relevant for multiple reasons. First, they unveil one important determinant of the wage differentials across firms. Several studies in the literature document the importance of the firm component of individual earnings (e.g. Groshen (1991),Goux and Maurin (1999),Abowd et al. (2002),Card et al. (2013)). Recent studies find evidence of a strong correlations between firm productivity measures and wage premiums (Card et al. (2015)). Our study provides evidence to believe that a sizable part of this correlation can be explained by differences in the degree of hours coordination.

Second, this is the first study that documents the spillover effects of a tax policy due to coordination using detailed data on hours worked and actual tax changes. The existence of spillover effects due to coordination is relevant to every policy that affects the preferences of a fraction of workers in a firm. Our study suggests that the assessment of the effects of this type of policies should account for the spillover effects as they play a non-negligible role. Third, the existence of spillover across coworkers suggests that the empirical models that use workers unaffected by the tax change as a control group to estimate the elasticity of labor

[3]We develop a tax simulator for the years 2006-2011 building on Kleven and Schultz (2014)

supply[4], might produce downwards biased elasticity estimates[5]. Such a bias, provides an other dimension to explain the difference between elasticity estimated in macro versus micro studies (Chetty (2012)). Finally, similar to Chetty et al. (2011) also in our setting if the number of firms that coordinate is high enough, hours worked in a country reflect the preferences of the largest group of workers. This implies large differences in the labor supply across countries under different tax regimes and small changes in hours worked from changes that only affect a small group of workers in a country[6]. The existence of spillover in coordinated firms can thus contribute to explain the difference between micro and macro estimates of the elasticity of labor supply to tax rate changes.

2 Conceptual framework

To guide the empirical analysis, in this section we discuss a simple model of labor supply with restrictions on hours worked. The framework describes the basic mechanism through which coordination of hours generates wage differentials across firms. The framework also delivers testable predictions on the effects of tax rate changes that only affect a fraction of the workforce in firms that coordinate hours.

In our model, we assume to have two types of workers and two types of firms[7]. Workers can be either high or low skilled. For simplicity, we assume that individual preferences are parametrized by the following utility function:

$$U\left(c_i, h_i\right) = c_i - \beta_i^{-\frac{1}{\varepsilon}} \frac{h_i^{1+\frac{1}{\varepsilon}}}{1+\frac{1}{\varepsilon}} \tag{1}$$

where the subscript i identifies high skilled (H) and low skilled (L) workers, c_i indicates units

[4]See for example Eissa (1995),Eissa and Hoynes (1998),Blundell et al. (1998)

[5]This is because workers in the control group might be indirectly affected by the tax change

[6]While our model reaches similar conclusion to Chetty et al. (2011), we do not impose searching cost and we have heterogeneous workers in a firm. These features generate wage differentials across firms that are key to our analysis and absent in other studies.

[7]At the end of the section we discuss how to extend the intuitions gained in this simple setting to more general frameworks with a multitude of workers and firms.

of a numeraire consumption good and h_i indicates hours worked. $\beta_i > 0$ is a taste parameter that characterizes preferences over hours worked[8]. We assume that high and low skilled workers differ in desired hours. In particular, backed by the empirical evidence discussed in Section 4, we assume that high skilled desire to work more than low skilled. Such differences in optimal hours can be seen as due to either differences in tastes (i.e. $\beta_L \geq \beta_H$) or to differences in productivity that reflect in market wages and thus in hours worked[9].

Workers are employed in either type 1 or type 2 firms. Both types of firms make use of high and low skilled labor in production. We assume that type 1 firms have a production function that requires high and low skilled workers to work the same number of hours. Type 2 firms on the other hand, do not impose restrictions on the number of hours worked by their employees. In what follows we start the discussion with the case of workers in type 2 firms. We then turn to type 1 firms analyzing how restrictions on hours worked reflect into wages and responses to tax rate changes.

2.1 The demand and supply of labor in uncoordinated firms

Workers in type 2 firms maximize the utility function (1) subject to the budget constraint $c_i \leq w_i^* h_i(1 - t_i)$. Where w_i^* is the wage rate paid by the market to type i workers. Firms and workers take this wage rate as given. For simplicity we assume that labor earnings are the only source of income. These are taxed at the marginal tax rate t_i.

Point A in Figure 1 identifies the optimal combination of hours worked and consumption. While working their optimum h_i^*, workers in type 2 firms are paid the hourly wage rate prevailing into the market net of taxes ($W_i^* = w_i^*(1 - t_i)$). The optimal combination of hours worked and consumption provides workers with the utility level $U\left(C_i^*, h_i^*\right)$. In the specific case of the utility

[8]While the quasi-linear functional form, allows for a more transparent exposition of the main predictions of the model it also assumes away income effects. Most of these predictions however, do not depend on whether the income or the substitution effect prevails. In those cases in which the prevalence of one of the two effects makes a difference, we discuss how the predictions would change if the income effect prevails. In Appendix C we then show how to generalize the model to more general functional forms. This part of the analysis is not fully finalized yet. It is thus only partially reported in the Appendix C.

[9]In the latter case, if high skilled are assumed to be more productive than low skilled, then income effect needs to prevail for high skilled to desire to work more than low skilled

function (1), the optimal number of hours takes the following form:

$$h_i^* = \left[w_i^* \left(1 - t_i\right) \beta_i^{\frac{1}{\varepsilon}} \right]^{\varepsilon} \tag{2}$$

Type 2 firms solve the standard profit maximization problem:

$$\max_{L_L, L_H} F^2(L_L, L_H) - w_L^* L_L h - w_H^* L_H \tag{3}$$

where $L_i = N_i h_i$ and N_i is the number of type i workers. The optimal demand of labor is then defined by equalizing the marginal product of each type of labor to the corresponding wage rate paid by the market. Competitive wage rates are such that the supply and the demand of hours for each type of labor are equalized under full employment of both high and low skilled.

2.2 The wage function in coordinated firms

Both high and low skilled workers in Type 1 firms are required to work the same number of hours h. Assuming that workers can freely move between type 1 and type 2 firms, then type 1 firms will offer wage rates w_i so that the following condition is satisfied:

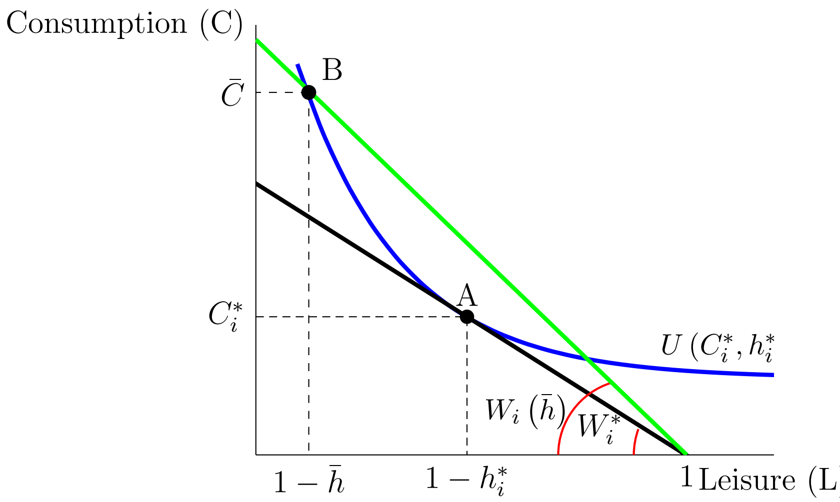
$$U\left(w_i h(1 - t_i), h\right) = U\left(w_i^* h_i^* (1 - t_i), h_i^*\right) \tag{4}$$

Condition (4) imposes that each type of workers must be indifferent between working in type 1 or type 2 firms. Such a condition implicitly defines the wage rate paid by type 1 firms w_i as a function of the hours worked h. This can be easily seen in Figure 1. If we assume, for instance, that type 1 firms set the hours worked at $\bar{h} > h_i^*$, condition (4) implies that type i workers in coordinated firms (type 1) will be at point B in Figure 1. If the utility function is well-behaved[10], the wage rate paid by type 1 firms at B ($W_i\left(\bar{h}\right)$) is greater than that paid by type 2 firms at A (W_i^*) for the same type of workers. The same reasoning applies to any choice

[10] In particular if it shows diminishing Marginal Rate of Substitution. For more details see Appendix C.

of hours $\bar{h}$ that differs from the optimum h_i^*.

Figure 1: Wage rates and hours worked



In the specific case of the utility function (1), the wage function implied by (4) takes the following form:

$$w_i\left(h\right) = \left\{\beta_i^{-\frac{1}{\varepsilon}} \frac{h^{\frac{1}{\varepsilon}+1}}{1+\frac{1}{\varepsilon}} \frac{1}{(1-t_i)} + \left[w_i^*(1-t_i)\right]^{1+\varepsilon} \frac{\alpha}{1+\varepsilon}\right\} \frac{1}{(1-t_i)h} \tag{5}$$

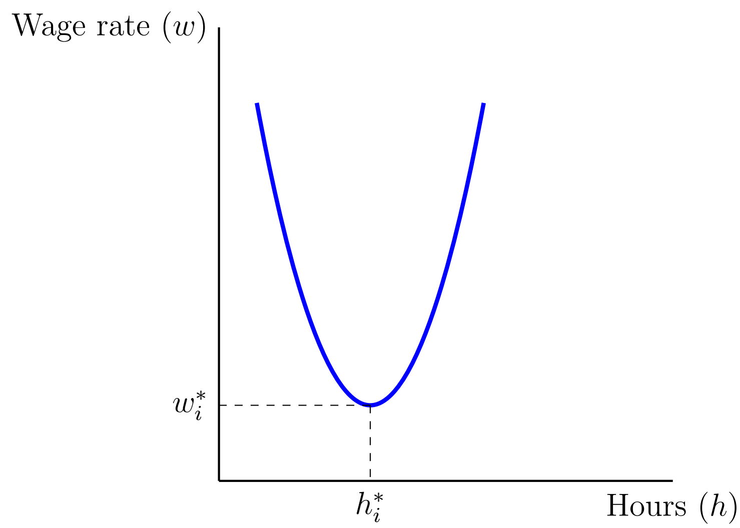
Under the assumption of ε being positive, the first derivative of this wage function $w'\left(h\right)$ can be shown to be positive if the worker is over-employed ($h > h_i^*$). In this case, in fact, a marginal increase in hours worked would increase the distance between hours worked and the optimum thus requiring higher compensation. In case the worker is under-employed ($h < h_i^*$), $w'\left(h\right)$ is negative. A marginal increase in hours would move the worker closer to the optimum. Finally $w'\left(h\right) = 0$ if hours worked in type 1 and type 2 firms are the same ($h = h_i^*$).

Under the additional assumption of ε being smaller than 1, the second derivative of the wage function $w''\left(h\right)$ can be shown to be positive[11]. Based on this, the resulting wage-hours function

[11] Appendix C shows detailed derivations on the specific case of the utility function (1) as well as the more general case of a generic quasi-linear utility function. The assumption of ε being in between zero and one is consistent with the existing empirical evidence. Most of the existing studies, in fact, estimate the elasticity of hours worked to be close to zero. Chetty (2012) reports the average elasticity of hours worked estimated by the major studies in the literature to be 0.15.

is U shaped with minimum at w_i^* as shown in Figure 2. Such a shape is of key importance in deriving the effects of coordination on wage differential and tax response.

Figure 2: The wage function



2.3 Optimal number of hours and wage rate in coordinated firms

While the discussion of the previous section focuses on workers, in this section we analyze the optimal choice of hours worked by type 1 firms. These firms produce through a production function that requires both types of workers to work the same number of hours. The optimal demand of hours thus results from the following profit maximization problem:

$$\max_{N_L,N_H,h} F_1(N_L h, N_H h) - w_L(h)\, N_L h - w_H(h)\, N_H h \tag{6}$$

where $w_L(h)$ and $w_H(h)$ are hourly wage rates paid to low and high skilled workers respectively. For the reasons discussed in section 2.2, those are assumed to vary with hours worked h. In this setting Type 1 firms are assumed to take the wage-hours function induced by individual preferences as given. From (6) it follows that hours are optimally chosen to satisfy the following condition[12]:

$$w_H'(h) + \alpha w_L'(h) = 0 \tag{7}$$

where α indicates the ratio between the number of low and high skilled workers. Condition (7) requires optimal hours worked in type 1 firms to be in between those most preferred by high and low skilled workers. Since the two types of workers are assumed to have different preferences over hours worked, setting h to be in between their different optima makes one type of workers under-employed and the other over-employed. If we assume that high skilled have higher desired hours then based on the results from section 2.2, at the optimum $w_L'(h)$ is negative and conversely $w_H'(h)$ is positive. Figure 3 graphically shows the choice of the optimal h in type 1 firms. The Figure highlights also an other important feature of the optimal choice of hours. When h is in between the two optimums, both $w_H'(h)$ and $w_L'(h)$ are different from zero implying a wage premium for both types of workers. Intuitively, in type 1 firms neither low or high skilled workers work their relative optimum making it necessary for the firm to compensate them with higher wages. The wage premium paid to each type of workers depends on his specific wage function. This leads to the first testable prediction of the model:

Prediction 1: Firms that impose stricter restrictions on hours worked pay higher hourly wages. The implicit assumption behind this prediction is that type 1 firms while producing products that requires restrictions on hours, also gain from coordination through higher marginal products of both types of labor. The gains from coordination are thus used to pay higher wage rates[13]. Existing papers in the literature discuss examples of production functions that allow for gains from coordination (Rosen (1978),Siow (1987)).

The optimal number of hours worked in type 1 firms also depends on the ratio between low and high skilled workers (α). As the dashed line in Figure 3 shows, the higher this ratio is, the closer optimal hours are to the desired hours by low skilled workers. Or in other words, condition (7) requires the optimal h to be closer to the optimum of the larger group of workers

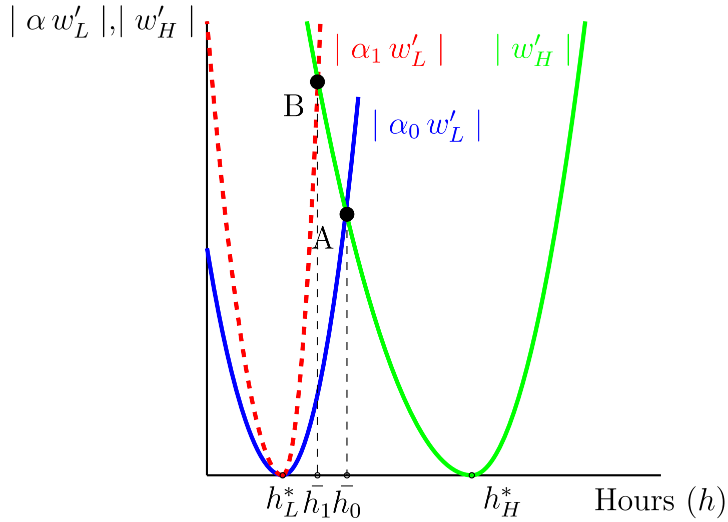
[12]See Appendix C for more details on the derivations.

[13]This also implies that type 1 and type 2 firms produce different products. Assuming perfect competition in all product markets, profits are zero for all firms types.

in the firm.

The intuitions gained from this simple framework can be extended to a more general setting in which we have a continuum of firms and worker types. Also in this case, if workers can not sort perfectly across firms, those firms that impose larger constraints on hours worked will pay wage premiums to attract workers that would otherwise prefer to work a different number of hours. Wage differentials as a compensation for facing constraints on hours can not exist instead, if workers are able to sort perfectly across firms so that desired hours by different types of workers are all equal in each firm. In a setting in which there is a large number of workers with sufficiently heterogeneous tastes and only a limited number of firms, perfect sorting can be reasonably excluded.

Figure 3: Optimal hours worked in coordinated firms



2.4 The effect of a tax rate change on hours worked

In this section we analyze how the coordination of hours worked affects the labor supply response to tax changes that only affect a fraction of the labor force. We frame this analysis within the model described in the previous sections. We assume that only high skilled workers pay taxes. This assumption, while restrictive, reasonably suits the empirical part of our study that analyzes the effects of the 2010 Danish tax reform. This tax reform, in fact, mostly interested high income earners (see section **??** for more details). From section 2.3, we know that hours in type 1 firms are chosen to satisfy condition (7). This condition implicitly defines hours worked as a function of the tax rate paid by high skilled workers. In the specific case of the quasi-linear utility function assumed in (1), condition (7) takes the following form

$$g\left(h, t_H\right) = \left[\beta_H^{-\frac{1}{\varepsilon}} \frac{h^{\frac{1}{\varepsilon}}}{\left(1-t_H\right)} - \frac{w^{*\varepsilon+1}(1-t_H)^{\varepsilon}}{h}\beta_H\right] \frac{1}{h\left(\varepsilon+1\right)} + \alpha\left[\beta_L^{-\frac{1}{\varepsilon}} h^{\frac{1}{\varepsilon}} - \frac{w^{*\varepsilon+1}}{h}\beta_L\right] \frac{1}{h\left(\varepsilon+1\right)} = 0 \tag{8}$$

The implicit function (8) can thus be used to derive the effects of a tax rate change on hours worked:

$$\frac{\partial h}{\partial t_H} = -\frac{\frac{\partial g(h,t_H)}{\partial t_H}}{\frac{\partial g(h,t_H)}{\partial h}} = -\frac{\left\{\left(\frac{h}{\beta_H}\right)^{\frac{1}{\varepsilon}} + \frac{\varepsilon[w^*(1-t_H)]^{\varepsilon+1}\alpha_H}{h}\right\}}{\left\{\left(\frac{\partial^2 w_H}{\partial h^2} + \alpha\frac{\partial^2 w_L}{\partial h^2}\right)\left[h\left(1-t_H\right)^2\left(\varepsilon+1\right)\right]\right\}} \tag{9}$$

Assuming $0 < \varepsilon < 1$, both numerator and denominator in (9) are positive thus implying a negative effect of a marginal tax rate increase on hours worked. Absent any income effect, a tax rate increase drives down the optimal hours worked of high skilled workers. Type 1 firms thus find it optimal to adjust hours worked to reflect, at least partially, the change of preferences of one part of their working force. As a result, hours worked by all workers in type 1 firms go down. Figure 3 shows this graphically. The two curves in the Figure represent $\mid \alpha\, w_L' \mid$ and $\mid w_H' \mid$ respectively. Under the assumption of $0 < \varepsilon < 1$ those are increasing functions of h and they take value zero at the optimum[14]. Assuming away the income effect, as the tax rate on high skilled workers goes up the optimal hours worked go down to h_{1H}^*. The entire curve $\mid w_H' \mid$ thus shifts towards the origin and the new equilibrium is reached at point B. When the desired hours worked by high skilled workers go down from h_{0H}^* to h_{1H}^*, type 1 firms optimally respond decreasing hours worked from $\bar{h}_0$ to $\bar{h}_1$. The magnitude of the adjustment is inversely related to the relative size of the low skilled group in that firm (α). The smaller is α, the greater is the adjustment. To see this graphically, the dashed line in Figure 3 plots the case of a lower

[14]In drawing Figure (5) we assume the two functions to be convex. The conclusions of our analysis do not change if we assume the third derivative of the wage function to have a different sign.

α. In the Figure moving from C to D when the tax rate goes up, implies a greater reduction in hours than moving from A to B. This leads to the following testable predictions:

Prediction 2: Low skilled workers in firms that impose constraints on hours worked indirectly respond to tax rate changes that directly affect only high skilled workers. Such effect is larger in coordinated firms that employ relatively more high skilled

Prediction 3: High skilled workers in firms that impose constraints on hours worked respond less to tax rate changes than similar workers in less constrained firms. Such effect is smaller in coordinated firms that employ relatively more high skilled.

These predictions are based on the assumption that the labor force composition (α) does not change when the tax rate changes. While relaxing this assumption does not change the content of the predictions, the magnitude of the induced change in hours in type 1 firms can be affected. A reduction in desired hours worked by high skilled makes those workers more attractive in type 1 firms. An increase in the demand of high skilled under full employment however, drives market wages up in general equilibrium. Higher wages and the prevalence of the substitution effect would then move desired hours back up offsetting the initial effect. To the extent that the general equilibrium effects are weaker than the direct effects, the former do not completely offset the latter and the predictions still apply.

The special case of the quasi-linear utility function rules out the possibility that the income effect prevails. The prevalence of the income effect would invert the sign of the relation between tax changes and optimal hours worked in type 1 firms. It would not change however, prediction 2 and 3 from the model.

Finally, in the stylized model that we develop here, we do not explicitly consider unions. As long as unions' objectives reflect workers' preferences, however, the main predictions of the model would not be altered by their inclusion. The magnitude and the timing of the effects described in this section might however change. The magnitude might change because unions might want to extract rents by altering the wage function[15]. The timing of the labor

[15]The might for example increase the wage premium required at any given number of hours worked thus shifting up the entire wage curve. This would in turn affect the optimal choice of hours made by type 1 firms and thus the magnitude of the response to tax rate changes.

supply response to tax changes might also be altered to match more closely the timing of the renegotiation of the collective labor agreements. In the empirical part of the study we will use the rich information from the Danish administrative data to shed some light on the relation between coordination and unions.

2.5 The effects of a tax rate change on wage rates in coordinated firms

The same framework can be used to study the effects of a tax rate change on wages paid to workers who are not directly affected by the reform in coordinated firms. The sign of this effect depends on whether the income or the substitution effect prevails. If we maintain the assumption that high skilled prefer to work more than low skilled, and if we keep the quasi-linear functional form of the utility function, wage rates of both low and high skilled workers go down as the tax rate goes up. This is shown in Figure 3 where moving from A to B implies that both $\mid w'_H \mid$ and $\mid w'_L \mid$ decrease. Under the assumptions required for the wage-hours function to be convex (Section 2.2), this reduction corresponds to a decrease in wages. Intuitively, the lower level of hours induced by the tax reform moves low skilled workers (who are over-employed) closer to the optimum. Low skilled wages thus go down. Focusing on high skilled workers, the reform drives down both their actual and optimal hours worked. Following condition (7), actual hours decrease less than the desired hours thus reducing the distance between the optimum and the number of hours worked. This results in lower wage rates. The sign of the effects depends on the quasi-linearity of the utility function. This in fact, rules out the income effect. If on the contrary we assume that the income effect prevails, then as long as the wage-hours function is convex, the same reasoning applies and while the sign of the effects on wages is flipped.

This discussion leads to the last testable prediction of the model:

Prediction 4: Wages paid to low skilled workers in coordinated firms are positively affected by tax rate changes that only affect high skilled workers if the income effect prevails and negatively affected by the changes if the substitution effect prevails.

3 The Data

The data used are drawn from multiple data sources. Table 1 summarizes the main steps involved in the data preparation. First, we use administrative data on all Danish employees in between 15 and 65 years old from the Integrated Database for Labor Market Research (IDA). IDA collects annual data on many of the individual socio-economic characteristics such as tax returns, earnings, occupation and education. We link this information to data on hours worked from *Lønstatistikken* (LON). This survey covers the totality of workers in public and private firms with more than 10 full-time equivalent employees. Data on about 15% of the firms surveyed however, are judged of low quality by Statistics Denmark. As a consequence they are not released in LON. The survey records normal hours worked. Those are paid hours of work on an annual basis excluding overtime hours[16]. We use data on the 2003-2011 period for which we are able to match 55% of the observations in IDA[17]. Since the focus of our analysis is on coordination of hours across coworkers, it is particularly important for us to be able to observe hours worked by all workers in a firm. For this reason we focus most of our analysis on firms for which at least 95% of the observations in IDA can be linked to LON. Existing studies show that the labor market of part-time workers can follow dynamics that differ from those of full-time workers (Owen (1978)). We abstract from those differences, focusing on full-time workers only[18].

We link individual records to data on firms using the Firm-Integrated Database for Labor Market Research (FIDA) which links employees and employer in week 48 of each year. We use firm data from the Firm Statistics Register (Firmstat) and the Danish Foreign Trade Statistics Register which cover the universe of private sector Danish firms. These provide information on firms characteristics such as number of employees, industry affiliation, accounting and trade data. Our final sample has has more than 400 thousand employees and around 8200 firms.

[16]Data on overtime hours are available only for a very limited fraction of workers in LON.This is the reason why we do not use them in most of our analysis.

[17]2002 data are available in LON. In this year however around 70% of the observations in IDA can not be linked in LON. For this reason, we decided not to use 2002 in the analysis.

[18]Following Statistics Denmark, we define part-time workers as those who work not more than 27 weekly hours.

The first column in Table 2 shows descriptive statistics on individual and firm characteristics in the entire population (IDA). The second column refers to the sample of workers that could be linked to data on firms (FirmStat) and hours worked (LON). The last column shows descriptive statistics on the sample of workers in firms in which 95% of the workers in IDA could be linked to LON. This is the sample used in our analysis. Comparing the first and the second column, we notice that the workers that are matched in FirmStat and LON are more educated, they have higher average annual earnings and they are less likely to work in agriculture or in the public sector. Those differences reflect the restrictions induced by FirmStat and LON that cover larger private firms. Workers or firms statistics however, do not substantially change while going from the second to the third column. We take this as indicative of the fact that the sample on which we base our analysis, while providing more complete information on the workforce at the firm level, does not distort the composition of the population for which firms and hours records are available.

Finally, in support of the main analysis we use data from *E-indkomst* and *O*Net*. O*Net is a survey that provides detailed information on job requirements and worker attributes for 965 occupations in the United States. Information on 277 occupation-specific descriptors such as work style, work content, interests, experience is annually updated based on ongoing surveys of workers in each occupation and occupational experts. In our analysis we focus on 4 occupation characteristics: *Teamwork*, *Contact*, *Impact* and *Communication*. For each one of those, O*Net provides a measure of their importance in each one of the 295 occupations surveyed. Using the available information on occupation from IDA, we link this measure to our sample of the Danish data[19].

E-indkomst records monthly hours worked by the entire population of Danish employees in the period 2008-2011. The relatively short time length of this register limits the scope of its use for our analysis. The large cross-sectional coverage however, makes of it suitable to be used to check the robustness of our main results. To make hours in E-indkomst comparable to hours

[19]Danish registers record occupation following the International Standard Classification of Occupations (ISCO-88). O*Net classification is based on the Standard Occupation Classification (SOC). We mapped ISCO-88 into SOC using the cross-walk provided by the National Crosswalk center.

in LON, we aggregate monthly hours into annual hours. We only use information on hours recorded. This is missing for some workers. For this reason, we only focus on workers in firms in which at least 95% of the records in IDA can be linked to E-indkomst.

4 Coordination and wage differentials across firms

Prediction 1 from the model states that firms that coordinate hours pay higher wages. We test this hypothesis using a two steps procedure. In the first step we estimate the firm specific component of the hourly wages associated to each Danish firm. In the second step we study how the firm component relates to coordination of hours.

In the first step we estimate the following AKM[20] regression:

$$ln\, w_{ijt} = \alpha_i + \psi_{j(i,t)} + \beta_1 X_{it} + \beta_2 Z_{jt} + + \varepsilon_{ijt} \tag{10}$$

where w_{ijt} is the gross hourly wage earned by individual i in firm j in year t. X_{it} is a vector of individual specific controls that change overtime. Following Card et al. (2013), we include in X a set of interactions between year dummies and educational attainments as well as interaction terms between quadratic and cubic terms in age and educational attainments. In addition to those, we also control for other factors that might affect wage rates such as experience, tenure, occupation, number of children, a dummy for the first child and region fixed effects. The vector Z_{jt} contains firm specific controls that change overtime and that influence wages such as value added, sales and capital per employee, exporter status and the fraction of salaried workers[21]. α_i and $\psi_{j(i,t)}$ are individual and firm specific fixed effects. The variable of primary interest in equation (10) is $\psi_{j(i,t)}$. This captures the fixed component of the wage that is specific of firm j.

We estimate equation (10) on 2003-2011 data. To convey in this estimation as much in-

[20] The acronym is from the seminal paper by Abowd, Kramatz and Margolis (1999) on estimating this type of regressions.

[21] The reasoning behind the inclusion of the fraction of salaried workers is that we thinks at it as strictly related to coordination. Hourly workers can be used in fact to relax coordination. This variable might therefore capture changes in preferences over coordination by firms. These changes create problems in this setting if they induce endogenous mobility.

formation as we can, we estimate it on the largest sample for which we have information on both firm and individual characteristics. This consists of the employers and employees in the FirmStat and LON sample described in the previous paragraph (second column in Table 2). We estimate (10) using the methodology developed in Abowd et al. (2002). This is based on the identification of connected sets of firms. Those consist of firms that have movers in common. In the analysis that follows we focus on the largest set of connected firms[22]. Due to the high mobility that characterizes the Danish labor market and the relatively long time period considered, the largest connected set contains more than 99% of the workers and firms in the sample. The simultaneous identification of the firm and individual wage components requires to set either one firm fixed effect or one individual fixed effect equal to zero. The firm effect $\psi_{j(i,t)}$ can thus be interpreted as the proportional wage premium or discount paid by firm j to all employees.

In the second step, we regress the firm fixed effect obtained from the previous regression $\widehat{\psi_{j(i,t)}}$ on a measure of coordination of hours worked in that firm (σ_j) and a vector $\bar{Z}_j$ of firm specific controls averaged over the period 2003-2011. The estimating equation takes the following forms:

$$\widehat{\psi_{j(i,t)}} = \delta_0 + \delta_1 \sigma_j + \delta_2 \bar{Z}_j + v_j \tag{11}$$

σ_j in (11) measures the average dispersion of hours worked across skills groups. Higher dispersion is seen as implying lower coordination. Based on the first prediction from the model, we therefore expect $\hat{\delta_1}$ to be significant and negative. That is, higher coordination implies higher wage premiums. While in the next section we discuss the details behind the construction of σ_j, we dedicate the remaining part of this section to the discussion of the conditions required to estimate unbiased firms fixed effects from equation (10).

Estimating unbiased coefficients from equation (10) requires that the unobserved component of the hourly wage rate ε_{ijt} is mean independent of individual and firm fixed effects and time

[22]The Abowd et al. (2002) procedure simultaneously estimates firm and individual fixed effects using the conjugate gradient (CG) algorithm as in Dongarra et al. (1990).

varying characteristics:

$$\mathbb{E}\left(\varepsilon_{ijt}|X_{it},\, Z_{jt},\, \alpha_i,\, \psi_{j(i,t)}\right) = 0 \tag{12}$$

This assumption is often referred to in the literature as ”conditional exogenous mobility” (Abowd et al. (1999)). As in Card et al. (2013), we investigate the plausibility of this assumption considering 3 cases in which the assumption is violated. First, we consider the case of sorting based on the idiosyncratic employer-employee match component of wages. This type of sorting is problematic because workers are paid differently at each firm depending on the match component. Absent any match effect, the average wage gains and losses from moving from high to low wage firms are expected to be symmetric. The existence of match effects however, will tend to offset the losses associated with moving to a low wage firm. In the limit if all transitions are voluntary and selection is based only on the match component movers would experience no wage losses.

Following Card et al. (2013), we construct mean log co-workers wages for each person in each year. We assign each worker to a quartile of the coworkers wage distribution. We do it separately for men and women. In each year we then derive average wage rates of movers by quartiles. Movers are defined as those who move from one firm to the other and who can be observed for two consecutive years in both the sending and the receiving firm. Figure 4 shows the average wage dynamics of workers who moved from a firm in the 1st or 4th quartile of the coworkers wage distribution. Similar to what found by the other studies, we find rather symmetric wage losses and wage gains for workers moving from high to low paying firms and the opposite. We do not find big wage changes for workers moving across firms paying similar wages. This suggests that the sorting based on a match component is likely to play a minor role in our setting.

A second case in which the exogenous conditional mobility is violated is when mobility is related to unobserved and temporary firm specific shocks. In this case for example, workers might be more likely to leave firms that are experiencing negative shocks to join those that are experiencing positive shocks. As in other studies however, we fail to find evidence in the data of particular dips in the wages of leavers or exceptional growth in the wages of joiners (Figure 4). Finally a third problematic case might arise if mobility is related to unobserved temporary individual shocks. This is the case for example, if workers who are performing well earn higher wages in the sending firm and they move to high paying firms and those who are performing worse experience wage cuts prior to moving to low paying firms[23]. Under this hypothesis, we would observe different trends prior to moving for workers who end up in high versus low paying firms. We do not find particularly different pre-trends for workers moving to high versus low paying firms (Figure 4), suggesting that temporary shocks have a a small effect on mobility in our sample.

In the specific setting of our model, we might also be worried that mobility relates to unobserved temporary shocks to preferences over hours worked. An unexpected disease for example, might induce a worker to move to a lower paying firm in exchange for working times that better fit the new desired hours. If this is the case however, we would observe substantial changes in hours worked by movers. This should be expecially true for workers moving from the bottom to the top quartile of the coworkers wage distribution and the opposite. Table 3 shows the average change in weekly hours worked by movers in the two years prior versus the two years after the job change. Hours worked by movers are pretty stable. This is the case also for workers who move from top to bottom paying firms and the opposite. Among male movers, those in the bottom paying firms experience the greatest change in hours. These changes however, are extremely small. They amount to less than 5 minutes per week. This is equivalent to less than 0.3% of the hours worked in an average working week in Denmark[24]. Female movers experience greater changes. Even for females who move from top paying firms however, the change remains below 10 minutes per week. This is less than 0.5% of the average hours in a week. This suggests that temporary shocks to preferences over hours play a minor role in determining mobility in our setting. To better deal with this possibility however, in estimating equation (10) we also control for an exhaustive set of individual and firm time varying characteristics that might

[23]This might be for example also the case when ability is slowly revealed overtime.

[24]Danish employees work on average around 36 hours per week (Table 2).

capture the variation in wages related to temporary changes in desired hours. Those are for example, number of children, an indicator for the birth of the first child, value added and sales per employee.

Our findings on movers in Denmark are in line with the findings of a number of other recent papers in the literature (e.g. Card et al. (2013), Card et al. (2015)). They support the idea that the worker-firm matching is based on a combination of permanent firm and individual characteristics that do not create major concerns for the estimation of equation (10).

4.1 Coordination of hours worked: Measures and Facts

In this section we start by describing how we measure coordination of hours at the firm level. We then discuss how coordination interacts with other observable firm characteristics in the data.

The measure of coordination that we use in this study is the standard deviation of annual hours worked across skills groups σ_{jt}:

$$\sigma_{jt} = \left[\frac{1}{S_{jt}} \sum_{s=1}^{S_{jt}} \left(\tilde{h}_{sjt} - \mu_{sjt} \right)^2 \right]^{1/2}, \tilde{h}_{sjt} = \frac{1}{N_{sjt}} \sum_{i=1}^{N_{sjt}} h_{isjt} \tag{13}$$

where S_{jt} is the number of skills groups in firm j in year t, N_{sjt} is the number of workers in skills group s in firm j at time t, μ_{sjt} is the average number of annual hours worked across skills groups ($\tilde{h}_{sjt}$). σ_j in equation (11) is then defined as the average σ_{jt} over the years 2003-2011. We measure coordination only in firms where we can observe hours worked by most of the workers in the workforce. Those are the firms for which we can match at least 95% of the observations in IDA with information on hours worked from LON (column 3 in Table 2).

In our setting, hours worked in equilibrium can be different from desired hours. While we can only observe hours worked in equilibrium, a desirable measure of coordination should capture differences in hours worked by workers with different preferences over hours. To capture these differences we divide workers into skills groups. A greater variation in hours worked across skills groups is interpreted as lower coordination of hours worked at the firm level.

We use two different definitions of skills. First, starting from the estimated coefficients from equation (10), we measure skills as the sum of the estimated fixed and the time varying individual components of the hourly wage: $\widehat{s_{ijt}} = X_{ijt}\hat{\beta}_1 + \hat{\alpha}_i$. We thus assign workers in each year to either one of the 10 skills groups defined as deciles of the distribution of $\widehat{s_{ijt}}$. Similar measures of skills are used in other recent studies (Irarrazabal et al. (2014),Iranzo et al. (2008)). In a setting where wages depend on hours however, $\widehat{s_{ijt}}$ might still reflect equilibrium outcomes to the extent that those are not fully captured by the firm components of wages in (10). If this is the case however, $\widehat{s_{ijt}}$ might not perform well as a proxy of desired hours. For this reason, we also define skills groups at the intersection of 3 educational groups (i.e. primary, secondary and tertiary education) and 3 broad occupational categories (i.e. manager, middle manager and blue collar). In what follows we refer to the standard deviation based on the former definition of skills as *Definition 1* and the latter as *Definition 2*.

Table 4 shows average annual hours worked in each skills group in firms where at least 90% of the workers belong to the same skills group. In our theoretical setting, these are the firms where we expect hours worked in equilibrium to match desired hours more closely. The table highlights a substantial difference in hours worked by workers in the bottom versus top deciles of the distribution of fitted skills ($\widehat{s_{ijt}}$). Workers in the top decile work on average 35 hours more on an annual basis than workers in the bottom decile (Panel A). The difference is particularly pronounced between white and blue collar jobs with primary schooling. Primary educated blue collars in fact, work on average 87 hours less than equally educated managers (Panel B). The difference shrinks at higher educational levels. Looking at tertiary educated employees, managers work 26 hours more on average than workers in blue collar jobs. This evidence is relevant for three reasons. First, it suggests that there is substantial heterogeneity in in desired hours across workers. Second, it shows that our measures of skills captures such heterogeneity. Third, in line with the assumptions of our theoretical framework (Section 2), it suggests that high skilled workers prefer to work more hours than low skilled workers.

To validate our measures of coordination, we select 4 questions in O*NET that capture aspects of a job that involve coordination of hours[25]. Those are: *Contact*: how much does this job require the worker to be in contact with others (face-to-face, by telephone, or otherwise) in order to perform it? *Teamwork*: how important is it to work with others in a group or team in this job? *Communication*: how important is communicating with supervisors, peers, or subordinates to the performance of your current job? *Impact*: what results do your decisions usually have on other people or the image or reputation or financial resources of your employer?

For each occupations, O*NET provides a measures of the importance of each one of the 4 aspects mentioned above. The score ranges between 1 and 100. We take the median score across coworkers in each year as a measure of the importance of each factor in a specific firm[26]. Figure 5 plots the standard deviation of hours (Definition 1) against the importance of each one of the 4 descriptors in each firm-year. For clarity, we group firms in equally sized bins. A clear negative relation emerges between each one of the descriptors and the standard deviation of hours across skills groups[27]. As expected, firms that operate at lower coordination (i.e. higher standard deviation) also show lower importance scores in aspects that involve coordination. The same evidence emerges from using the auxiliary definition of standard deviation based on occupation and education (Figure 6). This validation exercise using a combination of register and O*NET data, suggests that the measures of coordination that we propose can consistently capture the types of firm-level interactions that we are interested in studying.

Due to the limited availability of information on hours worked by workers in the same firm, little has been done so far in analyzing how coordination relates to other important firm characteristics. In what follows, we document few facts on coordination that emerge from our analysis. Table 5 shows the coefficients estimated from a regression of our measures of coordination on a number of firm characteristics. Few interesting facts emerge from the Table. First, lower coordination is associate with higher unionization rates. This suggests that coordination of hours reflects characteristics of the production process typical of a firm rather than institutional constrains. Second, firms that coordinate are more profitable. While they do

[25]The same questions are also used in Bombardini et al. (2012) to capture skills complementarity.

[26]We break ties in median scores using the average.

[27]The negative correlations in Figure 5 and 6 is statically significant at 1% level for all factors.

not use more capital per employee, they show higher relative value added and revenues. This provides suggestive evidence in support of the assumptions underlying our theoretical model in which coordination boosts labor productivity thus allowing for higher wages. Along the same line, firms that coordinate are more likely to be exporters, multi-plant and to have higher shares of highly educated workers in the workforce. The positive correlation between standard deviation of hours across skill groups and the share of hourly workers in a firm, seems to suggest that greater flexibility in uncoordinated firms is achieved by hiring hourly workers.

Table 6 compares coordination in different sectors. Independently of the definition used, firms in services coordinate more on average than those operating in agriculture, manufacturing or constructions. The average standard deviation in the latter sectors in fact, is more than 1.5 times larger than the average standard deviation in services.

4.2 Results

Table 7 presents descriptive statistics on the parameters estimated from the AKM regression (10). The largest group of interconnected firms contains more than 99% of the workers and firms in the overall sample. As a result, moving from the overall sample to the largest set of connected firms results into negligible changes in the descriptive statistics of the estimated parameters. Given such small changes, we estimate the second step regression (11) on firms in the largest set of interconnected firms only. In the baseline model we also restrict our attention only to firms for which we dispose of information on hours worked for at least 95% of the workers. In the next section we then relax this assumption as a robustness check.

Table 8 shows the coefficients estimated from equation (11). In line with Prediction 1 from the theoretical framework, the table shows that higher coordination in a firm is associated with higher relative wage premiums. This holds independently of the definition of skills groups used to derive the standard deviation of hours (i.e. Definition 1 vs Definition 2). The relation is robust to the inclusion of other variables such as size and exporter status that have been traditionally associated with higher wage premiums. Conditioning on the share of workers in each skills group (called *Composition controls* in the Table) or the share of unionized workers in a firm does not change the sign or the magnitude of the estimated effect in a non-negligible way (specification (2) and (6)).

The standard deviation of hours retains its significance and sign also in specifications where we control for 1 digit industry fixed effects (specification (3) and (7)). This suggests that coordination plays an important role in shaping wage differentials across firms within the same industry and not only between industries. Finally, the coefficient on the standard deviation of hours goes drastically down and it loses significance when we condition on measures of firm profitability such as value added or sales per employee (specification (4) and (8)). This is consistent with our theoretical framework in which wage premiums in coordinated firms are made possible by the productivity gains that coordination of hours allows to achieve. Conditioning on variables that capture these gains, such as value added or sales, we then expect coordination not have explanatory power on wage differentials across firms.

To gain a better understanding of the magnitude of the coefficients estimated in Table 8, Table 9 shows the corresponding standardized coefficients. From this table, it emerges that coordination plays a non-negligible role in predicting wage differentials across firms. A standard deviation increase in our measures of coordination in fact, is estimated to have a greater effect on wage premiums than a standard deviation increase in firm size or in capital per employee. The effect is estimated to be around 70% as high as the effect of a a standard deviation increase in the probability of being an exporter.

Recent studies find strong correlations between the firm-specific components of the wages and measures of firm productivity (Card et al. (2015)). The results in Table 8 suggest that coordination of hours might play a role in determining this correlation. To measure the contribution of coordination to the correlation between firm profitability and wage premiums, we estimate equation (11) omitting σ_j and adding measures of profitability such as value added and sales per employee as well as quadratic and cubic terms of value added (specification (3), (4), (7) and (8)). We then derive the Partial R-squared associated to these measure of productivity. By taking the ratio between the Partial R-squared associated to coordination and the Partial

R-squared associated to the measures of productivity, we estimate that the standard deviation of hours across skills groups can explain around 25% of the variation in wages explained by the productivity measures. When we condition om industry fixed effects, coordination explains in between 10% and 17% of the within industry variation in wages explained by the productivity measures.

To conclude, the results of our analysis are in line with the predictions of a model in which coordination on hours worked by workers with different preferences results in higher wages. Estimating the relation between coordination and wage differentails, we find that coordination of hours is an important and so far neglected determinant of wages at the firm level.

4.3 Robustness checks

In the baseline specification we only focus on those firms where attrition in hours is low (i.e. less than 5% of the observations is missing). The first two columns in Table 10 report the coefficients estimated on all firms in the largest set of connected firms. The coefficient remains negative and statistically significant. Due to the uneven effect that attrition might have on our measures of coordination across firms, we prefer to rely on the estimates from the low attrition sample as baseline results.

Hours worked might be measured with errors. If we assume that the measurement error is independent of the true hours, we would expect measurement errors to bias downwards the effects of coordination on wages[28]. To get a better idea of the size of the attenuation bias, column 3 and 4 in Table 10 consider firms that employ only hourly workers. For those workers in fact, hours worked should be more precisely measured than hours of salaried workers. Due to the reduced number of observations, the coefficients are less precisely estimated. The point estimates however, are only slightly larger than those of the baseline model. This suggests that

[28]This comes out of a straightforward extension of the classical measurement error theory in OLS regressions. The extension accounts for the fact that the variable of interest is the standard deviation of a variable measured with errors rather than the variable itself. The independence assumption is sufficient but not necessary. It can be relaxed assuming that the first and second moments of the distributions of the errors and the actual hours are uncorrelated.

while our estimates might be a lower bound to the actual effect of coordination on wages, the true effect is not too different from what we find.

The baseline results might be driven by compositional changes in the sample of firms used to derive average wage premiums and standard deviations of hours. Column 5 and 6 in Table 10 show the coefficients obtained only on firms that can be observed in all 9 years at our disposal. In this two specifications we consider all firms in the largest set of connected firms. The number of low attrition firms that can be observed in all years in fact, is too low to allow any reliable analysis. The tables shows that the coefficients remain negative and significant.

5 Coordination, labor supply and tax rate changes

5.1 The institutional setting

In this section we proceed with the study of how coordination affects labor supply responses to tax rate changes. We base our analysis on the changes to the Danish personal tax system that occurred in 2009 and 2010. These are particularly suitable for our analysis because they resulted in substantial changes of the tax rates faced by middle and high income earners, while leaving those faced by low income earners almost unchanged. To the extent that low and high income earners have different preferences over hours worked, the changes can be used to test the Predications 2 to 4 derived in Section 2.

The Danish personal income tax is based on the definition of different types of income that are aggregated in multiple ways to form different tax bases taxed at different rates. Table 11 reports all types of income relevant to the Danish tax system[29]. The taxable income (TI) is defined as the sum of personal income (PI) and capital income (CI) minus deductions (D). Personal income is given by the sum of labor income (LI) and other sources of income such as transfers or grants. Table 12 shows tax rates and tax bases in the years 2008-2011. As shwon

[29]We base Table 11 on Table 1 in Kleven and Schultz (2014). We update the table to reflect the tax code relevant in the period that we analyze.

in the table, the tax system consists of a flat regional tax[30], progressive national taxes, labor market and EITC contributions. Income deriving from stocks (SI) is taxed following a separate progressive schedule. The tax rates shown in the table are cumulative. This means that the tax rate for a taxpayer in the top tax bracket for instance, is the sum of the tax rates in the bottom, middle and top tax bracket along with the regional tax rate, the labor market and EITC contribution rates. The sum of the tax rates however, can not exceed a marginal tax rate ceiling[31]. If it does then the ceiling is binding.

As shown in Table 12, several changes to the tax system occurred over the years that we consider. In 2009 the income cut-off of the middle and top tax brackets were equalized, while the bottom tax rate went slightly down. The changes were particularly beneficial to taxpayer in the middle bracket for which the marginal tax rate ceiling was not binding and who had a tax base wide enough to fully exploit the change in bottom tax rates. In the following year, the Danish 2010 Tax Reform abolished the middle tax bracket, it lowered the bottom tax rate from 5.04% to 3.67%. As an effect of those changes the marginal tax ceiling was also lowered from 59% to 51.5%. This resulted in substantial decreases in the marginal tax rates on labor income of top and middle taxpayers. As shown in Figure 7, in between 2009 and 2010 the marginal tax rate on labor income in the top bracket declined from 62% to 55% , while the marginal tax rate in the middle bracket went down from 52% to 46%. In the same period the marginal tax rate on labor income in the bottom tax bracket went down by 1 percentage point from 47% to 46%. The same reform also introduced a 40000 DKK deduction on capital income in the top bracket , while increasing the income cut-off of the top tax bracket thus lowering the actual marginal tax rate faced by high income earners even more.

[30]The regional tax consists of a church, a municipality and a county tax. In the exposition that follows we show regional tax rates on the average municipality.

[31]In the case of the labor income, the 8% labor market contributions is added to the ceiling. Since LI enters all other tax bases net of the labor market contributions however, the effective ceiling for labor income is $(MarginalCeiling) \times (1 - 0.08) + 8$.

5.2 The empirical strategy

Prediction 2 from Section 2 implies that in coordinated firms tax rate changes that target one type of workers affect hours worked by other workers in the same firm. We test this hypothesis by modifying the standard empirical model used in the taxation literature (Gruber and Saez (2002)) in two ways. First, we estimate the effect of tax changes on changes in hours worked rather than taxable income. In our setting in fact, a tax rate change might move hours and wage rates in opposite directions making the interpretation of the effects on taxable income difficult. Second, we add one extra term that captures the "spill-over effects" of tax rate changes among coworkers. The estimating equation takes the following form:

$$log\left(\frac{h^L_{ijt+3}}{h^L_{ijt}}\right) = \alpha_0 + \alpha_1\, log\left(\frac{1-\tau^L_{it+3}}{1-\tau^L_{it}}\right) + \alpha_2\, log\left(\frac{\overline{h^H_{jt+3}}}{\overline{h^H_{jt}}}\right) + \alpha_3\, log\left(\frac{y^L_{it+3}}{y^L_{it}}\right) + \alpha_4\, X_{it} + \alpha_5\, Z_{jt} + \epsilon_{ijt} \tag{14}$$

where h^L_{ijt} is the number of hours worked by the low skilled worker i in firm j in year t, while $1-\tau^L_{it}$ and y^L_{it} are respectively the net-of-tax-rate and the virtual income of low skilled workers. X_{it} and Z_{jt} are vectors of individual and firm controls. Finally, $\overline{h^H_{jt}}$ is the average number of hours worked by high skilled coworkers. Based on the predictions from the model, we expect α_2 to be positive and significant. We also expect the coefficient to be larger in magnitude in more coordinated firms.

Following other studies in the literature (e.g. Feldstein (1995), Gruber and Saez (2002)), we consider changes over 3 years. This choice is also consistent with the findings of recent studies on labor supply responses to tax changes in Denmark that highlight how changes in labor supply build up gradually rather than happening soon after the reform (Kleven and Schultz (2014)). Studying changes over 3 years periods also minimize the concerns related to the intertemporal shifting of earnings for tax avoidance. While this is less of a concern in our analysis that is mostly focused on hours, recent studies find evidence of intertemporal shifting induced by the Danish 2010 Tax Reform (Kreiner et al. (2012)).

Due to the non-linearity of the tax system, the marginal net-of-tax-rate and the virtual income can be endogenous to the supply of hours. In our framework, hours worked by coworkers can also be correlated to the supply of hours in coordinated firms. Even absent any coordination, sorting of workers across firms based on unobserved characteristics might provide reasons to think at the change in hours worked by coworkers as endogenous. To deal with these problems, we use (mechanical) changes in marginal tax rates and virtual income driven only by the tax law as an instrument. In practice, we construct a tax simulator for the years 2006-2011 and we use it to simulate post-reform marginal tax rates and virtual incomes under pre-reform behavior. We thus use the mechanical change in the net-of-tax-rate $log\left(1-\tau^L_{Mit+3}\right)-log\left(1-\tau^L_{it}\right)$ and virtual income $log\left(y^L_{Mit+3}\right)-log\left(y^L_{it}\right)$ as an instrument for actual changes $\Delta log\left(1-\tau^L_i\right)$ and $\Delta log\left(1-y^L_i\right)$ respectively. Following a similar approach, we use the average change in the mechanical net-of-tax-rate and virtual income of high skilled coworkers (i.e. $log\left(\overline{1-\tau^H_{Mit+3}}\right)-log\left(\overline{1-\tau^H_{it}}\right)$ and $log\left(\overline{y^H_{Mit+3}}\right)-log\left(\overline{y^H_{it}}\right)$ respectively) as an instrument for the change in hours worked by high skilled coworkers $\Delta log\left(\overline{h^H_j}\right)$.

We define low skilled as those who are either tax exempt or in the bottom tax bracket in the base year t. High skilled on the other hand, are defined as those who are either in the top tax bracket or in the middle tax bracket at t. Figure 8 shows mechanical net-of-tax rate changes for workers in different tax brackets. We notice that while workers at the bottom experience changes that are close to zero, workers in the middle and top tax bracket experience substantial decreases in marginal tax rates. Changes however, are highly heterogeneous across high skilled workers. In particular, those who move from the top to the bottom tax bracket as an effect of the reform experience average changes in the net-of-tax rate greater than 50%, while workers who are in the middle tax bracket or those who stay in the top tax bracket experience much lower changes. Due to the different magnitude of the change, different types of high skilled might respond differently to the tax changes. We thus consider them separately. In particular, since we do not find sizable hours response by the top-bottom movers, in the baseline specification we only consider spill-over from high skilled who either stayed in the top tax bracket or who were in the middle tax bracket in the base year. We then include in the regression the share of top-bottom movers in each firm to control for their effect on hours worked by low skilled. As a robustness check, we then show the results obtained adding on extra group of high skilled to equation (14). While adding the extra group, we use the same type of instrumental variable approach described above for the general case of a single high skilled group.

We use a similar empirical strategy to analyze the effects of the tax rate change on hours worked by high skilled workers. The estimating equation for high skilled takes the following form:

$$log\left(\frac{h^H_{ijt+3}}{h^H_{ijt}}\right) = \beta_0 + \beta_1\, log\left(\frac{1-\tau^H_{it+3}}{1-\tau^H_{it}}\right) + \beta_2\, log\left(\frac{y^H_{it+3}}{y^H_{it}}\right) + \beta_3\, X_{it} + \beta_4\, Z_{jt} + \epsilon_{ijt} \tag{15}$$

We estimate this model separately on firms characterized by higher versus lower coordination. Prediction 3 would suggest in fact, that high skilled react more in firms that coordinate less. We use mechanical changes in tax rates and virtual income as an instrument for actual changes.

To study how changes in tax rate faced by high skilled coworkers relate to wage rates paid to low skilled workers, we use an empirical model similar to the one described above in which we substitute wage rates to hours as dependent variable in equation (14). Based on prediction 4 from Section 2, we expect to find significant spill-over effects on wages of low skilled. The sign of the effect however, depends on whether high skilled coworkers work more or less in response to the tax change. In case hours worked by high skilled decrease (i.e. the income effect prevails), we expect hourly wages of low skilled workers to go down, and the opposite if hours increase.

5.3 Results

Table 13 shows the results obtained from estimating equation (14). We use 2008 as base year and we focus only on firms for which we have data on hours worked on at least 95% of the workers. The main variable of interest in the table is DHOURS HS. That variable captures the spillover effects. We see that the coefficient is significant and robust to an extensive set of income controls. The magnitude of the coefficients suggests that a 1% increase in hours worked by high skilled workers as an effect of the tax rate change leads to an increase of around 1% in the number of hours worked by low skilled workers. In the baseline regression we predict income in the post-reform period using inflation only. In the first 3 columns of Table 14 we follow Dahl and Lochner (2012) to predict post reform income from a a fifth order polynomial of the income in the base year. The spillover effects are robust to this alternative way of obtaining mechanical tax rates. In the last 3 columns of Table 14 we use a different dataset to perform the same analysis. In particular we use administrative data from BFL. We obtain spillover effects of similar magnitude and significance.

Finally Table 15 compare the effects for firms above versus those below the median coordination. We measure coordination in the base year using the standard deviation of hours across skills groups described in the previous sections. The spillover effects are much larger in firms that coordinate more. The results are robust to the inclusion of an extensive set of income controls.

6 Conclusions

This paper discusses the role of the coordination of hours in affecting wages and labor supply responses to tax change. Our findings suggest that coordination plays a key role in predicting wage differentials across firms and in shaping labor supply responses to tax policies. The spillover effects that we document in this paper have so far received little attention in the assessment of the policies that affect the preference over hours of a group of workers in a firm. Our study suggests that they are likely to play a key role and they thus deserve more attention in the future.

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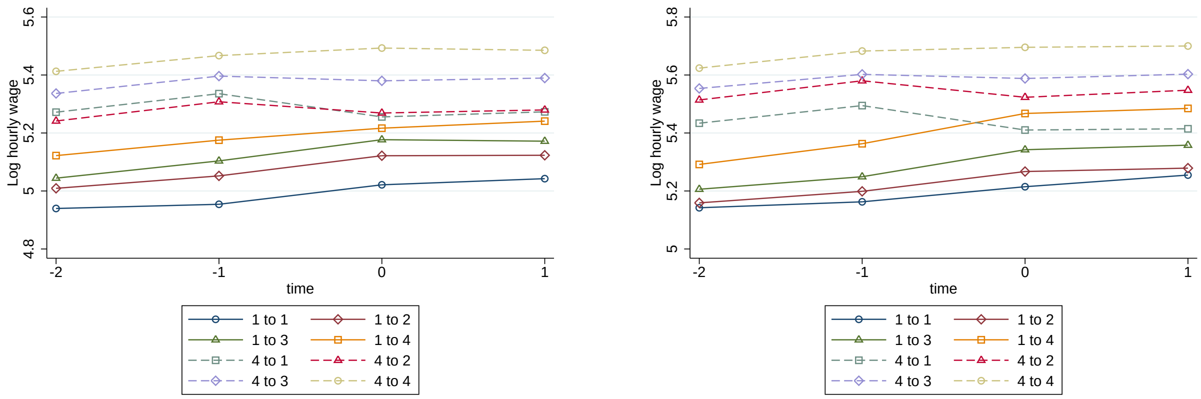
A Figures

Figure 4: Wage Dynamics of Movers



(a) Females (b) Males

Figure 5: Tasks and Coordination of hours (Def. 1 Skills Measure)

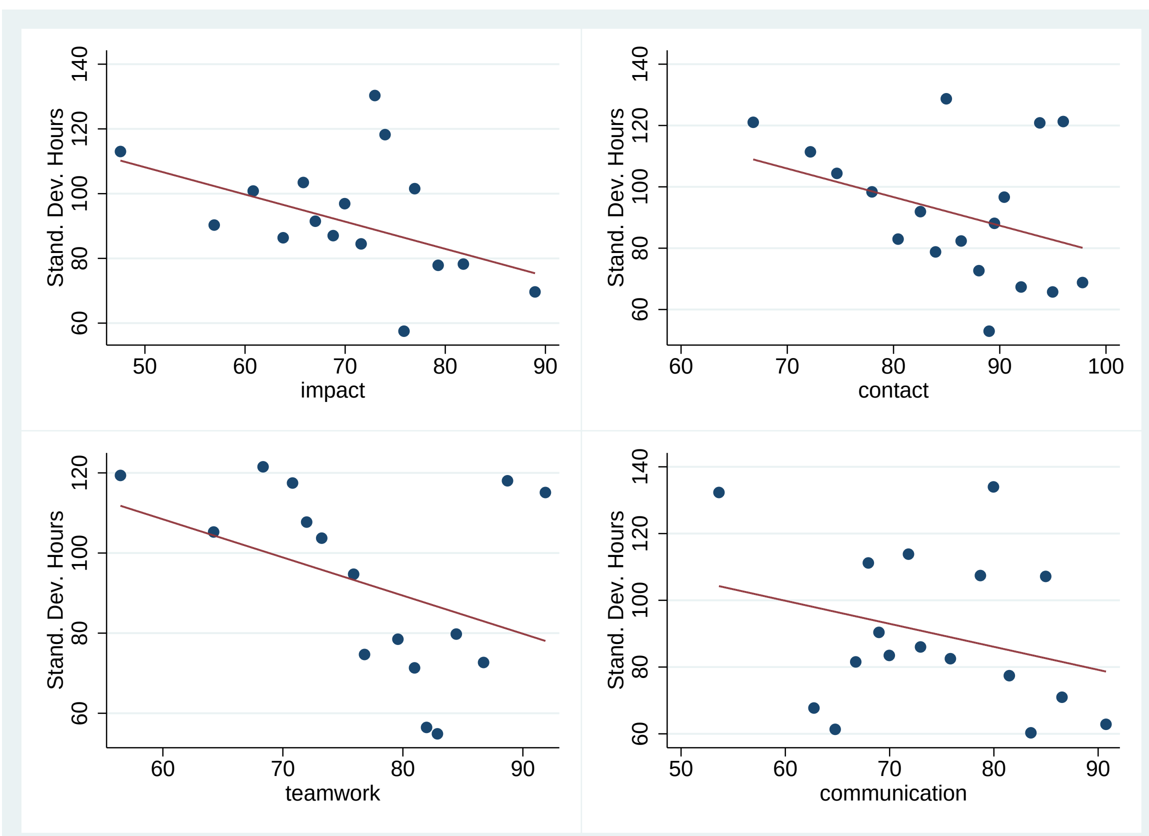


Figure 6: Tasks and Coordination of hours (Def. 2 Education-Occupation)

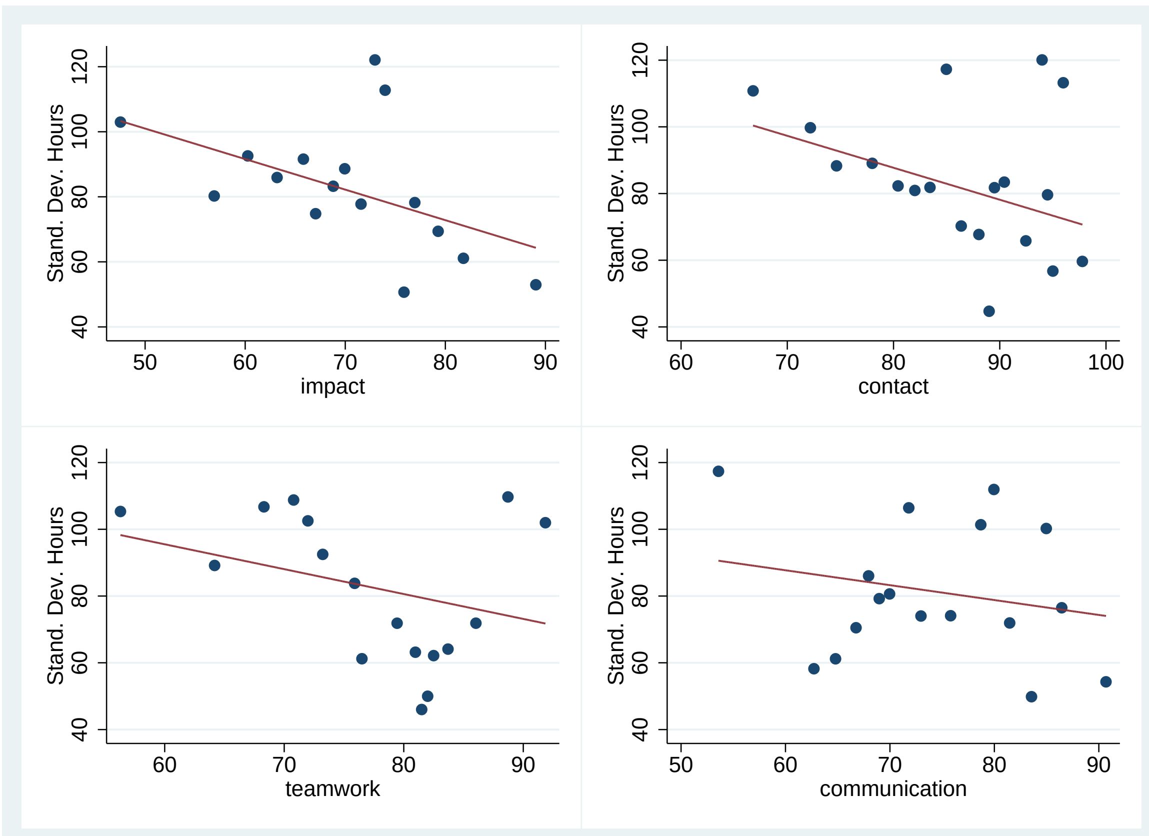


Figure 7: The evolution of the marginal tax rate on labor income

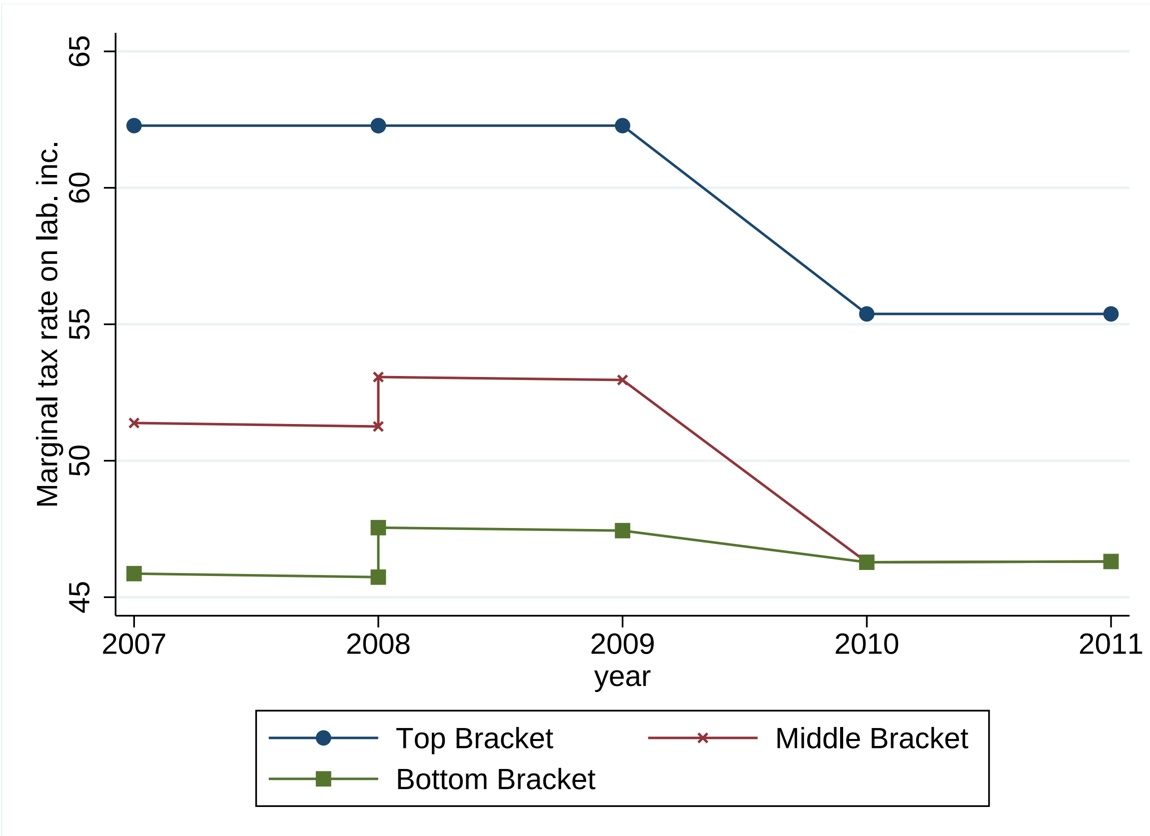
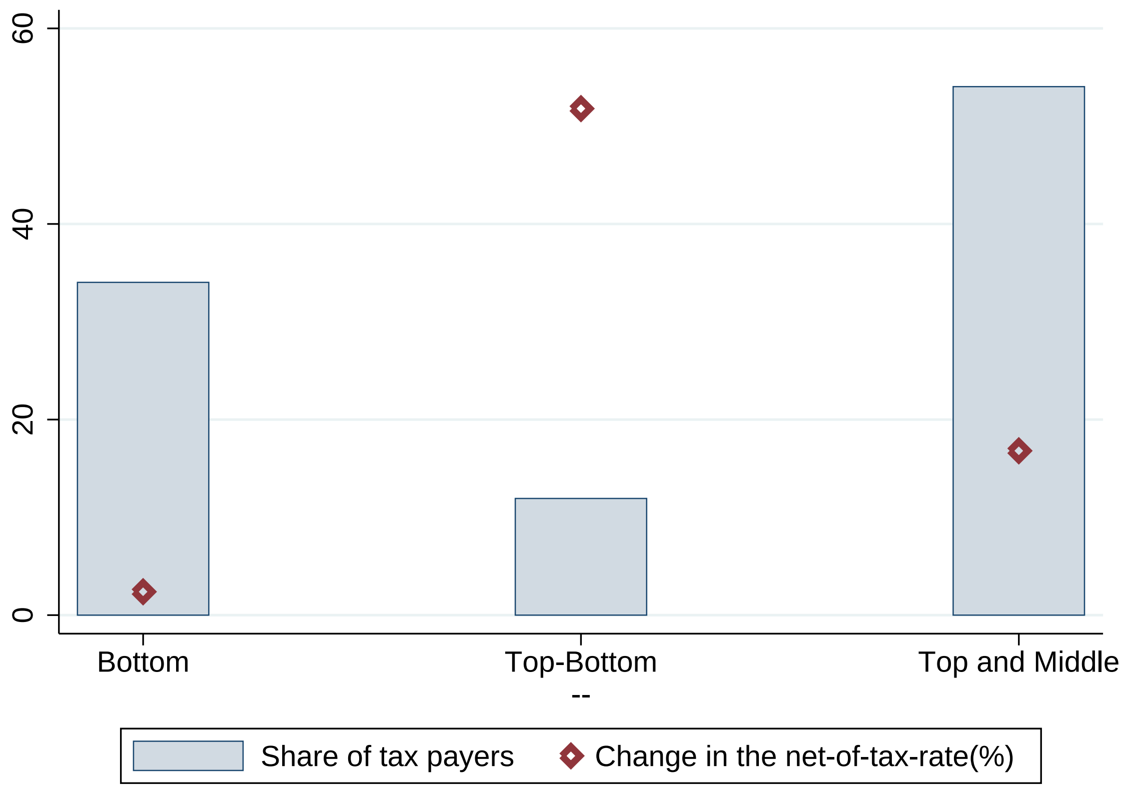


Figure 8: Mechanical Net-of-tax rate changes (%)



B Tables

Table 1: Steps of the data preparation

	Obs.	**Workers**	**Firms**	**Obs. share tot.**	**Workers share tot.**	**Firms share tot.**
1. Entire Population	22,379,298	3,518,236	266,196	1	1	1
2. Lønstatistikken sample	12,130,358	2,649,618	39,778	54.20	75.31	14.94
3. Firms administrative data sample	5,211,149	1,485,789	29,957	23.29	42.23	11.25
4. Keep firms with more than 2 workers	5,209,536	1,485,478	29,576	23.28	42.22	11.11
5. Keep full time workers only	4,476,222	1,207,580	29,116	20.00	34.32	10.94
6. Drop Outliers in hours and income	4,466,676	1,205,301	29,111	19.96	34.26	10.94
7. Keep firms with less than 5% of obs. missing	787,684	400,653	8,293	3.52	11.39	3.12

Table 2: Descriptive Statsitics

	IDA	**IDA merges FirmStat and LON**	**Less than 5% missing**
Workers Characteristics			
Mean Age	39.82	41.11	42.05
Fraction < 30	0.27	0.19	0.16
Fraction > 50	0.27	0.25	0.27
Primary Education	0.33	0.28	0.29
Secondary Education	0.40	0.52	0.51
Tertiary Education	0.25	0.19	0.18
Hourly wage (in kr.)		345.42	186.33
Real Labor Income (annual in 1000 kr.)	267.00	357.93	349.36
Mean Contractual Hours (weekly)		36.16	35.93
Agriculture, forestry and fishing, mining and quarrying	2.52	0.37	0.16
Manufacturing	26.60	32.48	35.73
Construction	10.35	8.67	9.43
Electricity, gas, steam and air conditioning supply, Trade and transport	30.14	43.46	40.82
Financial and insurance, Real estate, Other business	22.95	14.82	13.71
Public administration, education, health, arts, entertainment and other services	7.44	0.2	0.15
Firms Characteristics			
Mean Firm Size		51.42	43.78
Mean Capital per employee (1000 kr.)		462.75	525.64
Mean Value Added per employee (1000 kr.)		475.56	526.34
Mean Revenues per employee (1000 kr.)		1841.47	2269.169
Exporters (%)		39.40	39.97
Number of observations	22,379,298	4,466,676	787,684
Number of individuals	3,518,236	1,205,301	400,653
Number of firms	266,196	26,402	8,293

Data on employment by industry for the entire population are from Statistikbanken (Statistics Denmark).
Annual Earnings are deflated using the CPI with base year 2000.

Table 3: Dynamics in Hours of Movers

Average change in weekly hours worked by movers

Type of origin firm	Males	Averg obs.	Females	Averg obs.
1st Quartile	-0.083	1176	-0.142	874
2nd Quartile	-0.053	1233	-0.146	596
3rd Quartile	0.017	2213	-0.013	1039
4th Quartile	-0.048	1971	-0.169	1033

Average change in weekly hours worked by movers
Breakdown for top and bottom paying firms

Sending to Receiving firm	Males	Averg obs.	Females	Averg obs.
1st to 1st	-0.007	579	0.268	574
1st to 2nd	-0.210	303	-0.622	152
1st to 3rd	-0.117	193	-0.087	99
1st to 4th	0.002	100	-0.128	48
4th to 1st	-0.044	61	-0.273	39
4th to 2nd	-0.023	160	-0.298	84
4th to 3rd	0.008	471	0.004	274
4th to 4th	-0.134	1279	-0.109	636

The tables shows changes in average weekly hours worked in the two years prior to the job change versus the two years after the change.
Averages in the top panel are weighted by the number of movers in each quartile and in each one of the 5 4-years intervals in 2003-2011.

Table 4: Average hours worked in skills groups dominated firms

Panel A: Skill group definition 1 (deciles of the skills distribution)		
Deciles	**Av. Annual Hours Worked**	**Obs**
1st	1878.94	5680
2nd	1866.07	1113
3rd	1871.17	864
4th	1873.43	812
5th	1856.78	838
6th	1880.04	858
7th	1869.34	904
8th	1884.49	955
9th	1885.60	995
10th	1913.33	3356

Panel B: Skill group definition 2 (education-occupation)		
	Av. Annual Hours Worked	**Obs**
Primary Education		
Blue Collar	1856.40	10871
Middle Manager	1937.22	442
Manager	1939.10	512
Secondary Education		
Blue Collar	1874.74	63255
Middle Manager	1877.53	8387
Manager	1954.07	2259
Tertiary Education		
Blue Collar	1908.85	353
Middle Manager	1937.12	19511
Manager	1934.57	610

Each cell shows average annual hours worked in firms with a share of workers in that skill group of 0.9 or higher.

Table 5: Coordination and Firm Characteristics

	Std Dev. Def. 1 (deciles of skills distr.)	Obs.	Std. hours Def. 2 (education-occupation)	Obs.
Share of union members	39.99401***	16044	38.92407***	17315
	(4.14085)		(3.34168)	
Value Added /employee	-0.00266***	16044	-0.00283***	17315
	(0.00063)		(0.00054)	
Capital/employee	-0.00002	16044	-0.00002	17315
	(0.00003)		(0.00002)	
Sales/employee	-0.00029***	16044	-0.00045***	17315
	(0.00008)		(0.00008)	
Firm size	-0.00602***	16044	-0.00323*	17315
	(0.00206)		(0.00180)	
Share of tertiary educ. workers	-86.54217***	16044	-68.60837***	17315
	(3.99829)		(3.38437)	
Number of plants	-0.34081***	16044	-0.26804***	17315
	(0.11224)		(0.09820)	
Exporter status	-30.05073***	15267	-30.44008***	16475
	(1.70045)		(1.43741)	
Multiplant indic.	-11.86330***	15735	-12.61826***	16994
	(2.09149)		(1.78714)	
Share of hourly workers	105.53935***	16044	104.41898***	17315
	(2.49664)		(2.08490)	

The table shows the estimated coefficients from a regression of the standard deviation of hours (Def 1 or 2) on firm characteristics.

Table 6: Coordination by sector

	Std Dev. Def. 1 (deciles of skills distr.)	Std. hours Def. 2 (education occupation)	Unionization rate
Coordination by Industry (2003-2011)			
Agriculture, forestry and fishing, mining and quarrying	132.42	117.73	0.67
Manufacturing	113.84	100.12	0.76
Constructions	144.47	129.38	0.71
Electricity, gas, steam and air conditioning supply, Trade and transport	79.34	65.15	0.64
Financial and insurance, Real estate, Other business	90.88	75.82	0.63
Public administration, education, health, arts, entertainment and other services	63.02	62.80	0.70
Observations	7589	8280	8280

Table 7: Summary Statistics of the AKM regression

	IDA Merge FIDA and LON sample	**Largest group of connected firms**
Person and estabilishment parameters		
Number of person effects	1205292	1195881
Number of firm effects	26227	26121
Summary of parameters estimates		
Std. dev. of person effects	0.964	0.962
Std. dev. of firm effects	0.143	0.138
Std. dev. Of Xb	0.839	0.838
RMSE of AKM residuals	0.289	
Adjusted R-squared	0.911	
Std. dev. of log wages	0.452	0.452
Sample size	4466650	4445479

Controls in first step (AKM) regressions: year dummies interacted with education dummies, quadratic and cubic terms in age interacted with with education dummies, VA per employee, capital per employee, sales per employee, exporter status, fraction of salaried workers, tenure, work experience, marital status, number of children, dummy for the first child, occupational dummies, regional dummies.

Table 8: Coordination and wage premiums

	(1) **Firm fe**	(2) **Firm fe**	(3) **Firm fe**	(4) **Firm fe**	(5) **Firm fe**	(6) **Firm fe**	(7) **Firm fe**	(8) **Firm fe**
Stand. Dev. Def. 1	-0.00014***	-0.00014***	-0.00010**	-0.00007				
	(0.00004)	(0.00004)	(0.00004)	(0.00004)				
Stand. Dev. Def. 2					-0.00017***	-0.00011***	-0.00010**	-0.00008**
					(0.00005)	(0.00003)	(0.00004)	(0.00004)
log(Cap/empl)		0.00400	0.00498*	-0.00158		0.00754***	0.00768***	0.00278
		(0.00264)	(0.00254)	(0.00286)		(0.00236)	(0.00223)	(0.00244)
Firm size		0.00002*	0.00002*	0.00002**		0.00002**	0.00002**	0.00002**
		(0.00001)	(0.00001)	(0.00001)		(0.00001)	(0.00001)	(0.00001)
Exporter status		0.03840***	0.02851**	0.01540		0.03570***	0.02480**	0.01453
		(0.01083)	(0.01266)	(0.01227)		(0.00945)	(0.01192)	(0.01270)
Union. Rate		-0.00235	0.03026	0.03112		-0.01802	0.00145	-0.00025
		(0.02397)	(0.03135)	(0.03154)		(0.02622)	(0.03105)	(0.03052)
log(VA/empl)				0.06311***				0.03734***
				(0.00963)				(0.01099)
log(Sales/empl)				0.00798				0.01200
				(0.00990)				(0.00797)
Compos. cntr	NO	YES	YES	YES	NO	YES	YES	YES
Region fe	NO	NO	YES	YES	NO	NO	YES	YES
Industry fe	NO	NO	YES	YES	NO	NO	YES	YES
R-sq	0.0033	0.0422	0.0541	0.0705	0.0039	0.0233	0.0305	0.0380
N	7336	7336	7336	7336	7409	7409	7409	7409

All regressions contain quadratic and cubic terms of capital per employee (Capital/empl) and a multi-plant dummy.
Specifications (4) and (8) also control for quadratic and cubic terms in value added per employee.
Standard errors in parentheses. Standard errors are clustered at the two digits industry level.
*, ** and *** are 10, 5 and 1 percent significance levels.

Table 9: Evaluating the effect of coordination on wage differentials

	(1) **Firm fe**	(2) **Firm fe**	(3) **Firm fe**	(4) **Firm fe**	(5) **Firm fe**	(6) **Firm fe**	(7) **Firm fe**	(8) **Firm fe**
Stand. Dev. Def. 1	-0.05711***	-0.04305**						
	(0.00004)	(0.00004)						
Stand. Dev. Def. 2					-0.04270***	-0.03560**		
					(0.00003)	(0.00004)		
log(Cap/empl)	0.02563	0.03190*	-0.01486	-0.01048	0.04707***	0.04788***	0.01768	0.01731
	(0.00264)	(0.00254)	(0.00286)	(0.00284)	(0.00236)	(0.00223)	(0.00242)	(0.00242)
Firm size	0.02331*	0.02087*	0.02383**	0.02136**	0.02276**	0.01997**	0.02311**	0.02032**
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Exporter status	0.07841***	0.05822**	0.05526**	0.03331	0.07083***	0.04921**	0.05268**	0.03050
	(0.01083)	(0.01266)	(0.01093)	(0.01264)	(0.00945)	(0.01192)	(0.01163)	(0.01303)
Union. Rate	-0.00199	0.02561	0.00766	0.02592	-0.01486	0.00120	-0.01243	-0.00120
	(0.02397)	(0.03135)	(0.02727)	(0.03241)	(0.02622)	(0.03105)	(0.02920)	(0.03167)
log(VA/empl)			0.15509***	0.13733***			0.08786***	0.08048***
			(0.01034)	(0.00964)			(0.00916)	(0.01061)
log(Sales/empl)			0.01986	0.02830			0.03733	0.03963
			(0.01146)	(0.00985)			(0.00937)	(0.00795)
Compos. cntr	YES	YES	YES	YES	YES	YES	YES	YES
Region fe	NO	YES	NO	YES	NO	YES	NO	YES
Industry fe	NO	YES	NO	YES	NO	YES	NO	YES
Part. R-sq SD Hours	0.003790	0.001138			0.001786	0.001100		
Part. R-sq VA and Sales			0.0157	0.0120			0.0077	0.0064
SD contribution	0.241	0.095			0.232	0.172		
R-sq	0.0422	0.0541	0.0608	0.0698	0.0233	0.0305	0.0310	0.0374
N	7336	7336	7336	7336	7409	7409	7409	7409

All regressions show beta coefficients. Standard errors in parentheses refer to the non-standardized coefficient.
All regressions contain quadratic and cubic terms of capital per employee (Capital/empl) and a multi-plant dummy.
Specification (3) (4) (7) and (8) also include quadratic and cubic terms of Value added per employee.
SD contribution is derived as the ratio of Part. R-sq SD Hours and Part. R-sq VA and Sales.
Part. R-sq VA and Sales accounts for the contribution of quadratic and cubic terms of the VA per employee.
Standard errors are clustered at the two digits industry level. *, ** and *** are 10, 5 and 1 percent significance levels.

Table 10: Coordination and wage differentials: Robustness checks

	(1) **Firm fe**	(2) **Firm fe**	(3) **Firm fe**	(4) **Firm fe**	(5) **Firm fe**	(6) **Firm fe**
Stand. Dev. Def. 1		-0.00029***		-0.00015		-0.00017***
		(0.00005)		(0.00015)		(0.00004)
Stand. Dev. Def. 2	-0.00034***		-0.00016		-0.00009**	
	(0.00005)		(0.00011)		(0.00004)	
log(Cap/empl)	0.02080*	0.01735	0.03450***	0.01283	0.00869***	0.00507
	(0.01078)	(0.01652)	(0.00892)	(0.01663)	(0.00289)	(0.00334)
Firm size	-0.00010	-0.00003	0.00159**	0.00120	0.00001***	0.00001***
	(0.00027)	(0.00026)	(0.00067)	(0.00100)	(0.00000)	(0.00000)
Exporter status	0.02633	0.00447	0.06760	-0.00080	0.01903**	0.02647***
	(0.04201)	(0.04009)	(0.05256)	(0.05270)	(0.00849)	(0.00765)
Union. Rate	0.10828**	0.15432***	0.10993*	0.10521	-0.00434	0.01864
	(0.05244)	(0.03276)	(0.05796)	(0.06931)	(0.02246)	(0.02231)
Compos. cntr	YES	YES	YES	YES	YES	YES
All Firms in the largest set of connected firms	YES	YES	NO	NO	YES	YES
Hourly Workers only	NO	NO	YES	YES	NO	NO
Firms that never exit the sample	NO	NO	NO	NO	YES	YES
R-sq	0.028052	0.058617	0.007593	0.014503	0.056079	0.159029
N	1527	1761	412	440	3381	3381

All regressions contain quadratic and cubic terms of capital per employee (Capital/empl) and a multi-plant dummy.
Standard errors in parentheses. Standard errors are clustered at the two digits industry level.
*, ** and *** are 10, 5 and 1 percent significance levels.

Table 11: Income Types in the Danish Tax System

Acronym	**Income Type**	**Main Intems Included**
LI	Labor income	Salary, wages, honoraria, fees, bonuses, fringe benefits, business earnings
PI	Personal income	LI+ transfers, grants, awards, gifts, received alimony -Labor market contribution, certain pension contributions
CI	Capital income	Interest income, rental income, business capital income -interest on debt (mortgage, bank loan, credit cards, student loans)
D	Deductions	Commuting costs, union fees, UI contribution, other work expenditures, charity, paid alimony
PCP		Private capital pension contribution
ECP		Employer paid capital pension contribution
TI	Taxable income	PI+CI-D
SI	Stock Income	Dividends and realized capital gains from shares

Table 12: Persona Income Tax System in Denmark

	2008			2009		
Tax type	**Base**	**Rate**	**Tax Bracket (DKK)**	**Base**	**Rate**	**Tax Bracket (DKK)**
Regional tax*	TI	33.16		TI	33.21	
National taxes						
Bottom tax	PI+CI(>0)	5.48	0 - 279799	PI+CI(>0)	5.04	0 - 347199
Middle tax	PI +CI(>0)	6.0	279800 - 335799	PI +CI(>0)	6.0	>347200
Top tax	PI+CI(>0)+PCP+ECP	15.0	335800	PI +CI(>0)+PCP+ECP	15.0	>347200
Labor market contribution	LI	8.0		LI	8.0	
EITC	LI	4.0		LI	4.25	
Tax on stock income	SI	28.0, 43.0, 45.0		SI	28.0, 43.0. 45.0	
Marginal tax ceiling	PI/CI/TI	59.0		PI/CI/TI	59.0	

	2010			2011		
Tax type	**Base**	**Rate**	**Tax Bracket (DKK)**	**Base**	**Rate**	**Tax Bracket (DKK)**
Regional tax*	TI	33.32		TI	33.38	
National taxes						
Bottom tax	PI+CI(>0)	3.67	0 - 389899	PI+CI(>0)	3.64	0 - 389899
Middle tax	-	-		-	-	
Top tax	PI +CI(>40000)+PCP+ECP	15.0	>389900	PI +CI(>40000)+PCP+ECP	15.0	>389900
Labor market contribution	LI	8.0		LI	8.0	
EITC	LI	4.25		LI	4.25	
Tax on stock income	SI	28.0, 42.0		SI	28.0, 42.0	
Marginal tax ceiling	PI/CI/TI	51.5		PI/CI/TI	51.5	

The regional tax includes municipal, county and church taxes. The Regional Tax Rate is the average across municipalities.
The sum of regional and National taxes (with the exclusion of the stock income tax) can not exceed the Marginal Tax ceiling.

Table 13: The spillover effects of a tax rate change

	(1) DHOURS	(2) DHOURS	(3) DHOURS	(4) DHOURS	(5) DHOURS	(6) DHOURS	(7) DHOURS
1-MTR SLS	0.02054	0.02297	0.01810	-0.02241	-0.02063	-0.01873	-0.03613
	(0.06005)	(0.06054)	(0.05976)	(0.06359)	(0.09253)	(0.06934)	(0.07019)
DHOURS HS	0.99202***	1.00597***	0.95378***	1.12795***	1.17828***	1.17642***	1.16911***
	(0.28085)	(0.29786)	(0.32219)	(0.31111)	(0.34818)	(0.35370)	(0.35428)
VI SLS	0.00125	0.00069	0.00091	-0.00416	-0.00905	-0.00896	-0.01292
	(0.01622)	(0.01608)	(0.01612)	(0.01565)	(0.02587)	(0.01944)	(0.01877)
Unemp. Ind.		-0.00220	-0.00210	0.10822	-0.00245	-0.00247	-0.00246
		(0.00202)	(0.00201)	(0.08221)	(0.00170)	(0.00170)	(0.00170)
Unemp. Firm		0.00231	0.00188	0.00310	0.00222	0.00220	0.00217
		(0.00241)	(0.00242)	(0.00225)	(0.00230)	(0.00231)	(0.00230)
Exp.	0.00085	0.00086	0.00079	0.00090	0.00107*	0.00097	0.00098*
	(0.00075)	(0.00075)	(0.00074)	(0.00077)	(0.00062)	(0.00060)	(0.00059)
Exp.$\hat{2}$	-0.00003	-0.00003*	-0.00003	-0.00004*	-0.00004**	-0.00003**	-0.00003**
	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)
Sex	0.00629***	0.00645***	0.00644***	0.00579***	0.00672***	0.00699***	0.00687***
	(0.00236)	(0.00240)	(0.00247)	(0.00215)	(0.00236)	(0.00237)	(0.00234)
Married dum.	-0.00168	-0.00177	-0.00170	-0.00193	-0.00239	-0.00236	-0.00250
	(0.00156)	(0.00157)	(0.00156)	(0.00149)	(0.00160)	(0.00158)	(0.00160)
Age	0.00016	0.00015	0.00012	0.00018	0.00010	0.00009	0.00009
	(0.00014)	(0.00014)	(0.00014)	(0.00015)	(0.00013)	(0.00013)	(0.00013)
Exporter dum.	0.00765**	0.00819**	0.00302	0.01004***	0.00844***	0.00845***	0.00845***
	(0.00375)	(0.00363)	(0.00412)	(0.00343)	(0.00316)	(0.00315)	(0.00313)
Share of HS	-0.01344	-0.01436	-0.01119	-0.01556	-0.01545	-0.01511	-0.01484
	(0.01026)	(0.01021)	(0.01031)	(0.00955)	(0.00977)	(0.00956)	(0.00949)
Share Top-Bot.	-0.01520	-0.01296	-0.00758	-0.01475	-0.01051	-0.00924	-0.00979
	(0.01924)	(0.01891)	(0.01849)	(0.01906)	(0.01720)	(0.01732)	(0.01747)
Splines DY_t	YES	YES	YES	YES	NO	NO	NO
Region fe	YES	YES	YES	NO	YES	YES	YES
Municip. fe	NO	NO	NO	YES	NO	NO	NO
Movers	NO	NO	NO	NO	NO	NO	NO
Ind. fe	NO	NO	YES	YES	NO	NO	NO
Y_t	NO	NO	NO	NO	YES	NO	NO
Splines Y_t	NO	NO	NO	NO	NO	YES	NO
5th Ord. Polyn. Y_t	NO	NO	NO	NO	NO	NO	YES
N	10078	10078	10078	10078	14385	14385	14385

Each regression includes controls for educational attainments, number of children, a dummy for being married, firm size and a multi-plant dummy.

Table 14: The spillover effects of a tax rate change: Robustness checks

	(1) DHOURS PRED. INC	(2) DHOURS PRED. INC	(3) DHOURS PRED. INC	(4) DHOURS BFL	(5) DHOURS BFL	(6) DHOURS BFL
1-MTR SLS	0.07408	0.07448	0.07136	-0.48611***	-0.47952***	-0.46623***
	(0.08387)	(0.08284)	(0.08514)	(0.08832)	(0.08734)	(0.09582)
DHOURS HS NM	1.32606**	1.30601**	1.30396**	0.84539*	0.96780**	1.23804**
	(0.56375)	(0.54853)	(0.60290)	(0.44857)	(0.49329)	(0.59044)
VI SLS	0.01760	0.01751	0.01681	-0.13524***	-0.13180***	-0.12283***
	(0.01760)	(0.01749)	(0.01758)	(0.02923)	(0.02993)	(0.03484)
Unemp. Ind.		-0.00074	-0.00074		-0.00133	-0.00187
		(0.00126)	(0.00124)		(0.00165)	(0.00195)
Unemp. Firm		-0.00101	-0.00115		0.00157	0.00287
		(0.00206)	(0.00220)		(0.00242)	(0.00309)
Exp.	0.00108**	0.00107**	0.00105**	0.00273***	0.00276***	0.00283***
	(0.00053)	(0.00053)	(0.00054)	(0.00054)	(0.00054)	(0.00060)
Exp.$\hat{2}$	-0.00004**	-0.00004**	-0.00004**	-0.00007***	-0.00007***	-0.00007***
	(0.00002)	(0.00002)	(0.00002)	(0.00001)	(0.00002)	(0.00002)
Sex	0.00633***	0.00640***	0.00666***	-0.01451***	-0.01518***	-0.01694***
	(0.00227)	(0.00225)	(0.00233)	(0.00370)	(0.00382)	(0.00370)
Married dum.	-0.00156	-0.00160	-0.00159	-0.00890***	-0.00919***	-0.00959***
	(0.00170)	(0.00169)	(0.00169)	(0.00171)	(0.00179)	(0.00186)
Age	0.00019	0.00019	0.00017	0.00003	0.00004	0.00006
	(0.00015)	(0.00014)	(0.00015)	(0.00014)	(0.00014)	(0.00015)
Exporter dum.	0.00762**	0.00767**	0.00381	0.00967***	0.00982***	0.00648
	(0.00342)	(0.00341)	(0.00382)	(0.00294)	(0.00295)	(0.00477)
Share of LS	0.00423	0.00559	0.00198	-0.05114***	-0.05041***	-0.04810***
	(0.02092)	(0.01975)	(0.01974)	(0.00936)	(0.00963)	(0.01162)
Share of HS	-0.01948	-0.01783	-0.01933	-0.01589	-0.01763	-0.02126
	(0.02235)	(0.02187)	(0.02161)	(0.01705)	(0.01759)	(0.02006)
Splines DY_t	YES	YES	YES	YES	YES	YES
Region fe	YES	YES	YES	YES	YES	YES
Ind. fe	NO	NO	YES	NO	NO	YES
N	13641	13641	13641	118189	118182	118170

Table 15: High versus Low coordination firms

	(1) DHOURS SD Def. 1 ABOVE MEDIAN	(2) DHOURS SD Def. 1 BELOW MEDIAN	(3) DHOURS SD Def. 1 ABOVE MEDIAN	(4) DHOURS SD Def. 1 BELOW MEDIAN	(5) DHOURS SD Def. 1 ABOVE MEDIAN	(6) DHOURS SD Def. 1 BELOW MEDIAN
1-MTR SLS	0.00096	-0.04547	0.00018	-0.04191	-0.00826	-0.04173
	(0.16194)	(0.07262)	(0.15946)	(0.07156)	(0.15856)	(0.07319)
DHOURS HS NM	-0.13589	2.47930***	0.04759	2.71201***	0.25924	2.59179***
	(1.11053)	(0.60685)	(0.96847)	(0.75513)	(0.89475)	(0.72121)
VI SLS	0.03055	-0.00644	0.02811	-0.00740	0.02761	-0.00568
	(0.03827)	(0.01758)	(0.03724)	(0.01719)	(0.03698)	(0.01773)
Exp.	0.00346*	-0.00072	0.00333*	-0.00069	0.00312*	-0.00072
	(0.00210)	(0.00116)	(0.00195)	(0.00117)	(0.00189)	(0.00117)
Exp.$\hat{2}$	-0.00010**	0.00001	-0.00009**	0.00001	-0.00009**	0.00001
	(0.00005)	(0.00003)	(0.00005)	(0.00003)	(0.00005)	(0.00003)
Sex	0.00787	0.00542***	0.00680	0.00627***	0.00772	0.00526***
	(0.00568)	(0.00207)	(0.00560)	(0.00211)	(0.00564)	(0.00190)
Married dum.	0.00010	0.00111	0.00020	0.00102	0.00038	0.00098
	(0.00362)	(0.00217)	(0.00353)	(0.00218)	(0.00353)	(0.00218)
Age	0.00019	-0.00012	0.00025	-0.00012	0.00024	-0.00011
	(0.00042)	(0.00015)	(0.00038)	(0.00015)	(0.00037)	(0.00015)
Exporter dum.	0.01143	0.00115	0.01034	0.00450	-0.00044	0.00455
	(0.00855)	(0.00400)	(0.00801)	(0.00424)	(0.00891)	(0.00400)
Multiplant	0.00154	-0.00366	0.00487	-0.00322	0.00151	0.00060
	(0.00936)	(0.00384)	(0.00901)	(0.00391)	(0.00825)	(0.00588)
Share of HS	-0.03952*	-0.00477	-0.04798**	-0.00644	-0.04392**	-0.00888
	(0.02295)	(0.01357)	(0.02002)	(0.01410)	(0.02030)	(0.01296)
Share Top-Bot.	-0.00001	0.02545	-0.00185	0.03052	0.01143	0.03555*
	(0.04236)	(0.02456)	(0.03901)	(0.02319)	(0.04057)	(0.02137)
Unemp. Ind.			0.00469	-0.00470***	0.00371	-0.00414**
			(0.00425)	(0.00168)	(0.00393)	(0.00169)
Unemp. Firm			-0.01031*	0.00430*	-0.00912*	0.00412*
			(0.00558)	(0.00242)	(0.00538)	(0.00219)
Splines DY_t	YES	YES	YES	YES	YES	YES
Region fe	YES	YES	YES	YES	YES	YES
Year fe	YES	YES	YES	YES	YES	YES
Movers	NO	NO	NO	NO	NO	NO
Ind. fe	NO	NO	NO	NO	YES	YES
N	2150	3462	2150	3462	2150	3462

C Supplementary derivations

Optimal hours worked: the firm maximization problem

Firms are assumed to maximize profits:

$$\max_{N_L,N_H,h} F(N_L h, N_H h) - w_L(h)N_L h - w_H(h)N_H h \tag{C.1}$$

The first order conditions relative to this maximization problem are given by

$$w'_L(h)hN_L + w_L(h)N_L + w'_H hN_H + w_H(h)N_H = F_H N_H + F_L N_L \tag{C.2}$$

$$F_H = w_H(h) \tag{C.3}$$

$$F_L = w_L(h) \tag{C.4}$$

Replacing F_H from (C.3) and F_L from (C.4) into (C.2) we obtain

$$w'_H(h)N_H h + w'_L N_L h = 0 \tag{C.5}$$

dividing by $N_H h$ and setting $\alpha = \frac{N_L}{N_H}$ we obtain condition (7).

Quasi-linear utility function with constant elasticity

Let us assume the utility function to take the following functional form

$$U(c_i, h_i) = c_i - \beta_i^{-\frac{1}{\varepsilon}} \frac{h_i^{1+\frac{1}{\varepsilon}}}{1+\frac{1}{\varepsilon}} \tag{C.6}$$

Condition (4) can then be written as:

$$w_i(1-t_i)h - \beta_i^{-\frac{1}{\varepsilon}} \frac{h^{1+\frac{1}{\varepsilon}}}{1+\frac{1}{\varepsilon}} = w_i^*(1-t_i)h_i^* - \beta_i^{-\frac{1}{\varepsilon}} \frac{h_i^{*1+\frac{1}{\varepsilon}}}{1+\frac{1}{\varepsilon}} \tag{C.7}$$

where h_i^* is determined as the solution to the following maximization problem:

$$\max_h w_i^*(1-t_i)h - \beta_i^{-\frac{1}{\varepsilon}} \frac{h^{1+\frac{1}{\varepsilon}}}{1+\frac{1}{\varepsilon}} \tag{C.8}$$

where the wage w_i^* is taken as given. The resulting optimal supply of hours worked is

$$h_i^* = \left[w_i^*\left(1-t_i\right)\beta_i^{\frac{1}{\varepsilon}}\right]^{\varepsilon} \tag{C.9}$$

Plugging h^* from (C.9) into (C.7) we obtain the following wage function

$$w_i\left(h\right) = \left\{\beta_i^{-\frac{1}{\varepsilon}} \frac{h^{\frac{1}{\varepsilon}+1}}{1+\frac{1}{\varepsilon}} \frac{1}{(1-t_i)} + \left[w_i^*(1-t_i)\right]^{1+\varepsilon} \frac{\beta_i}{1+\varepsilon}\right\} \frac{1}{(1-t_i)h} \tag{C.10}$$

The first derivative of the wage function in (C.10) is

$$\frac{\partial w_i}{\partial h} = \left[\frac{\beta_i^{-\frac{1}{\varepsilon}} h^{\frac{1}{\varepsilon}}}{(1-t_i)} - \frac{w^{*\varepsilon+1}(1-t_i)^{\varepsilon}\beta_i}{h}\right] \frac{1}{h\left(\varepsilon+1\right)} \tag{C.11}$$

When $h = h_i^* = \left[w_i^*\left(1-t_i\right)\beta^{\frac{1}{\varepsilon}}\right]^{\varepsilon}$ the first derivative of the wage function is

$$w_i'\left(h\right) = \left[w_i^* - w_i^*\right] \frac{1}{h\left(\varepsilon+1\right)} = 0 \tag{C.12}$$

If $h \neq h_i^*$ the sign of the first derivative is determined by the sign of:

$$\left[\beta_i^{-\frac{1}{\varepsilon}} h^{\frac{1}{\varepsilon}+1} - w_i^{*\varepsilon+1}(1-t_i)^{\varepsilon+1}\beta_i\right] \tag{C.13}$$

This is greater than zero when

$$\frac{1}{\varepsilon}\log h > log\left[w_i^*(1-t_i)\beta_i^{\frac{1}{\varepsilon}}\right] \tag{C.14}$$

If $\varepsilon > 0$ this is satisfied when $h > h_i^*$. Similarly $w_i' < 0$ when $h < h_i^*$.

The second derivative of the wage function is

$$w_i''(h) = \left[\left(\frac{1-\varepsilon}{\varepsilon} \right) \frac{\beta_i^{-\frac{1}{\varepsilon}} h^{\frac{1}{\varepsilon}}}{(1-t_i)} + \frac{2w^{*\varepsilon+1}(1-t_i)^{\varepsilon}\beta_i}{h} \right] \frac{1}{h^2(\varepsilon+1)} \tag{C.15}$$

that is positive if $-1 < \varepsilon < 1$. Under the assumption of $0 < \varepsilon < 1$ we thus have a positive first derivative on the right of the optimum, a negative first derivative on its left and a positive second derivative.

The case of a generic quasi-linear utility function

Let us assume the utility function to take the following functional form

$$U(c_i, h_i) = c_i - v(h_i) \tag{C.16}$$

Condition (4) can then be written as:

$$w_i(1-t_i)h - v(h) - w_i^*(1-t_i)h_i^* + v(h_i^*) = 0 \tag{C.17}$$

(C.17) implicitly defines w_i as a function of h. We can thus use the implicit function theorem to derive

$$w_i' = -\frac{w(1-t_i) - v'(h)}{h(1-t_i)} \tag{C.18}$$

when $h = h_i^*$ then $w(1-t_i) = v'(h)$ that implies $w_i' = 0$. When $h > h_i^*$, if the utility function satisfies decreasing marginal rate of substitution (i.e. if it's well behaved) then $w(1-t_i) < v'(h)$ that implies $w_i' > 0$. Finally if $h < h_i^*$ and if the utility function is well behaved then $w(1-t_i) > v'(h)$ that implies $w_i' < 0$.

Starting from (C.18), the second derivative of the wage function takes the following form

$$w_i'' = \frac{w(1-t_i) - v'(h) + v''(h) - w'(1-t_i)}{h^2(1-t_i)} \tag{C.19}$$

if $h < h_i^*$ then $w(1-t_i) > v'(h)$ and $w' < 0$ thus $w_i'' > 0$ [32]. When $h > h_i^*$ then under the assumption $v''(h) > 2w'(1-t_i)\,h$ we have $w_i'' > 0$.

[32] We keep here the assumption of the well bahaved utility function. This assumption not only implies that $w(1-t_i) > v'(h)$ when $h < h_i^*$, it also implies $v''(h) > 0$.