National Institute of Economic and Social Research

UNION DENSITY, PRODUCTIVITY, AND WAGES

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Erling Barth, Alex Bryson, and Harald Dale-Olsen

Abstract

We exploit tax-induced exogenous variance in the price of union membership to identify the effects of changes in firm union density on firm productivity and wages in the population of Norwegian firms over the period 2001 to 2012. Increases in union density lead to substantial increases in firm productivity and wages having accounted for the potential endogeneity of unionization. The wage effect is larger in more productive firms, consistent with rent-sharing models.

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1. Introduction

Do unions promote or hinder productivity growth? Theoretically there are several reasons to support both views. Union rent-seeking may impede capital investment, workers may shirk where unions provide insurance against dismissal, and union bargaining may be detrimental to manager-worker collaboration. On the other hand, unions may provide a "voice" for workers which improves information flows and increases tenure, raising the returns to firm investments in human capital, and local union bargaining may promote efficient provision of effort.

Empirically, it is difficult identifying the effect of unions on productivity. The drawbacks to the observational studies assessing union effects on firm performance are discussed in detail in Section Two, but the chief one is the absence of exogenous variance in unionization required to draw causal inferences. Firms are often organised for reasons linked to their performance. First, union formation and membership may be highly dependent on the potential rents to be reaped. On the one hand, it pays more to invest in unionization and membership in more productive firms. On the other hand, in firms facing risk of downsizing or closure, the value of membership may also be high since unions tend to offer legal services and help with conflict resolution. Second, union members may be highly selected. Again, the direction of selection is not clear: less productive workers are more likely to queue for union jobs because they gain more from union efforts to standardise wages but, because the supply of union jobs exceeds demand for those jobs, employers can pick the best workers from those queueing for the union jobs (Abowd and Farber, 1982). Regardless of the direction of the selection, it has proven difficult to come up with a research design that convincingly deals with this problem.

To our knowledge, only DiNardo and Lee (2004), and the follow up studies by Lee and Mas (2012), Frandsen (2012) and Sojourner et al. (2015) represent attempts at identifying causal effects. They use a regression discontinuity design related to union recognition in the United States: we discuss their contributions in more detail below. We contribute to the literature using exogenous variance in the price of union membership to identify the effects of changes in firm union density on firm productivity and wages. We do so using data for Norwegian firms over the period 2001 to 2012.

Exogenous shifts in the net price of union membership arise due to changes in the tax treatment of union membership. As with most normal goods, the demand for union membership (or the service this membership provides) is negatively related to its price, and thus the demand for union membership fluctuates with the size of tax subsidies. We know of no other studies using this source of exogenous price variance as a means of instrumenting for union membership.

We calculate the potential subsidy relative to the net price for each individual worker in the economy, and take the average for each firm. This firm average is then used as an instrument in our productivity and earnings regressions. Since our instrument can be interpreted as an interaction between the subsidy (exogenously determined by the government) and the union membership fee (determined by the unions), one might worry that it picks up productivity in some way. Thus, we control for the net union membership fee in all our instrumental variables regressions. To ensure that we control for selection of workers into firms we also control for average worker fixed effects by firm from earnings regressions on individual workers.

We find increases in union density lead to substantial increases in firm productivity having accounted for the potential endogeneity of unionization. We find unions claw back part of that additional productivity through a higher union wage premium, and that this premium is larger in more productive firms, which is consistent with rent-sharing.

The remainder of the paper is organised as follows. Section Two briefly reviews the theoretical and empirical literature and elaborates on the role of union density and union institutions in helping to understand heterogeneity in union effects. Section Three provides an axiomatic illustration. Section Four describes the Norwegian tax legislation and the relation to union membership. Section Five describes our data and outlines the empirical approach. Results are presented in Section Six before concluding in Section Seven with a discussion about the implications of the results for our understanding of union effects more generally.

2. Theory And Previous Empirical Literature

The literature exploring union effects on economic outcomes is one of the oldest and most extensive in economics. It goes back at least as far as Adam Smith's *The Wealth of Nations* which he wrote in 1776. The bulk of the literature treats unions as labour cartels, intent on strengthening the bargaining power of their members by threatening the supply of labour to firms if employers prove unwilling to accede to their wage demands. As such, they have the potential to extract rents from employers resulting in the payment of above-market wages. As Adam Smith pointed out in *The Wealth of Nations* employers are also liable to form cartels, not only to limit price competition, but also to offset union bargaining power. The wage outcome of union bargaining will depend on various factors. These include the relative bargaining power of the two parties which, in turn, is related to potential conflict outcomes, the price elasticity of demand for labour, the elasticity of demand for labour with respect to capital, the substitutability of non-union for union labour and worker support for the union, usually captured by the percentage of workers who are union members. *Inter alia*, the economic implications of a bargained outcome for the firm depend on the intensity of market competition faced by the firm, the rents available to the firm and its ability to attract and retain labour. Nevertheless, on the assumption that worker bargaining power rises, on average, in the presence of trade unions, it seems reasonable to assume union bargaining will raise wages above the counterfactual market wage set at the intersection between labour supply and demand.

The implications of a union bargained wage for employment outcomes will depend, in part, on whether unions bargain solely over wages - as in the right-to-manage model in which employers set employment conditional on the union bargained wage - or over wages and employment simultaneously (efficient bargaining) leading to potentially Pareto efficient outcomes. Employment outcomes will also depend on what utility the union is seeking to maximise. If the representative or median union member values continued employment as well as wages, this utility may be captured by the value of the total wage bill, in which case the union will be cognisant of potential negative employment consequences where bargained wages are set "too high".

There are multiple channels by which trade unions may affect labour productivity, and these effects may cut in different directions. More able workers may queue for union jobs where they pay above market wages, a worker selection effect that may raise labour productivity in the union sector. If selected from the queue by a unionised employer an employee may be less likely to quit compared to a non-union scenario given the wage wedge between the union job and the employee's outside options, in turn affecting employers' propensity to invest in human capital. If unionised labour is more expensive than non-unionised labour this may induce employers to substitute capital for

labour, leading to capital intensification that is productivity enhancing. A separate channel is the union "voice" effect, first identified by Freeman and Medoff (1984), whereby unions aggregate and convey the preferences and knowledge of workers to management in a manner that can be more efficient than eliciting individual workers' voices, or failing to engage with workers at all.[1] Unions may also serve to alleviate agency problems in a similar way as performance pay schemes (Vroman 1990; Barth et al., 2012), improve efficiency by reducing sub-optimal excessive hiring of workers (Bauer and Lingens, 2013) or provide efficient effort levels within a framework of local bargaining (Barth et al., 2014).

Unions may also be detrimental to labour productivity. Wage-effort bargaining may result in the sub-optimal deployment of labour through "restrictive practices" (Metcalf, 1989). Where union bargaining breaks down resultant strike action or actions short of strikes, such as go-slows, may adversely affect productivity. Unions' ability to insure workers against arbitrary employer actions, whilst potentially conducive to job security and thus improvements in productivity, may also lead to workers taking unauthorised absences, or "shirking" in other ways. Unions' ability to extract rents from new investments may lead to a "hold up" problem whereby investors, aware of the issue, may invest less than they might otherwise have done, leading to sub-optimal capital investments (Grout, 1984). In the worst case, investors may react adversely to the threat of unionization, taking evasive action by investing in the non-union sector.

The empirical literature has, until recently, been dominated by Anglo-US studies where sectoral bargaining is uncommon in the private sector and unions organise on a workplace-by-workplace or firm-by-firm basis. Consequently, the focus has been establishing the economic effects of unions obtaining bargaining rights at workplace level, and the bargaining strength of unions at workplace level, often proxied by the proportion of employees in membership.

There are four limitations to this literature. First, it is an empirical literature dominated by studies that identify the partial correlation between unionization and economic outcomes, the assumption being that selection into union status is captured by observable features of the worker or, if panel data are available, by time-varying observable traits and time-invariant unobserved traits. It has proven difficult to account for potentially endogenous selection into union status due to a lack of credible instruments. Second, most studies have relied on data collected from individual workers in household surveys such as the Current Population Survey (CPS) for the United States. Necessarily, these studies omit important features of the firm employing the workers, so that analysts have found it difficult to tackle biases associated with omitted variables influencing union status and the economic outcomes of interest. Studies using linked employer-employee data tend to find that the omission of these variables upwardly biases estimates of union effects on wages (Bryson, 2002; Blanchflower and Bryson, 2004).

Third, limited availability of firm-level data has prevented analysts from undertaking workplace-level or firm-level analyses, thus limiting what analysts have been able to say about outcomes that are best investigated at this level, such as profitability.[2]

[1] Freeman and Medoff (1984) adapt Hirschman's (1970) exit-voice-loyalty model, originally used by Hirschman primarily to understand consumer preferences, to an employment relations setting, emphasising its productivity-enhancing potential, as well as increasing employer pay-offs to human capital investments as employees resort to voice over exit when confronting workplace problems.

[2] In principle one can aggregate workers from worker-level data to construct firms where unique firm identifiers are available, but data are rarely available for the full population of workers in a firm and, in any case, such data rarely contain firm-level economic metrics other than wages.

Fourth, the particularities of the institutional setting characterising the liberal economies of the USA, UK, Canada, Australia and other Anglo-US economies mean it is difficult to know whether findings from those countries generalise to other settings characterised by more centralised and co-ordinated bargaining regimes. They may not read over directly since sectoral and national bargaining arrangements are likely to affect the costs and benefits of unionization for specific firms. For example, the meta-studies of Doucouliagos and Laroche (2003) and Doucouliagos et al. (2017) reveal quite mixed evidence on the association between unions and productivity both between the Anglo-US economies and other countries, but also within these groups of countries (e.g., between USA and UK) and even between industries.[3]

The empirical regularities regarding the union wage premium stem from a literature that is dominated by observational studies capturing the partial correlation between union status and wages in cross-sectional data or, in some cases, the association between changes in union status and wages with panel data.[4] The union wage premium - or what might more appropriately be termed the union wage "gap" to use Lewis's (1963; 1986) terminology - varies across groups of workers, over time, and is counter-cyclical (Lewis, op. cit.). Since union bargained wages apply to all covered workers, union bargained wages tend to be a public good rather than a private incentive good payable only to union members. Even so, studies often find a union wage premium among members in covered workplaces, which may partly reflect an upward bias associated with omitted variables affecting selection into membership status and wages, or else the effects of heterogeneous union bargaining power (Booth and Bryan, 2004). The latter arises where membership simply proxies higher union density, something that is not observed in studies which cannot link employees to the workplaces that employ them.

Unionization also slows the rate of employment growth in workplaces. This finding, which Addison and Belfield (2004) termed the "one constant" in the empirical union literature, when set alongside the persistence of a union wage premium, is consistent with right-to-manage models in which employers set employment levels conditional on the bargained wage. However, union effects are rarely sufficient to affect workplace survival (Bryson, 2004), suggesting either that unions seek to maximise the wage bill (some weighted function of wages and employment), that they successfully organize firms with surplus rents, or that wage effects are partially offset by productivity improvements.

Recently analysts in the United States have sought to identify the causal impact of union bargaining on workplace performance using a regression discontinuity design comparing economic outcomes in workplaces where the union vote just exceeded the majority threshold required for representation with workplaces where the vote felt just short of the required majority. Using this method DiNardo and Lee (2004) find little impact of new unionization on business survival, employment, output, productivity or wages over the period 1984-2001. When interpreting this result one must bear three points in mind. First, the vote for representation captures an "intention to treat" through union representation that does not always materialise in practice. This is because, under the US system, the majority vote requires the employer to negotiate with the newly formed union in good faith to arrive at new contractual terms and conditions. However, unions never get to "first contract" in a high percentage of cases (Ferguson, 2008), suggesting the regression discontinuity captures a lower bound estimate. Second, if union bargaining power is increasing in the demand for unionization, as

[3] On the other hand, the meta-studies yield quite coherent picture on the relationship between unions and investments: these associations are negative.

[4] The latter have rarely considered the endogeneity of union switching but for an examination of the implications of union endogenous switching in relation to pay satisfaction see Bryson and White (2016).

the literature on union density effects suggests, the margin just-being-unionised is likely to capture effects associated with weaker trade unions. This is precisely what Lee and Mas (2012) find in a follow up study which shows that, using an event study approach, the equity value of newly unionised firms drops markedly after 15-18 months, something that is not apparent using a regression discontinuity design. They reconcile results in Lee and Mas (2012) with those in DiNardo and Lee (2004) by showing that the negative relationship between cumulative abnormal returns and unionization rises with the vote share in support of the union. The implication is that firms' owners have a strong expectation that new unionization will have an impact on firms' economic performance, especially when union bargaining power is great.

Third, unions are known to focus their attention on raising the wages of low earners, providing the rationale for Frandsen's (2012) quantile regression investigation. He uses the same regression discontinuity as DiNardo and Lee and Lee and Mas and finds large countervailing effects of new unionization on wages in different parts of the wage distribution, with unions using their bargaining power to compress wages by increasing the wages of the lower paid and reducing the returns to skill at the top of the distribution. A recent paper using the same identification strategy found negative effects of unionization on staffing levels in nursing homes but no effects on care quality, suggesting positive labour productivity effects (Sojourner et al., 2015).

In a number of European countries the vast majority of workers and firms are covered by collective bargaining. In Austria and France, for example, over 95 per cent of workers have their pay set directly through collective bargaining - often at national or sectoral level - or else collectively bargained rates are extended to them under statutory procedures (OECD, 2016; 2017). In other major European countries coverage is less, e.g. Germany (Fitzenberger et al., 2013), but still higher than what is measured by union density at the firm-level.

Setting wages and terms and conditions at sectoral or national level necessarily involves the aggregation of firm and worker preferences above firm level. It is unclear, a priori, whether a bargained outcome set beyond the firm will operate to the benefit or disadvantage of a specific firm. It depends, in part, on where the firm sits in the firm wage hierarchy and on the firm's ability to withstand wage hikes. The bargained rate may be particularly beneficial to a firm where its competitors struggle to pay the new rate. At the macro-level sectoral and national bargaining are liable to compress wage dispersion since the uncovered sector is small, thus taking wages out of competition - at least at the lower end of the labour market where the bargained rates bite - potentially minimising any adverse effects of bargained rates on firm performance.

The situation is more complicated in those countries where firms may be subject to national or sector bargained rates *and* local bargaining, either at firm or plant level. Often local bargaining builds on national or sector bargained rates. How they do so depends on the degree of coordination across bargaining levels, as studies have shown, but also on the bargaining strength of local unions and thus their ability to bid up wages beyond the centrally set wage.[5] Studies confirm the importance of union density at plant or firm level in these circumstances. For example, Breda (2015) shows the union wage premium in France rises with workplace union density where the workplace has a high market share, consistent with workers extracting surplus rents via their local bargaining power. Fitzenberger et al. (2013) also find union wage effects rise with union density in covered workplaces (although higher union density is associated with lower wages in uncovered firms).

[5] For a review of this literature see Bryson (2007).

The setting for our empirical investigation is Norway, a country where firms may be covered by collective bargaining at local level (workplace of firm), sector level, national level, or a combination of local and sector/national bargaining. Eighty-seven percent of all employees are covered by collective agreements, and even if there is a high degree of coordination in bargaining, 79 percent of all employees work in workplaces with local bargaining following the national or sectoral level bargaining rounds (Barth et al., 2015). Around seventy per cent of private sector workplaces and seventy-seven per cent of private sector employees are covered by some form of collective bargaining. Four-in-ten workplaces have some local collective bargaining which covers over half (fifty-four per cent) of employees. In contrast to France where union membership is well below ten per cent, but in common with other Scandinavian countries, Norway has high levels of union membership. Half of all private sector employees are union members, while mean union density is forty percent in private sector workplaces (Bryson et al., 2015).

Although wages rise for all Norwegian workers where workplace union density is higher (Bryson et al., 2016), there is no evidence on the causal impact of union density on productivity and wages in Norway, and even studies of correlations are scarce. Barth et al. (2000) and Balsvik and Sæthre (2014) provide evidence on the relationship between union density and wages. Both studies estimate a union wage premium of around 7%, i.e., when union density increases by 10 percentage points then wages increase by 0.7 percent. Barth et al. (2000) point out that any effect of individual union membership disappears when adding controls for union density, which implies that the bargained wage at the workplace is a public good.

Finally, unions are in secular decline. Membership has been falling for decades in much of the developed world (Schnabel, 2012; OECD, 2017), and collective bargaining is under threat, even in countries like Germany where sectoral bargaining was previously regarded as a fixed feature of the economic landscape (Addison et al., 2011). Two salient facts go largely unnoticed in discussions of the economic implications of these changes. The first is that unions continue to procure a wage premium for covered employees both in Anglo-Saxon countries (Blanchflower and Bryson, 2007) and in Continental European countries like France (Breda, 2015). Second, the negative correlation between unionization and workplace or firm performance, apparent in the 1970s and 1980s (Hirsch, 2007; Metcalf, 1989), had largely disappeared by the 1990s, at least in Britain where much of the research was conducted (Blanchflower and Bryson, 2009).

This has led to speculation as to why. Some maintain that declining union density, together with a changed economic environment - notably increased global competition - began to undermine unions' ability to monopolise the supply of labour (Brown et al., 2009). Certainly, it is the case that where negative associations persist, they are confined to workplaces with strong bargaining power, either by virtue of high union density or the presence of multiple bargaining units (Bryson et al., 2011; Pencavel, 2004). Some point to a reorientation of union strategies resulting in partnerships with employers born of union weakness (Frege and Kelly, 2003). In France, the negative association between unionization and workplace performance is confined to a small number of militant unions (Bryson et al., 2011). Others point to differential union survival among firms and industries with higher rents (Brown et al., 2009) permitting unions to extract rents without obvious detrimental impacts on the workplace.

3. A Simple Model Of Union Membership

To briefly motivate our empirical analyses, we consider the worker's choice between becoming a union member or not. The union provides two kinds of services attractive to workers; they may increase the wage, and they may provide various forms of insurance and legal services at discounted prices. Assume that the utility of each worker can be expressed by a Cobb-Douglas utility function, depending on insurance I and consumption (or a composite good) C:

(1) $$U = I^{\alpha} C^{(1-\alpha)},$$

Each worker faces a budget set, which differs depending on union membership:

(2)

Union: $$p_I^U I + C + P - S = W_U,$$

Non-union: $$p_I^N I + C = W_{N,}$$

Where C is the numeraire good, $p_I^U \leq p_I^N$ are the prices of insurance for union and non-union members, P is the union membership fee, S is a tax subsidy on union membership (as provided in Norway, see Section 4), and the Ws are wages. In this simple setting we can derive the indirect utility functions:

(3)

Union: $$V^U = \tilde{\alpha}\left[\frac{1}{p_I^U}\right]^{\alpha}[W_U - (P-S)(1+\varepsilon)],$$

Non-union: $$V^N = \tilde{\alpha}\left[\frac{1}{p_I^N}\right]^{\alpha} W_N.$$

Where $\tilde{\alpha} = [\alpha^{\alpha}(1-\alpha)^{1-\alpha}]$. The term $(1+\varepsilon)$ represents workers' attitudes towards joining a union. The average worker considers only the monetary costs and benefits of joining ($\varepsilon = 0$), whereas some workers discount the net costs of joining ($\varepsilon < 0$), for instance because they believe in collective action, have a political leaning towards the left, feel a responsibility towards fellow workers, or enjoy to be part of the group; while other workers may have opposite attitudes and rather tend to exaggerate the costs of joining ($\varepsilon > 0$). The costs may also be attenuated or magnified by both union's and management's actions towards membership and non-membership. The worker becomes a union member if V^U-V^N>0. This utility differential can also be expressed as:

(4) $$V^U - V^N = K\left\{[W_U - (P-S)(1+\varepsilon)] - \left[\frac{p_I^U}{p_I^N}\right]^{\alpha} W_N\right\},$$

whose sign is independent of K=$\tilde{\alpha}\left[\frac{1}{p_I^U}\right]^{\alpha} > 0$. The bargaining power of the union may be represented by a wage mark-up, γ:

(5) $$W_U = \gamma W_{N,}$$

In order to express both wages in terms of union membership fees, we assume that the fee is set as a combination of a fixed fee and a proportional fee:

(6) $$P = \beta_0 + \beta_1 W_U$$

such that $W_U = \frac{P-\beta_0}{\beta_1}$, and $W_N = \frac{P-\beta_0}{\gamma\beta_1}$. We may then write the condition for membership $V^U - V^N > 0$ as:

(7) $$\delta + \delta\left(\frac{S}{P-S}\right) + \beta_0\delta\left(\frac{1}{P-S}\right) > \varepsilon,$$

where $\delta = \frac{1-g}{\beta_1}$ and $g = \frac{1}{\gamma}\left[\frac{p_I^U}{p_I^N}\right]^{\alpha}$. The choice of becoming a union member may thus be analyzed using a simple regression model of union membership on the inverse of the net membership fee, and on the subsidy relative to the net membership fee.

4. The Norwegian Tax Legislation And The Union Membership Fee

Union membership is subsidized in Norway via a tax break. Table 1 shows the development of the deductions allowed for union membership given by the tax legislation over the period 2001-2012. Row 1 is the gross deduction.

Table 1 Subsidy of union membership. Union deduction and average union membership fee (NOK)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Gross deduction	900	900	1450	1800	1800	1800	2700	3150	3150	3660	3660	3750
Subsidy	250	250	410	500	500	500	760	880	880	1020	1020	1050
Average fee	3430	3580	3740	3860	3990	4060	4240	4360	4510	4640	4820	4980

Note: The table reports the union membership tax deductions determined by the tax legislation and the average union membership fee for union members. The net union deduction is 28% of the gross union membership deduction. The average fee is measured in NOK (in 2011 1£=9.032NOK and 1$=5.607NOK)

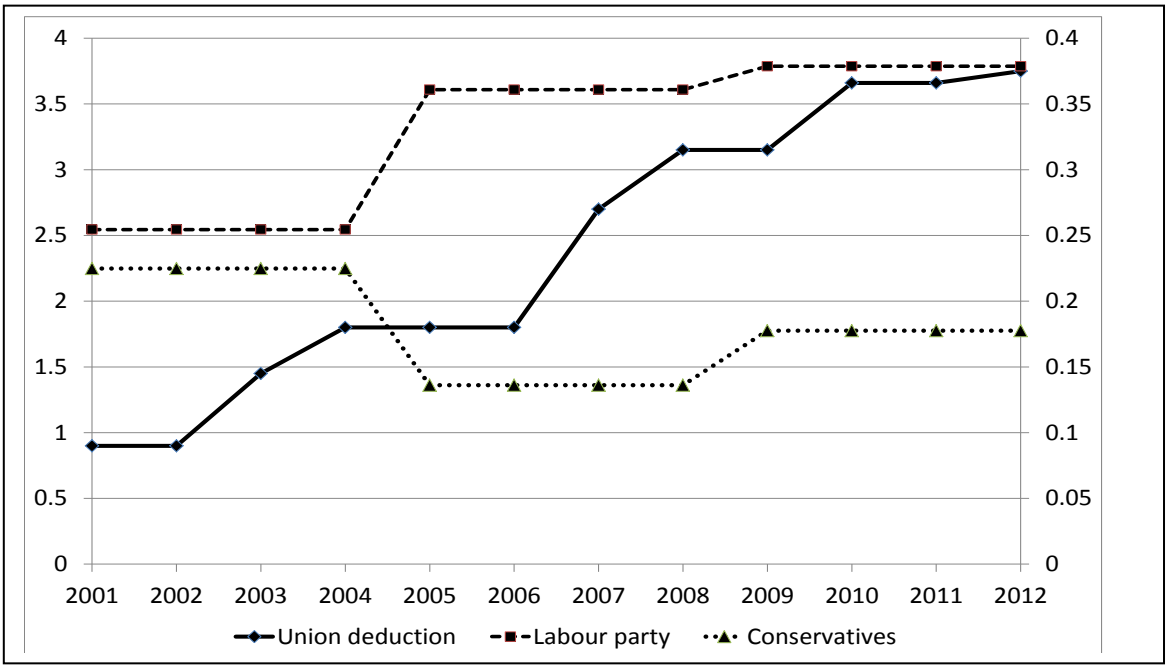
Employees benefit from the subsidy in row 2 which is 28% of the gross deduction since that is the marginal tax rate faced by taxpayers.[6] The subsidy rose over four-fold over the period, whereas the average membership fee rose 1.5 times, such that the subsidy was equivalent to 7% of the average membership fee in 2001, rising to 21% in 2012.

The Ministry of Finance determines the size of the subsidy at the end of the previous tax year. No explicit pronouncements were made as to why the tax subsidy rose, but it is linked to changes in political power in Norway.[7] In 1999 a liberal-conservative coalition cut union tax subsidies by half (from 1800 NOK to 900 NOK) leading to union protests. In the October 2005 election the Labour Party gained power at the expense of a liberal-conservative coalition. It retained power in the election of 2009. In Figure 1 we see the development of gross union membership deductions (left-hand side axis) and the Labour Party's and the Conservative Party's elected number of seats in the Norwegian parliament (right-hand side axis).

[6] It is a progressive taxation system so that tax deductions exist for low earners and high earners pay higher taxation rates for earnings above a certain level.

[7] The tax subsidy associated with union membership was cut by 50% between 1998-99 by the Bondevik-coalition government (Moderates-Conservatives).

Figure 1 Gross union tax deduction and political governance

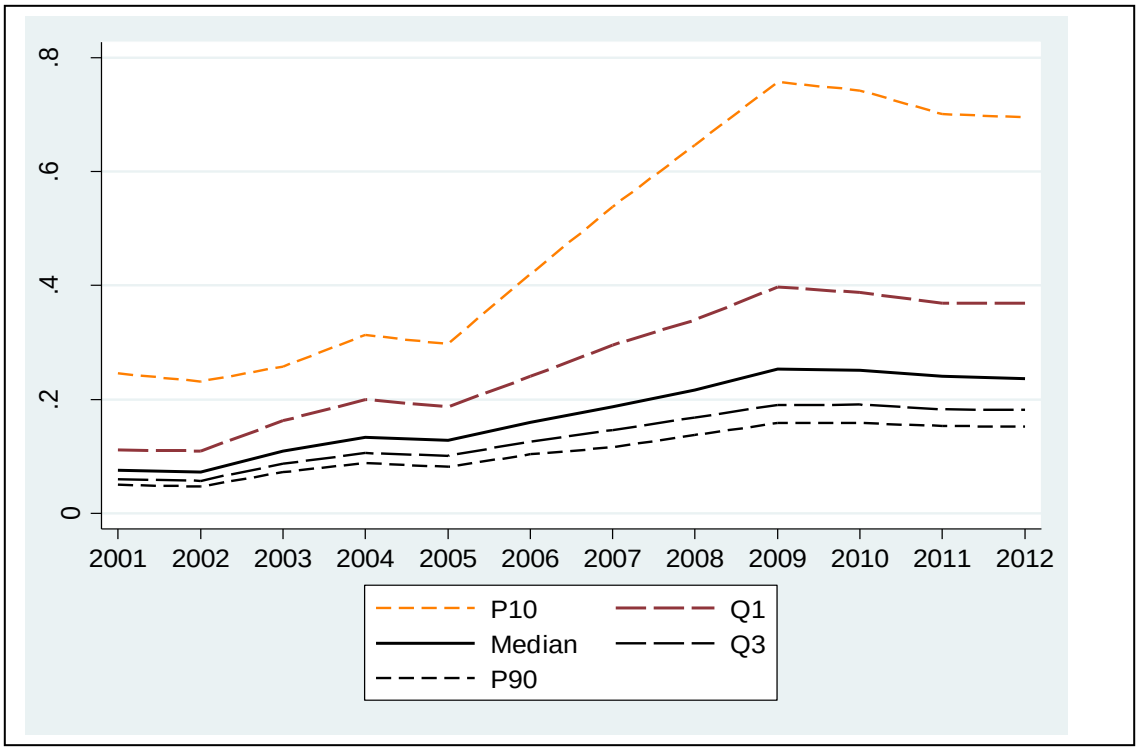


Note: Gross union tax deduction (in 1000 NOK) is measured on the left-hand side axis. The Labour Party's and the Conservative party's elected number of seats in the parliament are measured (in percent of 169) on the right-hand side axis.

Our data contain the union membership fees paid by all individuals as reported to the tax authorities. Figure 2 shows the relative difference between the net subsidy and the average net union membership fee for different percentiles of the union member wage distribution. For most the subsidy amounts to 5-10% of the net union fee in the beginning of the period, increasing to around 15-30%. For those in the lowest decile of the union membership earnings distribution the net subsidy amounts to over half the net union fee they pay at the end of the period. Lower earners pay lower union membership fees, which is why there is a differential in the relative value of the tax subsidy across the earnings distribution. In all cases the subsidy appears sizeable enough to affect the rate of union membership take-up.

We use these data to construct our instrument for workplace unionization which is the net tax subsidy expressed as a share of the net union membership fee (net subsidy/(fee-net subsidy)).

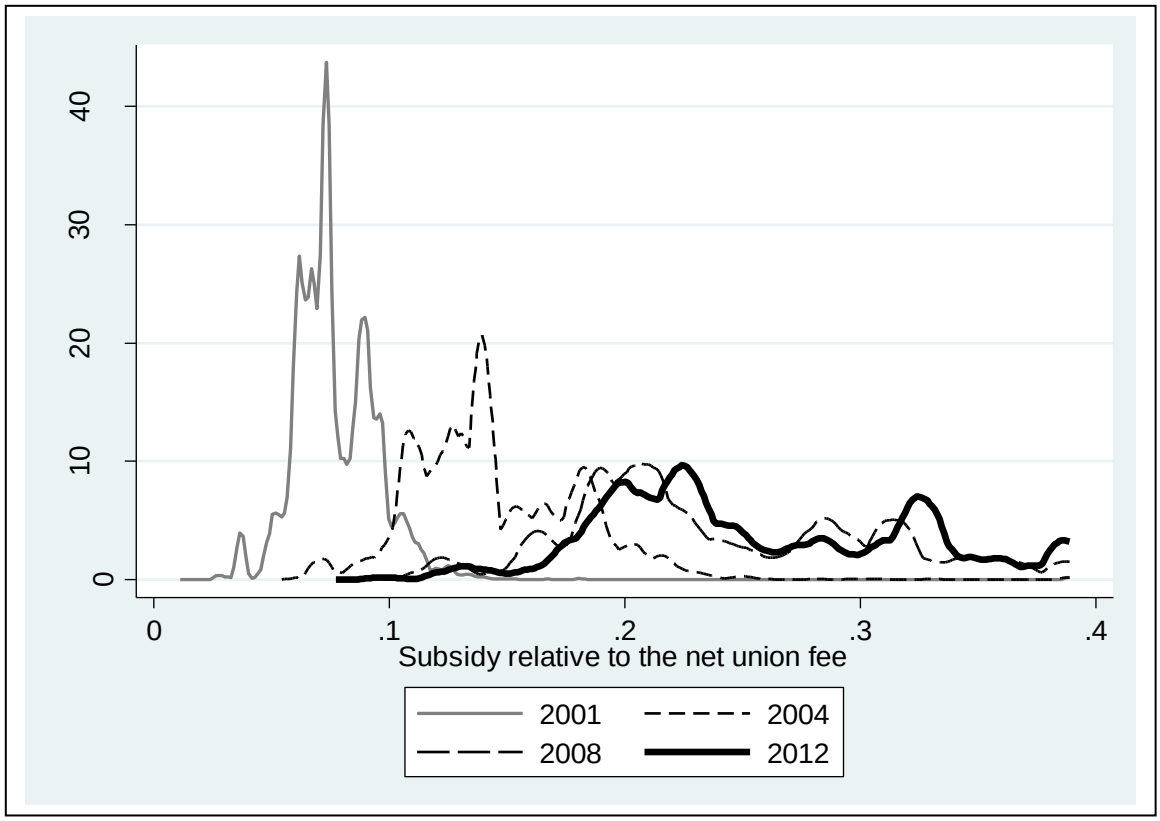
Figure 2 Union tax subsidy relative to the net union membership fee for union members in different parts of the union member wage distribution over time



Note: The percentiles relate to the union member wage distribution. The lines show the value of the tax subsidy relative to the net union fee for union members only at different points in the wage distribution. For each individual the tax legislation will in practice limit the subsidy rate below 40% even for those facing low union fees.

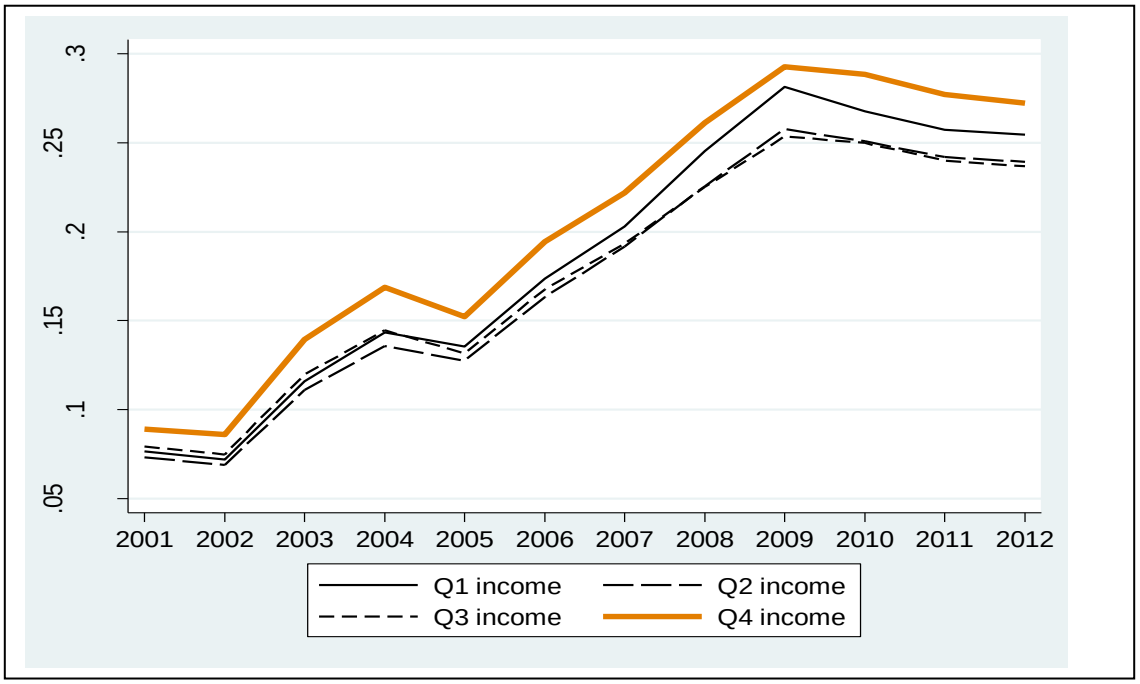
Since it is not possible to know the union fee for union non-members we have followed the simple rule of designating each worker a job class (or union) based on their main economic activity (2-digit SIC code X 3-digit occupational code, resulting in a total of roughly 7,000 cells across all years). Then we have calculated the average union fee for each job class based on union members only, and then linked this fee to every worker in the job class. The value of the instrument, the subsidy rate, for all workers is presented in Figure 3: it confirms that the value of the subsidy relative to the net price an individual is likely to pay for membership rises from a little under a median of 10% at the beginning of the period to between 25% and 30% at the end of the period. Figure 4 shows that its value is roughly similar for workers in different parts of the earnings distribution.

Figure 3 The development of the distribution of the subsidy relative to net union fee over time. All workers.



Note: Kernel density estimates based on epanecknikov kernel.

Figure 4 Union tax subsidies relative to the net union membership fee over the labour income quartiles and time. Worker level.



Although tax subsidies for union membership exist in other countries such as France and the United States no empirical evidence exists on the relationship between taxation and the demand for union membership. However, a related literature links the demand for fringe benefits, such as health care, savings plans, company cars, stocks and stock options, to the taxation of these goods and services (Gruber, 2001; Choi et al., 2011). For example, Gruber and Lettau (2004) estimate that removing the subsidization of employer-provided health care would reduce insurance spending by 45%. Similarly, Gutiérrez-i-Puigarnau and Van Ommeren (2011) find that the subsidization of a "company" car by the tax system leads to households demanding a more expensive car and driving more miles privately. Beneficial tax treatment increases the employees' demand for stock options (Austin et al., 1998) as well as employers' supply, since employees tend to exercise stock options when corporate taxable income is high, shifting corporate tax deductions to years with higher tax rates (Babenko and Tserlukevich, 2009). Our empirical approach does not preclude the existence of multiplier or social interaction effects. Although unions are usually unable to prevent non-members from benefiting from union bargained terms and conditions, free-riding behaviour does not affect our identification strategy (Olson, 1965; Booth, 1985).

5. Empirical Approach And Data

5.1 Empirical approach

5.1.1 Union membership

Equation (6) describes the probability of joining the union. We estimate this probability in series of linear probability models including the subsidy rate, net union membership fees, and a set of control variables to capture systematic differences in attitudes etc.:

$$(8) \qquad U_{jt} = \delta_0 + \delta_1 \left(\frac{S}{P-S}\right) + \delta_2 \left(\frac{1}{P-S}\right) + \delta_X X_{jt} + \varepsilon_{jt},$$

where U is a dummy variable taking the value of 1 if worker j is a union member, ε_{jt} is a standard normal error term, X is a control vector, while S/(P-S) and 1/(P-S) are the net subsidy rate and the inverse of the net union membership fee, respectively.

5.1.2 Productivity and wages at the firm-level

Consider the following simple Cobb-Douglas production function:

$$(9) \qquad Y_{it} = Ae^{\omega_i + u_{it} + \gamma_t + \beta^D D_{it}} {L_{ls}}^{\beta^{ls}} {L_{hs}}^{\beta^{hs}} K^{\beta^k}$$

where Y is value added for firm i at time t, ω_i is a firm specific productivity level known to the firm and potential union members as they choose the level of transitory inputs and make decisions on union membership, but not observed by us, γ_t represents technological change, D_{it} is union density of firm i at time t, ls represents low skill and hs high skill workers respectively, K is capital, and u is a stochastic term representing idiosyncratic shocks that are unknown to the firm when it makes its decisions. The coefficient β^D captures the effect of union density on productivity.

The chief estimation problem we address is the potential endogeneity of union density which, as discussed above, may occur for a variety of reasons which have different implications for the direction of any bias when making causal inferences. Workers are more likely to unionize, and unions more likely to invest in membership drives, when potential rents over which the union wishes to bargain are high. On the other hand, when firms face difficulties, union membership may provide important insurance and services related to the risk of job loss, inducing a potential negative relationship between membership and productivity.

We deal with this potential endogeneity issue by instrumenting D by the firm average across workers of the ratio of the amount of subsidy over the price of union membership, measured as net union subsidy relative to the net union membership fee. From our model consideration in Section 3, we know that this relationship affects union membership. We hold the union fee constant at the value observed the first time the firm enters our data: we thus avoid potential endogeneity problems in the way the union fee may be set following changes in the subsidy. The identification thus rests on variation in the tax subsidy over time interacted with the inverse of the net union price faced by workers at the firm (which is held constant at its first value in the panel). The instrument is defined at the firm X year level, and varies with the tax system and the number of workers in different job classes the first time the firm is observed in the data.[8] We assume that the elasticity of union membership demand is fixed and constant across workers, an assumption that is standard in consumption theory.[9]

Since the net union membership fee could be associated with productivity (e.g., through worker wages as indicated by our theoretical model), we condition on the inverse of the net union membership fee in all regressions.

A further threat to the identification strategy arises if the workers who sort into union membership differ in their productivity from those who do not: this might induce a correlation between union density and productivity.[10] In some of our regressions we therefore condition on the firm averages of the individual worker fixed effects from individual earnings regressions to net out any effects arising from time-varying differences in average worker quality which may be correlated with unionization.

[8] This IV-approach implies that we are to use a multi-varied (continuous) variable to instrument for a multi-varied (continuous) treatment variable. Under such circumstances, it is difficult to study who the compliers are. In individual regressions of 5.1.1, the treatment is binary (union member or not). Thus we follow Imbens and Rubin (1997) and Abadie (2003) as exemplified by Dahl et al. (2014) to characterize the compliers.

[9] Let e denote the fixed elasticity of union membership demand, while P, S and U denote the union fee, the union tax subsidy, and the demand for union membership. Then $e = \frac{P-S}{S}\frac{\partial U}{\partial S} \Rightarrow \frac{\partial U}{\partial S} = e\frac{S}{P-S}$.

[10] From standard economic theory, we know that the wage standardization policies of unions result in systematic differences in the wage premium workers can expect. Those with lower potential earnings get the biggest premia relative to their market outside options while those with high potential earnings see negative returns relative to their market outside options. Thus, if outside options reflect productivity, this would induce negative sorting since it would be the least productive workers who would queue for union jobs. However, as Abowd and Farber (1982) show, if supply of union jobs is less than the demand, employers would cherry-pick from the queue, with the result that union workers originate from the middle of the productivity distribution. It is standard in the union wage premium literature to find the raw union-non-union wage gap closes with the addition of human capital in the wage equation, indicating positive selection into union status based on worker observable traits. However, debate continues as to whether efforts to account for unobserved differences between union and non-union workers can tell us something about the underlying ability of workers in the two sectors (Robinson, 1989). For Norway, Mastekaasa (2013) shows that workers with a higher probability of experiencing sick leave spells sort into union membership and arguably health, absenteeism and productivity could be related.

Finally, a second estimation problem, familiar to those estimating firm production functions, is the endogeneity of capital and labour inputs. In sensitivity analyses presented in Table 4 we have addressed this issue using Petrin, Levinshon and Wooldridge's (Wooldridge, 2009) control function approach by including a proxy for ω_{it} using lagged values of capital and materials and their interactions directly in the production function, and instrumenting for low and high skilled labour using lagged values.

5.2 Data

We exploit population-wide administrative register data provided by Statistics Norway and Statistics Norway's *The Capital Data Base* (Raknerud et al., 2004). The former data, collected by the Norwegian Tax Authorities and Social Services, comprise the whole Norwegian population of workers, workplaces and firms during the period 2001-2012 (around 2,500,000 observations each year) and provide information on individuals and jobs including income, earnings, work hours, wages and union membership fees. Unique identifying numbers exist for individual workers, workplaces, and firms, thus allowing us to track these units over time. *The Capital Data Base* provides information on value added and revenues, and capital, labour, and intermediate good inputs, lagged log investments, together with their prices.[11] The value added measure used in our firm productivity analyses is the log of operating income less operating costs, wage costs, depreciation and rental costs.

Since *The Capital Data Base* utilizes the same firm identifier as the public administrative register data, we are able to link these data sources together. Although *The Capital Data Base* comprises firms from all private sectors, its coverage is only complete for manufacturing. Thus, our final data set contains 6-6,500 firm observations each year, and when linked to the administrative data the final regressions comprise around 8,000 firms and 50,000 observations. Most, but not all, are drawn from the manufacturing sector.

Workers' union status is apparent from the administrative data containing annual union fees. To avoid volatility in union fees arising from spells of individuals not working, we focus on workers reporting taxable income in year t and year t-1, t∈(2000,2012) above 1G (G is the Social Service's baseline figure, 1G is equivalent to £8685 in 2011), i.e., we restrict the analyses to roughly 2,400,000 jobs each year or 28,695,942 observations over the whole period. Then we calculate the average union fee for each job class based on union members only, and then link this fee to every worker in the job class, non-members and members alike.

[11] Note that we have information on lagged investments for all existing firms 2001-2012.

6. Results

6.1. Unionization

In Table 2 we estimate linear probability models at the level of the individual worker to establish the role played by the tax subsidy measured as the net subsidy divided by the net union fee for a worker in different job classes. Our data comprise all observations of workers employed by the Capital Data Base firms reporting taxable income year t and year t-1, t∈(2000,2012) above 1,000 NOK.

In Model 1 the regressions comprise the job classes used to measure union fees, year dummies and an intercept. We see that when the net subsidy relative to the net union fee increases by the value of 1 then the probability of union membership significantly increases by 10.8 percentage points. This is apparently a strong impact, but increasing the relative measure by 1 is a big increase. A 10 percentage point increase in the subsidy rate yields a 1.08 percentage point increase in the probability of union membership.

Table 2 The impact of subsidizing union membership on the probability of union membership

	Model 1	Model 2	Model 3	Model 4	Model 5
Net union fee inverse		-4.5024	-4.5689	-1.9387	-1.5360
		(3.4172)	(4.3130)	(1.4911)	(1.2308)
Subsidy relative to net union fee	0.1077*	0.1120*	0.1344**	0.2094**	0.1986**
	(0.0459)	(0.0463)	(0.0457)	(0.0435)	(0.0295)
Controls					
Years	Yes	Yes	Yes	Yes	Yes
Job class	Yes	Yes	Yes	Yes	Yes
Demography			Yes		
Human capital			Yes		
Worker-Job class (FE)				Yes	
Job-Job class (FE)					Yes
NXT	2018879	2018879	2018879	1874713	1852005
Marginal effects on the probability of union membership of increasing the subsidy by 100 Nok at average fees					
2001	0.0037*	0.0037*	0.0045**	0.0071**	0.0067**
	(0.0016)	(0.0016)	(0.0015)	(0.0015)	(0.0013)
2012	0.0035*	0.0036*	0.0043**	0.0067**	0.0064*
	(0.0015)	(0.0015)	(0.0015)	(0.0014)	(0.0013)

Marginal effects on the probability of union membership of increasing the average gross fee by 10%.					
2001	-0.0009*	-0.0008*	-0.0010**	-0.0017**	-0.0016**
	(0.0004)	(0.0004)	(0.0004)	(0.0003)	(0.0003)
2012	-0.0036*	-0.0036*	-0.0044**	-0.0070**	-0.0067**
	(0.0016)	(0.0016)	(0.0015)	(0.0015)	(0.0013)

Note: These regressions estimate a set of equations describing the relationship between union membership, the net fee inverse and the net subsidy relative to the net fee based on the following expression; 1) $U=\alpha\frac{1}{P-S}+\beta\frac{S}{P-S}$. P and S express the gross union fee and the subsidy, respectively. Our underlying assumptions are that increasing the subsidy should increase the demand, while increasing the gross price should decrease the demand. In other words, the derivative of 1) w.r.t. S should be positive, i.e., $\frac{\partial U}{\partial S}=[\frac{1}{P-S}]^2[\alpha+\beta P]>0$, while the derivative of 1) w.r.t. P should be negative, i.e., $\frac{\partial U}{\partial P}=-[\frac{1}{P-S}]^2[\alpha+\beta S]<0$. Job class: 2925 units (3-digit occupationX2-digit industry); Demography controls for gender (dummy for women), country of origin (dummy for immigrants) and log age. Human capital expresses educational qualification (2-digit) and seniority in years. Worker-job class FE and Job-job class FE control for 4381829 and 401266 fixed effects, respectively. Note that the marginal effects are estimated based on the average union fees of 3430 and 4980 Nok and subsidies of 250 and 1050 Nok for 2001 and 2012, respectively.

The remaining models all incorporate the inverse of the net union fee to account for potential endogeneity in union price setting. As expected, the higher the net union fee, the lower the demand for union membership. Its introduction increases the size of the subsidy coefficient a little. Additional controls for demography, income and unobserved worker and job heterogeneity increase the size of the subsidy effect still further. These regressions clearly establish that the price of union membership matters for individuals. To see this clearly, we have estimated the marginal effects of the net union membership fee and of the net subsidy on union membership.[12] These estimates are presented at the bottom of Table 2. The marginal effects depend on the level of the subsidy and the net union fee, so we have estimated effects for: i) a 100 Nok increase in the subsidy for those on average union fees, and ii) an increase in average gross fee of 10 percent. For each 100 Norwegian krone in subsidy, the probability of union membership for those facing average fees decreases by 4-7 percentage points. A similar but opposite relationship is seen for the marginal effect of increasing the average gross fee by 100 Nok. For 100 Norwegian krone in average fees, the probability for union membership falls by 0.1 to 0.7 percentage points for those facing average fees.

To visually show the importance of the subsidy rate for the union membership probability, Figure A1 shows the relationship depicted by Model 3 of Table 2, as well as the density distribution of the subsidy rate. We see the positive relationship between the subsidy rate and unionization. However, we also see that the overall variation in membership probability is no more than 6 percentage points. Thus, we do not argue that variation in the subsidy rate is the main reason why workers unionize. Still, the government's union subsidization clearly influences the unionization rate. Figure A2 in the appendix shows the unionization rate in our sample of workers and firms with and without the tax policy reforms.

[12] We estimate a set of equations describing the relationship between union membership, the net fee inverse and the net subsidy relative to the net fee based on the following expression; 1) $U=\alpha\frac{1}{P-S}+\beta\frac{S}{P-S}$. P and S express the gross union fee and the net subsidy, respectively. Our underlying assumptions are that increasing the subsidy should increase the demand, while increasing the net price (i.e., the net fee) should decrease the demand. In other words, the derivative of 1) w.r.t. S should be positive, i.e., $\frac{\partial U}{\partial S}=[\frac{1}{P-S}]^2[\alpha+\beta P]>0$, while the derivative of 1) w.r.t. P-S should be negative, i.e., $\frac{\partial U}{\partial (P-S)}=-[\frac{1}{P-S}]^2[\alpha+\beta S]<0$.

A natural question following our analysis is who are the compliers? The analysis above can be interpreted within the framework of Imbens and Rubin (1997) and Abadie (2003), as this was implemented in Dahl et al. (2014). The impact of the net subsidy rate (the subsidy relative to the net union fee inverse) on union membership can be interpreted as a dichotomous outcome following a multivalued treatment. The regressions above would then constitute the first-stage regressions, where the subsidy rate would be the instrument.

In Table 3 we have estimated models equivalent to Model 3 of Table 2, but estimated these separately for different worker and firm groups. This allows us to characterize the compliers, the never-takers and the always-takers.

Table 3 Compliers

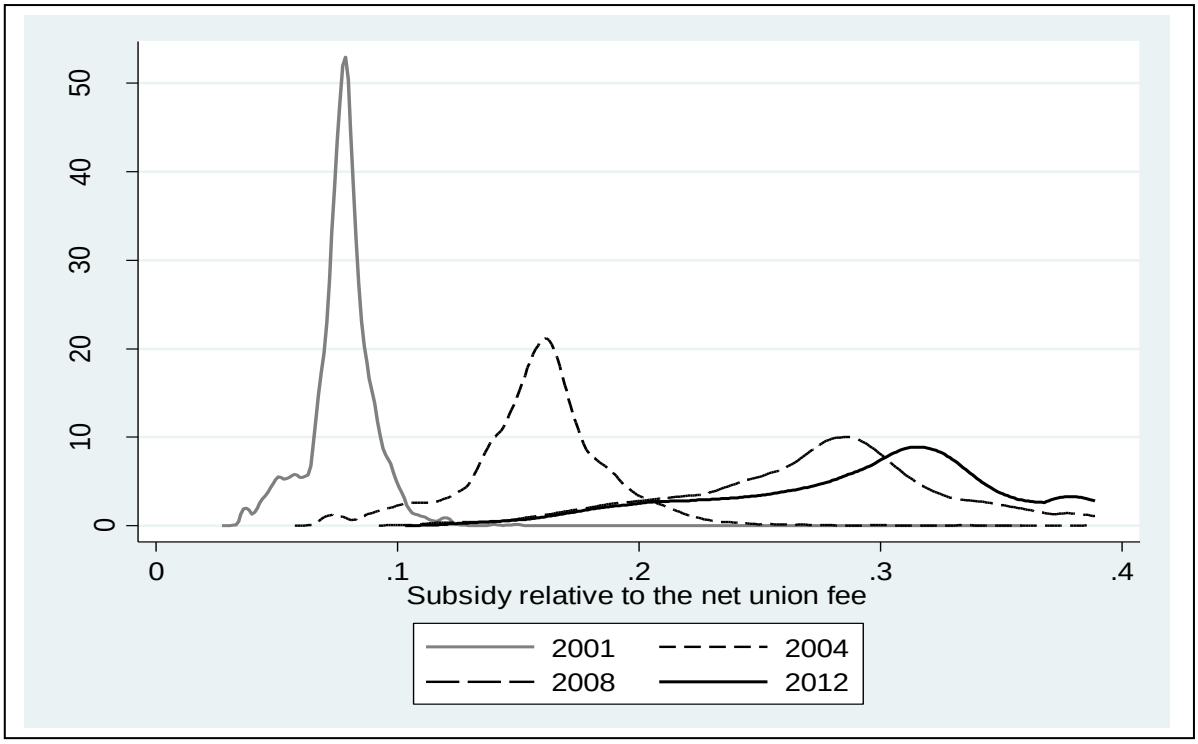
	First stage	Pr(Xi=xi)	Pr(complier |Xi=xi)	Pr(always union|Xi=xi)	$\frac{\mathbf{Pr(Xi=xi\|complier}}{\mathbf{Pr(Xi=xi)}}$
Individual characteristics					
Young	0.1477**	0.4336	0.1037**	0.5692**	2.0700
	(0.0211)				
Old	0.0658**	0.5664	0.0091	0.6250**	0.1816
	(0.0613)				
Men	0.1735**	0.7659	0.0585**	0.6137**	1.1630
	(0.0632)				
Women	0.0725	0.2308	0.0240	0.5543	0.4771
	(0.0816)				
Natives	0.1629**	0.9054	0.0548**	0.6114**	1.0418
	(0.0480)				
Immigrants	0.0638*	0.0946	0.0314	0.4929**	0.5970
	(0.0277)				
Low wage	0.0738	0.5300	0.0249	0.6042**	0.6748
	(0.0605)				
High wage	0.1507**	0.4700	0.0504**	0.5907	1.3659
	(0.0665)				
Firm characteristics					
Manufacturing-low	0.1171	0.6663	0.0392x	0.6011**	0.8365

tech					
	(0.0730)				
Manufacturing-high tech	0.1886**	0.2558	0.0628**	0.5972**	1.3402
	(0.0896)				
Construction	0.0460	0.0081	0.0145	0.5709**	0.3094
	(0.5498)				
Trade	0.2637	0.0229	0.0864	0.5938**	1.8434
	(0.3881)				
Others	0.1987	0.0391	0.0660	0.5929**	1.4085
	(0.1848)				
1-25 employees	0.2768**	0.1820	0.0954**	0.2826**	1.4182
	(0.0813)				
26-100 employees	0.2715**	0.2284	0.0912**	0.5482**	1.3557
	(0.0835)				
101-500 employees	0.2083*	0.2834	0.0701*	0.7085**	1.0421
	(0.0903)				
>500 employees	0.0908	0.3021	0.0305	0.7369**	0.4534
	(0.0860)				
0-25% union members	0.0860x	0.1635	0.0287x	0.0858	0.4266
	(0.0450)				
26-50% union members	0.3656**	0.1345	0.1219**	0.4206**	1.8121
	(0.0982)				
>50% union members	0.0697	0.6974	0.0235	0.7535**	0.3493
	(0.0515)				

Note Job cell: 2935 units (3-digit occupationX2-digit industry). Note that the estimated models are equivalent to Model 3 of Table 2, but estimated separately for each group as indicated by row heading. **, * and x denote significant at the 1, 5 and 10 percent level of significance, respectively.

Thus we can see which groups are primarily affected by the government tax subsidization of union membership.[13] In Table 3 we only present the predicted probabilities of being compliers and always-takers (which then can be used to derive the predicted probabilities of being never-takers). The last column in Table 3 expresses the relative risk. Table 3 shows that the compliers to a larger extent comprise employees at hi-tech firms and smaller and medium-sized firms, where union workers are a minority, but also employees who are younger, more often men and natives, and more highly paid. For example, young workers comprise twice as much of the complier group than their relative size in the data should indicate.

Figure 5 The development of the distribution of the subsidy relative to net union fee over time. Across firms and contingent on the firms' worker composition the first observational year.



Note: Kernel density estimates based on epanecknikov kernel.

Figure 5 shows the same densities as Figure 3, but this time for firms and conditional of the firm composition for the first year, i.e., the densities of the firm average of the subsidy rate, which will act as our instrument for union density in our firm productivity and wage regressions to come. We see quite similar development of the subsidy rate over time.

[13] In Appendix Table A4 we provide additional information on the compliers. We have estimated the probability of union membership using all the controls except the subsidy rate, and then used these estimates to predict the probability. We then estimate separate first stage regressions for the four quartiles of predicted union membership. For all quartiles we see that the subsidy rate affect union membership positively, and for the third quartile this is strongly significant. Thus the results in Table A4 and in Table 3 seem to support the assumption of monotonicity which would be necessary for the subsidy rate to be a valid instrument.

Our key interest in this paper is the impact of union density on productivity, i.e., an analysis conducted at the firm-level.[14] Full descriptive information on the data used in the firm-level analyses are contained in Appendix Table A1. The table shows firm-level union density has declined a little over the period, despite the tax subsidy, reflecting declining union membership in much of the developed world (Schnabel, 2012).

6.2. The impact of union density on productivity

Our starting point for the productivity analyses is the estimation of the Cobb-Douglas production function with homogenous production technology across industries. The union density measures union influence. It is measured in percentage points to aid interpretation. The results are shown in Table 4.

Table 4 The impact of union density on workplace productivity.

	Model 1 OLS	Model 2 FE	Model 3 IV	Model 4 IV
Union density	-0.0004**	0.0001	0.018*	0.017*
	(0.0001)	(0.0002)	(0.008)	(0.007)
Basic	Yes	Yes	Yes	Yes
Firm FE		Yes	Yes	Yes
High-/low-skilled				Yes
First Stage Union density				
Subsidy/Net union fee			30.594**	30.775**
			(7.961)	(7.952)
Tests weak instruments				
Cragg-Donald F:			73.25	74.01
Kleibergen-Paap F:			14.77	14.98
FXT	67016	65506	65506	65506

Note: Dependent variable: log value added. Union density is measured in percentage points. Controls: Basic: Net union fee inverse, log capital, log workforce size and years. Industry time-trends control for 1-digit industry linear time trends. Skill trends control for low, medium and high-skilled linear time trends, where skills are defined based on job cell (occupationXindustry) wages. High/low skilled (educational qualification) denotes that workforce size is split into log number of low educated workers and log number of high-educated workers. Robust standard errors adjusted for firm-level and year clustering are reported in parentheses. **, * and x denote significant at the 1, 5 and 10 percent level of significance, respectively.

[14] Note that firm-level IV-regressions, where the first stage comprise multivalued outcome (e.g., changes in union density) following a multivalued treatment (e.g., changes in the the subsidy rate), are less suited to be interpreted within the framework of Imbens and Rubin (1997) and Abadie (2003).

The first model shows results from an OLS regression on all firms, conditioning on the union fee, capital, labour (number of employees) and year dummies. Firms with higher union density appear to be less productive than firms with low union density. The negative relationship between union membership and productivity becomes positive but is not statistically significant when we estimate changes in union density within firm over time using firm fixed effects (Model 2). In Models (3) and (4) union density is instrumented using the firm-average of the subsidy relative to net union fee.[15] We can reject the null hypothesis that we have weak instruments. As in the individual regressions in Table 2, we see our instrument influences union density positively.

In these models union density is positively and strongly associated with improvements in firm productivity. The results imply that an increase in the firm mean of union density of around 1 percentage point raises firm productivity by 1.7-1.8%, with the inclusion of heterogeneous labour (high and low skilled) making little difference.

One might worry that our results are really driven by other mechanisms and confounding factors. In Table 5 we explore three other explanations. First, we study whether we are just picking up the effects of industry trends. Next, skill-biased technological change would influence our estimates if skills and unionisation are strongly related. Third, we tackle unobserved time-varying productivity and the endogeneity of other factor inputs which are ignored in the previous analyses.

We see that the instrumented union density coefficient is stable and robust to the specification tests presented in Table 5 in relation to industry time-trends (Model 2), skills-biased technological change (Model 3), and the endogeneity of other factor inputs such as the two types of labour and using the Levinsohn-Petrin-Wooldridge control function approach (see Wooldridge 2009) to take into account lagged unobserved productivity (Models 4 and 5).[16] In this approach we include a proxy for ω_{it} using lagged values of capital and materials and their interactions directly in the production function, and instrumenting for the two L's using lagged values. This proxy, derived from the firm's first order condition in period t-1, effectively controls for ω_{it} in the equation, and thus removes the correlation between the lagged L's and the error term.

[15] Note that in all these IV regressions we add the firm average of the net union fee inverse as a control to take care of the potential endogenous nature of the union fee (based on the same first year firm composition as the subsidy rate. This acts as a non-linear time control. Thus we effectively avoid the criticism of Christian and Barrett (2017), arguing that causal effects identified from inter-temporal variation in the IV differently scaled by cross-sectional exposure are susceptible to exclusion restriction violation arising from non-linear trends. In addition, we will in later models also incorporate linear skill trends.

[16] Saturating the model with even more controls reflecting composition and human capital such as firm average seniority, share of women and share of immigrants yields similar results (not shown), i.e., it enlarges the point estimate even further. Although the standard errors increase strongly, potentially indicating limits to data, the point estimates always remains significant.

Table 5 The impact of union density on workplace productivity. Alternative hypotheses and robustness checks

		Model 1	Model 2	Model 3	Model 4 IV	Model 5 IV
Union density		0.018*	0.020*	0.029*	0.015*	0.029*
		(0.008)	(0.010)	(0.014)	(0.007)	(0.012)
Basic, High-/low-skilled, Occupational shares, workforce age vigintile shares, Average worker effects		Yes	Yes	Yes	Yes	Yes
Firm FE		Yes	Yes	Yes	Yes	Yes
Linear industry trends			Yes	Yes	Yes	Yes
Linear skill trends				Yes		Yes
First Stage Union density						
Subsidy/Net union fee		28.141**	24.772**	22.266**	29.618**	26.061**
		(7.813)	(7.686)	(7.926)	(9.219)	(9.656)
Tests weak instruments						
Cragg-Donald F:		61.84	44.08	33.33	49.75	34.96
Kleibergen-Paap F:		12.97	10.39	7.89	10.32	7.29
FXT		65394	65394	65394	51425	51425

Note: Population: Model 1-3: All (Capital Data Base (CDB)), Model 4-5: Firms in CDB operating in SIC-industries 14-15, 17-22, 24-36, 45, 51-52 and 74, with also lagged observations. Dependent variable: Model 1-4: log value added, Model 5-6: the residual from the industry-specific GMM-IV-regressions of Table A5. Union density is measured in percentage points. Controls: Basic: Net union fee inverse, log capital, log workforce size and years. Industry time-trends control for 1-digit industry linear time trends. Skill trends control for low, medium and high-skilled linear time trends, where skills are defined based on job cell (occupationXindustry) wages. High/low skilled (educational qualification) denotes that workforce size is split into log number of low educated workers and log number of high-educated workers. Occupational share denotes shares of workers in 1-digit occupational class. Average worker effect is the firm average of the estimated fixed worker effect from a worker-level log hourly wage regression on year dummies (10) and age vigintile (19) dummies. Robust standard errors adjusted for firm-level and year clustering are reported in parentheses. **, * and x denote significant at the 1, 5 and 10 percent level of significance, respectively.

6.3. Union wage effects

We have found a positive effect of union density on firm productivity. What is the effect on wages? Table 6 reports results from log hourly earnings regressions, estimated at the firm level. The dependent variable is the firm level average each year of the residual hourly wage from log hourly wage regressions including year dummies (10), worker vigintile age dummies (19), as well as worker fixed effects. Model 1 indicates a small negative correlation between union density and wages reminiscent of the negative correlation between union density and productivity in Model 1 in Table 4. The correlation remains negative having conditioned on firm fixed effects, but the estimate becomes slightly larger.

Table 6 The impact of union density on firm-average log hourly wage.

	Model 1 OLS	Model 2 FE	Model 3 IV	Model 4 IV	Model 5 IV	Model 6 IV	Model 7 IV	Model 8 IV
Union density (U)	-0.0004**	-0.0007**	0.013**	0.015**	0.013**	0.009*	0.012*	0.010**
	(0.0001)	(0.0002)	(0.004)	(0.005)	(0.005)	(0.003)	(0.005)	(0.004)
Ln value added per worker (VA)					0.094**	0.127**	0.125**	0.096**
					(0.005)	(0.019)	(0.023)	(0.025)
U X VA								0.0015**
								(0.0005)
Basic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry time-trends, High-/low-skilled, age vigintile shares, occupational shares, average worker effects				Yes	Yes		Yes	Yes
Endogenous right-hand-side variables								
Union density		Yes	Yes	Yes	Yes	Yes	Yes	Yes
VA					No	Yes	Yes	Yes
Union density X VA								Yes

Excluded instruments:								
Subsidy(S)/Net union fee(F)			Yes	Yes	Yes	Yes	Yes	Yes
Ln capital (LnC)						Yes	Yes	Yes
S/F X LnC								Yes
Low (S/F X LnC)								Yes
Cragg-Donald F:			103.43	70.60	70.45	39.56	26.23	16.88
Kleibergen-Paap F:			22.94	17.47	17.42	9.14	6.60	7.07
FXT	62778	61452	61452	61452	61452	62192	62192	62192

Note: The table reports OLS, FE and 2nd stage IV estimates from 2-stage regressions. See Table A2 for first stage estimates. Dependent variable: Log hourly wage expresses the firm average of the residuals a worker-level log hourly wage regression on year dummies (10) and age vigintile (19) dummies. Union density is measured in percentage points. Log value added per worker is standardized, i.e., measured as deviation from global mean divided by the global standard deviation. Controls: Basic: Net union fee inverse, log workforce size, and years. Industry time-trends control for 1-digit industry time trends. High/low skilled denotes that low workforce size is split into low employment low educated workers and log high-educated workers. Occupational share denotes shares of workers in 1-digit occupational class. *Age vigintile shares* denotes shares of workers in age groups within firms. Average worker effect is the firm average of the estimated fixed worker effect from a worker-level log hourly wage regression on year dummies (10) and age vigintile (19) dummies. Robust standard errors adjusted for firm-level and year clustering are reported in parentheses. **, * and x denote significant at the 1, 5 and 10 percent level of significance, respectively.

A very different picture emerges when we instrument for union density in Models 3 to 8.[17] Union density is strongly positively related to firm wages. The coefficients imply that a 1 percentage point increase in density increases wages by around 1.0-1.5% depending on the model specification. The effect is apparent across specifications which include controls for heterogeneous skills, unobserved worker quality, and firm value added per worker.[18] Once again we see that the instrument for union density in most specifications passes the standard tests for a weak instrument.

Firm-value added is included both as an exogenous variable (Model 5) and as an instrumented variable (Models 6-8).[19] Comparing the coefficients for union density from Model 5 to Model 6 we find that about one third of the union density effect may be attributed to rent sharing, but that a considerable effect remains. To establish the extent to which union density increases the level of rent sharing in the firm, we interact firm union density with firm value added per worker in Models (7) and (8), having instrumented for both density, value added, and the interaction (Model 8 only).

[17] As in the value-added regressions, we instrument for union density with the net subsidy relative to the net fee. Appendix Table A2 presents the first stage estimates for the IV.

[18] As for the value added regressions we have tested out specifications controlling for linear skill trends, and several variables capturing workforce composition such as firm-average seniority, share of women and share of immigrants. While linear skill trends significantly affected value added, in these wage regressions they are highly insignificant and the inclusion as controls does not qualitatively affect our main results regarding the relationship between union density and wages. The same is true for the other composition variables. If anything, by saturating the model we only achieve to enlarge the effect of union density on wages.

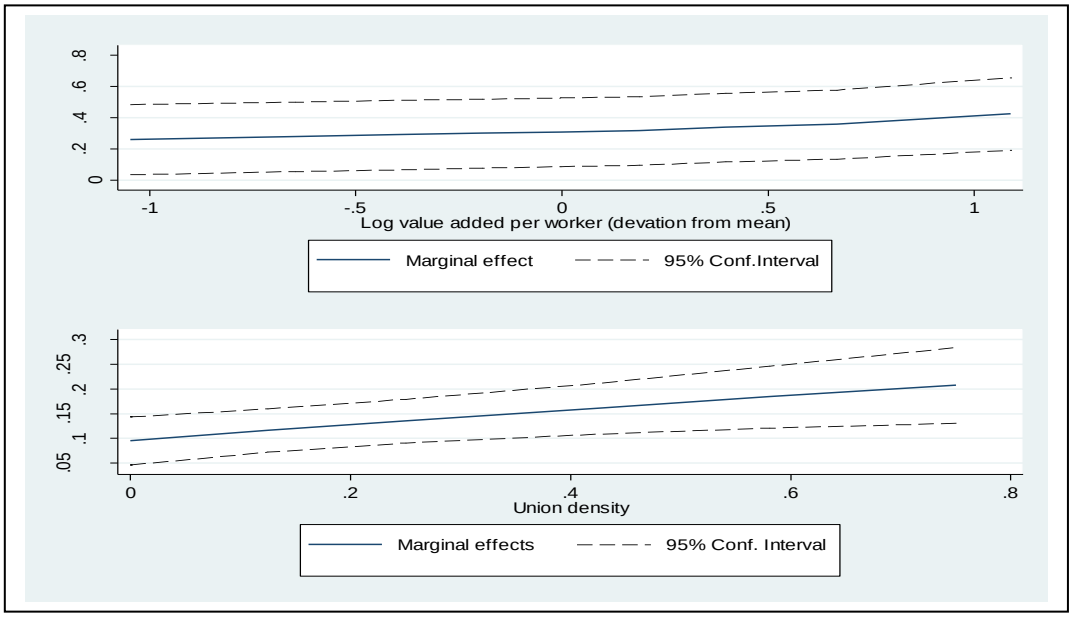
[19] Again, the instrument for union density is the net subsidy relative to the net fee. Following a rich literature we instrument for value added per worker utilizing lagged log investments. Note that for roughly 4000 newly established firms (and thus with missing lagged log investments), we use log total capital instead.

Both contribute positively to firm wages as evaluated at zero union density and average labor productivity. The interaction is precisely estimated and positive, indicating that the causal impact of higher union density is larger in more productive firms, which is consistent with rent-sharing.

To ease interpretation, we have calculated the wage elasticities at different points in the productivity (value added per worker) and union density distribution (Figures 6 and 7). Figure 6 shows the marginal effect of union density is increasing as firms become more productive. From the 10th percentile in the productivity distribution to the 90^{th,} the marginal effects of union density double. Similarly, the marginal impacts of increased productivity more than double when going from zero unionization to the 90th percentile in the union density distribution.

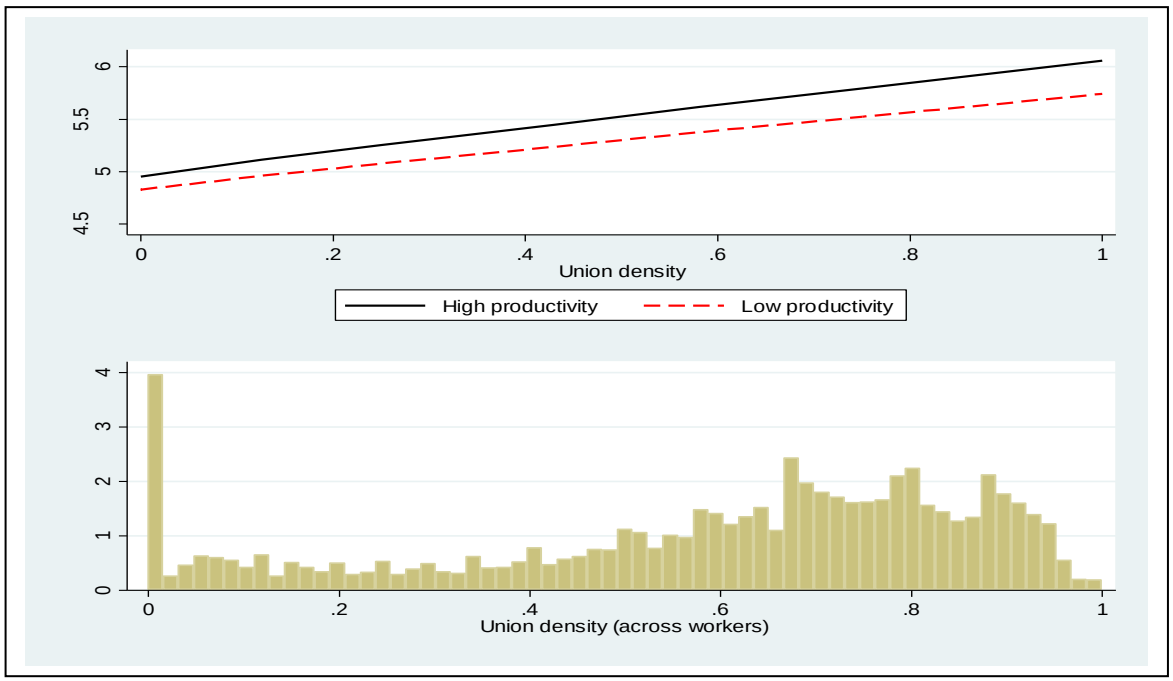
Figure 7 illustrates how these effects translate into wage levels (at global average wage). The top half of the figure shows how average wages change for low and high productivity firms across the distribution of union density. The bottom half of the figure shows the distribution of firms' union density across workers in the economy.

Figure 6 Marginal effects under productivity (value added per worker) and union density interactions. Mean and 95%-confidence intervals.



Note: Marginal effects estimate from Model 8 in Table 6. The marginal effects are calculated at 10-percentile intervals of the value added per worker- and union density distribution, respectively. Note that due to censoring of union density at zero, the left-most estimate in the bottom-half figure, represents the 10-40 percentile.

Figure 7 Average wage under value added per worker and union density interactions. Mean and 95%-confidence intervals. Across union density distribution.



Note: Top figure shows average wage based on estimates of Model 8 in Table 6. The effects are calculated at 10-percentile intervals of the union density distribution. Low and high productivity firms are defined as the 20-and 80-percentile of the value added per worker-distribution. Note that due to censoring of union density at zero, the left-most estimate in the bottom-half figure, represents 10-40 percentile. The bottom figure shows a histogram over the distribution of unionized workers.

Wages increase with increasing unionization for both high and low productivity firms, but at a faster rate for the high productivity firms than the low productivity firms such that, at the top of the union density distribution the wage gains are twice as large in high productivity firms as they are in low productivity firms.

7. Conclusion

We find increasing union density leads to improved firm level productivity in Norway. The negative relationship between union density and productivity apparent in OLS estimates disappears and becomes weakly positive but non-significant once we control for firm fixed effects. However, it becomes statistically significant and strongly positive when controlling for endogenous union density using exogenous variation in union membership fees. The exogenous variation in union membership fees is generated by variations in tax subsidies over time. The OLS results are not surprising: if the risk of job loss increases demand for union services (and thus membership) or less productive workers sort into union membership, this would induce a negative correlation. Our IV-approach takes this into account: when we exploit the variation in union density caused by the exogenous variation in the subsidy of union membership, we identify a positive causal impact on productivity. The effect is quite sizeable. If the subsidy of union density had been kept at the 2001level union membership rates would have been roughly 3 percentage points lower, implying that these firms would have experienced a 6 percentage productivity drop.

What possible mechanisms might explain this causal relationship? First, these local productivity effects could clearly be caused by Freeman and Medoff's voice-effect. As seen by the complier analyses, the percentage of workers affected, the compliers, are rather small, so such an interpretation implies some tipping point or threshold effects. Second, the complier analyses show that the tax reforms induce more workers from smaller firms with moderate unionisation rather than from large firms, from highly unionised firms or from firms with no unions whatsoever, to join a union. Thus the productivity effects we causally identify suggest the tax reform induces enough workers to join a union so that a union represented at a firm can demand a trade union agreement between the firm and the union. This threshold usually varies between 10 to 25 percent of the workers within a occupational group at the firm. Such a trade union agreement will have profound influence on work organisation and policies at the firm level, and could thus raise productivity. Finally, as seen in the complier analyses the tax reforms induce relatively speaking more young productive workers to seek union membership than older non-productive workers. However, we control for individual skills and productivity (through the inclusion of the average worker fixed effects in our regressions), thus the union density effect is not a pure worker selection effect, but must reflect the fact that the union makes these young and able workers more productive.

We also find a positive relationship between firm level wages and union density. The effect is positive and occurs independently of a rent sharing effect, which is also present in our data. However, the causal impact of union density is greater in more productive firms, as one might anticipate if unions are successful in bargaining over firm rents.

It is not possible to say whether one might expect to see similar positive union effects on productivity and wages in other countries because union effects are likely heterogeneous with respect to national systems of employment relations and the institutional underpinnings to union influence – most notably the presence of different bargaining coverage arrangements and the strength of union presence at workplace level.

The only efforts at capturing the causal effects of unionisation to date are confined to the United States where the employment relations system and union institutions are very different to those in Norway. The tax subsidisation of union membership in the United States[20] and elsewhere nevertheless provides an opportunity for analysts to deploy a similar identification strategy to the one deployed here to recover causal effects of unionisation on firm-level outcomes.

[20] When completing a tax return in the United States one can deduct dues and initiation fees paid for union membership. These are entered as unreimbursed employee expenses on Line 21 of Schedule A (Form 1040) Itemized Deductions.

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Appendix

Table A1 Descriptive statistics. Firm-level.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
lnVA	8.54	8.58	8.46	8.51	8.55	8.66	8.77	8.83	8.72	8.77	8.83	8.92
	(1.49)	(1.48)	(1.50)	(1.49)	(1.51)	(1.53)	(1.51)	(1.50)	(1.54)	(1.53)	(1.54)	(1.57)
lnC	7.30	7.23	7.01	7.00	6.99	7.05	7.17	7.31	7.33	7.30	7.31	7.24
	(2.15)	(2.19)	(2.22)	(2.22)	(2.22)	(2.37)	(2.19)	(2.22)	(2.25)	(2.25)	(2.24)	(2.32)
lnL_t	2.53	2.53	2.40	2.35	2.35	2.37	2.40	2.42	2.38	2.34	2.37	2.42
	(1.28)	(1.28)	(1.29)	(1.29)	(1.30)	(1.30)	(1.29)	(1.30)	(1.29)	(1.28)	(1.28)	(1.30)
lnL^{un}_t	2.36	1.35	2.21	2.15	2.15	2.16	2.18	2.20	2.15	2.13	2.12	2.17
	(1.29)	(1.29)	(1.30)	(1.30)	(1.30)	(1.31)	(1.30)	(1.31)	(1.30)	(1.29)	(1.29)	(1.30)
lnL^{sk}	0.78	0.80	0.76	0.74	0.77	0.80	0.82	0.86	0.87	0.88	0.89	0.95
	(1.13)	(1.14)	(1.11)	(1.11)	(1.12)	(1.14)	(1.14)	(1.16)	(1.17)	(1.17)	(1.18)	(1.21)
Union	0.30	0.31	0.28	0.27	0.26	0.27	0.26	0.27	0.26	0.26	0.26	0.26
	(0.32)	(0.32)	(0.31)	(0.31)	(0.31)	(0.30)	(0.30)	(0.30)	(0.30)	(0.30)	(0.30)	(0.30)
Subsidy/Net union fee	0.077 (0.02)	0.076 (0.01)	0.125 (0.04)	0.159 (0.03)	0.155 (0.03)	0.195 (0.04)	0.238 (0.05)	0.272 (0.05)	0.303 (0.06)	0.299 (0.06)	0.294 (0.06)	0.291 (0.06)
1000/ Net union fee	0.315 (0.32)	0.311 (0.31)	0.315 (0.32)	0.315 (0.32)	0.317 (0.32)	0.320 (0.32)	0.327 (0.33)	0.322 (0.34)	0.321 (0.33)	0.310 (0.32)	0.301 (0.12)	0.236 (0.06)
LnW	0.03	0.02	-0.01	-0.01	-0.01	-0.01	-0.00	0.01	-0.04	-0.06	-0.06	-0.05
	(0.22)	(0.23)	(0.23)	(0.25)	(0.28)	(0.28)	(0.30)	(0.27)	(0.27)	(0.27)	(0.26)	(0.25)
Worker fixed effect	-0.05	-0.04	-0.04	-0.05	-0.06	-0.07	-0.10	-0.11	-0.12	-0.13	-0.14	-0.16
	(0.28)	(0.27)	(0.29)	(0.29)	(0.29)	(0.29)	(0.28)	(0.28)	(0.28)	(0.29)	(0.28)	(0.28)
Lnvalue added per worker	6.00	6.05	6.06	6.16	6.19	6.28	6.38	6.42	6.34	6.39	6.46	6.50
	(0.59)	(0.55)	(0.58)	(0.57)	(0.58)	(0.61)	(0.60)	(0.64)	(0.66)	(0.66)	(0.66)	(0.68)
N	5009	4894	5396	5536	5648	5716	5463	5232	5186	5331	5128	5004

Note: Table elements report means and standard deviations[in parentheses]. Population: Firms in Statistics Norway's The Capital Data Base linked to individual worker information. LnVA and lnC denote log value added and log capital, respectively. lnL denotes log number of workers, while superscript un and sk differentiate between unskilled and skilled

workers (low educated vs. medium/high). Union denotes union density. lnW and Worker fixed effect denote the residual and the fixed worker effect from a worker-level log hourly wage regression on year dummies(10) and age vigintile(19) dummies, respectively. Note that the net union fee inverse and the subsidy relative to the net union fee is calculated keeping the gross union price fixed from the first observational year and then letting only the subsidy vary across time.

Table A2 The impact of union density on workplace productivity. Heterogeneous production technology across industries.

	lnL^{sk}	lnL^{unsk}	lnC	Lagged polynomial
SIC2				
14	-0.253* (0.126)	0.918** (0.195)	-0.026** (0.043)	Yes
15	0.255** (0.025)	0.409** (0.027)	0.074** (0.020)	Yes
17	0.121** (0.043)	0.490** (0.042)	0.034** (0.012)	Yes
18	-0.005 (0.074)	0.487** (0.063)	0.006 (0.024)	Yes
19	0.239 (0.217)	0.457** (0.089)	-0.010 (0.055)	Yes
20	0.204** (0.028)	0.575** (0.029)	0.037** (0.014)	Yes
21	0.276** (0.020)	0.166** (0.030)	0.098** (0.024)	Yes
22	0.266** (0.035)	0.559** (0.030)	0.048** (0.009)	Yes
24	0.362** (0.051)	0.326** (0.064)	0.049** (0.043)	Yes
25	0.276** (0.035)	0.420** (0.037)	0.072** (0.020)	Yes
26	0.104** (0.029)	0.400** (0.029)	0.020 (0.013)	Yes
27	0.262** (0.059)	0.533* (0.061)	0.014(0.021)	Yes
28	0.186** (0.021)	0.590** (0.021)	0.045** (0.007)	Yes
29	0.268** (0.029)	0.447** (0.030)	0.079 (0.012)	Yes
30	0.329 (0.196)	-0.066 (0.240)	0.027 (0.062)	Yes
31	0.340** (0.041)	0.350** (0.043)	0.045** (0.013)	Yes
32	0.389** (0.077)	0.125* (0.057)	0.020 (0.032)	Yes
33	0.319** (0.045)	0.389** (0.042)	0.034* (0.015)	Yes
34	0.310** (0.086)	0.390** (0.138)	0.062 (0.038)	Yes
35	0.383** (0.035)	0.559** (0.042)	0.019 (0.017)	Yes
36	0.166** (0.029)	0.525** (0.040)	0.014 (0.014)	Yes
45	0.133 (0.101)	0.140 (0.114)	0.106** (0.039)	Yes
51	0.046 (0.118)	0.229* (0.103)	0.044 (0.029)	Yes

52	0.023 (0.065)	0.280** (0.086)	0.076** (0.032)	Yes
74	0.168 (0.154)	0.505** (0.131)	-0.009 (0.055)	Yes
Method:	LPW-GMMIV			

Note: Estimation of Cobb-Douglas production functions. Method: GMM-IV (based on Wooldridge's improvements on the method of Levinsohn and Petrin). Dependent variable: ln(value added). Each row reports results separately for 2-digit industries. Lagged unobserved productivity is approximated by a 3rd order polynomial. Robust standard errors adjusted for firm-level clustering are reported in parentheses. ** and * denote significant at the 1 and 5 percent level of significance, respectively.

Table A3 The impact of union density on workplace average log hourly wage. First stage estimates.

	Model 1 -OLS	Model 2 -FE	Model 3 – IV	Model 4 –IV	Model 5 – IV	Model 6 – IV	Model 7 – IV	Model 8 – IV
First stage union density								
Subsidy(S) /Net union fee (F)			74.159**	32.080**	32.144**	34.625**	28.961**	27.208**
			(7.749)	(7.634)	(7.640)	(7.878)	(7.762)	(7.939)
Ln capital (lnC))						0.112	0.109	0.126
						(0.081)	(0.081)	(0.150)
S/F X LnC								0.261
								(0.517)
Low (S/F X LnC)								0.748**
								(0.273)
First stage Ln VA per worker								
Subsidy(S) /Net union fee (F)						0.891**	0.705*	0.310
						(0.298)	(0.304)	(0.355)
Ln capital (LnC)						0.087**	0.086**	0.073**
						(0.008)	(0.008)	(0.011)
S/F X LnC								0.057*
								(0.027)
Low (S/F X LnC)								-0.0002
								(0.011)
First stage union density X Ln VA per worker								
Subsidy(S) /Net union fee (F)								-119.33**
								(17.709)
Ln capital (LnC)								-2.123**
								(0.513)

S/F X LnC								17.831**
								(1.981)
Low (S/F X LnC)								0.068
								(0.486)

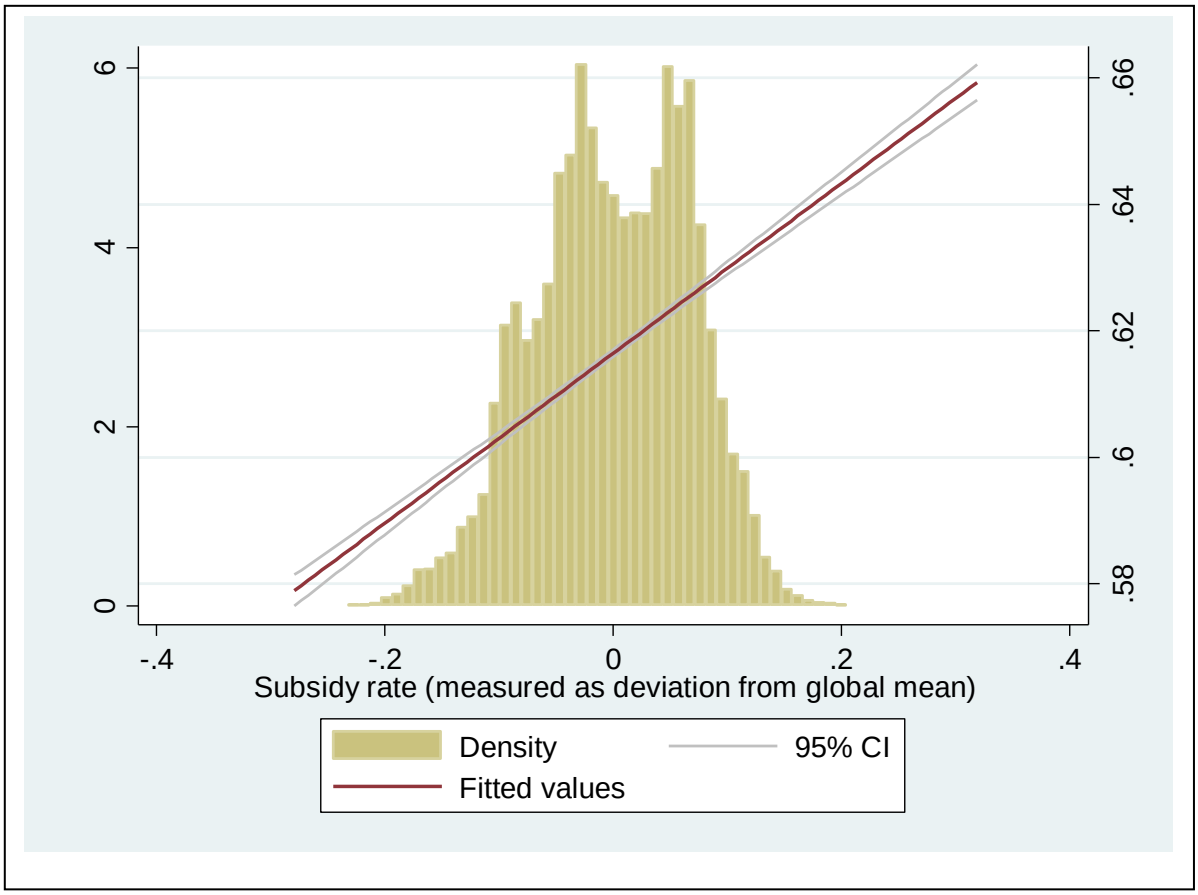
Note: First stage estimates of the IV wage regressions reported in Table 4. Low (S/F X LnC) denotes a dummy taking the value of 1 if being in the bottom 40% of the S/F X LnC distribution. See note Table 5 on other controls and details. Robust standard errors adjusted for firm-level and year clustering are reported in parentheses. **, * and x denote significant at the 1, 5 and 10 percent level of significance, respectively.

Table A4 Compliers

	1.quartile	2.quartile	3.quartile	4. quartile
Pr(Xi=xi)	0.2500	0.2500	0.2500	0.2500
1.stg.est. Intercept	0.2422**	0.5265**	0.7046**	0.8948**
	(0.0002)	(0.1556)	(0.0001)	(0.0001)
1.stg.est. instrument	0.0368	0.2731x	0.4149**	0.1122
	(0.0428)	(0.1556)	(0.1033)	(0.0752)
Pr(complier|Xi=xi)	0.0120	0.0910*	0.1394**	0.0377
Pr(always union|Xi=xi)	0.2446**	0.5420**	0.7266**	0.9005**
Pr(never union|Xi=xi)	0.7432**	0.3673**	0.1394**	0.0618*
Pr(Xi=xi|complier)	0.0429	0.3250	0.4979	0.1346
Pr(Xi=xi|complier)/ Pr(Xi=xi)	0.1714	1.3000	1.9914	0.5386
N	504843	504843	504843	504843

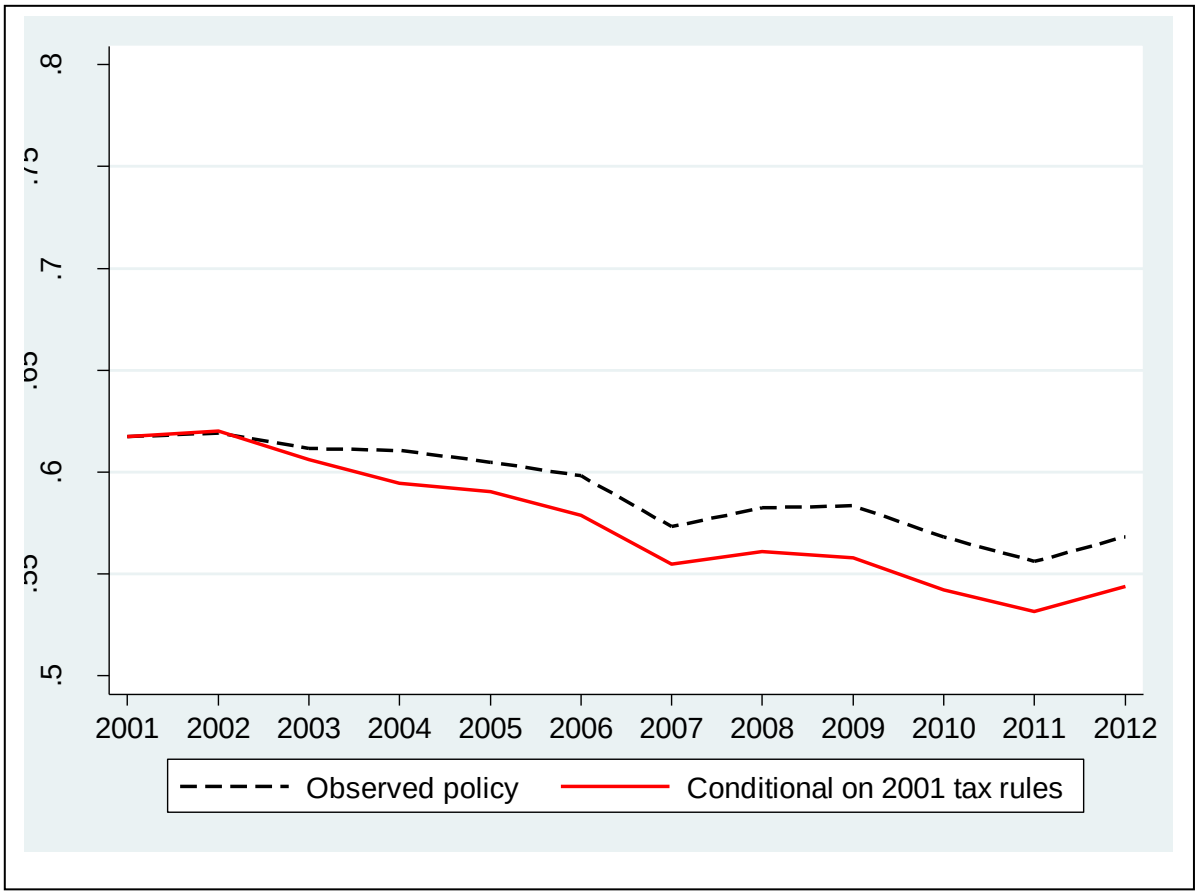
Note: Job cell: 2935 units (3-digit occupationX2-digit industry); Note the predicted probability is predicted based on Model 3 of Table 2 excluding the instrument, and data is then sorted into the 4 quartiles. *1.stg.est. instrument* expresses the estimate associated with the subsidy relative to net union fee in separate regressions for each quartile comprising the same controls as Model 3 of Table 2. **, * and x denote significant at the 1, 5 and 10 percent level of significance, respectively.

Figure A1 The relationship between the subsidy rate and the probability of union membership. Worker-level analysis.



Note: Figures predicted based on estimates of Table 2.

Figure A2 The counterfactual development in union membership without tax policy reforms: worker-level analysis.



Note: Figures predicted based on estimates of Table 2.