How Do Firms Respond to Unions?

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Abstract

This paper provides a comprehensive assessment of the margins along which firms respond to shifts in union density. Based on identification designs that exploit exogenous variation in exposure to union density across Norwegian firms, we show that the average manufacturing firm increases labor compensation and scales up production through increases in labor, capital, and material inputs, driven by a reallocation of labor to larger firms. In addition, value added per worker and product price markups rise, while labor markdowns fall. We find no decline in profits. Estimates of price pass-through from customs data suggest that firms pass on the entire labor cost increase in prices and that the measured increase in value added is driven by price increases rather than by productivity increases. Our results are consistent with the average Norwegian manufacturing firm having both considerable product and labor market power. When considering the private sector as a whole, increases in unionization increase earnings but reduce employment and other production inputs in the average firm, leading to lower total sales and lower firm profits.

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1 Introduction

Trade unions represent one of the most powerful labor market institutions in the Western world. Through their monopolization of labor supply, they constitute one of the biggest departures from market wage-setting in modern economies, and they have featured prominently in policy debates across Europe and the US. Underlying much of this policy debate are tensions between businesses and workers about whether the perceived benefits that unions bestow upon their members through group-level bargaining compromise the productivity and profitability of firms, alongside concerns that unionization may harm aggregate employment or economic efficiency.

Even though four decades have passed since the canonical work of Freeman and Medoff (1984), there is surprisingly little evidence on how firms respond to unionization (in large part because of difficulties in identifying plausibly exogenous shifts in firm-level unionization). This shortcoming is particularly acute given the importance policymakers place on understanding the overall effect of unions on the economy, especially in light of the recent surges in labor activity in the US (NLRB, 2022). Specifically, if unions raise the cost of labor by increasing worker wages, how do firms respond? Do they pass on the rising labor costs to consumers through higher output prices, do they pay for the increased costs themselves through lower profits, or is it resolved through input substitution and productivity adjustments? On a more aggregate level, what are the overall implications on price levels, wage inflation, and consumer purchasing power?

In this paper, we present a comprehensive assessment of the margins along which firms respond to shifts in union density. We do so by exploiting a change in subsidies for union membership in Norway, where a change in tax policy led to a quadrupling of the maximum tax deduction workers could take to pay for their union membership between 2002 and 2010. These changes significantly reduced the monetary cost of joining a union for workers whose union due subsidies were previously bounded by a tax deduction cap (Barth et al., 2020). This means that workers at firms whose union dues were high prior to the change in tax policy by the national government were more intensely "treated" relative to those with lower baseline union dues. This distinction in exposure generates exogenous variation in the incentive to join a union for individual workers depending on the firm at which the worker was employed and, therefore, different exogenous shifts in union densities across firms.

We estimate the margins along which firms respond to shifts in union density through an instrumented dose-response difference-in-differences design, leveraging the government subsidy policy and exploiting rich administrative data on the entire population of workers and firms in Norway —including detailed firm accounting data as well as information on union membership, union dues, and each worker's occupation. The apparent size and permanence of the unique policy change we exploit allows us to examine responses to a union density shift in a context where firms have strong incentives and flexibility to restructure their production process and re-optimize their operations. Our ability to supplement the rich firm-level accounting data with product-level export data from the Norwegian customs data bank represents a particularly novel feature of our analysis, enabling us to directly examine the potential price pass-through of higher labor costs as a result of increased union density.

For our main analysis, we restrict attention to firms in the manufacturing sector. The reason for this decision is two-fold. First, our product-level customs data are dominated by the manufacturing sector. Second, the production function approach we rely on to back out price markups and labor markdowns requires that at least one input is competitively supplied. This assumption is met with respect to raw materials in the manufacturing sector, but perhaps not in other sectors such as retail or services (e.g., Loecker and Warzynski (2012); Yeh et al. (2022)). For completeness, we also show results for the entire private sector, though we note that the production function approach assumption that relies on competitively supplied materials may not be satisfied for some industries. Comparing results across sectors is of particular interest as manufacturing is a highly concentrated sector with a relatively strong union presence, and looking across sectors allows us to better understand how the power dynamics between employers and employees influence the firm response to union density increases.

We first estimate the firm-level relationship between the government subsidies and the fraction of workers who are induced to join a union. We find that firms that experience a 1,000 Kr ($110) larger reduction in average net-of-subsidy dues see a 16 percentage point larger increase (or smaller decrease) in firm-level union density. This suggests a sizeable price elasticity of union membership for marginal union members. For the full private sector, this change is -8.6 percentage points. Because the manufacturing sector is highly concentrated both in terms of product and labor markets, the difference in response to the subsidies between the sectors implies a significant gradient in responsiveness over market concentration, which has also been found in prior work (Dodini et al., 2022). Comparing our results to the existing literature, the effects we obtain for the full private sector are similar in magnitude to those estimated in Barth et al. (2020); Dodini et al. (2021), and are similar to the results from a survey of Norwegian workers' self-reported responsiveness to union dues (Dodini et al., 2023).

The administrative data combined with the very large union density shock allow us to provide a comprehensive assessment of the margins along which firms respond to these documented shifts in union density.

First, in terms of earnings and non-earnings compensation, we show that the changes in firm-level union density result in higher compensation for workers at the firm. Specifically, we find that a 1 percentage point increase in firm-level union density leads to a 1 log point increase in compensation per worker (comprised of increases of approximately 1 log point in both earnings and non-wage compensation). While the earnings effects are in line with the estimates in Barth et al. (2020); Dodini et al. (2022), the non-earnings compensation effects are new to the literature. The divergence in union density and earnings between firms with different levels of exposure to the subsidies emerged only after the government subsidies, which underlines that the earnings changes are driven by the policy-induced shift in union density and not some other factor. Provided that the composition of the workforce has not been altered in response to the union density shift, which we explore, the compensation results imply that the per unit price of labor is increasing as a consequence of higher union density.

Second, with respect to input substitution and scaling, we find that an increase in unionization pushes the average manufacturing firm to expand. A 1 percentage point increase in firm-level union density leads the average firm to increase its employment (1 log point), as well as its expenditure on capital and materials, by approximately 0.9 and 0.4 log points, respectively. These estimates are consistent with scaling up total production by around 1 percent under the assumption of no diseconomies of scale. The expansion of labor usage in response to a higher per-unit cost of labor would be consistent with a high degree of monopsony power in the manufacturing sector, which may arise, for example, from high levels of labor market concentration (Schubert et al. (2020); Caldwell and Danieli (2018); Prager and Schmitt (2021)). It also suggests that labor-capital substitution in the manufacturing sector is difficult – at least in the short run.

Third, we find that the production scaling effect translates into an increase in the nominal value of firm sales by 1.4 log points. This effect is slightly larger than the expansion of labor usage, and nominal value added per worker also increases (by 1.1 log points). Because measures of worker productivity like value added are combinations of their marginal product and prices, the increase in value added per worker could be a result of an increase in the quantity produced by each worker (a “true” productivity increase), or an increase in the price.

Fourth, in terms of price markups and labor markdowns, we show that unionization increases lead to an increase in product markups and a decrease in labor markdowns. Interestingly, we find no decline in profits after the policy-induced rise in union density. In fact, if anything, profitability slightly increases as value added per worker goes up by more than the increase in labor compensation.

Fifth, by using detailed product-level export data and novel mediation analyses, we show that the average manufacturing firm passes on the entire labor cost increase in prices and that the measured increase in average value added is entirely driven by price increases rather than by productivity increases. Understanding to what extent the measured increase in value added is driven by price increases versus productivity increases is key to being able to map out the impact of unionization on firms – and on the broader economy. This has important implications not only for the welfare effects of unionization but also for how we should interpret prior literature on this topic. For example, Barth et al. (2020) find increases in value added per worker after increases in union density induced by the same tax deductibility changes, and attribute this to productivity-enhancing effects of unions. However, our analysis suggests that most of that effect may be coming through a price effect and not a real productivity gain.

We then examine the differential effects of union density across firm size in the manufacturing sector. We find that, while the markup effect is consistent over firm size, smaller manufacturing firms reduce employment and other inputs and reduce their total sales. Larger firms, however, increase their employment, reduce markdowns, and scale up production. The net effect is a reallocation of labor and production from smaller firms to larger firms such that the labor share of value added does not significantly change.

After having explored the margins of adjustment across the manufacturing industry in Norway, we expand our analysis and show results for the broader private sector. While a scarcity of exporters in these sectors prevents us from performing our direct pass-through exercise, we can still estimate both price markups and labor markdowns under the assumption that raw materials are competitively supplied, though we note that this may not hold for all industries. It is, however, useful to examine the other margins of adjustment.

The results for the broader private sector reveal some key differences from our manufacturing analysis. The biggest difference between these two analyses concerns the employment and scaling response to increased union density: we find an expansion of the average firm in the manufacturing sector versus a contraction in the broader private sector. Comparing results across the manufacturing sector and the whole private sector is particularly interesting as manufacturing is subject to substantial labor market concentration while the whole private sector is considerably less concentrated in terms of local occupation employment shares (mean HHI of 0.116 in manufacturing compared to 0.043 for the rest of the sector), local industry employment shares (mean HHI of 0.238 compared to 0.042), and national industry revenue shares (mean HHI of 0.041 compared to 0.012). These industries also have slightly lower markdowns (1.7 in manufacturing compared to 1.68 for the rest of the private sector). In addition, the manufacturing sector is subject to a relatively substantial baseline union density (mean across all firms of 32.1%) compared to the other private-sector industries (mean of 16.7%). Thus, the dynamics of power on both sides of the labor market differ across these sectors, and while speculative, we believe that one explanation for the differential effect across these industries relates to labor market concentration differences across them. This is an important result that implies that the effect of changes in firm-level union density may depend on the baseline power dynamics between employers and employees.

Finally, as a means to better understand the macroeconomic price and wage inflation effects of our findings, we perform a set of back-of-the-envelope calculations, using our results in conjunction with a prior estimate of the effect of the union dues subsidy changes on overall union density in Norway. Prior work and our estimates suggest that the unionization rate in the country would have been approximately 5-6 percentage points lower had the subsidies not expanded (Barth and Nergaard, 2015)), while our estimates for manufacturing imply that the average firm-level union density in manufacturing would have been approximately 12 percentage points lower. We find that overall price levels in Norway would have been 2.7-5.9 percent lower in the absence of the change in union subsidies by 2014 via the effect on prices in the manufacturing sector. Over the 2001-2014 period, the overall price level increased by 46 percent during a period of strong economic growth. In manufacturing, we calculate that union density effects increased wages by approximately 5.5-12% between 2001 and 2014 compared to a total increase in manufacturing earnings of approximately 79 percent. Together, this suggests that the increased union density in the manufacturing sector alone could explain 5.9-12.8% of the overall increase in the price level during the period and 6.9-15.2% of the total earnings gains in Norwegian manufacturing.

The core contribution of this paper is to provide a comprehensive assessment of the margins along which firms respond to shifts in union density, leveraging a unique subsidy policy that generates quasi-random variation in union density exposure across firms and exploiting rich administrative data on the entire population of workers and firms in Norway. The paper makes several contributions to the existing literature.

First, there is a large and growing literature that causally identifies the effect of unions on individual workers through quasi-experimental research designs, using anything from regression discontinuity designs and propensity score matching techniques. While many of these studies have focused exclusively on wage and inequality effects (e.g., DiNardo and Lee (2004); Lee and Mas (2012); Frandsen (2021); Sojourner et al. (2015); Card and De La Rica (2006); Bryson (2002); Fortin et al. (2022); Barth et al. (2020); Farber et al. (2021); Dodini et al. (2022)), a more recent set of papers have begun exploring other career dimensions as well (e.g., Finnigan and Hale (2018); Frandsen and Webb (forthcoming); Hagedorn et al. (2016); Park et al. (2019); Dodini et al. (2023)). On average, these papers find union wage premiums in the range of 0.1-0.4 log points, and that workers benefit from unions not only in terms of compensation, but also in terms of the quality of the work environment, improved job security, and enhanced advancement opportunities.

A key question that emerges from this literature is how firms respond to the higher wage and personnel costs driven by union representation. Do they substitute labor for capital, do they adjust the composition of their workforce, do they absorb costs through reduced markdowns, or do they pass on the costs through higher markups? In addition, do profits fall? and are firms more likely to go out of business? We advance this literature and break new ground by comprehensively examining the margins along which firms respond to shifts in union density. We show that firms in the highly concentrated manufacturing sector scale up production in response to increased union presence at the firm and that they pass on the entire cost of this adjustment to consumers through higher output prices. In the private sector as a whole, union density leads to lower employment and output. These results have important implications for how we view the role of unions in labor markets and for understanding the overall effect of unions on the economy. We, therefore, see our paper as opening up a new avenue of research, exploring the dynamics of how unions and firms impact not only the well-being of workers but also the economy's production process and overall performance.

Second, there is a relatively small literature exploring the causal impact of plausibly exogenous changes in firm-level union representation on firm profit, performance, and productivity (e.g., Barth et al. (2020); Lee and Mas (2012); DiNardo and Lee (2004); Sojourner et al. (2015). The results from this literature are somewhat mixed, ranging from large negative to slight positive productivity effects.[1]

While these papers have provided important insights into the effect of unions on firms, they have been limited in their ability to disentangle the margins along which firms respond to shifts in union density. As such, it also has been difficult to understand how these results tie together and why they differ as much as they do. Our administrative data combined with the very large union density shock allows us to provide a comprehensive assessment of the margins along which firms respond to these shifts in union density, and fully disentangle the mechanisms through which increased union density influences firm behavior. One particularly novel feature of our analysis is our ability to directly examine price pass-through to output prices using detailed export data from the Norwegian customs data bank, enabling us to disentangle true productivity effects from price effects.

[1]For example, Lee and Mas (2012) finds a negative effect on the equity value of firms using representation elections in the US matched with stock market data; Sojourner et al. (2015) find suggestive evidence of productivity gains of unionization using data from nursing homes in the US; DiNardo and Lee (2004) find little evidence of productivity changes by examining output effects of close representation elections in the US, and Barth et al. (2020) find suggestive productivity gains in Norway using a similar setup to us.

Third, there is a growing literature exploring the pass-through effect of changes in the input prices of firms, ranging from minimum wage legislation (e.g., Harasztosi and Lindner (2019)) to unexpected shocks in energy prices (e.g., Fontagné et al. (2023)). These related literatures tend to find a large pass-through of rising input costs to output prices, with consumers bearing the majority of the cost of the change in the price of inputs. However, there are key differences between these settings that make the union pass-through particularly interesting to examine. Unlike a change in minimum wages which are uniform across a given segment of the labor market, some firms are affected more than others in the same product (and labor) market by differential changes in firm-level union density, changing the margins along which firms can respond. Moreover, unlike a typical input cost shock, the magnitude of the increase in wages negotiated by a union is endogenous to the firm's conditions: unions typically take into account the firm's likely employment response or continued viability when setting wage demands, and firms may also adjust their negotiation strategy depending on these variables.

The paper proceeds as follows. In Section 2, we describe the institutional context of the union environment and the government-induced union due subsidies in Norway. In Section 3, we introduce our data and present our empirical research design. In Section 4, we first present results for our first stage effects on union density and effects on worker earnings (4.1). In 4.2, we present various margins of adjustment by firms. In Section 4.3 we provide evidence on price pass-through from customs data, and in 4.4 we separate productivity effects from price effects. In Sections 4.5 and 4.6, we examine heterogeneous treatment effects and worker composition effects, respectively. In Section 5, we discuss the implications of these findings and conclude.

2 Background

In this section, we begin by providing a detailed overview of unions in the Norwegian labor market. Next, we discuss how the bargaining process between employers and unions works and what abilities firms and local unions have to adjust individual wages. Finally, we provide detailed information on how the government-induced union due subsidies operate and how they provide us with exogenous variation in union status across workers and union density across firms.

2.1 Unions in Norway

Norway has a strong tradition of union representation, and each worker has the legal right to join a union irrespective of who they work for. However, this has to be on a voluntary basis; closed-shop union agreements are not allowed. As in other countries, the stated goals of the Norwegian trade unions are to improve members' rights and work conditions through collective bargaining. This concerns not only monetary compensation, but also factors related to workplace environment, non-pecuniary benefits, and hours. In addition, they provide legal representation in the event of workplace disputes.

Similar to other OECD countries, Norway has experienced a slight decline in union density over the past 20 years, but this drop is much smaller than that in neighboring countries (4 percentage points in Norway over the past 20 years compared to 14 percentage points in Sweden, 8 percentage points in Denmark and 15 percentage points in Finland). Existing research has attributed the slower decline in unionization in Norway to the government subsidies of union dues that we exploit for identification in this paper, and has projected that aggregate union density would be approximately 5-6 percentage points lower had the subsidies not been introduced (e.g., Barth and Nergaard (2015)).

Approximately 50 percent of the Norwegian workforce are organized members, though there is substantial variation both across sectors (79 percent in the public sector and 40 percent in the private sector) and industries (70 percent in mining and 20 percent in the hotel and restaurant industry). A visual illustration of the trends in union density over time and across sectors is provided in Figure 1. For the manufacturing sector, which is the focus of our main analysis, union membership is approximately 55 percent and, while it experienced a decline during the late 1990s and early 2000s, has remained relatively stable since approximately 2004. While there is a range of different types of labor unions that workers can join, the majority of workers select their union based on which occupation and industry they belong to.

In terms of professional structure, each individual union is connected to a larger national confederation of unions, of which there are four in the country (LO, Unio, YS, and Akademikerne). On behalf of their members, unions can negotiate not only wages but also help settle legal disputes, push for better work conditions, provide counsel in the event of promotions and appointments, protect against unfair work conditions and dismissals, aid in the event of occupational injuries and poor health standards, and provide non-work related non-pecuniary benefits.

2.2 The Bargaining Process

Similar to other Scandinavian countries, the Norwegian labor market is characterized by high coverage of collective bargaining agreements. However, the ability of firms and local unions to adjust individual wages remains high (Blandhol et al., 2020).

In the most common collective bargaining agreements, which cover 50 percent of the private sector workforce (and 80 percent of the overall workforce), the bargaining process proceeds in two steps. In the first step, industry-wide collective bargaining agreements are established to set minimum wage guidelines.[2] In the second step, local negotiations take place in which unions and employers discuss not only firm-specific wage increases for union members but also individual-specific wage increases. Non-union employees do not have the right to bargain, and it is up to the employer to adjust the pay as they deem appropriate.

Among the 50 percent of the private sector not covered by agreements through this standard sectoral collective bargaining process, more than half (30 percent of the private sector) are not covered by any agreement at all, and all their bargaining takes place at the local level. Thus, for 80 percent of the private sector workforce (the 50 percent covered by the common collective bargaining agreement and the 30 percent not covered by any agreement at all), individual firms and local unions can have a substantial influence on wages and work conditions (Blandhol et al., 2020).[3]

Union density at a firm is particularly meaningful during the local negotiations where local union bargaining power is leveraged to extract concessions from firms. While the national and sectoral wage agreements have played a key role in setting worker wages in the past, local negotiations now account for more than 70 percent of total negotiated wage increases (Bhuller et al., 2022). For a more detailed discussion on the institutional details surrounding the wage bargaining process, please see Dodini et al. (2021).

2.3 Union Tax Deductions

Workers are required to pay monthly dues in order to become (and remain) members of unions. These dues are used to finance a wide variety of the union's professional activities, including (but not limited to) personnel costs, the legal representation offered by the union, lobbying activities, a strike fund, and potential campaign programs.

Baseline union dues are commonly set during the union's annual national meeting. On average, dues typically range from 1.5 to 3.5 percent of a worker's pre-tax income. Most union payments are facilitated through a "dues checkoff" mechanism in which the employer agrees to deduct the union due from the worker's paycheck directly and transfer that amount to the union. This is shown explicitly on the workers' wage statements at the end of each month.

Union membership is subsidized in Norway, with the government providing a direct tax deduction for union dues up to a legislated maximum. This tax deduction is automatically entered on an individual's tax return, making the price subsidy very salient to the worker. Beginning in the early 2000s, the Norwegian government increased the maximum allowable tax deduction for union dues multiple times, effectively quadrupling the maximum from 2001

[2] If negotiations fail, the parties are entitled to take industrial action. This usually occurs in the form of a strike (unions) or a lockout (employers).

[3] For the remaining 20 percent, all bargaining takes place at the sector- or industry-level in a process separate from the typical two-step process (Blandhol et al., 2020).

through 2010 (Figure 2). At the same time, average membership fees rose much more slowly, such that the subsidy value as a share of the total membership fee rose from 7 percent in 2001 to more than 20 percent in 2012 (Barth et al., 2020). The realized value of the subsidies to workers depends on the union dues required of prospective members.

Our empirical strategy exploits the national changes in the maximum allowable tax deduction for union dues. These changes significantly reduce the monetary cost of joining a union for those workers whose union dues were previously greater than the tax deduction cap (since these workers can deduct more once the cap is lifted), but do not affect the monetary cost of joining a union for the workers whose dues were already below the tax deduction cap. Thus, workers at firms whose union dues were high prior to the reform are more intensely "treated" by the reform relative to those with lower baseline union dues because their net dues would fall by disproportionately more. This distinction generates exogenous variation in predicted unionization rates for workers and, therefore, different union densities across firms. We use this exogenous variation in union density to identify the effect of unionization on earnings, employment, and other outcomes at the firm, including who pays for labor cost increases.

3 Empirical Design

In this section, we discuss the data we rely on for our analysis and provide descriptive statistics on our sample. We then provide detailed explanations of how we use our data to calculate key variables of interest: markups, markdowns, total factor productivity, and price indices. Next, we provide intuition and a description of how we use increases in the union dues tax deduction cap to construct our instrument. Finally, we carefully walk through the technical implementation of our estimation approach and offer a detailed discussion on the identifying variation that we rely on, what assumptions must hold for our estimates to be interpreted as causal, and what are the main threats to identification.

3.1 Data

Data Overview. Our main data come from detailed administrative registers at Statistics Norway. These registers provide us with annual socioeconomic and demographic information of each individual aged 16 through 74 between 2001 and 2014. The demographic information includes details on gender, age, marital status, family composition, educational attainment, and residency location. The socioeconomic data provide information on employment, occupation, industry, earnings, and social welfare participation.

By linking the individual-level data to the union membership and dues database, we collect information on all workers' union status and the amount that they have paid in dues for each year over our sample period.

Once we have obtained our individual-level data, we merge it with detailed employer-employee matched data and subsequently merge it to firm tax data. These data include information on the firm's input costs (personnel costs, capital costs, and material costs), workforce (size and average earnings), and output (sales revenue and profits). These data also enable us to construct measures of value-added (sales revenue minus the cost of goods), as well as markdowns, markups, and total factor productivity (discussed further below).

We also link our data with firm-level data from the Norwegian export register, which contains information on all exports (quantity/weight, product identifiers, and prices) for the sample period. While we do not have price data for domestic sales, the fact that nearly 50% of all Norwegian manufacturing firms export means that we are able to estimate price pass-through for a large share of our sample.[4] These data also enable us to construct a firm-level Paasche price index for exports.

We include summary statistics on our data, which covers all Norwegian manufacturing firms with at least five workers, in Table 1 below. For comparison, we also include information on non-manufacturing firms to help understand the dimensions on which these sectors differ. The typical manufacturing firm employs more workers, pays them higher wages, and has higher value added per worker than the average non-manufacturing firm. Manufacturing firms also have higher costs across input types, slightly higher labor markdowns, and a lower labor share of value added. Manufacturing firms employ larger shares of their local labor markets as measured via occupation or industry employment shares, and account for larger shares of their product markets as measured by total national industry revenue shares. Perhaps as a result, profits in the manufacturing sector are higher, and firms close at lower rates. Finally, the average manufacturing firm has substantially higher union density than the average non-manufacturing firm.

Calculating markups, markdowns, and total factor productivity. To obtain measures of markups and markdowns, we begin by noting that the gaps between the output elasticity of labor and labor's revenue share reflect a firm's market power (in both product and labor markets combined). Following the insight of Yeh et al. (2022), we further note that one can separately identify markups and labor markdowns as long as one input is being competitively supplied. The reason for this is that the wedge of the flexible input should only reflect product market power, such that the ratio of the labor wedge to the flexible input wedge enables us to identify labor market power.

We obtain the output elasticities through the IO production function approach (e.g., Loecker and Warzynski (2012)). This is a three-step approach that begins by relating firm

[4]In our main analysis, we focus on firms with at least five workers in order to avoid small firms from driving our results or generating noise in our production function estimates.

output (revenues) to inputs through the following expression, which we perform separately by industry sectors (e.g. manufacturing, construction, etc.):

$$y_{ft} = f(x_{ft}; \beta) + \omega_{ft} + \epsilon_{ft} \tag{1}$$

in which $\tilde{x}_{ft} = (k_{ft}, l_{ft}, m_{ft})'$ and represents a vector of firm f's input costs (capital, labor, materials) in year t, ϵ_{ft} is measurement error, and ω_{ft} is productivity. Following the IO convention, we instrument x_{ft} with the one-year lag of each variable to eliminate endogeneity issues (except capital, which can be considered fixed in the short run).

We first estimate a third-order polynomial of y_{ft} on x_{ft} and controls for time trends to acquire non-parametric estimates of output free of measurement error. We then construct productivity estimates, $\omega_{ft}(\tilde{\beta}) = \varphi_{ft} - f(x_{ft}; \tilde{\beta})$, and estimate a third-order polynomial of productivity on lagged productivity to obtain productivity shocks $\xi_{ft}(\tilde{\beta})$. Finally, we obtain $\hat{\beta}$ of production function parameters through GMM system induced by moment conditions $E(\xi_{ft}(\tilde{\beta}) * \mathbf{z}_{ft}) = \mathbf{0}_{Zx1}$.

Assuming a Cobb-Douglas production specification, β represents the output elasticities with respect to each input. Having estimated these output elasticities, we calculate the (product price) markup as the output elasticity times the input share of revenue ($\mu_{ft} = \frac{P_{ft} * Q_{ft}}{P^V_{ft} * Q^V_{ft}}$) for the inputs which are assumed to be flexibly supplied. The assumption that at least one production input is flexibly supplied is crucial for the separate identification of the product markup and the labor markdown. Since our analysis focuses on the manufacturing sector, we follow the IO literature (e.g., Loecker and Warzynski (2012); Yeh et al. (2022)) and use raw materials as our flexibly supplied production input. The labor markdown can then be calculated as $\frac{\beta^l_{ft}}{\alpha^l_{ft}} * \mu^{-1}_{ft}$ since the ratio of output elasticity of labor (β) and the labor share of revenue (α) equals the product of the markup and the markdown.

Calculating firm-level price indices. While calculating markups is an often-used approach in the IO literature, it relies on assumptions about the production function process. To complement this approach, we also directly examine price pass-through using customs data for exporting firms. Using this dataset, we calculate prices per kilogram for the specific products exported by each firm. Aggregating to the firm level, we also generate a firm-specific Paasche price index by combining information on product-specific revenue shares and product-specific pricing. Using information for each product code i in time t relative to base year b, we calculate: $\frac{\sum_i P_{i,t} Q_{i,b}}{\sum_i P_{i,b} Q_{i,b}} \cdot 100$. We anchor the base year b for each firm to the firm's last year in the dataset (2014 for most firms), in part because the set of products being exported during this period expanded.[5]

[5]Setting the base year to the firm's first year(s) would result in assigning zero quantity and price weights to new products in the index, which is problematic if firms respond to increased union presence by changing

3.2 Instrument for Unionization

Union density is not exogenously given to firms, but is a result of endogenous selection – both for the individual worker as well as for the firm. This typically makes it difficult to study the effects of unionization. To overcome the selection issue, we exploit national increases in the cap on the allowable tax deduction for union dues in Norway that took place between 2002 and 2010, with more minor increases between 2011 and 2014, and led to significant changes in the net price of union membership for some workers (Barth et al., 2020; Dodini et al., 2022). These changes significantly reduced the monetary cost of becoming a union member for workers whose ability to deduct their union dues from their taxes was previously bounded by the deduction cap. Figure 2 shows the evolution of the maximum deduction over time: the deduction cap was relaxed from 900 NOK in 2002 to over 3,800 by 2010.

Increases in the maximum dues deduction cap affect workers differently depending on their prior dues. To see this clearly, let D denote the union dues, τ the tax rate, and c_0 and c_1 the initial and new cap respectively. Net-of-subsidy union dues in period i are $(1-\tau)D$ for workers whose dues are below the cap, and $D-\tau c_i$ for workers whose dues are above the cap. The change in net-of-subsidy union dues therefore differs for three groups of workers. Workers whose dues were below the old cap ($D < c_0$) see no change. Workers whose dues were above the old cap but below the new cap ($c_0 < D < c_1$) see a decrease in their net-of-subsidy union dues of $\tau(D-c_0)$, with the total change increasing linearly in their dues amount. Workers whose dues were above the new cap ($D > c_1$) see a fixed decrease in their net-of-subsidy union dues of $\tau(c_1-c_0)$. Thus, our empirical approach is akin to an instrumented dose-response difference-in-differences design in which we compare individuals and firms over time as a function of the subsidy bite.

Figure 3 provides an illustrative example of the gap between base dues and net dues after the subsidy went into place assuming a tax rate of 42%, which was the typical top marginal rate from 2001-2014.[6] In 2002, the maximum deduction was capped at 900 NOK but increased to 1,800 by 2005, to 3,150 by 2008, and to 3,850 by 2014. For a worker whose base dues were 3,000 NOK, net dues would have been 2,600 NOK in 2002 but would have fallen to 1,750 by 2008. For a worker whose base dues were 4,000 NOK, net dues would have fallen from 3,600 in 2002 to 2,675 in 2008 and to 2,380 in 2014 —a reduction of over 1,200 NOK ($\approx$ 34%).

A worker's union dues depend mostly on the job in which they are working, namely, their

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the products they sell, particularly if they are higher-priced goods. We find evidence of this (discussed below).

[6] We use the 42% rate for demonstration purposes. In our estimation models, we apply the base tax rate (28%). In practice, the difference is only a matter of scaling the first-stage estimates.

occupation and industry. We, therefore, impute a union dues amount for each worker in our data by calculating the mean union dues paid by workers in their occupation-industry cell in each year. For workers in a union, this helps us rule out concerns about heterogeneous selection into differently-priced unions and individual determinants of union dues. For workers who are not union members, this allows us to assign counterfactual union dues, i.e., the dues they would most likely have paid if they had joined. We then measure union dues at the firm level by calculating the average of imputed dues across all the firm's workers in each year. This imputation is identical to (Barth et al., 2020). Our measure represents the typical gross cost of union membership at the firm in any given year if all workers were union members. This imputed due helps us characterize the firm's exposure to the change in union dues subsidies, since a firm may be affected both by existing union members being less likely to leave their union if they experience an increase in dues subsidies and by non-members deciding to join a union.

Because unions may respond endogenously to the changes in union deductions, and because firms may alter their occupation mix in response to unionization, we fix each firm's imputed "baseline" union due, $\overline{D_f^0}$, at the firm's first year in the data. For most firms, this base year is 2001. We then adjust for inflation forward to nominal Norwegian Kroner in year t to get $\overline{D_{ft}^0}$. This measures what the "typical" gross union due would be at the firm in year t if their occupation-industry composition were held constant at baseline levels.

Finally, we define the net-of-tax union due $NetDue_{ft}$ as the baseline union due at the firm minus the effective subsidy to unionization from the tax deduction in a given year t. This subsidy is equal to the base tax rate multiplied by the lesser of the legislated maximum deduction ($MaxDeduction_t$) and the worker's imputed base union due. We, therefore, have our instrument

$$NetDue_{ft} = \overline{D_{ft}^0} - T_t * (min\{\overline{D_{ft}^0}, MaxDeduction_t\}) \ , \tag{2}$$

where T_t is the base tax rate in year t.[7] We use this net-of-tax union due to instrument for firm-level union density.[8]

[7]This is 28 percent from 2001 to 2013 and 27 percent from 2014 onward. We apply the base tax rate to isolate changes in the guaranteed *statutory* subsidy from changes in the *realized* subsidy that may depend on marginal tax rates. When we use the average top marginal rate (42%) to scale the subsidies rather than the base rate, we obtain first-stage estimates that are marginally smaller with the same second-stage estimates. This only shifts the scale of the first stage estimates.

[8]Note that our instrument abstracts away from endogenous responses to the tax deduction changes by unions - specifically, raising dues in response. We evaluate this response in Appendix Table A1, estimating that unions did indeed raise dues in response and extract a portion of the subsidy. Part of this response may be mechanical if union density raises worker earnings and unions charge dues as a share of earnings. For our estimation strategy in this paper, however, the incidence of the increase in the effective subsidy to

3.3 Empirical Method

In our baseline empirical analysis, we regress firm-level outcomes on our instrument for firm-level union density in a two-stage least-squares approach, using standard errors clustered at the firm level, and we note that clustered standard errors in many cases can be quite conservative (Abadie et al., 2023). Specifically, we regress firm-level outcomes Y_f on our predicted union density as follows:

$$Y_{ft} = \alpha + \beta \widehat{UD}_{fgt} + \delta_f + \tau_{gt} + \varepsilon_{fgt}, \tag{3}$$

where firm union density is predicted in the first stage equation:

$$UD_{fgt} = \gamma + \theta \text{NetDue}_{ft} + \delta_f + \tau_{gt} + \eta_{fgt}, \tag{4}$$

with firm (δ) and industry group (g) by year (τ) fixed effects in all specifications. The industry-group-by-year fixed effects account for any time-varying shocks to demand over time specific to each industry group, which may be important given the fast demand growth occurring during this period.

As described in Section 2, our baseline regressions cover all firms with at least five workers in manufacturing industries. We focus on this sector for two reasons. First, our product-level export dataset is dominated by manufacturing, with limited observations in other sectors. Second, to separately identify price markups and labor markdowns through the production function approach, at least one input (which we assume is raw materials) has to be competitively supplied, and this assumption is not necessarily satisfied in non-manufacturing sectors. However, we will show results for all other outcomes with respect to the broader private sector. While a scarcity of exporters in these sectors prevents us from performing our direct pass-through exercise, we can still estimate both price markups and labor markdowns under the assumption that raw materials are competitively supplied.

Identifying variation in our instrument comes from differences in the occupation-industry mix of the firm in the base year combined with changes in the legislated maximum tax deduction over time. Since all our specifications have firm and industry group by year fixed effects, our identification strategy leverages differential exposure across firms to the increases in the tax deduction over time while controlling flexibly for broad industry-specific shocks

unionization is less relevant: the magnitude of the subsidy remains the same and, whether it is captured by the worker or the union, there are channels by which we would expect an increased effective subsidy on union membership to increase union membership. To the extent the subsidy reduced the net price of union membership that the worker faces, and to the extent that workers are price-sensitive, we would expect more workers to join the union or fewer workers to leave. To the extent that the subsidy increased revenues for the union, we might expect the union to invest more resources in organizing workers, or to provide more benefits to increase the incentive for workers to join the union.

to product or labor demand. Following Barth et al. (2020); Dodini et al. (2021), we show in Section 4.1 that the first stage is strong: firms which saw larger decreases in their average net-of-subsidy union due saw larger increases (or smaller decreases) in their firm-level union density.

Our identification strategy requires that the standard IV assumptions of relevance, exclusion, and monotonicity apply. This means that changes in the firm-level average net-of-subsidy union dues must directly influence firm-level union density, that an increase in union density is the only channel through which changes in the firm-level average net-of-subsidy union dues affect firm-level outcomes, and that there are no firms for which a decrease in the firm-level average net-of-subsidy union dues generate a drop in union density. With respect to the relevance assumption, we will show directly in the next section that workers are highly responsive to changes in union membership price, and that this assumption therefore is met. In terms of the exclusion restriction, this cannot be tested directly. However, given the fact that these subsidy schemes were imposed across the entire country by the national government, and because identifying variation comes from pre-implementation differences across firms, we can think of no other pathway through which the union-dues subsidy may impact firm outcomes. With respect to the monotonicity assumption, this cannot be tested directly in the data either. However, the only way for this assumption to be violated would be if union membership is a Giffen good at certain prices, which is highly unlikely.

Note that our identification approach is akin to an instrumented dose-response difference-in-differences design, in which we leverage the differential change in exposure to the effective union dues subsidy over time as the cap is raised. Firms with high ex-ante dues have greater exposure to the increase in the tax deduction cap than firms with low ex-ante union dues, and we, therefore, expect the firms with higher ex-ante union dues to see bigger increases in firm-level union density. Importantly, since our identification leverages differential cross-sectional exposure to changes over time, we do not need ex-ante-high-dues firms and ex-ante-low-dues firms to be similar. Instead, we require that the difference in outcomes between ex-ante-high-dues firms and ex-ante-low-dues firms would be constant over time in the absence of treatment (intuitively, a parallel trends assumption).

An illustration of the parallel trends assumption is provided in Figure 4. Panel A shows the evolution of average firm-level union density over 1998-2014 for firms with above-median and below-median changes in their net-of-subsidy union dues (effectively visualizing the first stage for firms with above-median and below-median exposure to the instrument). Panels B-D show the evolution of average firm-level earnings, value added per worker, and profits, again for firms with above-median and below-median exposure to the instrument. The 1998-2002 period is the pre-treatment period, since the first large increase in the union dues tax deduction came into effect in 2002, and the large increases in maximum deductions ended in 2009-2010. As Panel A illustrates, while firms with below-median exposure to the instrument had slightly higher union density in the pre-period (25% vs. 24%) and slightly higher earnings (around 7% higher), we do not see any evidence of differential pre-treatment trends in terms of union density or earnings over the 1998-2002 period. This is consistent with our assumption that low-exposure firms can be used as counterfactuals for high-exposure firms in the post period had they not been more exposed to the policy changes, and therefore supports a causal interpretation of the results we present in Section 4.[9]

Examining Panel A of Figure 4, we also see preliminary raw evidence of a first-stage effect of the reduction in net dues on union density. Specifically, we see that the union density gap between high- and low-subsidy firms changed by 1.6 percentage points between 2002 and 2010 after the introduction of the new subsidy policies. A difference in the change in net dues of 163 NOK between these two groups over the same time period implies approximately a 10 percentage point increase in union density for every 1,000 NOK reduction in net dues. As we show in Section 4, this is remarkably similar to both our survey evidence and our measured first-stage effects. Notably, as shown in the figure, the average manufacturing firm's union density fell over the period of the subsidy increases. However, it fell by more in low-subsidy firms. It may therefore be appropriate to interpret the subsidies as having stemmed the tide of decreasing union density in individual firms (and not necessarily as having increased firm's union density levels relative to prior years). Moreover, in Panels B-D we see preliminary raw evidence of earnings, value added per worker, and profits effects of the differential change in union membership, as these measures in high-subsidy firms grew faster than in low-subsidy firms, but only during the time in which the subsidies were substantially changing (2002-2010). The trends are noticeably parallel from 1999-2001 and 2010-2014.

3.3.1 Compliers Analysis

Our estimates are based on the local average treatment effect (LATE) of an increase in union density among complier firms (i.e., those firms whose union density changes in response to the instrument). To facilitate the interpretation of our core findings and their generalizability, it is therefore informative to examine the complier population. This poses a challenge in our setting because both the instrument and the treatment are continuous.

In our estimation framework, treatment is continuous and measured within firms over

[9] The accounting data on firm-level outcomes is only available going back to 1999. Not all firm identifiers linked to individual workers in our set of combined registers are available prior to 2000, and union dues linkages are not available before 1998, so we cannot estimate a full event study model. These are raw trends that account only for firm fixed effects. The fact that we observe parallel pre-treatment trends from a less saturated model than that underlying our main results is encouraging.

time, which poses a challenge for directly measuring compliance rates. To reduce the dimensions under consideration, we construct an alternative "treatment" as having a positive change in union density over a three-year moving window and adapt our instrument to capture the three-year change in the net union due at each firm and condition on year by industry group fixed effects. We then estimate this for different subgroups of firms.

Following Dahl et al. (2014), we adapt our continuous instrument by estimating this adapted "first stage" and comparing predicted treatment take-up (having a positive change in union density in this setup) at the sample's lowest measured three-year change in net union due (the 1st percentile) versus the highest measured change in net union due (the 99th percentile). In other words, we examine the set of firms that would change treatment status at the extremes of the instrument distribution. This approach gives us the range of treatment take-up scaling by the entire range of the instrument and allows us to characterize compliers in the sample as in the common binary instrument case.

To examine who the compliers are over the distribution of union density, we estimate our adapted first stage regression for separate samples for moving windows of union density of widths of 20 percentage points (e.g. 20-40, 30-50 percent union density). To analyze complier rates for types of firms along other characteristics, we perform a similar exercise, but instead of splitting the sample based on union density, we split the sample based on other firm characteristics. Nearly all firm characteristics in the data are continuous, so for ease of comparison, we split various observed continuous attributes of firms at the median and separately estimate compliance rates for each split. For example, we examine compliance rates for firms with above-median value added per worker and compare this to compliance rates for firms with below-median value added per worker.

We plot the compliance rates over windows of union density in Panel A of Figure A1 and the compliance rates for different types of firms in Panel B. In both panels, we bootstrap the standard errors with 1,000 replications.

The results in Figure A1 reveal two main patterns. First, in Panel A, we find the highest compliance rates among firms in the range of 20-40 and 30-50 percent union density. This pattern matches that found in Barth et al. (2020) where compliance rates were highest in the 25-50% range. Second, in Panel B, we find that the complier shares are relatively similar across each of the splits, and that none of the differences are statistically significantly. Taken together, Figure A1 suggests that our LATE is represented by a wide variety of firms at different margins representative of the typical Norwegian manufacturing firm.

4 Results

In this section, we present our main findings. We begin by demonstrating that workers respond to reductions in the cost of union membership by enrolling at a higher frequency. We then turn to our core results, examining the margins along which firms respond to shifts in union density using the union due subsidies as an instrument for increased unionization. First, we consider the wage and non-wage compensation effects of union density, and whether firms face higher personnel costs as a consequence of increased unionization. Second, we examine impacts on input usage and whether firms adjust their use of labor, capital, and materials in response to the unionization increase. Third, we consider product price markups and labor markdowns as a means to better understand the price pass-through and cost absorption effects of increased unionization. Fourth, we explore the impact on worker productivity and firm profitability to get a more complete understanding of how unions impact firm performance.

Following our core analysis, we match our data with granular product-level price and quantity data on the universe of exports and examine to what extent the potential productivity effects found in our core results reflect actual productivity effects or simply price effects. We also analyze heterogeneity by firm size and by measures of ex ante labor market power, and explore how the worker-firm match changes as a result of increased unionization.

Next, while our main results focus on manufacturing firms, we present results for all private-sector firms and compare these to our results for the manufacturing sector alone. Comparing results across sectors is particularly interesting as manufacturing is a highly concentrated sector with a relatively strong union presence, and looking across sectors allows us to better understand how the power dynamics between employers and employees influence the firm response to union density increases.

4.1 First Stage

Table 2 shows the effect of the Norwegian tax subsidies on workers' propensity to unionize. These results are obtained through estimation of Equation (4) as specified in Section 3.3, and includes both firm and industry-group-by-year fixed effects.

Consistent with prior work in this literature (e.g., (Barth et al., 2020; Dodini et al., 2021)), we find that decreases in the net-of-subsidy union dues at the firm induce increases in firm-level union density. Specifically, Column (1) of Table 2 show that firms which experience a 1,000 Kr larger reduction in their average net-of-subsidy dues see a 16 percentage point larger increase (or smaller decrease) in firm-level union density. This suggests a sizeable price elasticity of union membership for marginal union members in Norway's manufacturing sector. For the full private sector, this change is -8.6 percentage points (see Section 4.7).

Because the manufacturing sector is highly concentrated both in terms of product and labor markets, the difference in response to the subsidies between the sectors implies a significant gradient in responsiveness over market concentration, which has also been found in prior work (Dodini et al., 2022). It is a slightly larger degree of responsiveness than that estimated in Barth et al. (2020), though our instrument construction differs, making differences in industry-specific estimates more likely.[10]

In addition to empirically estimating the first-stage response through our instrumented difference-in-differences strategy, we also borrow insight from Dodini et al. (2021)'s survey of Norwegian workers' self-reported responsiveness to union dues. The survey asks more than 5,000 workers in the Norwegian labor market how they would respond to a change in their net cost of joining a union. In Figure 5 we show worker's self-reported responses to a 500 NOK change in their net due (6,000 NOK annually) as a means to externally verify the first-stage results we obtain. The results correspond to a 7-10 percentage point average increase (decrease) in the likelihood of being in a union if net-of-subsidy dues fell (grew) by 1,000 NOK per year for most workers ($\approx$ 40-60% change at 6,000 NOK divided by six to scale to a 1,000 NOK change). Thus, the workers' self-reported responsiveness to union dues is extremely similar to the empirical estimates we obtain in this analysis.[11]

4.2 Margins of Adjustment

Wage and non-wage compensation. We first estimate the effect of increased union density on worker wages and non-wage compensation (estimated with Equations (4) and (3) as described in Section 3.3).

The estimate in Column (2) of Table 2 shows that the change in firm-level union density induced by increased union-due subsidies results in higher earnings for workers at the firm. Specifically, we find that a 1 percentage point increase in firm-level union density leads to a 1 log point increase in average earnings per worker. This is in line with the estimates in Barth et al. (2020); Dodini et al. (2022).

The estimate in Column (3) of Table 2 shows that the positive compensation effect is not only restricted to earnings, but extends to non-wage compensation as well. The magnitude of the effect on non-earnings compensation is extremely similar to that on earnings: a 1 percentage point increase in firm-level union density leads to a 0.9 log point increase in

[10]Our estimate of the first-stage responsiveness is likely an upper bound since we calculate our net-of-tax union dues using the base tax rate, and some workers will be in higher marginal tax brackets. Importantly, a scalar of the first stage does not alter the second-stage estimates.

[11]When examining the broader private sector in Section 4.7, the first stage estimate is approximately 8.6 percentage points, which is nearly identical to our survey evidence. Note that we use an estimate of 40-60% responsiveness as an aggregate over non-union members and union members and that non-union workers are disproportionately likely to be younger (25-39) while union members are disproportionately likely to be over 40.

average non-earnings compensation per worker.

Provided that the composition of the workforce has not been altered in response to the union density shift (something we explore in Section 4.6), the compensation results in Table 2 imply that the per unit price of labor is increasing as a consequence of higher union density.[12] This is a standard result in the union wage literature, and one which underlies much of the policy debate on worker representation at firms. Specifically, if unions raise firms' per-unit labor costs, how do firms pass on this cost, and how does that impact their productivity and profitability? Next, we examine how firms respond to this increased labor input cost in their operations.

Input substitution and scaling. An increase in the per unit cost of labor suggests that firms may adjust and re-optimize their use of inputs in the production process and perhaps even substitute labor for alternative inputs as long as the production process allows it. To examine this margin of adjustment, we estimate our main specifications as described in Section 3.3, using total log expenditure on labor, capital, and materials, as dependent variables. We also examine the effect on the log number of workers employed. The results from this analysis are provided in Columns (1) through (4) of Table 3 Panel A.

We find that an increase in unionization pushes the average manufacturing firm to expand employment. A 1 percentage point increase in firm-level union density leads the average firm to increase its employment by around 1 log points (and since per-worker compensation also increases, total personnel costs increase by 2 log points.). Increased employment in response to a higher unit cost of labor would be consistent with a relatively high degree of monopsony power in the manufacturing sector, as illustrated, for example, by its high level of labor market concentration (Schubert et al. (2020); Prager and Schmitt (2021); Caldwell and Danieli (2018)). Employers with monopsony power can hire and retain workers for wages that are below the marginal revenue product of labor. If a union is able to leverage its power to push wages above the current wage offered by the employer, such as a wage equal to the marginal revenue product, the firm would hire more workers, but their profits per labor unit would be lower.[13] In such a market, a union density wage premium could therefore lead to an increase in employment (e.g., Dodini et al. (2021)).[14]

[12]Specifically, in Section 4.6 we explore workforce composition and find that there are large increases in wages even net of any composition changes.

[13]In contrast, a union wage premium should generate a reduction in employment in perfectly competitive labor markets because employers in these markets pay wages equal to the marginal revenue product of labor. If a union is able to leverage its bargaining power to push wages above the marginal revenue product, at the new wage level, the employer will be unable to sustain current employment levels and will reduce either the number of workers or the number of work hours (e.g., Dodini et al. (2021)).

[14]However, a sufficiently large union wage premium that exceeds the marginal revenue product of labor would reduce employment, even in a highly monopsonistic market.

We also see the average manufacturing firm increasing its expenditure on capital and materials by around 0.9 and 0.4 log points each, though the estimate on materials is slightly noisy, so we cannot rule out an equal response to the employment increase. This means there appears to be little to no substitution response across inputs, at least in the short run over which we estimate our results: employment and capital use all increased by the same proportion.[15] This suggests substantial complementarities between labor and other inputs. Instead, firms appear to scale up total production by around 1 percent (assuming no diseconomies of scale). Interestingly, this expansion appears to be at least in part debt-financed, as long-term debts and debts to credit institutions increase along with assets (see Appendix Table A2).

To examine the scaling effect in more detail, Column (5) in Table 3 Panel A shows the impact of increased union density on firm sales. The estimate shows that the nominal value of firm sales increases by 1.4 log points in response to increased union density shift. This effect is larger than the expansion of labor or other input usage, implying that sales per worker have also increased. Indeed, we estimate that the nominal value added per worker increases as a result of the increase in union density (by 1.1 log points, as illustrated in Panel B Column (3)). This result is similar to that in Barth et al. (2020).

Measures of a worker's average revenue product are, by definition, a combination of their average product and prices. Thus, the increase in value added per worker could be a result of an increase in the quantity produced by each worker (a "true" productivity increase), or an increase in the price. We will disentangle this below using detailed product-level export data and novel mediation analyses. Understanding to what extent the measured increase in value added is driven by price increases versus productivity increases is key to being able to map out the impact of unionization on firms. This has not been explored in prior literature and represents one of the main contributions of the current paper.[16]

Price markups and labor markdowns. The increase in labor compensation and usage combined with the rise in the nominal value added per worker suggests that both labor markdowns (the ratio of the marginal revenue product of labor to wages) and product price markups (the difference between the firm's selling price and the marginal amount the item

[15] We assume that any changes in capital or materials prices are orthogonal to firm-level exposure to the union dues subsidy conditional on our fixed effects, meaning that we can infer that an increase in total materials expenditure reflects an increase in use of materials, rather than an increase in materials prices.

[16] As explained in Section 3, our sample is restricted to those firms for whom we can estimate markups and markdowns. One concern with this is that we may be excluding disproportionately smaller firms. If so, our "average firm" effect might be skewed, since there is substantial heterogeneity in responsiveness by firm size (something we will return to in the next section). However, if we relax that sample restriction, we get nearly identical results for the outcomes we can measure such as employment and other inputs, so this does not appear to be a concern.

costs the company to produce) may be impacted by the increased union density. Disentangling these effects is important both for workers (are they being paid their marginal product?), firms (is their profitability impacted?), and consumers (are they facing higher price levels?).

To examine labor markdowns and product markups, we borrow insight from the IO literature and use the production function approach to obtain estimates of both variables. As described in Section 3, our ability to separately identify markdowns and markups rests on the assumption that at least one production input is flexibly supplied. Since our analysis focuses on the manufacturing sector, we follow the IO literature and use raw material as our flexibly supplied production input (e.g., Loecker and Warzynski (2012); Yeh et al. (2022)).

The results from our markup and markdown analysis are provided in Columns (4) and (5) in Panel B of Table 3. In response to the increased union density at the firm, we find that the average product price markup increases by 1.8 percentage points and that the average labor markdown decreases by 2.2 percentage points.

Note that since the elasticity of sales to variable costs is estimated within each manufacturing industry and is time-invariant, our estimated increase in firm-level markups in response to higher union density must be driven by an increase in the ratio of revenues to materials costs - again, consistent either with an increase in productivity, or an increase in prices. Similarly, since the output elasticity of labor is estimated within each manufacturing industry and is time-invariant, the estimated decline in the labor markdown must be driven by an increase in labor costs relative to materials costs.

Worker productivity and firm profitability. The increase in value added per worker we estimate in Table 3, 1.1 log points, is of the same magnitude as the increase in average earnings per worker of 0.99 log points. This means that the additional labor costs firms incur as unionization increases are fully compensated for by increased (nominal) labor productivity. This, in turn, implies that while the labor share of total costs increases as earnings rise, the labor share of value added does not (Panel B, columns (1) and (2)): workers do not claim a larger share of the proceeds of production than they did at lower union densities. In fact, while our estimate is noisy, our results would suggest that the labor share of value added weakly decreases (the 95% confidence interval spans a decrease of 9 percentage points to an increase of 1.3 percentage points).

Similarly, we find no evidence that the increase in firm-level union density reduces firm profitability (Panel C, columns (1)-(3)). In fact, for firms with positive profits, we estimate a small increase in total profits of 2.25 log points. This suggests that, if anything, firms' unit profitability has increased: assuming an average profit margin of 5% (the average profit/revenues for Norwegian manufacturing firms in 2021), a 2.25 log point average increase in profits alongside a 1.4 log point average increase in sales would correspond to a 0.05 percentage point increase in the profit margin. Moreover, the probability of reporting a negative or zero profit falls by 0.6 percentage points from a baseline of 0.23; and the probability of firm exit does not change (with the point estimate negative, and a 95% confidence interval ruling out any increase in exit probability greater than 0.11 percentage points). Overall, the effects on measured total factor productivity are quite small, particularly in comparison to the effects on markups and markdowns.

Taken together, the results from this subsection show that a higher level of union density at the firm generates an increase in (nominal) value added per worker, that the labor share of value added stays the same or weakly decreases, and that firms enjoy a small increase in total profits. Next, we turn to our product-level export data in an effort to (1) provide direct evidence of price increases not identified through the production function approach and (2) disentangle whether these effects are a result of true productivity effects.

4.3 Price Pass-through: Exporters Analysis

Increased firm-level union density increases (nominal) value added per worker. Whether this is a result of true productivity effects (if the quantity produced per worker has risen) as opposed to price effects matters for our understanding of the mechanism and for overall welfare implications. While there is no data available on product-level prices for domestic sales, we are able to match our data with granular product-level price and quantity data on the universe of exports by Norwegian manufacturing firms over the entire period of our analysis. The fact that approximately 50% of Norwegian manufacturing firms ever export means that we are able to estimate price pass-through for a large share of our sample.

We use this dataset to study how export prices respond to an increase in union density. Our estimates are based on the same IV strategy as our other results (Equations (4) and (3) in Section 4), and the results from this analysis are shown in Table 4.[17]

We examine price responses in three ways. First, we estimate the effect on the average price per kg of each firm's exports. The result is shown in Column (1) of Panel A, and indicates an increase of 3.5 log points in response to the increase in unionization. This large price increase may reflect some combination of increased product-level prices and changes in the sales mix. We, therefore, run regressions at the product level, with product and firm fixed effects or firm-by-product fixed effects. In these product-level regressions, we also interact the year fixed effects with product fixed effects to control for any time-varying demand shocks to particular products. These results are shown in Columns (2) and (3) of Panel A,

[17] We find similar results for our exporter sample as the overall manufacturing sector for the other outcomes we consider, with slightly larger effects on employment and value added per worker in the exporter sample (see Appendix Table A3).

respectively. We find that within product categories, prices increase by approximately 1.9 log points. The product-level price increase of 1.9 log points is (more than) consistent with full passthrough of the increase in costs, noting that the increase in unit labor costs for this firm sample is estimated to be 1.5 log points (Appendix Table A3). Finally, we construct a firm-level index of export prices (a Paasche index with product shares fixed at the last year in our data, which for most firms is 2014). Column (4) of Panel A in Table 4 shows a 3 percent increase in this price index in response to the increase in unionization.

How do the output price changes impact the total export volume of firms? To address this question, we estimate the impact of union density on total export volume as measured by the total weight of a firm's exports. Column (2) of Panel B in Table 4 shows a decrease in total export volume on this dimension of 5.6 log points (p-value of 0.121). Specifically, a 95% confidence interval ranges from -12.7 log points to +1.5 log points.

In terms of the total value of firms' exports, we find no detectable change (Column (1) of Panel B). However, this estimate is imprecise, with the 95% confidence interval from -7.9 log points to +3.6 log points. We have more precision when examining exports at the product level. Column (3) of Panel B shows that the total value of exports within products at the firm increases by 2.5 log points, consistent with the increase in price of 1.9 log points and the not statistically significant increase in total volume of 0.5 log points in Column (4). Thus, despite firms' increase in export prices, we find little effect on export volumes holding fixed the distribution of products: our product level regressions find 1.9 log points higher prices and no change in export volumes, with a 95% confidence interval ruling out decreases greater than 1.3 log points.

The fact that firms' overall average export prices rise by substantially more than the prices of individual products tells us that product composition plays a role: firms not only increase the price of existing products, but also shift to a higher-priced product mix. We see some suggestive evidence of this in Column (2) of Panel C of Table 4, where we estimate an increase in the number of different unique product lines a firm exports (an average increase of 0.05 products). Column (3) of Panel C also provides some noisy evidence that these new products are higher-priced than firms' existing product mix, though this result is imprecisely estimated.

What can we infer about productivity from these price changes? The estimated product-level price increase of 1.9 log points is roughly the same size as the estimated increase in nominal value added per worker of 2.1 log points among the exporter sample (Appendix Table A3) (and larger than the 1.5 log point increase in value added per worker in the main sample in Table 3). Therefore, product-level price increases are roughly large enough to account for the entire increase in observed nominal productivity.[18] In order for there to be "true" productivity effects of increased union density, we would have to assume that firms increase prices by *less* in the domestic market than they do for their exports. We carry out three empirical exercises which suggest this is unlikely.

First, one way to investigate the likely level of price pass-through on domestic sales is to separate our estimates into goods exported to other parts of Scandinavia vs. goods exported to the rest of the world. By value, 71% of Norway's manufacturing sales are sold domestically. Of those goods that are exported, 21% go to Scandinavia and 79% go to the rest of the world. However, the median exporting firm generates approximately 46% of its total export revenue via sales to Scandinavia.[19] Due to similarities in language, customs procedures, consumer preferences, and geographic distance, we see the Scandinavian market as something closer to an extension of the domestic Norwegian market than a true international export market. In contrast, firms selling to the rest of the world may be more likely to face internationally competitive product markets with more price-elastic demand for their products. Consistent with this hypothesis, Table 5 shows product-level price increases in exports to Scandinavia that are larger than the product-level price increases in exports to the rest of the world (2.1 log points vs. 1.7 log points when estimating with firm and product-by-year fixed effects). The differences are starker for the firm-level regressions, where there is a gap of more than 3 log points between the effects in the two destinations.

Second, we re-estimate our export price regression segmenting firms into two groups by the share of revenues made up by exports: less than 25% of revenues (which make up 82% of all exporting firms) and more than 25% of revenues (See Table A4). The export price effect comes predominantly from firms that mostly sell domestically: for firms for which exports are over 25 percent of revenues, we in fact find no statistically detectable change in prices per kg as a result of increased unionization. Again, this would be consistent with the idea that firms that mostly sell internationally are facing more competitive product markets, while firms that mostly sell domestically may have more market power to pass on costs in higher product prices.

Third, the fact that firms increase total sales in response to unionization (which we show in Table 3 for our full sample and in Appendix Table A3 for our exporter-only sample), but total export values do *not* increase on average (which we show in Table 4), suggests that the export share of revenues falls. Indeed, our estimates of the export share of revenue show a

[18] The 95% confidence interval for the product-level price increase is 0.0095 to 0.0287, and for value added per worker is 0.0060 to 0.024.

[19] This differs significantly across firm size. The typical firm within the smallest quartile of firm size (by employment) with exports in the data generates 85% of their export revenue via sales to Scandinavia. For the top quartile, this is only 34%.

decrease of 0.4 percentage points. This shifting of revenue shares toward the domestic market would be consistent with firms raising prices more domestically than they do on exports.

Overall, this evidence suggests a large degree of price pass-through by firms of the increased costs of unionization. The magnitude of price increases is consistent with the entirety of the effect on value added per worker we observe as a result of increased unionization coming through increased prices. This has important implications not only for the welfare effects of unionization, but also for how we should interpret prior literature on this topic. For example, Barth et al. (2020) find increases in value added per worker after increases in union density induced by the same tax deductibility changes, and attribute this to productivity-enhancing effects of unions. However, the analysis in this subsection suggests that most of that effect may be coming through a price effect and not a real productivity gain.

4.4 Separating Price From Productivity Effects: A Mediation Analysis

To more formally test the role of prices as a mediator for the increase in value added per worker we observe, we follow Pinto et al. (2019); Dippel et al. (2020) and use our instrument to disentangle the two outcomes.

This approach is straightforward in a setting with outcome Y, treatment T, mediator M, and instrument Z. Under the assumption of linearity, this method consists of three regressions estimated in two-stage least squares for the effects of the treatment T on the outcome Y (the total effect) as well as the effect of T on M and the effect of the mediator M on Y conditional on treatment T. The identifying assumption rests on the relationship between unobserved determinants of the mediator, treatment, and final outcome, i.e. that we are concerned about the endogeneity of treatment T only because of unobserved variables that affect both the mediator and the treatment, not those that affect the treatment and outcome independent of the mediator. In other words, the confounders that affect Y and T jointly and make treatment endogenous to Y primarily through M, are the same confounders that also affect the relationship between M and T.

This appears plausible in our setting because unobserved factors that affect pricing/markups (the mediator) and firm value added per worker (the outcome) arise from factors that are also likely to affect returns to unionization and union-induced wage increases and not unrelated channels. When this holds a new exogenous condition allows Z to be used as an instrument for T and M conditional on T: $Z \perp\!\!\!\perp Y(m)|T$.

Table 6 shows estimates of the mediating role of export prices (in Column (1), exporters only) and of markups (in Column (2), our main sample) in explaining changes in nominal value added per worker induced by higher union density. The results in Column (1) show that the effect of union density on value added per worker can be entirely explained by changes in the price per kg of the firm's products (using the price of exports to proxy for the prices of the firm's total sales basket). In fact, to the extent there is any direct effect of union density outside of price effects, it runs in the opposite direction, meaning there might be a minor MPL productivity penalty associated with higher union density for these exporting firms (albeit small at around 0.32 log points).[20] The results in Column (2) show that the effect of union density on value added per worker in our full manufacturing sample can be entirely explained by changes in the estimated markup. While changes in the measured markup might reflect changes in nominal labor productivity or changes in unit pricing, the fact that the mediation analyses look so similar when using exporters only and export prices, or when using all manufacturing firms and markups, is consistent with the explanation that increased prices explain the increase in markups which, in turn, explains the increase in nominal value added per worker that we see.

4.5 Heterogeneity by Firm Size and Ex Ante Labor Market Power

It is likely that firms of different sizes face differential adjustment margins as their input flexibility, substitutability of labor, market power, and product power, may differ. This is particularly important if, as in the minimum wage literature, unionization induces a reallocation of labor from small firms to large firms. To explore this in detail and help establish a more complete picture of the margins along which firms respond to unionization, we re-estimate our baseline regressions with interactions for firm size quartile, with firm size measured by number of workers. The results from this exercise are shown in Table 7, where each coefficient represents the total effect for each quartile (i.e., the coefficients are not relative to another quartile).

Table 7 shows that the earnings effects are relatively similar across firm size quartile, with the smallest quartile of firms seeing a 1.3 log point increase in average earnings as compared to a 0.93 log point increase for the largest firms. However, we see a strikingly different pattern of results in terms of firms' margins of response to this increase in labor costs.

The smallest quartile of firms reduce their employment substantially, by 2.4 log points, and do not change their spending on capital by as much (suggesting a slight capital intensification of production). Total sales value changes little, while nominal value added per worker rises by 2.4 log points and estimated markups rise by 2 percentage points. These patterns would be consistent with an increase in prices, decline in total sales volume, and an increase in the productivity of the retained workers largely balancing each other out. We see small and statistically insignificant effect on the labor markdown (i.e. the ratio of labor costs to

[20] If there are diminishing marginal returns to labor, a decline in MPL would be consistent with the increase in employment we see in the average manufacturing firm (without any negative productivity effect per se of the union density itself).

materials costs stayed the same). We see a large negative point estimate on the labor share of value added, but this is imprecisely estimated. As a result of all these changes, firm profits are unchanged. There is no change in the probability of earning a zero or negative profit, and the probability of exit falls by 1 percentage point.

In contrast, the largest quartile of firms scale up substantially in response to an increase in unionization: employment increases by 2.2 log points, capital and materials spending by 1.6 and 1.2 log points respectively, and total sales value by 2.2 log points. Large firms see smaller increases in value added per worker than small firms, with an increase of 0.747 log points (compared to 2.4 for the smallest quartile of firms). This is consistent with declining marginal productivity for the added workers. The estimated product price markup rises by a similar amount for large and small firms, around 1.8-1.99 log points.[21] Consistent with larger firms having more ex-ante labor market power, we see a decrease in the labor markdown of 2.5 log points. Consistent with their increase in sales volume, large firms see an *increase* in profits, of 3 log points (again consistent with a 0.05pp increase in the profit margin), alongside a decrease in the probability of negative profits and a decrease in the probability of firm exit. Importantly, despite inceasing the labor share of value added being a likely goal for unions as they grow, the labor share does not significantly change in any quartile of the size distribution, and is, in fact, slightly negative (though not statistically significant).

While we have focused here on contrasting the largest and smallest quartile of firms, it is interesting to note that in almost all the cases where there are statistically significant differences in coefficients by firm size quartile, the coefficients scale monotonically with firm size. This implies that the differential effects we have identified in this section are highly indicative of a true firm-size pattern. It is clear from these results that increased unionization results in a significant reallocation effect of labor and other production inputs from small firms to larger firms.

We further explore heterogeneity by various measures related to productivity and market power in Appendix Table A5: the labor markdown, local occupation labor market HHI, local industry labor market HHI, profit margin, and value added per worker in the prior year. We see consistently that employment increases by a larger amount as union density increases when firms have more labor market power as measured by markdowns and labor market concentration, or when firms are more profitable or more productive. The same is true for the other inputs we measure, capital and materials. This, in turn, generates larger increases

[21]In the exporter sample, there is a gradient on price increases: the smallest quartile of exporting firms increases their prices per KG by 2.4 log points compared to 2 log points for the largest exporters. This aligns with the distribution of export destinations by firm size: larger exporters send more of their goods to the global market, which is likely to have a higher price elasticity of demand, leaving less room to substantially raise prices.

in total sales. This pattern of results is highly consistent with more monopsonistic firms increasing employment and output in response to increases in labor costs.

4.6 Worker-Firm Match and Composition

Our results above look at firms' responses on the margin of factor mix or product price. But firms can also adjust *within* a given factor of production, for example by changing the mix of workers they employ. To estimate the role this plays in firm adjustment to increased unionization, we re-estimate our baseline regressions conditional on the worker mix at the firm. Specifically, we residualize each firm-level outcome (e.g. average earnings per worker, value added per worker) on a set of worker and firm fixed effects, and then use these residualized firm-level outcomes as the dependent variables in our baseline regressions. We present results for earnings and value added per worker in Table 8 Columns (3) and (4), and a wider set of outcomes in Appendix Table A6.[22] Residualizing on worker fixed effects, we see a substantially smaller effect of unionization on average earnings and log value added per worker of only 0.5 and 0.65 log points, suggesting that firms respond to increased unionization in part by increasing the average quality of workers (as proxied by workers' wage and VA/worker fixed effects). However, it is important to note that the earnings and nominal productivity effects are far from fully explained by these compositional shifts.[23]

To further disentangle the compositional effect of increased unionization, we re-estimate our baseline model but use two different dependent variables: the average worker fixed effect at the firm, and the average worker's occupation by industry fixed effect (where fixed effects are estimated from a regression of individual annual earnings on worker or occupation by industry fixed effects, as well as firm fixed effects). The results from this exercise show that the average worker fixed effect increases, as does the average worker's occupation by industry fixed effect (Table 8, Panel B). Restricting only to new hires, the coefficients are even larger: firms' new hires are higher fixed effect workers, and from higher fixed effect occupation by industry cells. This again suggests that firms shift their employment composition toward higher fixed effect occupations.[24]

It is interesting to note that the average firm grows in response to unionization not by increasing its hiring rate but by reducing its separation rate (see Table 8). Specifically, the

[22] We analyze additional changes in workforce composition in Appendix Table A8.

[23] Similarly, when running these residualized regressions with interactions for firm size quartile, for the smallest quartile of firms average earnings increase by 0.8 log points, and VA/worker by 1.8 log points, and for the largest quartile, the earnings effect is 0.5 log points and the VA/worker is 0.4 log points. See Appendix Table A7.

[24] One interesting question is whether firms substitute non-union for union labor in response to these subsidy changes. To explore this possibility, we have estimated union membership rates in $t+1$,...,$t+5$. None of those estimates are negative, providing little evidence that there are shifts toward substituting non-union labor. This is consistent with the idea that retention of union members is happening more than new hiring of possibly non-union workers.

average firm's separation rate falls by 0.75 percentage points from a baseline of 13.6 percent (a 5% decline) but the hiring rate does not change. This suggests that the higher wages paid to individuals in response to increased unionization enable firms to retain more of their high-quality workers, as well as enabling firms to higher new high-quality workers.

4.7 The Broader Private Sector

So far, our analysis has focused on examining how firms in the manufacturing sector respond to an exogenous increase in union density. Our decision to focus on the manufacturing section is two-fold. First, our product-level export dataset is overwhelmingly dominated by manufacturing firms, with limited observations coming from firms in other industries. As a result, there is limited scope to measure within-firm changes in exports in other sectors. Second, to separately identify price markups and labor markdowns through the production function approach, at least one input has to be competitively supplied (which is assumed to be raw materials in the literature), and this assumption is most easily satisfied in the manufacturing sector (e.g., Loecker and Warzynski (2012); Yeh et al. (2022)).

In this section, we expand our analysis and show results for the broader private sector. While a scarcity of exporters in these sectors prevent us from performing our direct pass-through exercise, we can still estimate both price markups and labor markdowns under the assumption that raw materials are competitively supplied, though we note this assumption may not apply to all industries. It is informative to also examine other firm outcomes and choices.

Comparing results across the manufacturing sector and the broader private sector is particularly interesting as manufacturing is subject to substantial labor market concentration while the other industries in the private sector are considerably less concentrated in terms of local occupation employment shares (mean HHI of 0.116 in manufacturing compared to 0.043 for the rest of the sector), local industry employment shares (mean HHI of 0.238 compared to 0.042), and national industry revenue shares (mean HHI of 0.041 compared to 0.012). The private sector in general has lower markdowns (1.7 in manufacturing compared to 1.68 for the rest of the private sector).[25] In addition, the manufacturing sector is subject to a relatively substantial baseline union density (mean across all firms of 32.1%) compared to the other private-sector industries (mean of 16.7%). Thus, the dynamics of power are different across these sectors, potentially impacting the way in which firms can respond to exogenous increases in union density.

The results from our first-stage union density estimates and second-stage earnings estimates are shown in Table 9, and the results from our margins of adjustment analysis are

[25]In the other industry groups most likely to satisfy this assumption that materials are competitively supplied (construction, agriculture, and mining), the average markdown is 0.98.

shown in Table 10. In terms of the first-stage effect, we find that firms that experience a 1,000 NOK larger reduction in average net-of-subsidy dues see an 8.6 percentage point larger increase (or smaller decrease) in firm-level union density. This fits squarely with our survey evidence and suggests sizeable price elasticity of union membership for marginal union members in the broader private sector as well, albeit a smaller elasticity than in the manufacturing sector (16 percentage points). While speculative, we believe that one explanation for this differential effect relates to labor market concentration differences across sectors. Specifically, Dodini et al. (2021) find that individuals are more willing to unionize in markets where labor demand is more concentrated due to a higher potential return to unionization.

In Columns (2) and (3), we see average earnings increase by 0.7 log points with a 1 percentage point increase in union density (compared to a 0.99 log point increase in manufacturing) and a similar 0.88 log point increase in non-wage compensation. The fact that the private sector sees both a smaller induced increase in unionization from a given subsidy, *and* a smaller earnings effect of a given increase in unionization, is consistent with workers being more likely to want to join unions when the returns are higher – specifically, with a price elasticity of union membership that appears to scale with the returns to union density.[26]

In terms of the second-stage effect for other margins, Table 10 illustrates that there are important differences in how firms respond to increased unionization in the manufacturing sector compared to the private sector as a whole.

With respect to input substitution and scaling, an increase in union density results in a decline in overall employment and labor usage in the private sector as a whole. Overall employment falls by 1.6 log points – consistent with the theoretical predictions of the effects of unionization in a competitive labor market. This is in stark contrast to our findings in the manufacturing sector, where we find that the average firm increases employment in response to rising union density, consistent with monopsony theory. Again, while speculative, we believe that one explanation for this differential effect relates to labor market concentration and markdown differences across sectors.

Similar to our findings for the manufacturing sector, we see that the change in labor usage generates a scaling effect across the other inputs, but in this case, it causes a downscaling rather than an up-scaling due to the reduction in labor usage. Capital costs fall by 1.5 log points and material spending falls by 1.4 log points. Since the average private-sector firm reduces employment by more than it reduces use of capital or materials inputs, this suggests some input substitution away from labor and toward capital and materials, though

[26]Workers may be more concerned about employers trying to set their wages below marginal productivity in imperfect markets where there are limited outside options. They, therefore, expect returns to unionization to be higher under those circumstances.

the standard errors make strong inferences difficult.

To examine the scaling effect in more detail, Column (5) in Table 10 examines the impact of increased union density on firm sales in the private sector as a whole. The estimate shows that the nominal value of firm sales decreases by 1.4 log points in response to the union density shift. This effect is slightly smaller than the reduction of labor usage, and suggests that the nominal value added per worker increases, which we confirm in Panel B Column (3). This result is similar to that in Barth et al. (2020) as well as to our result for the manufacturing sector, which also finds increases in value added per worker after increases in union density induced by the tax deductibility changes. This increase in value added per worker combined with the reduction in employment suggests that firms are retaining only the more productive workers in the firm and either laying off or otherwise choosing not to hire less productive workers.

With respect to price markups and labor markdowns, Panel B shows notable differences from the manufacturing sector: there is no markup in prices and a significant reduction in wage markdowns, consistent with the typical Norwegian firm having little price-setting power in the product market but some price-setting power in the labor market. We note, however, that markups and markdowns are the two outcomes extracted through the production function process, and the assumption of competitively supplied materials may not be appropriate for all industries.[27]

Finally, unlike in the manufacturing sector, the effect on firms' profitability and survival is mixed. For firms making positive profits, there is a marginal decrease in firm profitability (Panel C). At the same time, there is a statistically significant decrease in the probability of exit of 0.9 percentage points (on a baseline annual exit probability of 11 percent). This also suggests a caveat to the negative finding for profits: increases in union density in this sector may alter the composition of surviving firms in the market. However, when we limit our estimation sample to firms in this sector that did not exit the market, we see effects that are slightly smaller than the estimates we present here for indicators of downscaling such as capital, materials, and total sales; and slightly larger effects for value added per worker. However, these differences are not statistically significant. Alongside each of these effects, total factor productivity does not significantly change.

Taken together, the results for the broader private sector paint a different picture than the results obtained for the manufacturing sector: the average firm in the private sector shrinks employment and output when union density increases, and is more likely to go out

[27]When estimating the production function on a set of industries for whom materials are an important input and where the production function approach is likely to be appropriate (e.g.. agriculture, mining, construction, manufacturing), there are both markup and markdown effects in the same direction as the manufacturing sector.

of business, while the average manufacturing firm increases employment and output (and, weakly, profits). While speculative, we believe that one explanation for this differential effect relates to labor market concentration differences across sectors. This is an important result that implies that the effect of changes in firm-level union density – when trying to extrapolate the results from this study to other contexts – may depend fundamentally on the baseline power dynamics between employers and employees.[28]

Notable, however, is that the effects of unionization on small firms appear to hold across the entire private sector. The main difference between the private sector as a whole and manufacturing is that, in manufacturing, employment losses for small firms are reallocated to larger firms. In the private sector at large, employment losses in small firms are larger than any employment gains in large firms, meaning there is not a full reallocation of employment or production. Because of these adjustments, the labor share of value added not does significantly change.

5 Discussion

5.1 Market Power

Our results are highly consistent with a monopsonistic model of the manufacturing labor market. The average manufacturing firm responds as a monopsonist would to an increase in unionization: with higher compensation *and* increased employment and output. Indicators of a firm's degree of monopsony power can include its size, markdown, concentration in its labor markets, or its profits or productivity. We find heterogeneity in employment and output responses across these dimensions consistent with monopsony theory. First and most strikingly, small manufacturing firms actually contract employment in response to higher unionization (as would be predicted in a competitive labor market model) while medium-sized firms expand somewhat and large firms expand substantially. Second, employment and scaling increases in response to unionization are larger for firms with higher ex-ante markdowns, labor market HHIs, profit margins, or value added per worker.

In contrast, our results are more consistent with a competitive model of the labor market for the broader private sector. The average firm in this sector responds to an increase in unionization with higher compensation but lower employment and output, and a higher probability of exit. Other indicators are consistent with less monopsony power in the full private sector than in manufacturing: substantially lower levels of labor market concentration

[28]A possible alternative explanation for these results that does not rest on monopsony arguments is that bargaining across the sectors represents a fundamentally different process. If that is the case, these results imply that manufacturing is subject to an efficient bargaining model in which unions help determine employment directly, while the other sectors rely on a monopoly bargaining model in which the firm chooses employment in response to bargaining over wages. While theoretically possible, the bargaining dynamics in Norway make this unlikely.

and lower markdowns.

On the product market side, our results suggest that most manufacturing firms have some degree of pricing power, such that much if not all of the increased labor costs induced by unionization can be passed on to consumers. We can address prices directly only for exports: we find that the average manufacturing firm raises export prices significantly in response to an increase in union density. Notably, there are meaningful price increases even for firms exporting outside Scandinavia, in international markets where one would typically assume the average Norwegian exporter's share of sales (and pricing power) is relatively limited. Using markups as a proxy for price responses for firms' domestic sales, we see increased markups across the board in manufacturing.

5.2 Price Levels, Wage Inflation, and Purchasing Power

Who bears the cost of the price increases we estimate for manufactured goods? To assess this, we perform a straightforward back-of-the-envelope calculation. Here, we make a few simplifying assumptions. First, we assume that the price pass-through in the domestic market matches that of exports at 1.91 percent, our estimates when controlling for product fixed effects (see Column (2) of Panel A in Table 4).[29] Second, we assume household consumption shares of domestically manufactured consumer goods are equal to the weights used in the Consumer Price Index. Consumer goods produced in Norway accounted for 26% of CPI weights in 2002. Because consumers may substitute away from more expensive domestically-produced goods for cheaper imported goods, we fix consumption shares at this value. Third, we assume that prices on manufactured goods in Norway that are used as intermediate inputs are fully passed through to consumer prices. In other words, for manufactured goods, price increases from unionization at the first stage of production are passed through linearly to consumers. If labor costs at the first stage of production increase the cost of raw materials at the second stage of production, we assume that cost is passed through to final consumer goods. We find this assumption plausible given our findings of full pass-through of labor costs and recent literature showing full pass-through of energy cost shocks as well (Fontagné et al., 2023; Lafrogne-Joussier et al., 2023).

The prior literature estimates that the unionization rate in Norway would have been approximately 5-6 percentage points lower had the subsidies not expanded during the 2001-2012 period (Barth and Nergaard, 2015). Our estimates in the manufacturing sector predict that the average firm-level union density would have been approximately 12 percentage points lower.[30] At a 1.91% price increase in the domestic market for manufactured goods

[29]This is comparable to the markup effect of 1.8 percent we measure in the full sample. Given that the international export market is expected, ex ante, to be more competitive, we view the 1.91 percent effect to possibly be a lower bound.

[30]We obtain this prediction by estimating our first stage model for the manufacturing sector and then

per percentage point increase in union density and assuming a 5.5-12 percent overall increase in union density relative to the counterfactual, we estimate that overall price levels in Norway would have been 2.7-5.9 percent lower in the absence of the change in union subsidies by 2014 via the effect on prices in the manufacturing sector. Over the 2001-2014 period, the overall price level increased by approximately 46 percentage points during a period of strong economic growth, suggesting that the increased union density in the manufacturing sector alone could explain approximately 5.9-12.8% of the overall increase in the price level during the period.

In terms of wages, our estimates suggest that in the manufacturing sector, average earnings increased by 0.99% for each percentage point increase in union density. At an aggregate increase of 5.5 percentage points, this suggests that the subsidy policy generated total wage increases of 5.5-12% between 2001 and 2014. Over this period of rapid economic growth, the index of monthly earnings in manufacturing increased by approximately 79%,[31] meaning that wage gains from local union density would explain approximately 6.9-15.2% of the total earnings gains in Norwegian manufacturing. In the private sector as a whole, at average earnings returns of 0.74%, a 5.5 percentage point increase in union density would lead to a 4.07% increase in earnings by 2014. Compared to the total wage index increase of 82 percentage points,[32] union density shifts can explain roughly 5% of the total wage gains in the private sector.

5.3 Redistribution

We find that, in manufacturing, increased union density increases worker compensation but not the labor share of value added at the firm level: firms maintain their profit share through price increases and other adjustment channels, as outlined in detail above. This stands in contrast to findings in other settings that increased unionization redistributes from capital to labor, increasing the labor share of income.

In our calculations above, for the manufacturing sector, union-induced wage gains outpaced the price effects significantly ($\approx$ 6-12% vs 2.7-5.9%). Overall, this represents a net transfer from consumers to workers in the manufacturing sector. Put differently, a cost born by a diffuse set of consumers resulted in net wage gains for a much smaller population of workers in the sector.

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use the coefficients to predict firm-level union density using the net imputed dues after the subsidy (i.e., our instrument: $NetDue_{ft}$). We then compare this to predictions setting dues at the base imputed dues (i.e., $\overline{D^0_{ft}}$). For the full private sector, our estimates closely match Barth and Nergaard (2015), predicting firm-level union density rates being approximately 6 percentage points lower by 2014.

[31] See https://www.ssb.no/en/statbank/table/07219/.

[32] See https://www.ssb.no/en/statbank/table/05320/.

6 Conclusion

Summary and Key Take-Aways. This paper provides a detailed analysis of the margins along which firms respond to large and permanent shifts in union density.

Based on identification designs that exploit exogenous variation in exposure to union density shifts across firms, we show that the average manufacturing firm increases labor compensation and scales up production through increases in labor, capital, and material usage. The expansion of labor usage in response to a higher per-unit cost of labor is consistent with the manufacturing sector enjoying a relatively high level of labor market concentration (and, perhaps, monopsony power from other sources). The accompanying increase in materials and capital usage hints at a relatively low level of input substitution capabilities in the manufacturing sector, at least in the short run.

As a consequence of scaling up production, the average manufacturing firm sees an increase in the nominal value of firm sales. This increase is larger than the expansion of labor, such that the nominal value added per worker increases. To understand whether the value-added improvement is a result of true productivity effects (if the quantity per worker produced has risen) or of price effects, we turn to our customs data. Estimates of price pass-through from these data suggest that firms pass on the entire labor cost increase in prices and that the measured increase in value added is driven by price increases rather than by productivity increases. We corroborate this through a novel mediation analysis which, under relatively mild assumptions, also attributes the entire value added increase to a price increase. Our results therefore are consistent with the average Norwegian manufacturing firm having both product and labor market power. We find that unionization leads to a significant reallocation from small firms to large firms, which may exacerbate labor and product market power such that the labor share of value added does not change, and profits may even increase at large firms as they expand production.

Turning to the broader private sector, the direction of the employment and scaling responses differ. Specifically, while we see an expansion of employment and other input use in the manufacturing sector, we see a contraction in the private sector as a whole. One explanation for this differential effect could relate to labor market concentration and labor market power differences across sectors. This is an important result that implies that the effect of changes in firm-level union density may depend on the baseline power dynamics between employers and employees.

The core contribution of this paper is to provide a comprehensive assessment of the margins along which firms respond to shifts in union density, leveraging a unique subsidy policy that generates quasi-random variation in union density exposure across firms and exploiting rich administrative data on the entire population of workers and firms in Norway.

The paper has several important policy implications for workers, firms, and society.

Implications for Workers. The core results from our paper suggest that the average worker in manufacturing enjoys higher compensation and increased employment opportunities due to increased unionization. However, this finding comes with three important caveats. First, our analysis of the wider private sector illustrates that the employment effects depend on market structures and that the positive employment effect may only be present in market segments defined by considerable firm labor market power. Second, our heterogeneity analysis by firm size suggests that small firms raise wages more but reduce employment, while large firms raise wages less but increase employment. This firm size effect carries important distributional implications across workers, and the reallocation effects towards larger firms may have important implications for future generations. Third, our analysis of workforce composition shows that some of the average firm-level wage effects come from firms employing higher-fixed-effect workers, and only some of the estimated effects are within-worker increases in pay, suggesting that in general equilibrium wage effects of unionization would be weakly lower than the firm-level estimates in our baseline analyses.

Implications for Firms. The key finding from our analysis as it relates to firms is that firms appear able to respond to unionization increases in ways that do not harm their profit margin. Firms are able to maintain profit levels and margins because increases in VA per worker more than compensate for the increase in labor costs. However, firms accomplish this in different ways. The average manufacturing firm scales up production, employs a higher-productivity mix of workers, and increases prices; profits and survival probabilities are not harmed. The average firm in the private sector scales down production, substitutes some labor for other inputs, and appears to experience an increase in the variance of firm outcomes: small firms reduce their employment, while larger firms maintain their levels of production. Our results are consistent with the average manufacturing firm having some labor market power (firms respond to higher wages by increasing employment and reducing labor markdowns), but with the smallest quartile of manufacturing firms (and most firms in the private sector) having little to none.

There are two important implications from this finding. First, our results suggest that input substitution is relatively limited, at least in the short term. Whether firms are able to gradually adjust the share of the different inputs in the longer term is an interesting question for future research. Second, the differential effects across firm size imply important reallocation effects toward larger firms and toward unionized firms. This finding is similar to that in the minimum wage literature, which shows that increases in minimum wages appear on the margin to reallocate output and employment toward larger firms and away from smaller firms (e.g., Dustmann et al. (2019)). Note, however, that this result is different from

Dustmann et al. (2019) in the sense that they are interrogating a blanket minimum wage that affects all firms, and our shift affects firms differently within industries.[33]

Our results on price pass-through suggest that manufacturing firms in Norway, even the small ones, seem to have some product market power. This enables them to raise prices *even though not all firms in their industry* are affected in the same way by the increased unionization. The power to raise prices allows firms to sustain the higher labor costs without suffering a profit reduction and appears as the most important margin of adjustment for firms in the face of increased unionization.

Implications for Society. The overall effects of increased unionization for firms and workers hint at a series of important societal implications.

First, the wage and employment gains suggest that the average manufacturing worker is unambiguously better off following the increased unionization, though there are distributional effects as small firms contract while large firms expand. However, the results for the broader private sector, where affected firms' employment shrinks as wages rise, suggest that in this broader sector, a more conventional set of trade-offs between wages and employment opportunities is present as union density increases.

Second, our analysis suggests that the increased labor cost in manufacturing is passed through – in its entirety – to consumers through higher output prices. Not only does this generate an increase in overall price levels, but it also has important implications for consumer purchasing power: non-union members will experience rising costs without enjoying the same career benefits of membership, and union members will see part of the wage gain eaten up by higher living costs. The distributional implications across individuals in society, and its impact on wage equality, are important for understanding the overall influence of unionization on society.

Third, the average manufacturing firm is able to adjust to the rising labor cost, maintain their profit levels, and avoid going out of business. This implies little to no reduction in the health of the manufacturing business community at large in response to the increase in unionization - but also implies limited efficacy on this margin of increased union density in transferring wealth from shareholders to workers. The differential effects across firm size also imply an important reallocation of economic activity towards larger firms. The welfare effects of this are ambiguous. On the one hand, larger firms tend to be more productive, suggesting that unionization may speed the natural reallocation of economic activity from lower- to higher-productivity firms. On the other hand, larger firms tend to have more

[33] We also see a reallocation of employment towards more-unionized firms on average (since they grow). This suggests that increased unionization actually grows the union sector relative to the non-union sector (in contradiction to the insider-outsider view of e.g. Lindbeck et al. (1989)).

market power. Thus, the reallocation toward larger firms may have important implications on the competitive climate of firms in the longer run, highlighting that the dynamics over time are important to understand in order to fully disentangle the union effect on society.

Fourth, to the extent that our results are consistent with the average manufacturing firm having a substantial degree of monopsony power, our analysis suggests that unions may plan an efficiency-enhancing role in Norwegian manufacturing: monopsony power induces firms to not only pay less but also produce less than they would in a more competitive market, generating a deadweight loss. By mandating higher pay and inducing monopsonists to hire more workers and produce more, higher unionization may offset some of these efficiency costs of monopsony power.

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Tables

Table 1: Summary Statistics by Sector

	(1)	(2)	(3)	(4)
	Manufacturing		All Non-Manufacturing	
	Mean	SD	Mean	SD
Union Density	32.14	29.10	16.74	21.22
Log(Average Earnings)	5.911	0.278	5.854	0.348
Log(Workers)	2.902	1.001	2.469	0.750
Log(Firm VA per Worker)	6.717	0.492	6.650	0.506
Markdown	1.702	1.756	1.676	1.703
Log(Personnel Costs)	9.016	1.113	8.520	0.900
Log(Capital Costs)	8.451	1.274	7.976	1.020
Log(Material Costs)	9.471	1.518	9.089	1.496
Labor Share Value Added	0.588	1.886	0.598	2.205
Labor Share of Costs	0.336	0.133	0.318	0.171
Markups	1.439	0.970	1.517	1.592
Log(Sales)	10.430	1.271	10.048	1.062
Log(Profits)	7.367	1.750	6.880	1.525
Log(Total Costs)	10.202	1.275	9.840	1.063
Pr(Negative Profits)	0.233	0.423	0.197	0.398
Pr(Exit)	0.092	0.289	0.113	0.317
Labor HHI - Occupation Empl. Share	0.116	0.136	0.043	0.069
Labor HHI - Industry Empl. Share	0.238	0.238	0.042	0.086
Product HHI - Natl Industry Rev. Share	0.041	0.058	0.012	0.031
Observations	44,805		195,865	

Source: Authors' calculations of Norwegian registry data from 2001 to 2014 at the firm level.
Notes: The sample consists of firms with at least five workers for whom we have enough data to estimate production functions at the industry level.

Table 2: First Stage and Earnings Effect

First stage		*Earnings effect*		
	(1) Union density		(2) Log(Average Earnings)	(3) Log(Non-Wage Compensation)
Net dues (1,000 Kr)	-16.427***	Union density	0.00990***	0.00900***
	(2.742)		(0.00105))	(0.00215)
Observations	43,559		43,559	43,558
Dep Var Mean	32.1		5.91	3.725
K-P Wald Stat	35.89			

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: Estimates come from Equations 4 (Column (1)) and 3 (Columns (2) and (3)). Models include fixed effects for firm and industry group by year. Standard errors clustered at the firm level.

Table 3: Main Results

Panel A	(1)	(2)	(3)	(4)	(5)
	Log(Personnel Costs)	Log(Workers)	Log(Capital Costs)	Log(Material Costs)	Log(Sales)
Union Density	0.0197***	0.0103**	0.00908*	0.00421	0.0140***
	(0.00567)	(0.00524)	(0.00526)	(0.00628)	(0.00542)
Observations	*43,559*	*43,559*	*43,559*	*43,559*	*43,559*
Dep Var Mean	*9.029*	*2.913*	*8.464*	*9.484*	*10.44*
Panel B					
	Labor Share of Costs	Labor Share of Value Added	Log(Value Added Per Worker)	Markup	Labor Markdown
Union Density	0.00253***	-0.0383	0.0108***	0.0178***	-0.0216**
	(0.000836)	(0.0262)	(0.00338)	(0.00668)	(0.00933)
Observations	*43,559*	*43,559*	*43,519*	*43,559*	*43,559*
Dep Var Mean	*0.336*	*0.582*	*6.723*	*1.433*	*1.703*
Panel C					
	Log(Profits)	Prob(Profits < 0)	Prob(Exit)	TFP	
Union Density	0.0225*	-0.00638	-0.00397	0.00517***	
	(0.0123)	(0.00400)	(0.00257)	(0.00146)	
Observations	*34,127*	*43,559*	*43,559*	*43,559*	
Dep Var Mean	*7.40*	*0.226*	*0.0723*		

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: Estimates come from Equations 4 and 3. Models include fixed effects for firm and industry group by year. Standard errors clustered at the firm level.

Table 4: Price pass-through (Exports Only)

Panel A	(1)	(2)	(3)	(4)
	Firm-level Avg. Log(Price Per KG)	Product-level Log(Price Per KG)	Product-level Log(Price Per KG)	Firm-level Firm Price Index
Union Density	0.0346*	0.0191***	0.0147***	0.0302**
	(0.0183)	(0.00492)	(0.00549)	(0.0135)
Observations	40,004	432,048	302,486	39,944
Firm FE	X	X		X
Industry Group by Year	X			X
Product-by-Year FE		X	X	
Firm-by-Product FE			X	

Panel B				
	Firm-level Log(Total Value)	Firm-level Log(Total Weight)	Product-level Log (Total Value)	Product-level Log(Total Weight)
Union Density	-0.0217	-0.0563	0.0245***	0.00537
	(0.0294)	(0.0363)	(0.00815)	(0.00955)
Observations	40,004	40,004	432,048	432,048
Firm FE	X	X	X	X
Industry Group by Year	X	X		
Product-by-Year FE			X	X

Panel C			
	Export Share of Revenue	# Products	Price New Product Relative to Existing
Union Density	-0.00403*	0.0498	0.0286
	(0.00220)	(0.103)	(0.0252)
Observations	39,653	39,947	21,763

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: Estimates come from Equations 4 and 3. Models include fixed effects for firm and product by year. Models are estimated on a sample of manufacturing firms with matched export data at the firm level or firm-by-product level. Standard errors clustered at the firm level in the firm-level estimates and the firm-product level in the firm-product estimates.

Table 5: Exports by Destination

	(1)	(2)	(3)	(4)
	Scandinavia Log(Price Per KG)	All others Log(Price Per KG)	Scandinavia Log(Price Per KG)	All others Log(Price Per KG)
Union Density	0.0336*	0.000357	0.0211**	0.0173***
	(0.0173)	(0.0204)	(0.00825)	(0.00530)
Observations	30,925	30,623	167,857	317,379
Firm FE	X	X	X	
Industry Group by Year	X	X		
Product-by-Year FE			X	X

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: Estimates come from Equations 4 and 3. Models include fixed effects for firm and industry group by year. Models are estimated on a sample of manufacturing firms with matched export data at the firm level or firm-by-product level, separated by export destination region. Standard errors clustered at the firm level in the firm-level estimates and the firm-product level in the firm-product estimates.

Table 6: Price as a Mediator of Firm Value Added per Worker

	(1)	(2)
	VA per Worker (Exporters)	VA per Worker
Total Effect of Union Density	0.0210***	0.0108***
	(0.00556)	(0.00204)
Direct Effect of Union Density	-0.00321***	-0.000164
	(0.000522)	(0.000204)
Indirect Effect through Mediator	0.0242*	0.0110***
	(0.0137)	(0.00385)
Mediator	Log(Price per KG)	Markup
Mediator Share of Total	115.2 %	101.9 %
Observations	40,976	44,762

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: Estimates come from following the procedure in Pinto et al. (2019); Dippel et al. (2020). Models include fixed effects for firm and industry group by year. Column (1) is estimated on a sample of manufacturing firms with matched export data. Column (2) is estimated on our main sample of firms using the production function approach.

Table 7: Heterogeneity by Firm Size Quartile

Panel A	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Log(Avg Earnings)	Log(Workers)	Log(Personnel Costs)	Log(Capital Costs)	Log(Material Costs)	Log(Sales)	Log(Value Added Per Worker)
Union Density in Quartile 1	0.0131***	-0.0239***	-0.00311	-0.00753	-0.0169***	-0.00657	0.0241***
	(0.00241)	(0.00503)	(0.00504)	(0.00536)	(0.00648)	(0.00521)	(0.00424)
Union Density in Quartile 2	0.0108***	-0.00457	0.00854*	0.00161	-0.00600	0.00415***	0.0156***
	(0.0022)	(0.0046)	(0.0047)	(0.0050)	(0.0060)	(0.0048)	(0.0039)
Union Density in Quartile 3	0.00991***	0.00898**	0.0185***	0.00797	0.00331	0.0129***	0.0110***
	(0.0021)	(0.0045)	(0.0046)	(0.0049)	(0.0058)	(0.0047)	(0.0038)
Union Density in Quartile 4	0.00934***	0.0223***	0.0290***	0.0159***	0.0124**	0.0222***	0.00747***
	(0.0021)	(0.0044)	(0.0044)	(0.0047)	(0.0056)	(0.0046)	(0.0037)
Observations	43,559	43,559	43,559	43,559	43,559	43,559	43,519

Panel B							
	Labor Share of Costs	Labor Share of Value Added	Markup	Markdown	Log(Profits)	Prob(Profits ≤ 0)	Prob(Exit)
Union Density in Quartile 1	0.00186**	-0.0423	0.0199***	-0.0149	0.00663	-0.000212	-0.00565
	(0.000909)	(0.0289)	(0.00754)	(0.0102)	(0.0138)	(0.00287)	(0.00443)
Union Density in Quartile 2	0.00215**	-0.0384	0.0187***	-0.0181*	0.0165	-0.00273	-0.00626
	(0.0008)	(0.0267)	(0.0070)	(0.0095)	(0.0125)	(0.0027)	(0.0041)
Union Density in Quartile 3	0.00249***	-0.0377	0.0176***	-0.0211**	0.0231*	-0.00389	-0.00634
	(0.0008)	(0.0257)	(0.0067)	(0.0092)	(0.0122)	(0.0026)	(0.0040)
Union Density in Quartile 4	0.00283***	-0.0395	0.0178***	-0.0247***	0.0296**	-0.00487*	-0.00653*
	(0.0008)	(0.0271)	(0.0065)	(0.0090)	(0.0119)	(0.0025)	(0.0039)
Observations	43,559	43,559	43,559	43,559	34,127	43,559	43,559

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: Estimates come from Equations 4 and 3 with additional interactions for firm size quartiles in the manufacturing sector. Models include fixed effects for firm and industry group by year. Standard errors clustered at the firm level. Coefficients and significance tests are relative to the null hypothesis of zero effect for each quartile and are total effects, not relative to a base quartile. Coefficients for quartiles 2-4 are significantly different from quartile 1 for all outcomes except labor share of value added (Panel B Column (2)) and negative profits (Panel B Column (7)).

Table 8: Worker Composition

Panel A	(1)	(2)	(3)	(4)
	Separation Rate	Hire Rate	Log(Avg Earnings)	Log(Value Added Per Worker)
Union Density	-0.00747***	0.000775	0.00528***	0.00647***
	(0.00196)	(0.00240)	(0.00126)	(0.00237)
Observations	43,559	43,559	43,559	43,519
Dep Var Mean	0.1357	0.1310		
Panel B				
	Worker FE	Worker Occ x Ind FE	New Hire FE	New Hire Occ x Ind FE
Union Density	0.00317***	0.00206**	0.00923***	0.00423**
	(0.00116)	(0.000860)	(0.00348)	(0.00201)
Observations	43,559	43,558	30,524	30,528
Dep Var Mean	0.0287	0.0651	-0.0532	0.0406

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: Estimates come from Equations 4 and 3. Models include fixed effects for firm and industry group by year. Standard errors clustered at the firm level. Panel A Columns (3) and (4) are firm-level outcomes after residualizing the firm-level outcome on fixed effects for individual workers and firm fixed effects and using these residuals as the dependent variable in our main IV estimation framework. Worker and occupation by industry fixed effects in Panel B are estimated from a regression of individual annual earnings on worker (or occupation by industry) and firm fixed effects. The firm-level average of the residuals is used in our main estimation framework.

Table 9: First Stage and Earnings Effect - Whole Private Sector

First stage		*Earnings effect*	
	(1)	(2)	(3)
	Union density	Log(Average Earnings)	Log(Non-Wage Compensation)
Net dues (1,000 Kr)	-8.645***	0.0074***	0.00882**
	(1.970)	(0.00256)	(0.00362)
Observations	231,703	231,703	231,703
Dep Var Mean	19.73		
K-P Wald Stat	19.26		

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: Estimates come from Equations 4 (Column (1)) and 3 (Columns (2) and (3)) for all private-sector firms with at least five workers. Models include fixed effects for firm and industry group by year. Standard errors clustered at the firm level.

Table 10: The Whole Private Sector

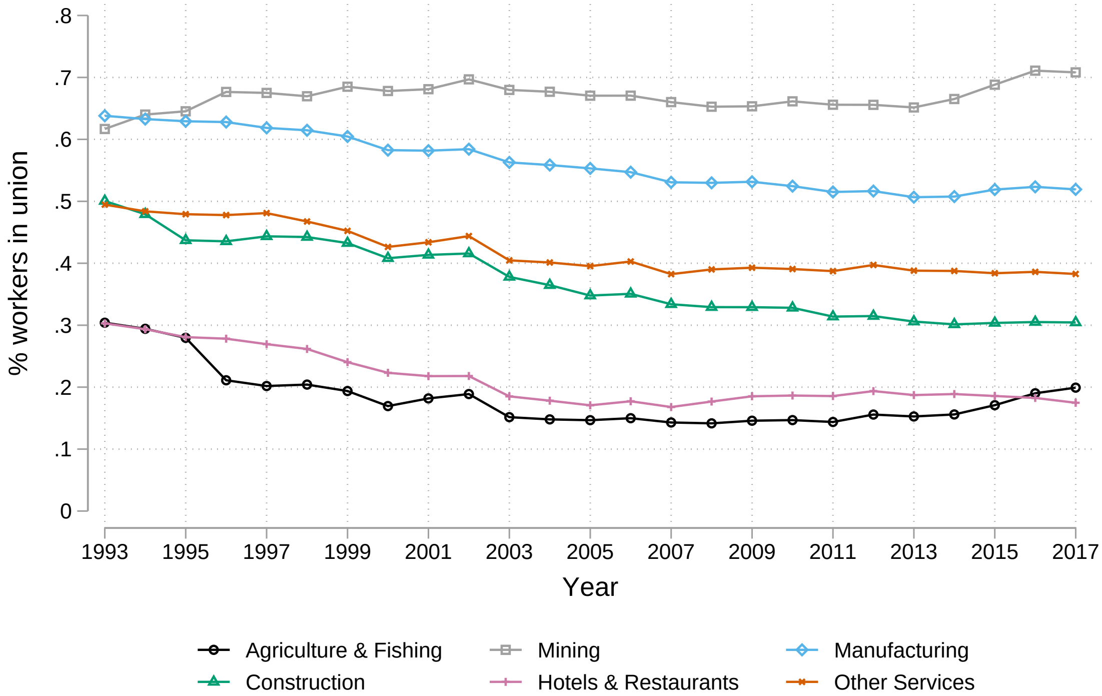
Panel A	(1)	(2)	(3)	(4)	(5)
	Log(Personnel Costs)	Log(Workers)	Log(Capital Costs)	Log(Material Costs)	Log(Sales)
Union Density	-0.00764	-0.0161**	-0.0146*	-0.0141	-0.0144*
	(0.00692)	(0.00761)	(0.00817)	(0.00964)	(0.00777)
Observations	231,703	231,703	231,703	231,703	231,703
Dep Var Mean	8.631	2.563	8.081	9.184	10.14
Panel B					
	Labor Share of Costs	Labor Share of Value Added	Log(Value Added Per Worker)	Markup	Markdown
Union Density	0.000396	-0.0613*	0.00962**	-0.00282	-0.0321**
	(0.00107)	(0.0341)	(0.00487)	(0.0128)	(0.0145)
Observations	231,703	231,703	231,502	231,703	231,703
Dep Var Mean	0.321	0.594	6.670	1.490	1.683
Panel C					
	Log(Profits)	Prob(Profits<0)	Prob(Exit)	TFP	
Union Density	-0.0142	-0.00421	-0.00992**	0.00205	
	(0.0178)	(0.00515)	(0.00436)	(0.00194)	
Observations	183,028	231,703	231,703	231,504	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: Estimates come from Equations 4 and 3. Models include fixed effects for firm and industry group by year.

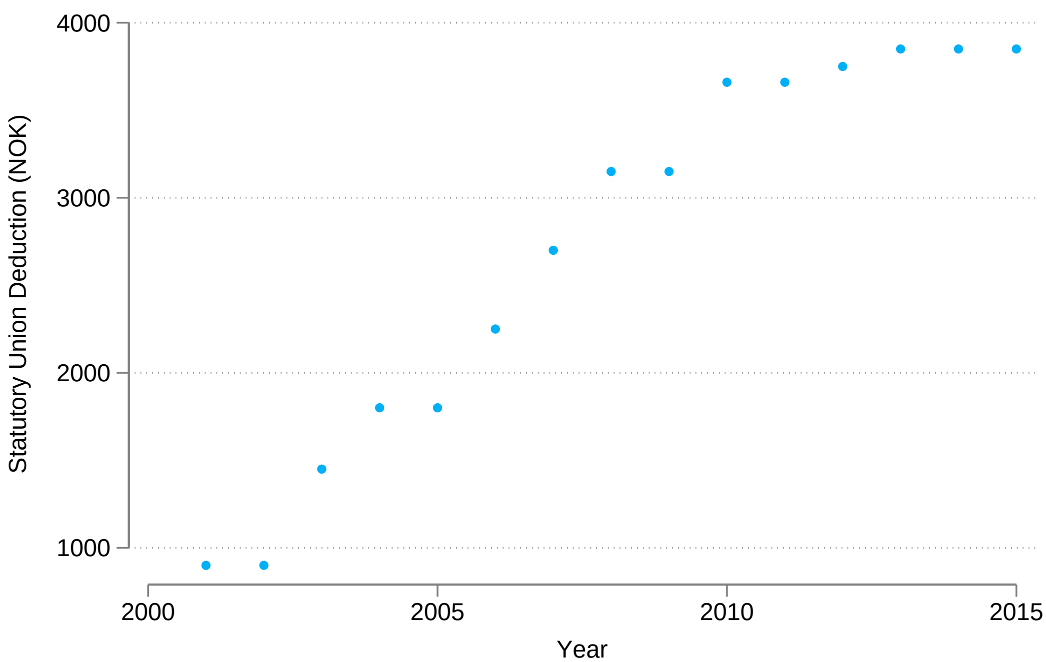
Figures

Figure 1: Union Membership Rate by Sector over Time



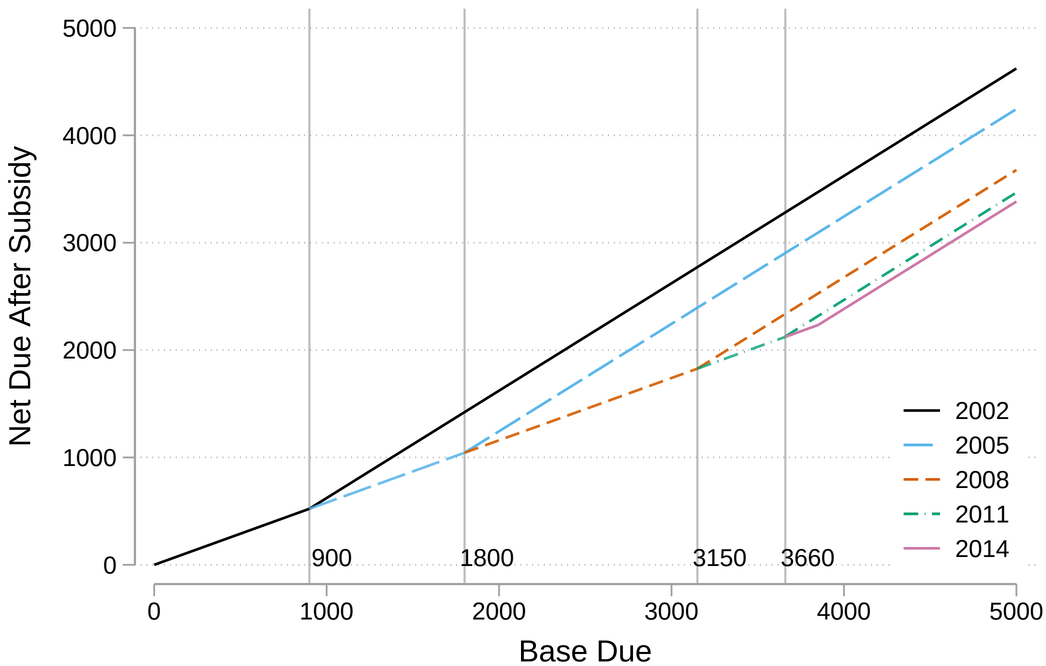
Source: Authors' calculations of Norwegian registry data from 1993 to 2017.

Figure 2: Statutory Maximum Tax Deduction for Union Dues by Year



Source: Authors' presentation of maximum tax deductions for union dues in Norway.

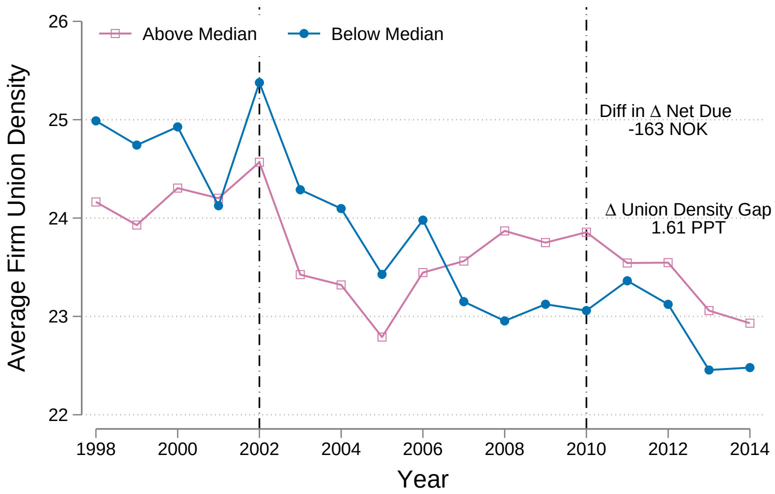
Figure 3: Net Union Dues After Subsidy vs Base Dues Over Time



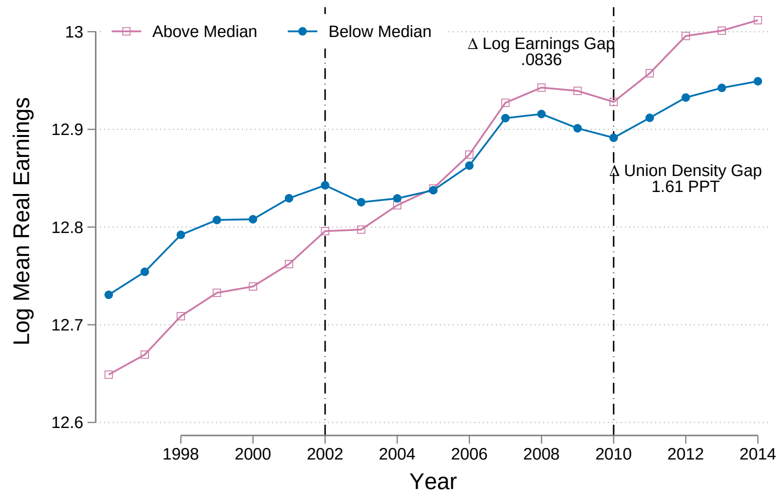
Source: Authors' illustration of the legislated maximum union due deduction in Norway over time.
Notes: The figure assumes a tax rate of 42%. This is the average top marginal rate over the 2001-2014 time period. Vertical lines at 900, 1800, 3150, and 3660 mark the maximum deductions at different years in Norway.

Figure 4: Trends in Firm-Level Union Density, Earnings, Value Added, and Sales by Net Due Reduction Intensity

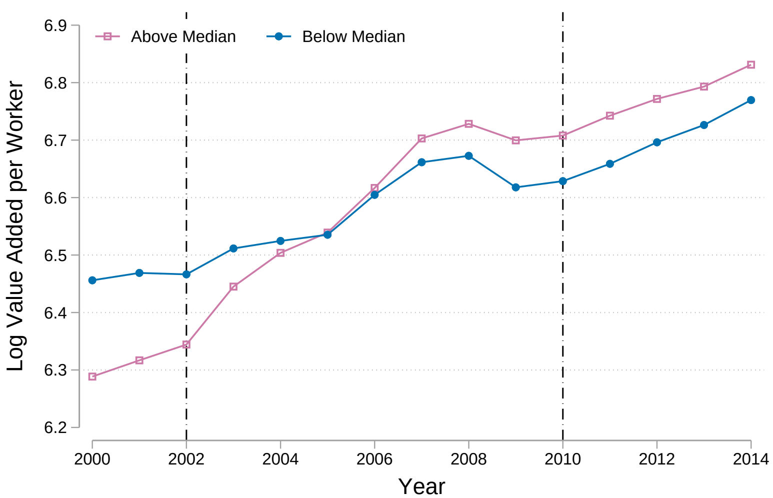
Panel A: Firm Union Density



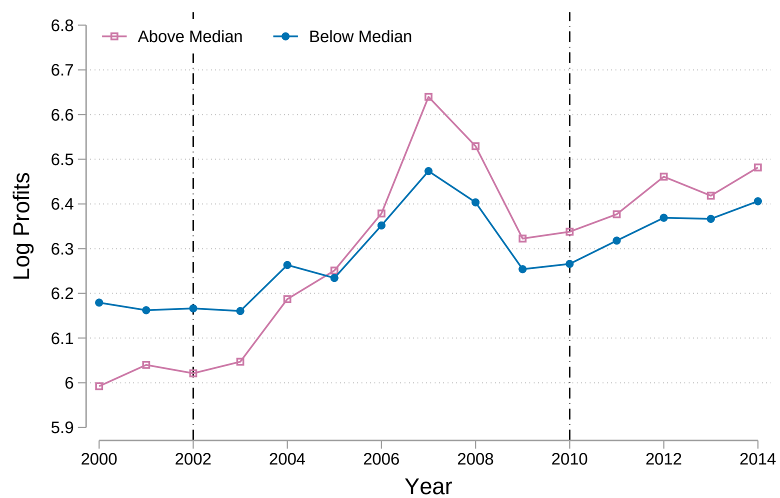
Panel B: Firm Log Average Annual Earnings



Panel C: Firm Value Added Per Worker

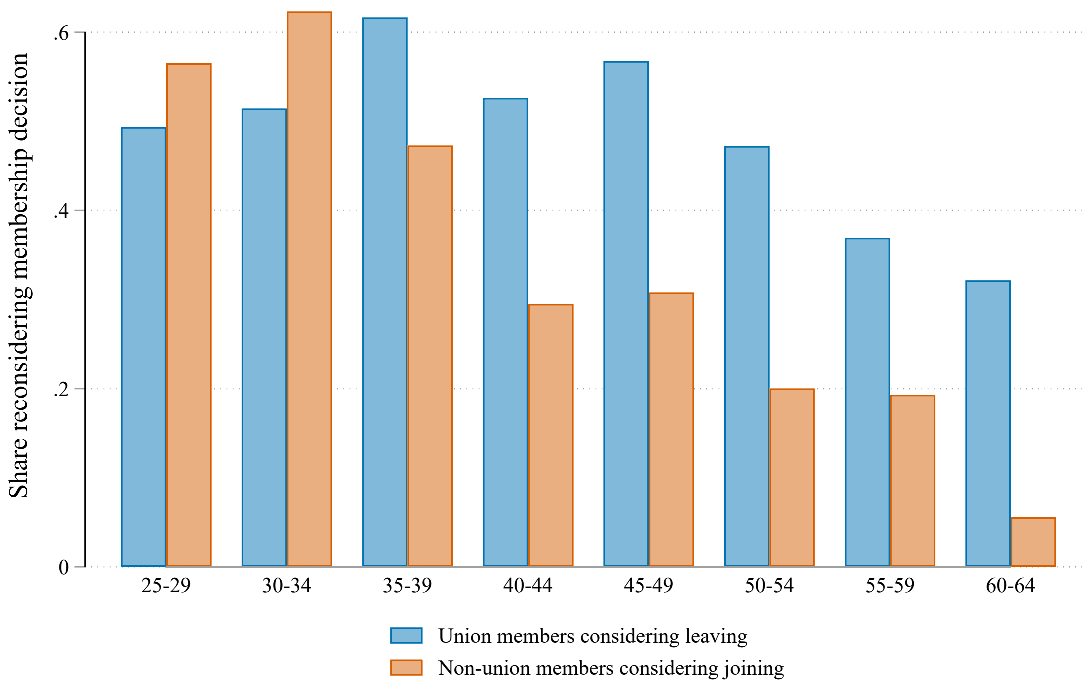


Panel D: Firm Log Profits



Source: Authors' calculations of Norwegian registry data.
Notes: Trends are residualized on firm fixed effects for our sample of manufacturing firms. "Above-median" corresponds to firms whose reductions in net union dues (after subsidies) were above the median value, while "below-median" corresponds to firms with smaller reductions. Panels C and D are based on raw values in thousands.

Figure 5: Reconsidering Union Membership with 500 NOK Change in Monthly Net Dues, by Age



Source: Authors' calculations based on survey data collected by NORSTAT and Dodini et al. (2021).
Notes: The survey question was: "If your after-tax dues for union membership were reduced [increased] by [XYZ] NOK, would you reconsider your decision to join a union?" Union members are asked about a 500 NOK increase in their net dues, while non-members are asked about a 500 NOK decrease in net dues.

A Additional Tables and Figures

Table A1: Union Extraction of Subsidies

VARIABLES	(1) Imputed Dues	(2) Actual Dues|Membership
Imputed Dues at Firm Baseline	0.000301	0.0204
	(0.00754)	(0.0224)
Imputed Subsidy	0.831***	0.699**
	(0.183)	(0.338)
Constant	4,213***	4,445***
	(133.0)	(234.0)
Observations	1,584,471	913,716
R-squared	0.951	0.745
Ind by Occ FE	X	X
Year FE	X	X
Individual FE	X	X

Bootstrapped standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: The model consists of data at the individual level and regresses either average dues at the industry-by-occupation level each year (Column (1)) or actual union dues for union members (Column (2)) on adjusted baseline dues $\overline{D^0_{ft}}$ and the imputed base subsidy (S_{ft}). The model includes fixed effects for individual workers, industry by occupation cell, and year. The estimation sample is a 50% random subsample of the full administrative dataset to ease computational constraints. The coefficient on the imputed subsidy tells what portion of the subsidy is being absorbed by unions in the form of increased union dues, either at the industry-occupation level or at the individual level. Part of this increase is likely mechanical if unions charge a portion of a worker's earnings in union dues and union density increases earnings at the firm.

Table A2: Effects of Union Density on Assets and Debts

	(1) Log(Total Assets)	(2) Log(Short Term Debt)	(3) Log(Long Term Debt)	(4) Log(Debt to Credit Institutions)	(5) Pr(Long Term Debt)	(6) Pr(Debt to Credit Institutions)
Union Density	0.0237***	0.000240	0.0497***	0.0496***	0.00326	0.000501
	(0.00732)	(0.00744)	(0.0190)	(0.0192)	(0.00510)	(0.00497)
Observations	43,559	42,670	28,309	21,665	43,559	43,559

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: Estimates come from Equations 4 and 3. Models include fixed effects for firm and industry group by year. Standard errors clustered at the firm level.

Table A3: Main Estimates, Manufacturing Exporter Sample

Panel A	(1) Log(Avg Earnings)	(2) Log(Workers)	(3) Log(Personnel Costs)	(4) Log(Capital Costs)	(5) Log(Materials)	(6) Log(Total Costs)
Union Density	0.0150***	0.00362	0.0118	-0.000375	0.00264	0.00873
	(0.00461)	(0.00998)	(0.00951)	(0.0100)	(0.0122)	(0.00920)
Observations	39,982	39,985	39,896	39,406	39,110	39,958

Panel B

	(1) Log(Sales)	(2) Log(Value Added Per Worker)	(3) Labor Share of Value Added	(4) Log(Profits)	(5) Pr(Profit<0)	(6) Pr(Exit)
Union Density	0.0168	0.0210**	-0.702	0.0506**	-0.0135**	-0.00528**
	(0.0106)	(0.00879)	(0.627)	(0.0214)	(0.00672)	(0.00266)
Observations	39,619	38,874	39,962	27,829	39,985	39,985

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: Estimates come from Equations 4 and 3. Models include fixed effects for firm and industry group by year. Estimates are for the sample of manufacturing firms recording exports. Standard errors clustered at the firm level.

Table A4: Export Price Changes by Export Shares

VARIABLES	(1) Log(Price Per KG)	(2) Log(Price Per KG)
Union Density	0.0414**	-0.00462
	(0.0190)	(0.0139)
Observations	30,111	8,865
Export Shares	0-25	>25

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: Estimates come from Equations 4 and 3. Models include fixed effects for firm and industry group by year. Estimates are for export prices per KG of goods sold in the customs data among exporting manufacturers. Standard errors clustered at the firm level.

Table A5: Heterogeneous Treatment Effects by Indicators of Market Power and Productivity

	(1) Log(Avg Earnings)	(2) Log(Workers)	(3) Log(Value Added Per Worker)	(4) Log(Capital Costs)	(5) Log(Material Costs)	(6) Markup	(7) Log(Sales)
Union Density	0.00987***	0.0103*	0.0107***	0.00894*	0.00388	0.0180***	0.0138**
	(0.00201)	(0.00527)	(0.00337)	(0.00529)	(0.00619)	(0.00660)	(0.00542)
UD x >Median Markdown	0.000322***	0.000998***	0.00119***	0.00169***	0.00384***	-0.00177***	0.00275***
	(7.10e-05)	(0.000164)	(0.000154)	(0.000212)	(0.000245)	(0.000200)	(0.000197)
Union Density	0.00981***	0.0110**	0.0109***	0.00991*	0.00506	0.0173***	0.0146***
	(0.00196)	(0.00524)	(0.00335)	(0.00525)	(0.00623)	(0.00654)	(0.00542)
UD x >Median Occ Labor HHI	-9.82e-05	0.000801***	0.000116	0.000939***	0.000965***	-0.000607**	0.000746***
	(7.32e-05)	(0.000164)	(0.000155)	(0.000201)	(0.000222)	(0.000278)	(0.000186)
Union Density	0.00989***	0.0102*	0.0108***	0.00897*	0.00409	0.0179***	0.0139**
	(0.00201)	(0.00526)	(0.00339)	(0.00527)	(0.00628)	(0.00666)	(0.00545)
UD x >Median Industry Labor HHI	7.13e-05	0.00111***	0.000133	0.00121***	0.00126***	-0.000466	0.00109***
	(7.66e-05)	(0.000166)	(0.000157)	(0.000210)	(0.000231)	(0.000310)	(0.000191)
Union Density	0.00994***	0.0104**	0.0109***	0.00917*	0.00434	0.0178***	0.0141***
	(0.00204)	(0.00527)	(0.00338)	(0.00529)	(0.00627)	(0.00668)	(0.00545)
UD x >Median Profit Margin	0.000569***	0.00131***	0.00121***	0.00131***	0.00198***	-0.000113	0.00226***
	(6.17e-05)	(0.000129)	(0.000116)	(0.000155)	(0.000176)	(0.000230)	(0.000150)
Union Density	0.0107***	0.0109**	0.0132***	0.0114**	0.00665	0.0174***	0.0166***
	(0.00218)	(0.00537)	(0.00362)	(0.00545)	(0.00645)	(0.00675)	(0.00577)
UD x >Median VA/Worker	0.000690***	0.000450***	0.00196***	0.00187***	0.00200***	-0.000316	0.00216***
	(7.34e-05)	(0.000157)	(0.000151)	(0.000188)	(0.000202)	(0.000250)	(0.000184)
Observations	43,559	43,559	43,519	43,559	43,559	43,559	43,559
Dep Var Mean	5.91	2.90	6.72	8.45	9.47	1.44	10.43

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations of Norwegian registry data from 2001 to 2014.

Notes: Estimates come from Equations 4 and 3 with additional interactions for being above or below the sample median for measures of each measure in year $t-1$ (a one-year lag). Models include fixed effects for firm and industry group by year. Standard errors clustered at the firm level.

Table A6: Firm Outcomes After Removing Worker Fixed Effects

Panel A	(1) Log(Avg Earnings)	(2) Log(Workers)	(3) Log(Personnel Costs)	(4) Log(Capital Costs)	(5) Log(Material Costs)	(6) Log(Sales)
Union Density	0.00528***	0.00744**	0.0123***	0.00595	0.00231	0.0102***
	(0.00126)	(0.00356)	(0.00368)	(0.00365)	(0.00444)	(0.00382)
Observations	43,559	43,559	43,559	43,559	43,559	43,559

Panel B

	(1) Log(Value Added Per Worker)	(2) Labor Share of Costs	(3) Labor Share of Value Added	(4) Markup	(5) Markdown	(6) Log(Profits)
Union Density	0.00647***	0.00175***	-0.0426*	0.0105**	-0.0143**	0.0129
	(0.00237)	(0.000604)	(0.0240)	(0.00462)	(0.00661)	(0.00882)
Observations	43,519	43,559	43,559	43,557	43,557	33,158

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: Estimates come from Equations 4 and 3. Firm-level outcomes are first estimated as a function of worker and firm fixed effects. We remove the fixed effects from each outcome and use each as the dependent variable in our models. Standard errors clustered at the firm level.

Table A7: Estimates by Firm Size After Removing Worker Fixed Effects

Panel A	(1)	(2)	(3)	(4)	(5)	(6)
	Log(Avg Earnings)	Log(Workers)	Log(Personnel Costs)	Log(Capital Costs)	Log(Material Costs)	Log(Sales)
Union Density in Quartile 1	0.00803***	-0.0192***	-0.00431	-0.00580	-0.0130***	-0.00484
	(0.00152)	(0.00372)	(0.00335)	(0.00381)	(0.00465)	(0.00372)
Union Density in Quartile 2	0.0061***	-0.00374	0.00447	0.000893	0.000893	0.00313
	(0.0014)	(0.0034)	(0.0031)	(0.0035)	(0.0035)	(0.0035)
Union Density in Quartile 3	0.0053***	0.00651*	0.0115***	0.00519	0.00519	0.00947***
	(0.0014)	(0.0033)	(0.0030)	(0.0035)	(0.0035)	(0.0034)
Union Density in Quartile 4	0.00475***	0.0162***	0.0188***	0.0106***	0.0106***	0.0161***
	(0.0013)	(0.0032)	(0.0029)	(0.0034)	(0.0034)	(0.0033)
Observations	43,559	43,559	43,559	43,559	43,559	43,559
Panel B						
	(1)	(2)	(3)	(4)	(5)	(6)
	Log(Value Added Per Worker)	Labor Share of Costs	Labor Share of Value Added	Markup	Markdown	Log(Profits)
Union Density in Quartile 1	0.0177***	0.00122*	-0.0468*	0.0117**	-0.00943	0.000655
	(0.00305)	(0.000656)	(0.0266)	(0.00516)	(0.00728)	(0.01000)
Union Density in Quartile 2	0.0104***	0.00147**	-0.0424*	0.0111**	-0.0121*	0.00840
	(0.0028)	(0.0006)	(0.0244)	(0.0048)	(0.0068)	(0.0091)
Union Density in Quartile 3	0.00663**	0.00172***	-0.0421*	0.0103**	-0.0140**	0.0133
	(0.0027)	(0.0006)	(0.0236)	(0.0046)	(0.0066)	(0.0089)
Union Density in Quartile 4	0.00371	0.00196***	-0.0437*	0.0104**	-0.0163**	0.0181**
	(0.0026)	(0.0006)	(0.0247)	(0.0045)	(0.0064)	(0.0086)
Observations	43,519	43,559	43,559	43,559	43,559	33,158

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: Estimates come from Equations 4 and 3. Firm-level outcomes are first estimated as a function of worker and firm fixed effects. We remove the fixed effects from each outcome and use each as the dependent variable in our models. Coefficients and significance tests are relative to the null hypothesis of zero effect for each quartile and are total effects, not relative to a base quartile. Coefficients for quartiles 2-4 are significantly different from quartile 1 for all outcomes except labor share of value added (Panel B Column (2)), markups (Panel B Column (3)), and negative profits (Panel B Column (7)). Standard errors clustered at the firm level.

Table A8: Worker Composition - Additional Characteristics

Panel A	(1) Age	(2) Female Share	(3) BA+ Share	(4) < HS Share
Union Density	-0.0904**	-0.00256**	-0.00273**	-0.00148
	(0.0437)	(0.00112)	(0.00107)	(0.00124)
Observations	43,559	43,559	43,559	43,559
Dep Variable Mean	42.00	0.2440	0.1472	0.2564
Panel B				
	Industry Experience	New Hire Industry Experience	New Hire Age <25 Share	New Hire 25-35 Share
Union Density	-0.160***	-0.192***	0.00720**	-0.00691*
	(0.0326)	(0.0467)	(0.00309)	(0.00406)
Observations	43,559	43,558	43,421	43,559
Dep Variable Mean	4.86	1.95	0.1299	0.3413
Panel C				
	Age <25 Share	25-35 Share	35-45 Share	55-65 Share
Union Density	0.00230**	-0.00148	0.00273	-0.00337*
	(0.000902)	(0.00170)	(0.00207)	(0.00186)
Observations	43,559	43,559	43,559	43,559
Dep Variable Mean	0.0697	0.2213	0.2858	0.1761

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: Estimates come from Equations 4 and 3. Industry experience is measured by average worker cumulative experience prior to period t working in the same two-digit industry as the firm. New hire characteristics are based on those that were not present at the firm in the prior year but are connected to the firm in the data in the current year. Standard errors clustered at the firm level.

Table A9: Heterogeneity by Firm Size Quartile, Whole Private Sector

Panel A	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Log(Avg Earnings)	Log(Workers)	Log(Personnel Costs)	Log(Capital Costs)	Log(Material Costs)	Log(Sales)	Log(Value Added Per Worker)
Union Density in Quartile 1	0.0109***	-0.0523***	-0.0312***	-0.0331***	-0.0358***	-0.0362***	0.0241***
	(0.00289)	(0.00950)	(0.00737)	(0.00882)	(0.0105)	(0.00845)	(0.00606)
Union Density in Quartile 2	0.00751***	-0.0245***	-0.0150**	-0.0206**	-0.0211**	-0.0213***	0.0112**
	(0.0027)	(0.0088)	(0.0069)	(0.0082)	(0.0098)	(0.0079)	(0.0057)
Union Density in Quartile 3	0.00605**	-0.00379	-0.000113	-0.00902	-0.00716	-0.00745	0.00428
	(0.0026)	(0.0085)	(0.0066)	(0.0079)	(0.0094)	(0.0076)	(0.0054)
Union Density in Quartile 4	0.00518**	0.0155*	0.0155**	0.00398	0.00731	0.00712	-0.000405
	(0.0025)	(0.0081)	(0.0063)	(0.0076)	(0.0090)	(0.0072)	(0.0052)
Observations	231,703	231,703	231,703	231,703	231,703	231,703	231,502

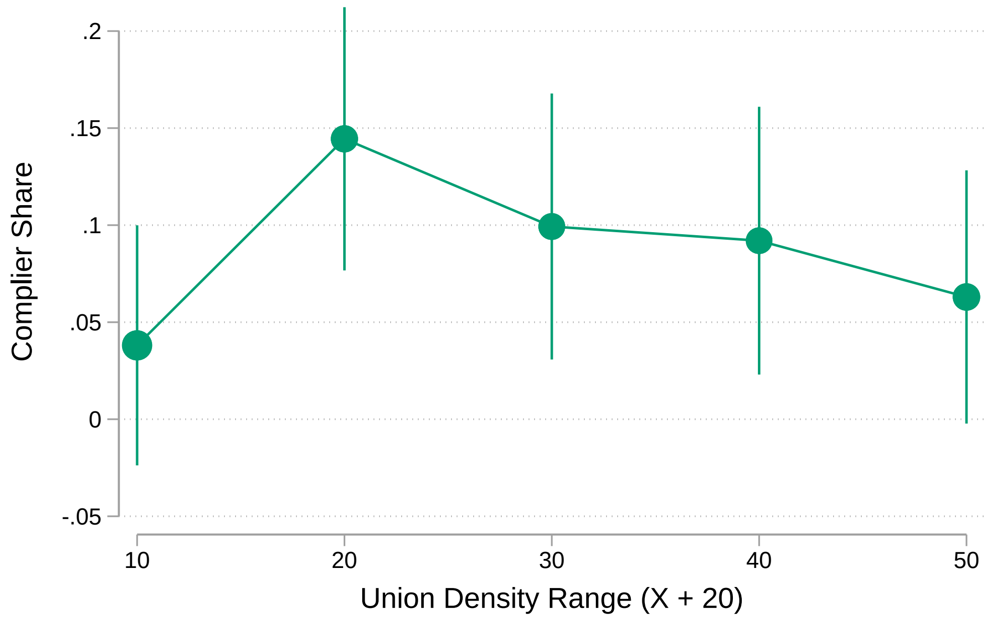
Panel B							
	Labor Share of Costs	Labor Share of Value Added	Markup	Markdown	Log(Profits)	Prob(Profits ≤ 0)	Prob(Exit)
Union Density in Quartile 1	-0.000259	-0.0671*	-0.00315	-0.0282*	-0.0306	-0.00758	-0.00371
	(0.00115)	(0.0370)	(0.0139)	(0.0158)	(0.0192)	(0.00477)	(0.00559)
Union Density in Quartile 2	0.000259	-0.0620*	-0.00298	-0.0309**	-0.0160	-0.00994**	-0.00421
	(0.0011)	(0.0346)	(0.0130)	(0.0147)	(0.0179)	(0.0045)	(0.0052)
Union Density in Quartile 3	0.00062	-0.0590*	-0.00265	-0.0338**	-0.0043	-0.0108**	-0.00451
	(0.0010)	(0.033)	(0.0125)	(0.0142)	(0.0173)	(0.0043)	(0.0050)
Union Density in Quartile 4	0.000953	-0.0571*	-0.00253	-0.0356***	0.00551	-0.0114***	-0.00439
	(0.0010)	(0.0321)	(0.0119)	(0.0135)	(0.0164)	(0.0041)	(0.0048)
Observations	231,703	231,703	231,703	231,703	183,028	231,703	231,703

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

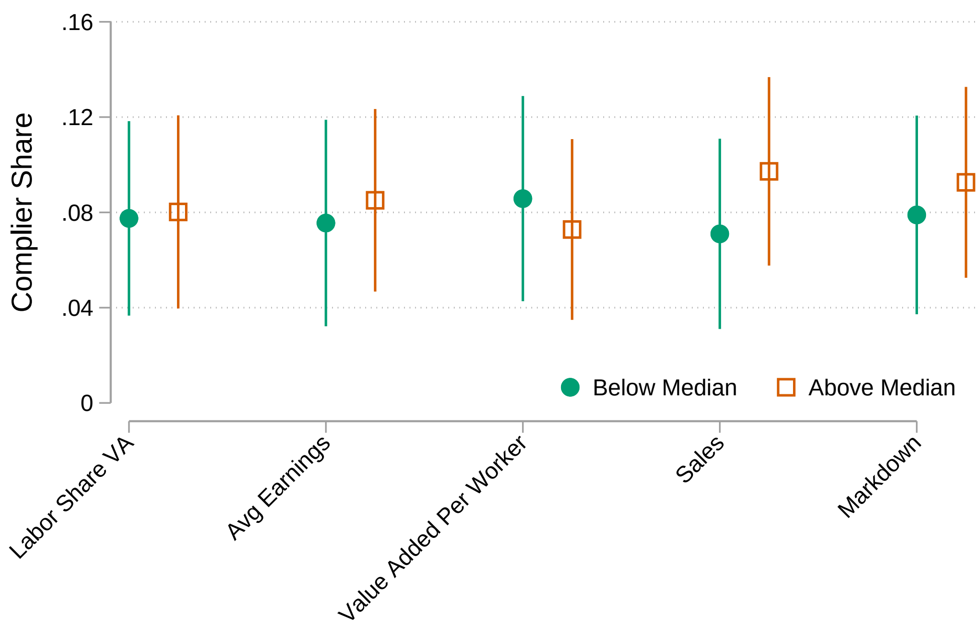
Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: Estimates come from Equations 4 and 3 with additional interactions for firm size quartiles in the manufacturing sector. Models include fixed effects for firm and industry group by year. Standard errors clustered at the firm level. Coefficients and significance tests are relative to the null hypothesis of zero effect for each quartile and are total effects, not relative to a base quartile.

Figure A1: Compliers by Union Density Window and by Attribute Median Split

Panel A: By Union Density Window, Treatment = Three-Year Δ Union Density > 0



Panel B: By Median Split, Treatment = Three-Year Δ Union Density > 0



Source: Authors' calculations of Norwegian registry data from 2001 to 2014.

Notes: Panel A examines firms in different windows of the union density distribution. In Panel B, "median splits" in Panel B refers to each attribute on the x-axis being divided into two groups based on the median value in the data. Compliers are based on the share changing treatment status when experiencing three-year instrument changes that are the lowest (1st percentile) and the highest (99th percentile) following Dahl et al. (2014). Bars represent the 95% confidence interval from bootstrapped standard errors with 1,000 replications.