CESifo WORKING PAPERS

10873
2023

December 2023

How Do Firms Respond to Unions?

Samuel Dodini, Anna Stansbury, Alexander Willén

CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editor: Clemens Fuest
https://www.cesifo.org/en/wp
An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
· from the RePEc website: www.RePEc.org
· from the CESifo website: https://www.cesifo.org/en/wp

CESifo *Working Paper No. 10873*

How Do Firms Respond to Unions?

Abstract

This paper provides a comprehensive assessment of the margins along which firms in Norway respond to increased union density, using legislative changes in the tax deductibility of union dues as a quasi-exogenous shock to firm-level unionization rates. Despite higher personnel costs driven by a union wage premium, the average manufacturing firm *increases* employment and scales up production, charges higher prices in the product market, enjoys higher nominal value added per worker, and experiences no decrease in profits. We show that this result is a direct implication of the labor- and product-market power that the average manufacturing firm possesses, in combination with a reallocation of inputs and industry revenue shares from smaller and less unionized firms to larger and more unionized firms. Larger firms are, therefore, increasing employment and output at the same time their ability to mark up prices is growing, thereby preventing negative profit effects. For the broader private sector in which firms do not hold much price- or wage-setting power, we observe the opposite result: the average firm reduces employment and profit falls. We synthesize these findings through a partial-equilibrium model of firm decision-making that incorporates union bargaining, product-market price-setting power, and labor market monopsony power.

JEL-Codes: J510, J300, D220, J420.

Keywords: unions, price pass-through, firms, market power, labor costs.

Samuel Dodini
Department of Economics
Norwegian School of Economics
Bergen / Norway
samuel.dodini@nhh.no

Anna Stansbury
MIT Sloan School of Management
Cambridge / MA / USA
amms@mit.edu

Alexander Willén
Department of Economics
Norwegian School of Economics
Bergen / Norway
alexander.willen@nhh.no

December 22, 2023

We are grateful to Attila Lindner, Michael Lovenheim, Manudeep Bhuller, Arin Dube, and Justin Bloesch for helpful comments and suggestions. We also thank seminar participants at the University of Gothenburg, the University of Oslo, the Federal Reserve Board, the Tinbergen Institute, the Norwegian School of Economics, the Institute for Social Research Oslo, and the University of Massachusetts Amherst for helpful discussion. This project was partially funded by the Research Council of Norway through its Centers of Excellence Scheme, FAIR project no. 262675, as well as through its Young Research Talent Scheme, POWER project no. 334912.

1 Introduction

Labor 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 compromise the productivity and profitability of firms, alongside concerns that unionization may harm aggregate employment and economic efficiency.

Even though four decades have passed since the canonical work of Freeman and Medoff (1984), there is very little evidence on how firms respond to unionization. This is primarily due to difficulties in finding plausibly exogenous shifts in firm-level unionization linked to detailed population-wide employer-employee matched longitudinal data. The lack of research on this topic 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 (e.g., (NLRB, 2022)). Specifically, if unions raise the unit 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 lower employment and production, input substitution, or productivity adjustments? On a more aggregate level, what are the overall implications on employment, price levels, wage growth, and consumer purchasing power?

In this paper, we present a complete assessment of the margins along which firms respond to shifts in union density. We do so by exploiting a policy change in subsidies for union membership in Norway, which 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 dues 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 creates exogenous variation in the incentive for a firm's workers to join a union depending on their prior level of union dues, and, therefore, different exogenous shifts in union densities across firms.

We estimate firms' responses to shifts in union density through an instrumented dose-response difference-in-differences design that leverages the subsidy policy for identification. We combine this strategy with 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. Our ability to supplement these data with product-level export data from Norwegian customs records 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 focus on the manufacturing sector. First, our product-level customs data, which enable us to examine price pass-through, are dominated by the manufacturing sector. Second, the production function approach we use to measure product price markups, labor markdowns, and total factor productivity, requires that at least one production input is competitively supplied. This assumption is met with respect to raw materials in the manufacturing sector, but not in other sectors such as retail or services (e.g., De Loecker and Warzynski (2012); Yeh et al. (2022)). This decision also allows us to directly compare our results to the recent literature on the implications of labor cost increases, which has predominantly focused on the manufacturing sector (e.g., Yeh et al. (2022); Cengiz et al. (2019); Barth et al. (2020)). However, we also show results for the entire private sector and compare them to the results in the manufacturing sector (though we encourage caution when interpreting the markup and markdown results in the non-manufacturing sector).

The main takeaways from our analysis are that unions in the Norwegian manufacturing sector: (1) counteract employer monopsony power which results in higher wages and employment; (2) redistribute economic resources from consumers to workers as the rising labor costs are passed on to consumers through higher output prices; and (3) reallocate labor and other inputs as well as industry revenue shares from small and less unionized firms to large and more unionized firms. We see no evidence of any negative effect on profits. This would be consistent with more-unionized firms' increased market share raising their ability to mark up prices, thereby preventing negative profit effects. Our results are consistent with the average manufacturing firm possessing a substantial degree of power in both labor markets and in product markets. For the broader private sector in which firms do not hold much price- or wage-setting power, we observe the opposite result: employment and output contracts, and profits (weakly) fall. We show that a stylized partial-equilibrium model that embeds monopsony labor market power, monopoly product market power, and a direct effect of unionization on firm product demand (either via increased market power or increased product quality), can fully account for the results we find. This framework may be applied to other types of wage-setting interventions or cost shocks.

Our main takeaways are supported by five core results. First, we show that increases in firm-level union density result in higher compensation for workers. Specifically, 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 labor costs). While the earnings effects are in line with the estimates in Barth et al. (2020) and Dodini et al. (2022), the non-earnings cost effects are new to the literature. The divergence in earnings between firms with different levels of exposure to the subsidies emerged only after the change in the tax policy, which underlines that the earnings changes are driven by the policy-induced shift in union density and not other factors.

Second, an increase in unionization leads the average manufacturing firm to expand. A 1 percentage point increase in firm-level union density leads the average firm to increase its employment by 1 log point and its expenditure on capital and materials by approximately 0.9 and 0.4 log points, respectively. The expansion of labor usage in response to a higher per-unit cost of labor is 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); Dodini et al. (2023a)). Another noteworthy aspect of this result is the roughly proportionate scaling of other inputs. This implies a low level of capital-labor substitution on the part of these firms, indicative either of significant substitution frictions or that affected firms have reached a level of optimization such that they find it more beneficial to scale inputs together rather than to reallocate them.

Third, increased unionization increases nominal productivity. Specifically, nominal value added per worker increases by 1.1 log points and nominal total factor productivity (TFP) increases by 0.5 log points. Because these measures of productivity are combinations of the 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, greater unionization leads to an increase in product price markups and a decrease in labor markdowns. In addition, profitability does not fall. If anything, it slightly increases as nominal labor productivity goes up by more than labor compensation. We find no increase in the labor share of value added. To explain this profit result, we show that heterogeneous effects of union density over firm size generate a reallocation of labor and other inputs and industry revenue shares from smaller and less unionized firms to larger and more unionized firms, which increases their product-market power. Larger firms are, therefore, increasing employment and output at the same time their ability to mark up prices is growing, thereby increasing profits. Thus, heterogeneous responses to a *firm-level* shock to union density generate a *market-level* shock that may increase profits for larger and more unionized firms when their product and labor markets are concentrated. Importantly, this increased profitability for large firms in concentrated markets would not occur without the contraction of small and less unionized firms and the reallocation to large and more unionized firms.[1]

Fifth, by using detailed product-level export data and mediation analyses, we show that

[1] In the private sector as a whole, after an increase in union density and per-unit labor costs, the average firm reduces employment and does not pass on the cost increase to consumers, implying a reduction in overall private-sector employment. This is consistent with the broader private sector being more competitive, both in the labor market and the product market. See Appendix E for details.

the average manufacturing firm passes on the entire labor cost increase in prices. Moreover, the increase in value added per worker can be fully explained by price increases rather than by increases in quantities produced per person. Understanding to what extent the measured increase in value added is driven by price versus productivity is key to understanding 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. Our analysis suggests that most of that average effect may be coming through a price effect and not a productivity gain in quantities produced.

What type of dynamics may explain this pattern of results? We propose a partial equilibrium model of firm choices to synthesize our results in a generalized framework that can easily be applied to other settings to examine cost shocks in labor or other inputs. We first incorporate firm monopsony power in the labor market as well as monopoly power in the product market to account for the increases we observe in employment and prices, respectively. However, this model cannot explain the concurrent price and output increases, which result in non-negative profit effects. This pattern of results can only be explained through an adjustment of the conventional firm models in which we allow the increased unionization to directly shift product demand. We propose two such mechanisms: (1) an increase in product market power which pivots the demand curve to become steeper, creating upward pressure on the price for any given amount of output; and/or (2) an improvement in product quality via a union productivity effect. We provide direct evidence of both these channels in our empirical analysis. Specifically, as evidence for (1), we show that product-market revenues are reallocated to larger and more unionized firms at the same time they are expanding labor inputs, such that the total quantity produced increases at the same time that product demand becomes less elastic. As evidence for (2), we demonstrate that despite reducing employment and other inputs, small firms increase average worker quality and worker hours, increase value added per worker, and raise their prices, resulting in no significant reduction in their profits.

In a set of back-of-the-envelope calculations, we show 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 for goods manufactured and sold in Norway. At the same time, we calculate that the change in union density in manufacturing induced by the subsidies increased wages by approximately 5.5-12% between 2001 and 2014. Thus, a cost born by a diffuse set of consumers resulted in net wage gains and non-negative (or even positive) profit effects for a much smaller population of workers and firms in the sector.

Our results highlight how the effects of unionization depend heavily upon the dynamic nature of market power in both the product and labor markets. Because firms do not operate in isolation, firm responses to their own cost shocks in inputs may simultaneously shift their production choices and significantly alter the landscape of their product markets. Importantly, unionization does not necessarily lead to lower profits or disruptions of the business process and may increase productivity and/or profitability for some firms depending on their size or market power. In settings where firms have power in both product and labor markets, the costs of raising worker wages via unionization may be more diffusely borne by consumers and workers at small unionized firms.

The core contribution of this paper is to provide the most comprehensive assessment of the margins along which firms causally respond to shifts in union density. This is achieved by leveraging a unique subsidy policy that generates exogenous 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 a range of approaches that include 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 effects of unionization as well (e.g., Finnigan and Hale (2018); Frandsen and Webb (forthcoming); Hagedorn et al. (2016); Park et al. (2019); Dodini et al. (2023b)). 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 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 lower employment and production, input substitution, or productivity adjustments? In addition, do profits fall, and are firms more likely to go out of business? On a more aggregate level, what are the overall implications on price levels, employment, wage growth, and consumer purchasing power? 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 employment and 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, which is considerably more competitive, 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 when market structures differ. By providing a stylized partial-equilibrium model that embeds these power dynamics, the paper also provides a framework that can be applied to other types of wage-setting interventions or cost shocks. We, therefore, see our paper as opening up a new avenue of research, exploring the dynamics of how unions and firms impact the well-being of workers and 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 profits, 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 mixed, ranging from large negative to slight positive productivity effects.[2]

These papers have provided important and novel insights into the effect of unions on firms, but they have been restricted in their ability to disentangle the margins along which firms respond to shifts in union density. As such, prior work has relied on proxies for firm outcomes such as stock prices (as a measure of profitability) or changes in staffing in comparison to patient health outcomes (as a proxy for worker productivity). Our administrative data combined with a precise and exogenous union density shock allow us to provide a comprehensive assessment of firms' response margins and to explore in detail 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 Norwegian customs records, enabling us to disentangle quantitative productivity effects from price effects. In addition, our stylized partial-equilibrium model also provides a framework for understanding how differences in power dynamics in labor and product markets across contexts generate very different firm responses to unionization, helping us better understand and synthesize the mixed results in this literature.

Relative to Barth et al. (2020), who use similar identifying variation to examine firm value added and wages in manufacturing, our analysis significantly broadens the scope of

[2]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. Dobbelaere et al. (2020) examine the relationship between their estimated labor markdowns and the presence of collective bargaining and works councils in German manufacturing and service plants. They find a negative descriptive association between both forms of organization and wage markdowns and a positive association between price markups and works councils.

our knowledge regarding firm responses to unions. This includes quantifying the effects of unionization on employment, prices (via markups and direct product price measures), wage markdowns, firm input mix, labor reallocation, changes in revenue concentration within industries, and ultimately profits. Though a secondary contribution, our analysis also expands beyond the manufacturing sector to demonstrate the effects of union density on the average private-sector firm. In addition, our ability to synthesize the findings in this paper through a model of firm decision-making that incorporates union bargaining power, product-market price-setting power, productivity, and labor market monopsony power, provides an important framework for future work on this topic.

Third, there is a small 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 firm-specific energy prices passed to firm export prices (e.g., Fontagné et al. (2023)). These related studies 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 are often assumed to 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. In addition, unionization can affect not only labor costs but other margins relevant to firm performance, such as productivity. This makes unionization a unique determinant of labor costs with substantial aggregate implications for how labor markets operate in terms of both efficiency and equity.

2 Background

2.1 Unions in Norway

Norway has a strong tradition of union representation. Each worker has the legal right to join a union, irrespective of who they work for, and on a voluntary basis; closed-shop union agreements are not allowed. As in other countries, the stated goals of the Norwegian labor unions are to improve members' rights and work conditions through bargaining.

Similar to other OECD countries, Norway has experienced a slight decline in union density over the past 20 years, albeit a considerably smaller decline than neighboring countries (4pp in Norway over the past 20 years compared to 14pp in Sweden, 8pp in Denmark, and

15pp in Finland). Research has attributed the slower decline in unionization in Norway to the government subsidies of union dues that we exploit for identification and has projected that aggregate union density would be approximately 5-6 percentage points lower had the subsidies not been increased (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). Figure 1 illustrates trends in union density over time and across sectors. For the manufacturing sector, which is our main focus, union membership is approximately 55 percent and, after declining in 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, almost all workers select their union based on the occupation and industry to which they belong.

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 wages and help settle legal disputes, push for better work conditions, provide counsel in the event of promotions and appointments, protect against unfair 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

The Norwegian labor market is characterized by high coverage of national sectoral collective bargaining agreements. However, the ability of firms and local unions to adjust individual wages is very high (Blandhol et al., 2020).

The most common wage determination process, which covers 50 percent of the private sector workforce (and 80 percent of the overall workforce), is a two-step bargaining procedure. In the first step, industry-wide collective bargaining agreements are established to set minimum wage guidelines; failure to reach an agreement at this stage can result in strikes or lockouts. These agreements are renegotiated every 2-4 years. 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. These negotiations usually take place annually. Non-union employees do not have the right to bargain, and it is up to the employer to adjust their pay as they deem appropriate.

A further 30 percent of the private sector is not covered by any industry-wide collective bargaining 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 two-step bargaining process 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] 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).

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).

2.3 Union Tax Deductions

Workers are required to pay monthly dues to become (and remain) members of unions. These dues are used to finance a wide variety of the union's professional activities, including personnel costs, the legal representation offered by the union, lobbying activities, strike funds, and campaign programs.

Baseline union dues are set during the union's annual national meeting. On average, dues typically range from 1 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 deducts the union dues from the worker's paycheck directly and transfers it 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 subsidy salient to the worker. Beginning in the early 2000s, the Norwegian government increased the maximum tax deduction for union dues multiple times, effectively quadrupling the maximum from 2001 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 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 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

[3] In the manufacturing sector, only 10 percent are covered exclusively by the sector-/industry-level process, such that as much as 90 percent of workers in the manufacturing sector are exposed to local bargaining (Table 4.2 in Dale-Olsen et al. (2018).

(or grow more slowly) by disproportionately more. This distinction generates exogenous variation in predicted unionization rates for workers and, therefore, different union densities across firms.

3 Empirical Design

3.1 Data

Data Overview. Our main data come from detailed administrative registers at Statistics Norway, and provide us with annual socioeconomic and demographic information on each individual aged 16 through 74 between 2001 and 2014. This includes information on gender, age, educational attainment, residency location, employment, occupation, industry, and earnings. By linking the individual-level data to the union 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.

We merge the individual data to detailed employer-employee matched data and subsequently to firm tax data. These data include information on the firm's input costs (broken down by category), workforce (size and average earnings), and output (sales revenue and profits). The tax data do not contain direct measures of capital use such as machine or building rental costs. We thus infer capital costs by subtracting each cost category, including personnel, materials, financial, and other detailed costs, from total operating costs. The remainder is a measure of capital costs with energy costs included. We calculate non-wage personnel costs as the difference between total personnel costs per worker and average earnings per worker. These data also enable us to construct measures of value added (sales revenue minus the cost of materials), wage markdowns, product price markups, and total factor productivity (via the production function approach discussed below).

We 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. These data also enable us to construct a firm-level Paasche price index for exports.

In our main analysis, we focus on firms with at least five workers. We include summary statistics on our analytical sample in Table 1. For comparison, we also include information on non-manufacturing firms. 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. In other words, the average manufacturing firm likely possesses more labor monopsony power, and more product monopoly power, than the average non-manufacturing firm in Norway. Profits in the manufacturing sector are slightly higher than profits in the non-manufacturing sector, and manufacturing 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. We estimate each firm's product price markup and labor markdown following Yeh et al. (2022), who build on the canonical "production function approach" to estimate markups (e.g. De Loecker and Warzynski, 2012). The production function approach is based on the insight that the wedge between the output elasticity with respect to a specific input and its revenue share reflects the firm's degree of market power.[4] One can therefore separately identify product market power and market power in a specific input market – like labor – as long as one production input is being competitively supplied. The wedge between the output elasticity and the revenue share for the competitively supplied input should reflect only product market power, while the ratio of the labor wedge to the flexible input wedge enables the identification of pure labor market power (the markdown). We follow Yeh et al. (2022) in using a flexible production function estimation approach to estimate industry-specific revenue output elasticities with respect to each input and in assuming that materials inputs are competitively supplied. We can then separately estimate the product price markup and the labor markdown.[5] Our production function estimation also gives us firm-year level estimates of TFP. We describe the procedure and its underlying assumptions in more detail in Appendix B.

Calculating firm-level price indices. While calculating markups is a common approach in the IO literature, it relies on certain assumptions about the production process. To complement this approach, we directly examine price pass-through using customs data for exporting firms. Using these data, we calculate prices per kilogram for the specific products exported by each firm. We also generate a firm-specific Paasche price index across all exports by each firm. Specifically, using information for each product code i in time t relative to base year b, we calculate:

[4]Intuitively, as Yeh et al. (2022) note, the output elasticity with respect to an input x reflects the gain from an additional unit of x, and the revenue share reflects its (normalized) cost. If the wedge exceeds one, the marginal gain is greater than the average cost – suggesting market power in either the product market or the input market, or both.

[5]Specifically, denoting the output elasticity with respect to input k as θ^k, and its revenue share as α^k, the product price markup is estimated as $\mu = \frac{\theta^m}{\alpha^m}$ and the labor markdown is estimated as $\nu = \frac{\theta^l}{\alpha^l}\mu^{-1}$ (where m indicates materials and l indicates labor).

$$\frac{\sum_i P_{i,t} Q_{i,b}}{\sum_i P_{i,b} Q_{i,b}} \tag{1}$$

We anchor the base year b for each firm to the firm's last year in the data (2014 for most firms), in part because the set of products being exported during this period expanded.[6]

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. 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 additional minor increases between 2011 and 2014. These increases led to significant changes in the net price of union membership for some workers (Barth et al., 2020; Dodini et al., 2022). Specifically, 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, an increase of more than 400 percent.

Increases in the maximum dues deduction cap affect workers differently depending on their prior dues. To illustrate this, 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 ($D < c_0$) experience no change. Workers whose dues were above the old cap but below the new cap ($c_0 < D < c_1$) experience 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 ($D > c_1$) face 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 effect assuming a tax rate of 42% (Panel A), which was the typical top marginal rate from 2001-2014, and 28% (Panel B), which was the base tax rate during our analysis period. 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. Assuming the 28% rate, for a worker whose base dues were 4,000 NOK, net dues would have fallen from 3,748 in 2002 to 3,118 in 2008 and to 2,922 in 2014—a reduction of over 800 NOK (≈ 21%).

[6]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.

A worker's union dues depend predominantly on the job in which they are working, namely, their 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 eliminates concerns about heterogeneous selection into differently-priced unions and individual determinants of union dues.[7] 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 been members. 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. These imputed dues help us characterize the firm's exposure to the change in union dues subsidies, since a firm may both be affected 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.

Unions may respond endogenously to the changes in union deductions, and firms may alter their occupation mix in response to unionization. We, therefore fix each firm's imputed "baseline" union dues, $\overline{D_f^0}$, 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 dues would be at the firm in year t if their occupation-industry composition were held constant at baseline levels.

We define the net-of-tax union dues $NetDues_{ft}$ as the baseline union dues 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 dues. We, therefore, have our instrument

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

where T_t is the base tax rate in year t.[8] We use these net-of-tax union dues to instrument for firm-level union density.[9]

[7]However, this imputed value is highly predictive of actual union dues paid in the raw data among union members (see Figure A1).

[8]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. If we use the average top marginal rate (42%) to scale the subsidies rather than the base rate, this shifts the first-stage estimates but not the estimated second-stage coefficients.

[9]Our instrument abstracts away from endogenous responses to the tax deduction changes by unions - specifically, raising dues in response to the policy. We evaluate this response in Appendix Table A1, and find that unions did raise dues in response to capture part 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. While we

3.3 Empirical Method

In our main 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.[10] Specifically, we regress firm-level outcomes Y_f on our predicted union density:

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

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

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

with firm fixed effects (δ_f) and industry group by year fixed effects (τ_{gt}) in all specifications. The industry group-by-year fixed effects account for any time-varying shocks to demand over time specific to each sub-industry group, which may be important given the fast demand growth occurring during this period. These also flexibly control for any sector-specific shocks that may have affected the labor market in each industry group. This includes average changes in productivity, new technologies, immigration, the broad effects of any industry-wide collective bargaining agreements, or any other unobserved shocks occurring within each industry group. Within manufacturing, industry groups are organized around the types of products the firms produce: food and drink; textiles, leathers, and wood; metals, chemicals, and raw production materials; machines; and other miscellaneous products.

Identifying variation in our instrument comes from differences in the occupation-industry group 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 to product or labor demand.

Our identification strategy requires that the standard IV assumptions of relevance, exclusion, SUTVA, and monotonicity apply. This means that changes in the firm-level average net-of-subsidy union dues must directly influence firm-level union density (relevance), that an increase in union density is the only channel through which changes in the firm-level

see this novel result as an important finding for policy purposes, the incidence of the increase in the effective subsidy to unionization is less relevant for our paper: 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, 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.

[10] As shown in Abadie et al. (2023), these clustered standard errors are likely conservative.

average net-of-subsidy union dues affect firm-level outcomes (exclusion), that changes in net dues in one firm do not affect dues in other firms (SUTVA), 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 (monotonicity). With respect to the relevance assumption, we show directly in the next section that workers are highly responsive to changes in union membership prices. 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 SUTVA, because we fix dues at their base year, there is no channel through which the union dues instrument can directly spill over to other firms. With respect to monotonicity, 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 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. We, therefore, expect the firms with higher ex-ante union dues to exhibit larger increases in firm-level union density. Importantly, since our approach leverages differential cross-sectional exposure to changes over time, with firm fixed effects, we do not need ex-ante-high-dues firms and ex-ante-low-dues firms to be similar at baseline; we only need ex-ante-high-dues firms and ex-ante-low-dues firms to have the same paths of potential outcomes.[11] In other words, we only require that baseline dues are not related to the potential outcomes of these firms over time. Parallel trends across firms with different intensities of exposure during the periods in which the deductions did not change would be strong evidence in favor of this assumption. However, we also show in Appendix Table A3 that there is essentially no systematic correlation between firms' baseline characteristics and their later exposure

[11]One concern with the interpretation of our results is that high concentrations of high-subsidy firms in a local labor market may affect the potential outcomes of low-subsidy firms in the same local labor market. This would not invalidate our findings, but it would imply that part of our effects are coming from negative (or positive) responses at low-subsidy firms rather than positive (or negative) responses from high-subsidy firms. This is similar to all difference-in-difference settings that estimate relative effects across units based on differential exposure to a shock or policy reform. We test for such spillovers in Table A2 by estimating our main specification with exposure to other local firms' instruments as an additional regressor, i.e. the employment-weighted average net due for other firms in the same industry in the same local labor market. We find that increased exposure to other local firms' instruments does not alter our main estimates and does not result in statistically or economically meaningful coefficients. In other words, we find no evidence that spillover effects to other firms are driving our results. Therefore, our results appear driven by firm choices in response to unionization within the firm rather than direct spillovers.

to the instrument, indicating that these firms are similar in their observable (and likely unobservable) characteristics.

An illustration of parallel trends before and after the period of significant changes to the tax deductions is provided in Figure 4. These are raw trends that account only for firm fixed effects. 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 through 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 2003. 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 find any evidence of differential pre-treatment trends in terms of union density or earnings over the 1998-2002 period. This result is consistent with our common trends 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. The strong suggestive evidence in favor of this assumption supports a causal interpretation of the results we present in Section 4. The fact that we observe parallel pre-treatment trends from a less saturated model than that underlying our main results is encouraging.[12]

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 show 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.[13] 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. Moreover, in Panels B-D we find preliminary raw evidence of effects of the differential change in union membership on earnings, value added per worker, and profits, all of which grew faster in high-subsidy firms than in low-subsidy firms (but only over 2002-2010 when the

[12]We test for differences in the pre-reform slopes from 2000-2002 in Appendix Table A4 in two ways and find no statistically significant differences in these trends. 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.

[13]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.

subsidies were substantially changing, with parallel trends from 1999-2001 and 2010-2014).

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. We analyze the population of compliers in the manufacturing sector in Appendix C.

4 Results

4.1 First Stage

Table 2 shows the effect of the union dues subsidies on workers' propensity to unionize, estimated with Equation 4 which includes both firm and industry-group-by-year fixed effects. Consistent with prior work (e.g., Barth et al. (2020) and Dodini et al. (2022)), decreases in the net-of-subsidy union dues at the firm induce increases in firm-level union density. Specifically, Column (1) of Table 2 shows that firms that experience a 1,000 Kr larger reduction in their average net-of-subsidy dues exhibit a 16 percentage point larger increase (or smaller decrease) in firm-level union density. This implies a sizeable price elasticity of union membership for marginal union members in Norway's manufacturing sector.[14] The magnitude of this estimated responsiveness is extremely similar to Norwegian workers' self-reported responsiveness to union dues, as surveyed in Dodini et al. (2023b). The survey asks more than 5,000 Norwegian workers how they would respond to a change in their net cost of joining a union. In Figure 5 we show workers' self-reported responses to a 500 NOK change in their net dues (6,000 NOK annually). 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).[15]

4.2 Margins of Adjustment

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

[14] For the full private sector, this change is 8.6 percentage points (see Appendix E). 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 suggests a significant gradient in responsiveness over market concentration, which also has been found in prior work (Dodini et al., 2022). It is a marginally larger degree of responsiveness than that estimated in Barth et al. (2020). Our estimate of the first-stage responsiveness may be an upper bound since we calculate the 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.

[15] When examining the broader private sector in Appendix E, the first stage estimate is nearly identical to our survey evidence. We use an estimate of 40-60% responsiveness as an aggregate over non-union members and union members, noting that non-union workers are disproportionately younger (25-39) while union members are disproportionately likely to be over 40.

in Section 3.3). The estimate in Column (2) of Table 2 shows that increased firm-level union density generates 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.[16] This is in line with the estimates in Barth et al. (2020) and Dodini et al. (2022). The positive effect is of a similar size for non-wage compensation (Column (3)), with a 0.9 log point increase in average non-earnings personnel costs per worker.

Provided that the composition of the workforce is unaffected by the union density shift, the compensation results in Table 2 imply that the per unit price of labor is increasing as a consequence of higher union density.[17] This is a standard result in the union wage literature and one that underlies much of the policy debate on worker representation at firms. If unions raise firms' per-unit labor costs, how do firms pass on this cost, and how does that impact their productivity and profitability?

Employment. Next, we examine the effect of increased unionization on total labor costs and log employment (Table 3 Panel A, Columns (1) and (2)). An increase in unionization pushes the average manufacturing firm to expand employment: a 1 percentage point increase in firm-level union density leads to an increase in employment of around 1 log point. 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 monopsony power in the manufacturing sector, which could be a result of, for example, its high level of labor market concentration (Schubert et al. (2020); Prager and Schmitt (2021); Caldwell and Danieli (2018)). Specifically, employers with monopsony power can hire and retain workers for wages that are below the marginal revenue product of labor. If a union can leverage its power to push wages above the current wage offered by the employer, the firm would hire more workers, but profits per labor unit would be lower because the wedge between the marginal worker's wage and productivity would be smaller.[18]

Input substitution and scaling. As the unit cost of labor increases, firms may adjust their

[16]Because we are measuring firm-level outcomes, we are agnostic about the exact source of this increase in average per-unit labor costs, whether it be concentrated wage gains to marginal union members or broad-based gains to more workers.

[17]We estimate the role of composition effects in Appendix Table A5. After residualizing firm-level average earnings and value added per worker on worker and firm fixed effects and using these residualized values in our firm-level analysis, we find an effect of unionization on average earnings of 0.5 log points. This implies that firms respond to increased unionization in part by increasing the average quality of workers (as proxied by workers' wage fixed effects) – but that there are still large wage increases net of compositional shifts.

[18]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 pushes 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. (2022)). However, a sufficiently large union wage premium that exceeds the marginal revenue product of labor would reduce employment, even in a highly monopsonistic market. See also our framework in Section 5.

input use, perhaps substituting alternative inputs in place of labor as long as the production process allows it. We found little evidence for this above as the average manufacturing firm increases, rather than decreases, its labor use as wages increase.

How do firms alter the rest of their input mix? In response to a 1 percentage point increase in union density, the average manufacturing firm increases its expenditure on capital and materials by around 0.9 and 0.4 log points respectively (we cannot rule out an equal response to the employment increase). This is shown in Columns (3) and (4) of Table 3. Thus, there is no evidence of substitution away from labor, at least in the short run over which we estimate our results.[19] Firms thus appear to scale up total production by around 1 percent (assuming no diseconomies of scale).[20]

Productivity. 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. 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 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). We also estimate that TFP increases as a result of increased union density (Panel C Column (4)).

Part of the nominal productivity effect we find may arise through changes in worker composition, which we explore in Appendix Tables A5 and A15. Two proxies for worker quality – the average worker fixed effect, and the average occupation-by-industry fixed effect (in an AKM-style regression of individual earnings) – both increase as union density increases. We also find that the increase in employment we measure comes primarily through retention rather than new hires, which suggests that the increase in unionization allows firms to retain higher-quality workers. However, even after residualizing on individual worker fixed effects, we still see significant increases in value added per worker as union density increases, implying that composition effects cannot be driving the full measured increase.

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 and TFP 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 the role of prices below using detailed product-level export data.

Price markups and labor markdowns. The results from our markup and markdown analysis are provided in Columns (4) and (5) in Panel B of Table 3. In response to a 1

[19]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.

[20]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 A6).

percentage point increase in 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. Since the elasticity of sales with respect to variable costs is estimated within manufacturing 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. This is consistent with an increase in either productivity or prices. Since the output elasticity of labor is similarly time-invariant, the estimated decline in the labor markdown must be driven by an increase in labor costs relative to materials costs.

Firm profitability. The increase in value added per worker we estimate in Table 3, 1.1 log points, is roughly of the same magnitude as the increase in average earnings per worker of 1 log point. 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)). In other words, 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 suggest that the labor share of value added weakly decreases.

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 marginally significant increase in total profits of 2.25 log points per percentage point increase in union density. This suggests that firms' unit profitability has increased. Specifically, 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, there is no statistically significant change in the probability of reporting a negative or zero profit, or in the probability of firm exit.

The profit results we obtain are surprising. Ex ante, we would expect a simple increase in wages to weakly reduce firm profits, all else equal. However, profits may increase if unionization increases firm productivity or pricing power. In Section 4.4, we attempt to disentangle these two possible mechanisms by examining a reallocation of labor and other inputs from small (and/or less unionized) manufacturing firms to larger (and more unionized) manufacturing firms, which may drive pricing power via an increase in industry revenue concentration.

4.3 Price Pass-through: Exporters Analysis

Increased firm-level union density raises (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 the welfare implications of these changes. While there are 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 firm-year observations contain exports means that we can estimate price pass-through for a large share of our sample.[21] Results from this analysis are shown in Table 4.[22]

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 2.3 log points in response to a 1 percentage point increase in union density. This large price increase may reflect some combination of increased product-level prices and changes in the sales mix. Second, we estimate regressions at the product level that allow us to disentangle the extent to which these effects represent increased product-level prices and changes in the sales mix. In these regressions, we include product-by-year fixed effects as well as either firm fixed effects or firm-by-product fixed effects. These results are shown in Columns (2) and (3) of Panel A, respectively. We find that within product categories, prices increase by 1.6-1.9 log points. The product-level price increase of 1.6-1.9 log points is consistent with full pass-through of the increase in labor costs (1.1 log points in Appendix Table A7). Finally, we construct a firm-level Paasche index of export prices as described in the data section. Column (1) of Panel B in Table 4 shows a 3.5 percent increase in this price index in response to the increase in unionization.

It is worth noting that one might expect, ex ante, that exports have a high elasticity of demand and that levels of competition are high. However, the empirical and theoretical evidence suggests that imperfect competition and pricing to market are not uncommon among exporters (e.g. Berman et al. (2012); Atkeson and Burstein (2008)). In addition, many of Norway's largest exports are for relatively inelastic products such as aluminum, nickel, zinc, and petroleum products (Shojaeddini et al., 2023; Fernandez, 2018); and fish, where Norwegian producers have short-run market power (Steen and Salvanes, 1999) and demand for Norwegian fish is relatively inelastic (Xie et al., 2009).

The fact that firms' overall average export prices rise by substantially more than the prices of individual products reveals 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 find some suggestive evidence of this in Column (3) of Panel B of Table 4. This shows that the share of the firm's total export revenues coming via sales of products that were above

[21] Firms that export tend to be larger. Two-thirds of observations for firms in the top size quartile have records in the export data, compared to a quarter of observations for bottom quartile firms.

[22] We also present the baseline unionization effects on earnings, employment, input costs, value added per worker, and profits for our exporter sample only in Appendix Table A7. These effects are similar to our main results in Table 3.

the median per-kilogram price for all products ever sold by the firm rose by approximately 1.4 percentage points for every percentage point increase in union density. This implies that greater union density leads firms to more intensely focus production inputs on producing and selling higher-priced goods.

What can we infer about productivity from these price changes? The estimated product-level price increase of 1.6-1.9 log points is roughly the same size as the estimated increase in nominal value added per worker of 1.7 log points among the exporter sample (Appendix Table A7). Therefore, if firms increase their domestic prices by the same amount as they increase their export prices, the product-level price increases we estimate are roughly large enough to account for the entire increase in nominal productivity. The assumption that firms increase their domestic prices by at least as much as their export prices seems a priori plausible, since export markets for manufactured goods are likely to be more competitive than domestic markets (Atkeson and Burstein, 2008). We also conduct four supplemental empirical exercises which point to price increases in the domestic market being (at least weakly) larger than price increases on exports.

First, we stratify our estimates into goods exported to other parts of Scandinavia versus goods exported to the rest of the world.[23] Due to similarities in language, customs procedures, consumer preferences, and geographic distance, we view 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, we find product-level price increases in exports to Scandinavia that are larger than the rest of the world (1.74 log points vs. 1.41 log points when estimating with firm and product-by-year fixed effects, as shown in Appendix Table A8). The differences are starker for the firm-level regressions without product fixed effects (2.8 log points vs. 1.0 log point).

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 Appendix Table A9). The export price effect comes mainly from firms that mostly sell domestically: for firms for which exports are over 25 percent of revenues, we find no statistically detectable change in prices per kg as a result of increased unionization. The difference between the two coefficients is statistically significant at the 5% level when we bootstrap the model differences. Again, this is consistent with the idea that firms that mostly sell internationally are facing more competitive product

[23]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.

markets.

Third, one sign that firms increase prices on their domestically-sold goods at least as much as on their exports would be a decline in the export share of a firm's revenue. For the same price increase, the domestic quantity demanded would decrease by less than the export quantity demanded. Alternatively, for the same decline in quantity demanded, domestic prices can increase more than export prices. In Column (2) of Panel B in Table A7, we show that increased unionization generates an increase in the share of a firm's revenue coming from domestic production. Specifically, the share of firm revenues accounted for by exports declines by 0.3 percentage points in response to a percentage point increase in unionization.

Finally, while we cannot directly examine prices on domestic goods, we can examine markups, which represent our best available approximation of domestic price changes. For non-exporters, markups increase by 3.5 log points in response to a 1 percentage point increase in union density, compared to an increase of 0.6 (though the estimate is imprecise with a standard error of 0.6) for exporters – consistent with larger price increases at firms selling domestically.

Taken together, the results in this subsection imply a substantial degree of price pass-through by firms of the increased costs of unionization. The magnitude of price increases is consistent with most if not all of the value added per worker effect 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 that a union density increase driven by the same tax deductibility change that we examine leads to an increase in value added per worker and attributes this to the productivity-enhancing effects of unions. However, the analysis in this subsection suggests that most of that effect may actually be coming through a price effect rather than through a real productivity effect in terms of quantities produced.

In Appendix D, we formally explore the relationship between the firm value added per worker effects and price effects in the mediation framework of Dippel et al. (2020) and Pinto et al. (2019) for the average manufacturing firm. This mediation analysis shows that for the average firm, the value added per worker effect can be explained entirely by changes in product prices or markups and not by effects on the number of units produced per worker. We note, however, that these average effects may mask heterogeneity in price effects versus productivity effects for different types of firms and that price effects could also reflect unobserved improvements to product quality.

4.4 Heterogeneity by Firm Size and Ex Ante Labor Market Power

Firms of different sizes may respond differently to increased union density: they may differ in terms of input flexibility, substitutability of labor, and/or market power. In the minimum wage literature, for example, higher minimum wages induce a reallocation of labor from smaller firms to larger firms (Dustmann et al., 2022). If similar results take place in response to the union density shifts that we examine, then the combined set of *firm-level* unionization shocks may generate a *market-level* shock that shapes both the labor and product markets. To explore this in detail and help establish a more complete picture of the margins along which firms respond to unionization, we estimate our regressions with interactions for firm size quartile (measured by the number of workers). The results from this exercise are shown in Table 5, where each coefficient represents the total effect for each quartile (i.e., the coefficients are not relative to another quartile).[24]

Table 5 shows that the earnings effects are similar across firm size quartile, with the smallest quartile of firms experiencing a 1.3 log point increase in average earnings as compared to a 0.93 log point increase for the largest firms. However, large and small firms' responses to this increase in labor costs are strikingly different.

The smallest quartile of firms reduce their employment by 2.4 log points and do not reduce 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. This increase in markups and value added per worker, alongside decreases in input use and no change in sales value, suggest some combination of increased prices or increased productivity. We find no statistically significant effect on the labor markdown. There is a large negative point estimate on the labor share of value added, but this is imprecisely estimated. Strikingly, firm profits are unchanged, and there is no increase in the probability of exit.

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 experience smaller increases in nominal value added per worker than smaller firms, with an increase of 0.75 log points. The estimated product price markup rises by a similar amount for larger and smaller firms, around 1.8-2.0 log points.[25] Consistent with larger firms having more ex-ante labor market power, we find a decrease in the labor markdown of 2.5 log points. Alongside their increase in total sales, large firms experience an *increase* in profits, of 3 log points (consistent with a 0.05 percentage point increase in the profit margin), alongside a decrease

[24]To include interactions in this IV model, the interaction between net dues and firm size quartile acts as a separate instrument for the interaction between that firm size quartile and union density (Wooldridge, 2010). The cutoffs for the quartiles of private-sector firms in Norway are 8, 11, and 20 workers. Recall that our sample is restricted only to firms with more than 5 workers.

[25]In the exporter sample, there is a gradient on price increases: the smallest quartile of exporting firms increases their prices per KG by 3.05 log points compared to 2.2 log points for the largest exporters. As a sign that the larger exporters may have less elastic demand, we find that the quantity sold by the smallest firms falls by 4.5 log points compared to 0.4 log points for the largest firms (Appendix Table A11). Note, however, that the smallest firms are also scaling back production while larger firms are expanding, suggesting supply- rather than demand-side constraints.

in the probability of negative profits and in the probability of firm exit. Importantly, even though unions may be interested in increasing the labor share of value added as they grow, the labor share does not significantly change in any quartile of the size distribution.

How should we interpret these heterogeneous effects by firm size? Note first that the results on employment and labor markdowns – increased employment and reduced markdowns for large firms, and decreased employment and little change in markdowns for small firms – are consistent with larger firms having substantial monopsony power and smaller firms having little monopsony power. Moreover, note that the price increases for smaller firms are consistent with these scaling results: if smaller firms have some product market power (facing downward-sloping demand curves), then as they reduce production they would be expected to increase prices as they move up the demand curve. However, the price increases for large firms cannot be explained through movements along the demand curve, since large firms increase production, which should put downward pressure on prices. Instead, as with our discussion on the average firm in Section 4.2, price increases for large firms suggest some combination of increased market power or increased productivity. Indeed, we see large firms increasing their market shares substantially (by 2.6 percentage points) even as smaller firms' revenue shares are marginally reduced. This leads to an increase in the concentration of total industry revenues in larger and more-unionized firms, which would be expected to increase their product-market price-setting power. We expand on this in our stylized model in section 5.

Finally, the lack of any negative effect on profits for both smaller and larger firms requires further exploration. For large firms, the increase in market shares and (likely) in market power can increase profitability if the union-induced increase in product market pricing power outweighs the increase in labor costs. For the smallest firms, however, this cannot hold: as they scale down, there is no mechanism through which their pricing power could increase. This suggests that for smaller firms, there must be a productivity effect of unions (unless they were not profit-maximizing before the increase in union density).

What might drive this productivity effect in smaller firms? We find evidence consistent with at least three mechanisms. First, we find evidence for a composition effect: the average quality of workers at small firms – as measured by average earnings fixed effects – increases by more than that at larger firms. Larger firms in contrast are hiring and retaining marginally less productive workers who are younger (below age 25) and have less industry experience. Since smaller firms reduce their employment, this suggests that they retain their more productive workers on the margin (Appendix Table A16). We also find that the average earnings fixed effect of new hires increases by more at smaller firms than at larger firms, consistent with smaller firms being able to attract incrementally more productive new hires as they increase their compensation. Second, we find evidence for a labor intensification effect: the smallest firms increase the average hours worked by their employees by 0.19% for each percentage point increase in union density, while the larger three quartiles do not significantly change work hours (Appendix Table A10). In other words, smaller firms are making more intense use of the labor of their workers and may be consolidating multiple part-time positions into fewer full-time positions. Third, we find evidence for an efficiency wage effect via a reduction in sick leave: smaller firms experience a decreased risk of having employees take sick leave as well as a decrease in the number of total sick days, both of which are larger than what a one-to-one relationship with employment would predict (Appendix Table A10).[26]

We have focused here on contrasting the largest and smallest quartile of firms. We note in addition 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 indicative of a true firm-size pattern.

We further explore heterogeneity by various measures related to productivity and market power in Appendix Table A12: the labor markdown, local occupation employment shares, local industry employment shares, profit margin, and value added per worker in the prior year. We consistently find that, when firms have more labor market power (as measured by markdowns or local employment shares), employment increases by a larger amount as union density increases. The same is true for the other inputs we measure; capital and materials. This, in turn, generates larger increases in total sales. This pattern of results is consistent with more monopsonistic firms increasing employment and output in response to increases in labor costs.

4.5 The Broader Private Sector

As discussed above, the core focus of our paper has been the manufacturing sector, due to the availability of export data and due to limitations with the production function approach. In Appendix E, we expand our analysis and show results for the broader private sector (including manufacturing). When interpreting these results we encourage caution with respect to the markup and markdown results as the flexible input assumption of raw materials may not hold for many of the non-manufacturing industries.

Our results for the average firm in the private sector differ from our results for the average manufacturing firm. Increased union density increases worker earnings, but reduces employment: a one percentage point increase in union density increases average compensation per worker by 0.8 log points and reduces employment by 1.6 log points. Firms scale down capital and materials roughly proportionately to the fall in employment, and total sales value

[26] For large firms, there is evidence consistent with an improvement in worker quality through worker fixed effects, but no evidence of labor intensification or a reduction in sick leave.

falls by 1.4 log points. There is no increase in the markup (suggestive that there is no or little price pass-through of the higher labor costs), and there is no evidence of an increase in profits. In fact, the coefficient on log profits is negative. These results for the private sector are consistent with these firms operating in more competitive product and labor markets, where increased labor costs reduce employment (consistent with little labor market power) and there is little evidence of price pass-through (consistent with limited product market power).[27] Indeed, labor and product market HHIs are much lower in the non-manufacturing sector than in manufacturing, suggestive of less market power (Table 1).

5 A Synthesizing Model

For the average manufacturing firm, an increase in union density results in higher wages and employment, higher sales, higher nominal productivity (measured as either VA/worker or TFP), higher prices, and no decline in profits. In this section, we present a stylized partial equilibrium model of firm-level unionization which can explain these results. We show that the increase in employment is consistent with the average manufacturing firm having monopsony power in the labor market. We also show that the firm's ability to increase prices is consistent with market power in the product market. However, a typical model featuring monopsony and monopoly power cannot explain the fact that prices increase alongside output (since this is not consistent with downward-sloping product demand). It also cannot explain the fact that profits do not decrease as labor costs increase (assuming the firm was maximizing profits beforehand). In fact, our combination of results can only be reconciled by an increase in product demand at a given price *alongside* the increase in unionization. We propose two possibilities that could generate this: an increase in product market power as a result of higher market shares, or an increase in product quality as a result of union productivity effects. We show this in more detail below.

5.1 Core Model Setup

Firm problem and wage bargaining process. Consider a firm with a linear production function in labor, and a union present. We assume a right-to-manage model in which the union and firm bargain over the wage, setting bargained wage $\bar{w}$. The firm's objective is to maximize profits, subject to an upward-sloping labor supply curve and a downward-sloping product demand curve, and to the bargained wage:

$$max_l \pi = p(l)zl - wl \qquad \text{s.t.} \quad l \leq w^{\eta} \;\; , \;\; p(l) = \left(\frac{zl}{Y}\right)^{-\frac{1}{\epsilon}} \;\; , \;\; w \geq \bar{w} \tag{5}$$

[27] When examining results for the broader private sector separately by firm size quartile, we find the largest decreases in employment among the smallest firms and small gains in employment in the largest quartile of firms (Appendix Table E3). This would be consistent with the largest private sector firms having some labor market monopsony power.

where l is the number of workers, z is productivity, p is the output price, w is the wage, $\bar{w}$ is the bargained wage, Y is aggregate output, η is the elasticity of labor supply to the firm, and ϵ is the elasticity of product demand. To be able to identify the effects of changing union density on outcomes, we further assume that the union and firm reach the bargained wage $\bar{w}$ through a Nash bargaining process, with union bargaining power β a function of union density, such that the bargained wage is a weighted average of the union's optimal wage (w^u) and the wage the firm would set in the absence of the union (w^*): $\bar{w} = \beta w^u + (1 - \beta) w^*$.

Firm optimization subject to bargained wage. Once the bargained wage is determined, the firm chooses its employment level l. Following Lo Bello and Pesaresi (2022), we note that the amount of labor the firm chooses will depend on how high the bargained wage $\bar{w}$ is set. Specifically, there exists a threshold wage w^{thresh} such that if the bargained wage is below this threshold, the firm will be bound by the labor supply curve, and if the bargained wage is above this threshold, the firm will be bound by the labor demand curve. Thus, the firm's labor choice is:

$$l = \bar{w}^{\eta} \quad \text{if } \bar{w} < w^{thresh} \qquad \text{and} \qquad l = \bar{w}^{-\epsilon} \left(\frac{Y}{z}\right) z^{\epsilon} \left(\frac{\epsilon - 1}{\epsilon}\right)^{\epsilon} \quad \text{if } \bar{w} > w^{thresh}, \tag{6}$$

where threshold wage w^{thresh} is the wage at which these conditions intersect. This is the point at which the labor supply curve crosses the marginal revenue product curve and can be written as follows:

$$w^{thresh} = \left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\frac{\epsilon - 1}{\epsilon}\right)^{\frac{\epsilon}{\epsilon+\eta}}. \tag{7}$$

Note that the amount of labor hired is increasing in the wage for $w < w^{thresh}$ (as the firm moves up the labor supply curve) and then decreasing in the wage for $w > w^{thresh}$ (as the firm moves up the labor demand curve).

Firm optimal wage. To determine the bargained wage, we need to first determine the firm's and the union's optimal wages. The firm's optimal wage w^* is the wage it would choose in the absence of a union. Maximizing profits subject to its product demand and labor supply curves, this generates the familiar expression that the optimal wage is marginal revenue product, marked down by both the product markup and labor markdown:

$$w^* = \left(\frac{\epsilon - 1}{\epsilon}\right) \left(\frac{\eta}{\eta + 1}\right) p^*(z) z = \left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\left(\frac{\epsilon - 1}{\epsilon}\right) \left(\frac{\eta}{\eta + 1}\right)\right)^{\frac{\epsilon}{\epsilon+\eta}}. \tag{8}$$

Union optimal wage. The union's optimal wage w^u is the wage that maximizes the union's utility, knowing that the firm will choose employment based on this wage. We specify the union's utility as a function of both wages and employment at the firm (with relative weight $\alpha < 1$ on wages), subject to constraints that (i) employment not fall below some fraction of non-union employment $\kappa_l l(w^*)$ and (ii) the wage not be lower than some multiple of the non-union wage $\kappa_w w^*$ (where $\kappa_l < 1$ and $\kappa_w > 1$):[28]

$$max_w U = w^\alpha l^{(1-\alpha)} \qquad \text{s.t.} \quad l \geq \kappa_l l^* \ , \ w \geq \kappa_w w^*. \tag{9}$$

The union's optimal wage will either be (i) $w^u = w^{thresh}$, which is the highest wage consistent with maximizing employment (aka the wage that eliminates the employment-suppressive effect of the firm's monopsony power), or (ii) the highest wage w^u such that employment does not fall below its employment constraint $l(w^u) \geq \kappa_l l(w^*)$:[29]

$$\begin{aligned} w^u &= w^{thresh} = \left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\epsilon}{\epsilon+\eta}} && \text{if } \frac{\alpha}{1-\alpha} < \epsilon \text{ and } \kappa_w \leq \left(\frac{\eta+1}{\eta}\right)^{\frac{\epsilon}{\epsilon+\eta}} \\ w^u &= \kappa_l^{\frac{-1}{\epsilon}} \left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\epsilon}{\epsilon+\eta}} \left(\frac{\eta}{\eta+1}\right)^{\frac{-\eta}{\epsilon+\eta}} && \text{if } \frac{\alpha}{1-\alpha} > \epsilon \text{ or } \kappa_w > \left(\frac{\eta+1}{\eta}\right)^{\frac{\epsilon}{\epsilon+\eta}}. \end{aligned} \tag{10}$$

Which one of these is the union's optimal wage depends on two conditions. The first condition, $\frac{\alpha}{1-\alpha} < \epsilon$, reflects the trade-off between wages and employment: the greater weight the union places on employment as well as wages (smaller α), the less willing the union is to raise the wage above w^{thresh} because this moves the firm onto its product demand curve, meaning incremental wage increases reduce employment.[30] The second condition, $\kappa_w \leq \left(\frac{\eta+1}{\eta}\right)^{\frac{\epsilon}{\epsilon+\eta}}$, reflects the degree to which the union's desired wage increment is bigger or smaller than the firm's monopsony markdown: the more monopsony power there is, the more room there is to move up the labor supply curve as the wage increases before the firm starts cutting employment in response to additional wage increases.

We now consider two cases separately, which can respectively explain our results for (1) the average manufacturing firm, and (2) the smallest manufacturing firms/average firm in the broader private sector.

[28] Where w^* is the wage the firm would set in the absence of a union, and $l(w^*)$ is the employment the firm would have in the absence of a union. The union's employment constraint might reflect a particular concern for the employment level of union members or incumbents with more power in the union. The union's wage constraint might reflect a legitimacy concern with, for example, recouping at least the incremental cost of union dues relative to a non-union case to ensure that workers are weakly better off unionized.

[29] We assume that the union's wage and employment constraints are compatible with each other.

[30] Why is this? First, note that the union will never set a wage below w^{thresh}, because for all $w^u < w^{thresh}$, as the union raises the wage the firm also increases employment (as it moves up its labor supply curve). Next, note that for $w^u > w^{thresh}$, employment falls as the wage increases. This means the union's utility is increasing in the wage only if the relative weight on the wage is sufficiently high relative to the price elasticity of demand (which governs the tradeoff between wages and employment): if $\frac{\alpha}{1-\alpha} > \epsilon$).

5.2 The Average Manufacturing Firm

The model as laid out above can explain our findings on wages and employment for the average manufacturing firm, but not our findings on prices or profits. To see this, note that the average manufacturing firm operates in highly concentrated labor markets, such that it likely has a high degree of monopsony power. If the degree of monopsony power is sufficiently high that the union's optimal wage is $w^u = w^{thresh}$ (based on the discussion above), the bargained wage $\bar{w} < w^{thresh}$.[31] As union density increases, boosting union bargaining power β, wages and employment both increase as the firm moves up its labor supply curve. However, the price falls (as output increases and the firm moves down the product demand curve), and profits fall:[32]

$$\begin{aligned}
\frac{\delta \bar{w}}{\delta \beta} &= \left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\epsilon}{\epsilon+\eta}} \left(1 - \left(\frac{\eta}{\eta+1}\right)^{\frac{\epsilon}{\epsilon+\eta}}\right) \quad > 0 \\
\frac{\delta l}{\delta \beta} &= \eta \bar{w}^{\eta-1} \frac{\delta \bar{w}}{\delta \beta} > 0 \\
\frac{\delta p}{\delta \beta} &= -\frac{1}{\epsilon} p \left(\frac{1}{l} \frac{\delta l}{\delta \beta}\right) < 0 \\
\frac{\delta \pi}{\delta \beta} &= \left(\left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon}} z^{\frac{\epsilon-1}{\epsilon}} \left(\frac{\epsilon-1}{\epsilon}\right) l^{\frac{-1}{\epsilon}} - \left(\frac{\eta+1}{\eta}\right) l^{\frac{1}{\eta}}\right) \frac{\delta l}{\delta \beta} < 0 \,. \qquad (11)
\end{aligned}$$

This is illustrated visually in Figure 6 Panel A.

To explain the fact that prices *rise* rather than fall in our empirical results, and profits *do not fall*, we therefore need a modification to our model which increases product demand at any given price. We propose two possibilities below.

i. Reduced price elasticity of demand. As union density increases, the average manufacturing firm expands. As we show in Table 3, this increases its market share relative to the firms that did not see an increase in union density. (In addition, we see that small firms shrink, exacerbating this effect). It is a common feature of models of market power that the price elasticity of demand ϵ is a function of a firm's market share (see e.g. Atkeson and Burstein (2008)). If so, the increase in union density β will reduce the price elasticity of demand: $\frac{\delta \epsilon}{\delta \beta} < 0$.[33]

This dynamic generates an additional countervailing effect of increased union density on the price. Increased union density increases wages and therefore employment, which increases output, and this creates downward pressure on the price, as in our model above.

[31] Specifically, the bargained wage is $\bar{w} = w^* \left(1 + \beta \left(\left(\frac{\eta+1}{\eta}\right)^{\frac{\epsilon}{\epsilon+\eta}} - 1\right)\right)$.

[32] Note that the term in parentheses is always negative for $l > l^*$.

[33] As similarly argued by Lo Bello and Pesaresi (2022) for the minimum wage.

However, increased union density also reduces the price elasticity of demand, which pivots the demand curve to become steeper, creating upward pressure on the price for any given amount of output. If the effect of increased market share on the price elasticity of demand is sufficiently large, the latter effect can dominate the former such that increased union density increases the price:[34]

$$\frac{\delta p}{\delta \epsilon} = -\frac{1}{\epsilon} p \frac{1}{l} \frac{\delta l}{\delta \beta} + \frac{1}{\epsilon^2} p \ln\left(\frac{zl}{Y}\right) \frac{\delta \epsilon}{\delta \beta}. \tag{12}$$

We illustrate this possibility graphically in Figure 6 Panel B. Unionization induces a decrease in the price elasticity of demand ϵ, pivoting the marginal revenue curve to become steeper and so enabling a higher price to be charged at any given level of output. If the positive price effect is sufficiently large, the net effect of increased union density on profits may even be positive.[35]

ii. Improved product quality. An alternate possibility is that the increase in unionization improves the firm's product quality, enabling the firm to charge a higher price for a given quantity of output. This is a form of union productivity effect, but it operates through the quality margin rather than the quantity margin (in which more products of a given quality are produced per unit of labor). This could happen, for example, if unionization – either through improved worker voice, through efficiency wage mechanisms as workers are more satisfied and less absent, or through lower turnover increasing average worker skill levels – reduces production line defects, improves pre- and post-sale customer service, or improves business processes (e.g. as in nursing (Sojourner et al., 2015), in firm financial accounting quality (Bryan, 2017), or in reductions in contract disputes (Mas, 2008)). In Figure 6 Panel C, we illustrate this possibility. If this outward shift in demand is large enough relative to the increase in employment, the model can generate an outcome where

[34] Noting that $zl < Y$ by definition of aggregate output Y.

[35] Is the increase in market share that we estimate large enough to explain the increase in markups? Using the formulation of the price elasticity of demand with respect to market share in Atkeson and Burstein (2008), we can show that this is plausibly the case. Atkeson and Burstein (2008) formulate price elasticity of demand ϵ as a market-share-weighted average of the cross-market elasticity η and within-market elasticity ρ: $\epsilon = \left(\frac{1}{\rho}(1-s) + \frac{1}{\eta}s\right)^{-1}$, calibrating $\eta = 1$ and $\rho = 10$. This implies that the derivative of the markup with respect to market share $\frac{\partial \mu_i}{\partial s_i} = (\frac{1}{\eta} - \frac{1}{\rho})\mu_i^2$. Noting that $\frac{\partial \mu}{\partial s} = \frac{\partial \mu}{\partial u}(\frac{\partial s}{\partial u})^{-1}$, where u is union density, we can use our empirical estimates of the change in markup and market share as a result of union density to estimate what increase in market share $\frac{\delta s}{\delta u}$ would be needed to generate our increase in the markup. Specifically, for the largest quartile of manufacturing firms, using the average markup of 1.4 and a change in markup of 0.0178 percentage points per percentage point increase in union density, this implies that $\frac{\delta s}{\delta u} = \frac{\delta \mu}{\delta u} \frac{1}{(\frac{1}{\eta} - \frac{1}{\rho})\mu^{-2}} \approx 0.01$ percentage points. For the largest quartile of manufacturing firms, we estimate that their shares of their five-digit industry revenues (the narrowest identifier in our data) increase by 0.112 percentage points per percentage point increase in their union density. Thus, the increase in market shares we estimate is more than large enough to explain the estimated increase in markup for reasonable assumptions about product market elasticities.

prices rise alongside employment as unionization increases. If the positive price effect is sufficiently large, the net effect of increased union density on profits may even be positive. For the largest manufacturing firms in our analysis, while both mechanisms could be operating simultaneously, the reallocation of revenue shares we presented previously combined with relatively smaller shifts in worker quality at the largest firms suggests case (i) above is the more likely mechanism.

5.3 The Smallest Manufacturing Firms or Broader Private Sector

For the smallest manufacturing firms, and for the average firm in the broader private sector, our empirical results are different than for the average manufacturing firm. Specifically, we find that as union density increases the wage, employment falls, prices/markups rise, and profits do not fall. Our core model setup can explain the first three of these dynamics – if small manufacturing firms, or firms in the broader private sector, have limited monopsony power – but cannot explain the finding that profits do not fall.

To see this, let us set the elasticity of labor supply to the firm η large enough that $\kappa_w >> \left(\frac{\eta+1}{\eta}\right)^{\frac{\epsilon}{\epsilon+\eta}}$, such that the union's desired wage and the bargained wage are above w^{thresh} and the firm is constrained by its demand curve. In this case, as union bargaining power β increases and the wage is raised, employment decreases, the price increases (as the firm moves up the demand curve), and profits fall:

$$\begin{aligned}
\frac{\delta \bar{w}}{\delta \beta} &= w^* \left(\kappa_l^{\frac{-1}{\epsilon}} \left(\frac{\eta+1}{\eta} \right) - 1 \right) > 0 \\
\frac{\delta l}{\delta \beta} &= -\epsilon \bar{w}^{\epsilon-1} \left(\frac{1}{Y} \right)^{-1} z^{\epsilon-1} \left(\frac{\epsilon-1}{\epsilon} \right)^{\epsilon} \frac{\delta \bar{w}}{\delta \beta} < 0 \\
\frac{\delta p}{\delta \beta} &= -\frac{1}{\epsilon} p \left(\frac{1}{l} \frac{\delta l}{\delta \beta} \right) > 0 \\
\frac{\delta \pi}{\delta \beta} &= -l \frac{\delta w}{\delta \beta} < 0 \quad .
\end{aligned} \tag{13}$$

This is illustrated in Figure 6 Panel D.

The predictions on employment and prices are consistent with our empirical findings, but the decrease in profits is not. To explain the finding that profits do not decrease as unionization increases, it must be the case that the increase in unionization has some positive effect on productivity, either by improving the quantity or quality of output produced. Consistent with this idea, we find the largest increases in value added per worker, TFP, average worker fixed effects, labor intensification, and workplace improvements (through reductions in absences and sick leave take-up) at the smallest firms (see Tables 5 and A16).[36]

[36]Note that the market power mechanism we discuss above for the average manufacturing firm does not apply to the smallest firms in manufacturing, or to the average firm in the broader private sector, because these firms contract and their market share is reduced.

6 Discussion

6.1 Price Levels, Wage Inflation, and Purchasing Power

Who bears the cost of the price increases we estimate for manufactured goods? To assess this question, we perform a back-of-the-envelope calculation. To simplify this exercise, we make a few assumptions. First, we assume that the price pass-through in the domestic market matches that of exports at 1.9 percent (Column (2) of Panel A in Table 4). 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 firm-specific energy cost shocks as well (Fontagné et al., 2023; Lafrogne-Joussier et al., 2023).

Our first-stage estimates predict that the average firm-level union density in the manufacturing sector would have been approximately 12 percentage points lower absent the union dues subsidy expansions.[37] At a 1.9% price increase in the domestic market for manufactured goods, per percentage point increase in union density, and assuming a 12 percent overall increase in union density relative to the counterfactual, overall price levels in Norway would have been 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, suggesting that the increased union density in the manufacturing sector alone could explain approximately 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 12 percentage points, this suggests that the subsidy policy generated total wage increases of 12% between 2001 and 2014. Over this period of rapid economic growth, the

[37] We obtain this prediction by estimating our first stage model for the manufacturing sector and then 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., $\overline{D^0_{ft}}$).

index of monthly earnings in manufacturing increased by approximately 79%,[38] meaning that wage gains from local union density would explain approximately 15.2% of the total earnings gains in Norwegian manufacturing.

6.2 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 ($\approx$ 12% vs 5.9%). Overall, to the extent that these were true price increases rather than reflecting quality improvements, this would represent 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 and profit gains for a much smaller population of workers and firms in the sector.

7 Conclusion

This paper provides a comprehensive assessment of the margins along which manufacturing firms in Norway respond to increased union density. Despite higher personnel costs driven by a union wage premium, the average manufacturing firm *increases* employment and scales up production, charges higher prices in the product market, enjoys higher nominal value added per worker, and experiences no decrease in profits. For the broader private sector, we observe the opposite result: lower employment, profits, and output. We show that a stylized partial-equilibrium model that embeds monopsony labor market power, monopoly product market power, and a direct effect of unionization on firm product demand, can fully account for the results we find. The core findings from our analysis suggest a series of important societal implications.

First, the wage and employment gains suggest that the average manufacturing worker is unambiguously better off as unionization increases, though there are important distributional effects as smaller firms contract while larger firms expand. The results for firms in the broader private sector, where employment shrinks as wages rise, suggest a more conventional set of trade-offs between wages and employment opportunities.

Second, the price pass-through effect that we identify suggests that unions causally generate an increase in overall price levels with important implications for consumer purchasing power: non-union members will experience rising costs without enjoying the career benefits of membership, and union members will see part of their wage gains offset by higher living

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

costs. The distributional effects of price and wage increases across individuals are important for understanding the overall net influence of unionization on society.

Third, the non-negative profit effect implies little to no reduction in the health of the manufacturing business community in response to the rise in unionization. When combined with no significant change in the labor share of value added, the profit effect also implies that union density in this setting has a limited capacity to transfer income from shareholders to workers. The differential effects across firm size also signify 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 accelerate the reallocation of economic activity from lower- to higher-productivity firms. On the other hand, larger firms tend to have more market power. Thus, the reallocation toward larger firms may have important implications for the competitive climate of firms in the long run.

Finally, 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 play an efficiency-enhancing role in labor markets 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. On the other hand, since our results are suggestive of firms increasing prices as a result of increased product market power, the net effect on total market efficiency is unclear.

An important question that emerges from our analysis relates to the long-term dynamics of the effects we find. Specifically, does the reallocation of inputs and market shares to larger and more unionized firms provide them with sufficient wage-setting power to diminish the union wage premium effect in the long run, or are workers able to maintain their increased bargaining power in wage negotiations in the future? The answer to this question have extremely important implications for understanding the dynamic effects of unions in labor markets, and we see this as a promising avenue for future research in the field

References

Abadie, Alberto, Susan Athey, Guido W Imbens, and Jeffrey M Wooldridge. 2023. "When Should You Adjust Standard Errors for Clustering?" *The Quarterly Journal of Economics*, 138(1): 1–35.

Atkeson, Andrew, and Ariel Burstein. 2008. "Pricing-to-Market, Trade Costs, and International Relative Prices." *American Economic Review*, 98(5): 1998–2031.

Barth, Erling, Alex Bryson, and Harald Dale-Olsen. 2020. "Union Density Effects on Productivity and Wages." *The Economic Journal*, 130(631): 1898–1936.

Barth, Erling, and Kristine Nergaard. 2015. "Kollektive Partsforhold: Status Quo Eller Endring?" In *Norsk arbeidsliv i turbulente tider*. ed. by Harald Dale-Olsen 83–104.

Berman, Nicolas, Philippe Martin, and Thierry Mayer. 2012. "How Do Different Exporters React to Exchange Rate Changes?" *The Quarterly Journal of Economics*, 127(1): 437–492.

Bhuller, Manudeep, Karl Ove Moene, Magne Mogstad, and Ola L. Vestad. 2022. "Facts and Fantasies about Wage Setting and Collective Bargaining." *Journal of Economic Perspectives*, 36(4): 29–52, URL: https://www.aeaweb.org/articles?id=10.1257/jep.36.4.29, DOI: http://dx.doi.org/10.1257/jep.36.4.29.

Blandhol, Christine, Magne Mogstad, Peter Nilsson, and Ola L Vestad. 2020. "Do employees benefit from worker representation on corporate boards?".

Bryan, David B. 2017. "Organized Labor, Audit Quality, and Internal Control." *Advances in Accounting*, 36 11–26.

Bryson, Alex. 2002. "The Union Membership Wage Premium: An Analysis Using Propensity Score Matching."

Caldwell, Sydnee, and Oren Danieli. 2018. "Outside Options in the Labor Market." *Working paper*.

Card, David, and Sara De La Rica. 2006. "Firm-Level Contracting and the Structure of Wages in Spain." *ILR Review*, 59(4): 573–592.

Cengiz, Doruk, Arindrajit Dube, Attila Lindner, and Ben Zipperer. 2019. "The Effect of Minimum Wages on Low-Wage Jobs." *Quarterly Journal of Economics*, 134(3): 1405–1454.

Dahl, Gordon B, Andreas Ravndal Kostøl, and Magne Mogstad. 2014. "Family Welfare Cultures." *The Quarterly Journal of Economics*, 129(4): 1711–1752.

Dale-Olsen, Harald, Marte Strøm, Kjersti Misje Østbakken, and Erling Barth. 2018. "Avtaleformer, lønnsvekst og lønnsspredning." *Rapport–Institutt for samfunnsforskning.*

De Loecker, Jan, and Frederic Warzynski. 2012. "Markups and Firm-Level Export Status." *American Economic Review*, 102(6): 2437–2471.

DiNardo, John, and David S Lee. 2004. "Economic Impacts of New Unionization on Private Sector Employers: 1984–2001." *The Quarterly Journal of Economics*, 119(4): 1383–1441.

Dippel, Christian, Andreas Ferrara, and Stephan Heblich. 2020. "Causal Mediation Analysis in Instrumental-Variables Regressions." *The Stata Journal*, 20(3): 613–626.

Dobbelaere, Sabien, Boris Hirsch, Steffen Müller, and Georg Neuschaeffer. 2020. "Organised Labour, Labour Market Imperfections, and Employer Wage Premia."

Dodini, Samuel, Michael F Lovenheim, Kjell G Salvanes, and Alexander Willén. 2023a. "Monopsony, Job Tasks, and Labor Market Concentration."Technical report, National Bureau of Economic Research.

Dodini, Samuel, Kjell G Salvanes, and Alexander Willén. 2022. "The Dynamics of Power in Labor Markets: Monopolistic Unions Versus Monopsonistic Employers." *CEPR Discussion Paper No. DP16834*.

Dodini, Samuel, Kjell G Salvanes, Alexander Willén, and Li Zhu. 2023b. "The Career Effects of Union Membership." *NHH Dept. of Economics Discussion Paper*(12): .

Dustmann, Christian, Attila Lindner, Uta Schönberg, Matthias Umkehrer, and Philipp Vom Berge. 2022. "Reallocation Effects of the Minimum Wage." *The Quarterly Journal of Economics*, 137(1): 267–328.

Farber, Henry, Daniel Herbst, Ilyana Kuziemko, and Suresh Naidu. 2021. "Unions and Inequality Over the Twentieth Century: New Evidence from Survey Data." *Quarterly Journal of Economics*, 136(3): , p. 1325–1385.

Fernandez, Viviana. 2018. "Price and Income Elasticity of Demand for Mineral Commodities." *Resources Policy*, 59 160–183.

Finnigan, Ryan, and Jo Hale. 2018. "Working 9 to 5? Union Membership and Work Hours and Schedules." *Social Forces*, 96(4): 1541–1568.

Fontagné, Lionel, Philippe Martin, and Gianluca Orefice. 2023. "The Many Channels of Firm's Adjustment to Energy Shocks: Evidence from France." *CESifo Working Paper No. 10548.*

Fortin, Nicole, Thomas Lemieux, and Neil Lloyd. 2022. "Right-to-Work Laws, Unionization, and Wage Setting." *NBER working paper 30098.*

Frandsen, Brigham R. 2021. "The Surprising Impacts of Unionization: Evidence from Matched Employer-Employee Data." *Journal of Labor Economics*, 39(4): 861–894.

Frandsen, Brigham, and Michael Webb. forthcoming. "Public Employee Pensions and Collective Bargaining Rights: Evidence from State and Local Government Finances." *Journal of Law, Economics & Policy.*

Freeman, Richard B, and James L Medoff. 1984. "What Do Unions Do?" *Industrial & Labor Relations Review*, 38, p. 244.

Hagedorn, Jenn, Claudia Paras, Howard Greenwich, and Amy Hagopian. 2016. "The Role of Labor Unions in Creating Working Conditions That Promote Public Health." *American Journal of Public Health.*

Harasztosi, Peter, and Attila Lindner. 2019. "Who Pays for the Minimum Wage?" *American Economic Review*, 109(8): 2693–2727.

Lafrogne-Joussier, Raphaël, Julien Martin, and Isabelle Mejean. 2023. "Cost Pass-Through and the Rise of Inflation." *Unpublished Manuscript.*

Lee, David S, and Alexandre Mas. 2012. "Long-Run Impacts of Unions on Firms: New Evidence from Financial Markets, 1961–1999." *The Quarterly Journal of Economics*, 127(1): 333–378.

Lo Bello, Salvatore, and Lorenzo Pesaresi. 2022. "Equilibrium Effects of the Minimum Wage: The Role of Product Market Power."

Mas, Alexandre. 2008. "Labour Unrest and the Quality of Production: Evidence from the Construction Equipment Resale Market." *The review of economic studies*, 75(1): 229–258.

NLRB. 2022. "Union Election Petitions Increase 57Fiscal Year 2022." April, URL: https://www.nlrb.gov/news-outreach/news-story/union-election-petitions-increase-57-in-first-half-of-fiscal-year-2022, (Accessed on Sept 1, 2023).

Park, Tae-Youn, Eun-Suk Lee, and John Budd. 2019. "What Do Unions Do for Mothers? Paid Maternity Leave Use and the Multifaceted Roles of Labor Unions." *ILR Review*, 72(3): 662–692.

Pinto, Rodrigo, Christian Dippel, Robert Gold, and Stephan Heblich. 2019. "Mediation Analysis in IV Settings with a Single Instrument." *url: https://www. anderson. ucla. edu/faculty_pages/christian. dippel/IVmediate. pdf.*

Prager, Elena, and Matt Schmitt. 2021. "Employer Consolidation and Wages: Evidence from Hospitals." *American Economic Review*, 111(2): 397–427.

Schubert, Gregor, Anna Stansbury, and Bledi Taska. 2020. "Monopsony and Outside Options." *Working paper.*

Shojaeddini, Ensieh, Elisa Alonso, and Nedal Nassar. 2023. "Estimating Price Elasticity of Demand for Mineral Commodities in the Face of Surging Demand." *Working Paper.*

Sojourner, Aaron J, Brigham R Frandsen, Robert J Town, David C Grabowski, and Min M Chen. 2015. "Impacts of Unionization on Quality and Productivity: Regression Discontinuity Evidence from Nursing Homes." *ILR Review*, 68(4): 771–806.

Steen, Frode, and Kjell G Salvanes. 1999. "Testing for Market Power using a Dynamic Oligopoly Model." *International Journal of Industrial Organization*, 17(2): 147–177.

Wooldridge, Jeffrey M. 2010. *Econometric Analysis of Cross Section and Panel Data.*: MIT press.

Xie, Jinghua, Henry W Kinnucan, and Øystein Myrland. 2009. "Demand Elasticities for Farmed Salmon in World Trade." *European Review of Agricultural Economics*, 36(3): 425–445.

Yeh, Chen, Claudia Macaluso, and Brad Hershbein. 2022. "Monopsony in the US labor market." *American Economic Review*, 112(7): 2099–2138.

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)	(2)	(3)
	Union Density	Log(Average Earnings)	Log(Non-Wage Costs)
Net dues (1,000 Kr)	-16.427***	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)	Log(TFP)	Log(Industry Revenue Shares)
Union Density	0.0225*	-0.00638	-0.00397	0.00517***	0.0182***
	(0.0123)	(0.00400)	(0.00257)	(0.00146)	(0.00660)
Observations	*34,127*	*43,559*	*43,559*	*43,559*	*43,559*
Dep Var Mean	*7.40*	*0.226*	*0.0723*	*0.0072*	*-6.440*

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)
	Firm-Level Avg. Log(Price Per KG)	Product-Level Avg. Log(Price Per KG)	Product-Level Avg. Log(Price Per KG)
Union Density	0.0232	0.0161	0.0193
	(0.0153)	(0.00715)**	(0.00941)**
	[0.0119]*	[0.00669]**	[0.00864]**
Observations	21,789	244,322	157,467
Firm FE	X	X	
Industry Group by Year	X		
Product-by-Year FE		X	X
Firm-by-Product FE			X
Panel B			
	Firm-Level Price Index	Export Share of Revenue	% Revenues, Above Median Priced
Union Density	0.0348	-0.00281	0.0140
	(0.0136)***	(0.00150)*	(0.00617)**
	[0.0108]***	[0.000876]***	[0.00466]***
Observations	21,687	21,806	22,134
Firm FE	X	X	X
Industry Group by Year	X	X	X

Clustered standard errors in parentheses; Huber-White robust standard errors in brackets
*** 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. Panel B Column (3) calculates the share of total export revenues coming via products that are above the median per-kilogram price in the distribution of all exported products ever sold by the firm. Standard errors clustered at the firm level in the firm-level estimates and the firm-product level in the firm-product estimates.

Table 5: Heterogeneity by Firm Size Quartile

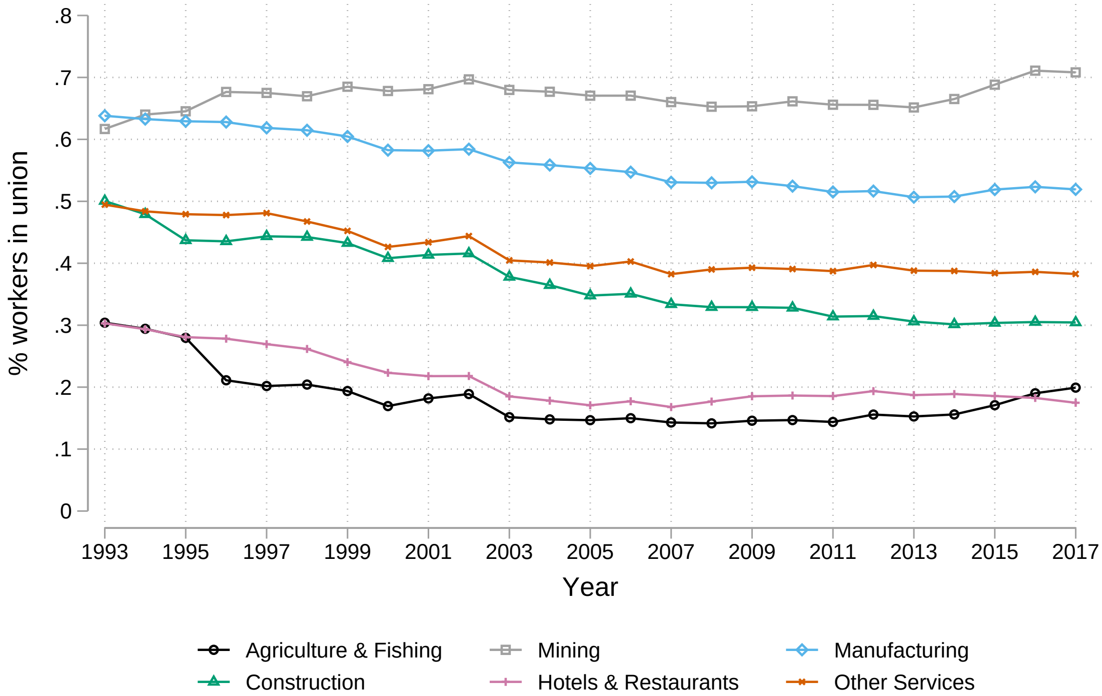
Panel A	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Log(Avg Earnings)	Log(Workers)	Log(Personnel Costs)	Log(Capital Costs)	Log(Material Costs)	Log(Sales)	Log(Value Added Per Worker)
Union Density in Quartile 1	0.0131***	-0.0239***	-0.00311	-0.00753	-0.0169***	-0.00657	0.0241***
	(0.00241)	(0.00503)	(0.00504)	(0.00536)	(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(Exit)	Log(Industry Revenue Shares)
Union Density in Quartile 1	0.00186**	-0.0423	0.0199***	-0.0149	0.00663	-0.000212	-0.00170
	(0.000909)	(0.0289)	(0.00754)	(0.0102)	(0.0138)	(0.00287)	(0.00670)
Union Density in Quartile 2	0.00215**	-0.0384	0.0187***	-0.0181*	0.0165	-0.00273	0.00891
	(0.0008)	(0.0267)	(0.0070)	(0.0095)	(0.0125)	(0.0027)	(0.0062)
Union Density in Quartile 3	0.00249***	-0.0377	0.0176***	-0.0211**	0.0231*	-0.00389	0.0172***
	(0.0008)	(0.0257)	(0.0067)	(0.0092)	(0.0122)	(0.0026)	(0.0060)
Union Density in Quartile 4	0.00283***	-0.0395	0.0178***	-0.0247***	0.0296**	-0.00487*	0.0258***
	(0.0008)	(0.0271)	(0.0065)	(0.0090)	(0.0119)	(0.0025)	(0.0058)
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)).

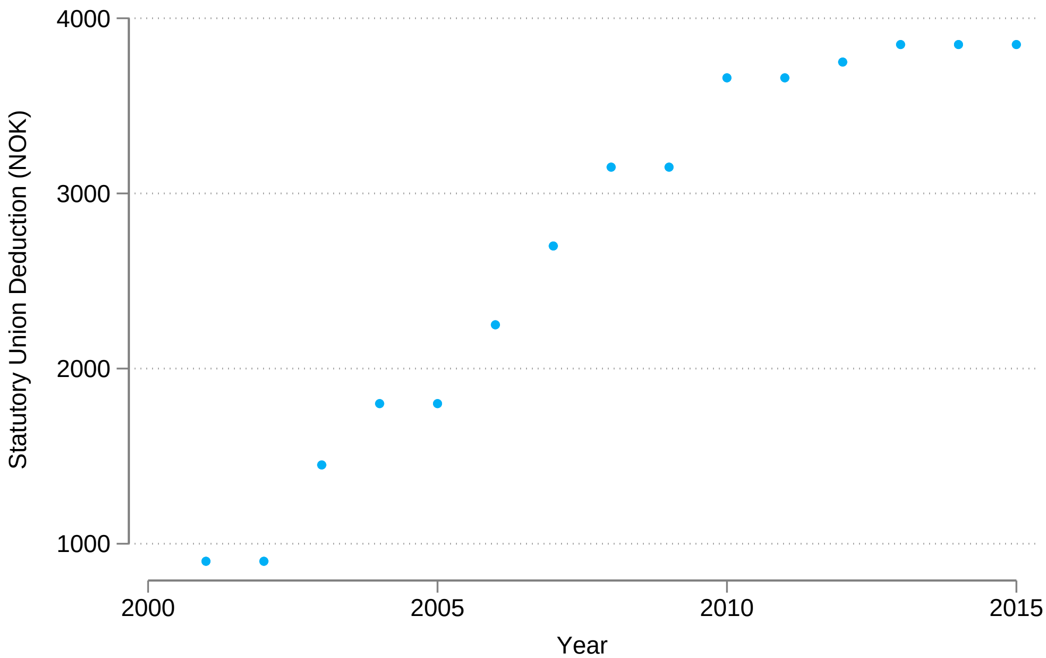
Figures

Figure 1: Union Membership Rate by Sector over Time



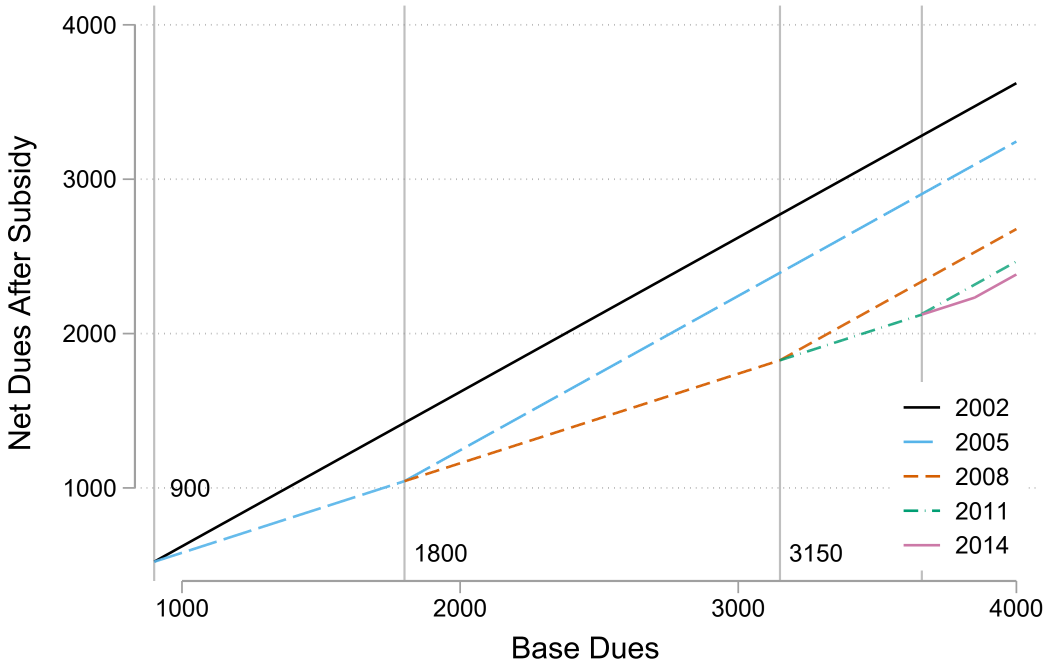
Source: Authors' calculations of Norwegian registry data from 1993 to 2017.

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

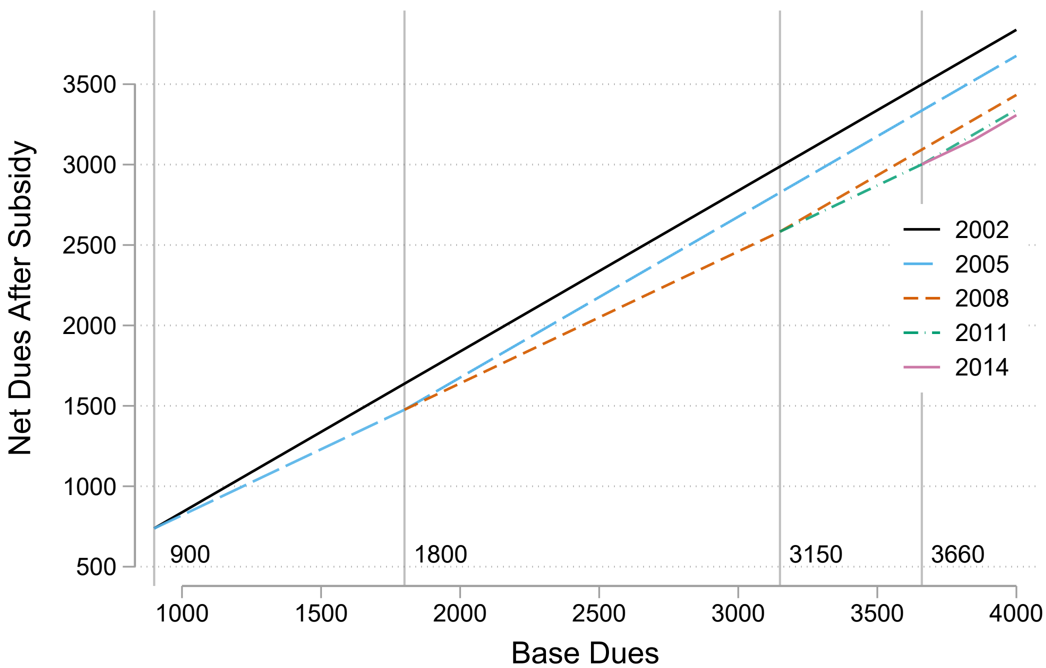


Source: Authors' presentation of maximum tax deductions for union dues in Norway.

Figure 3: Net Union Dues After Subsidy vs Base Dues Over Time
Panel A: Assuming a 42% Tax Rate



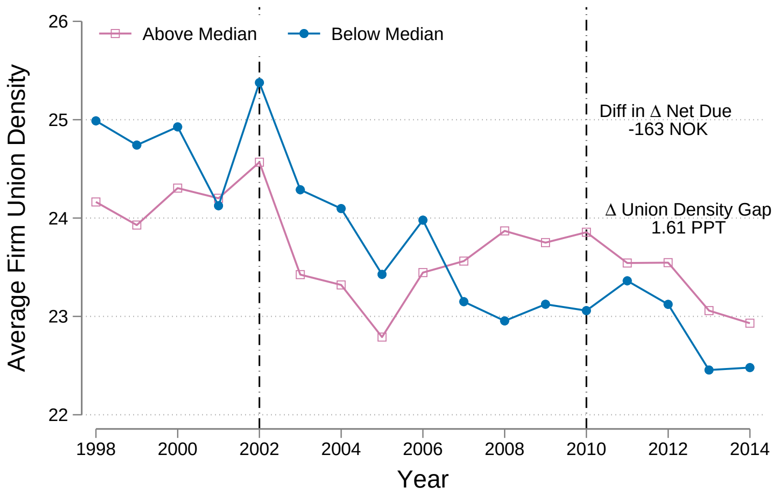
Panel B: Assuming a 28% Tax Rate



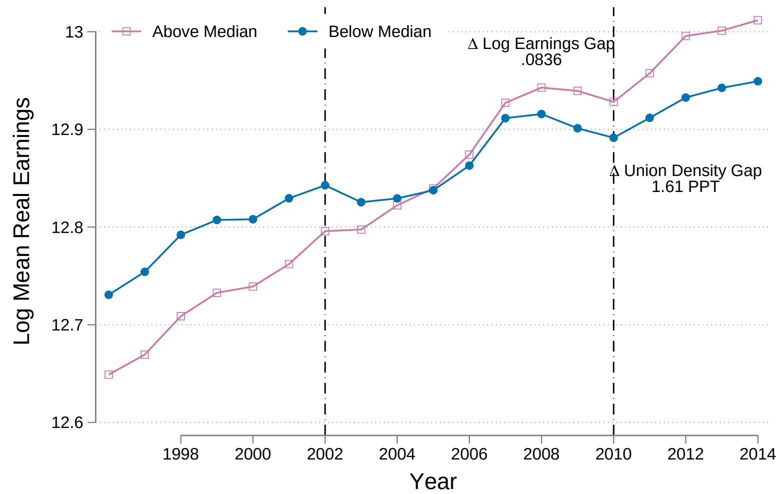
Source: Authors' illustration of the legislated maximum union dues deduction in Norway over time.
Notes: Panel A assumes a tax rate of 42%, and Panel B assumes 28%. This is the average top marginal rate over the 2001-2014 time period. Vertical lines at 900, 1800, 3150, and 3660 mark the maximum deductions at different years in Norway.

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

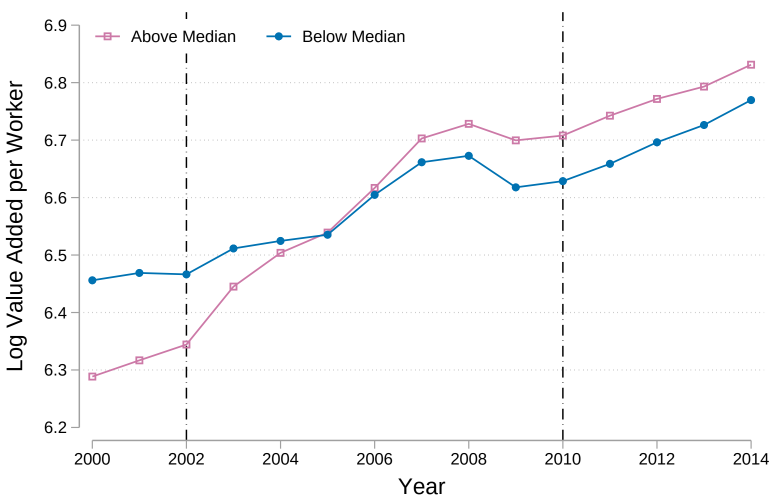
Panel A: Firm Union Density



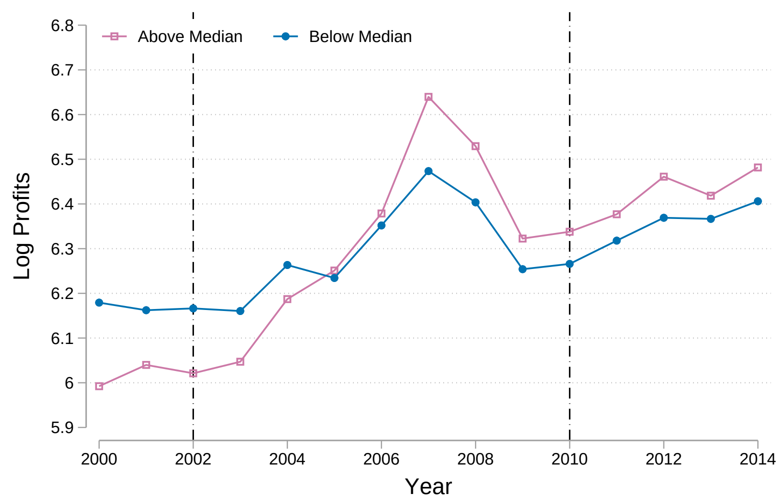
Panel B: Firm Log Average Annual Earnings



Panel C: Firm Value Added Per Worker



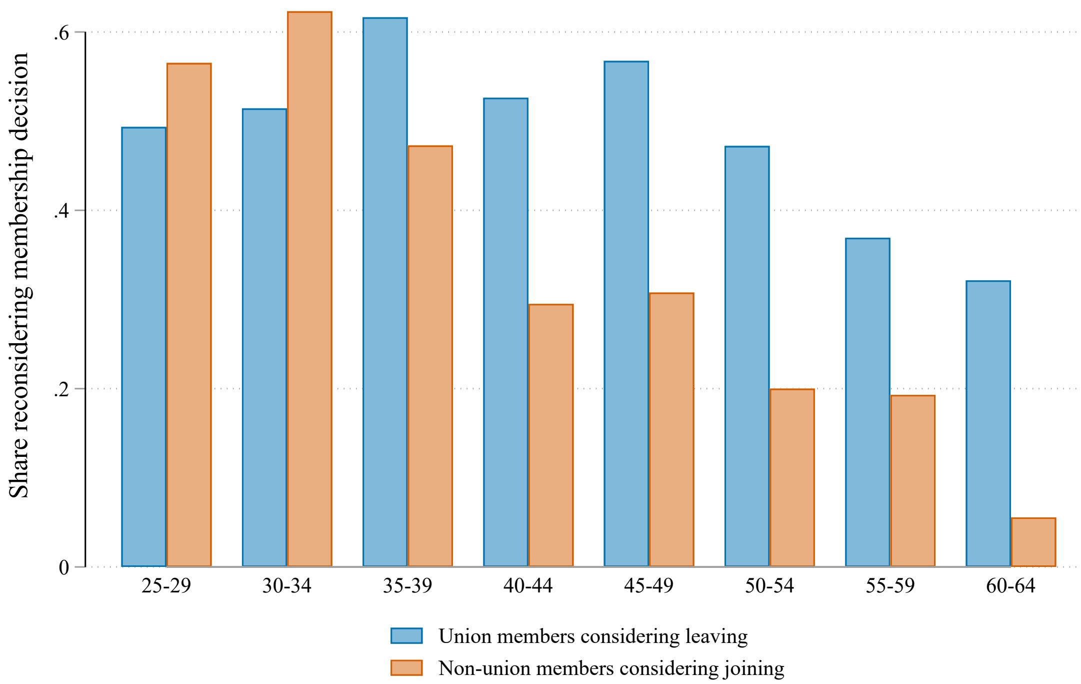
Panel D: Firm Log Profits



Source: Authors' calculations of Norwegian registry data.

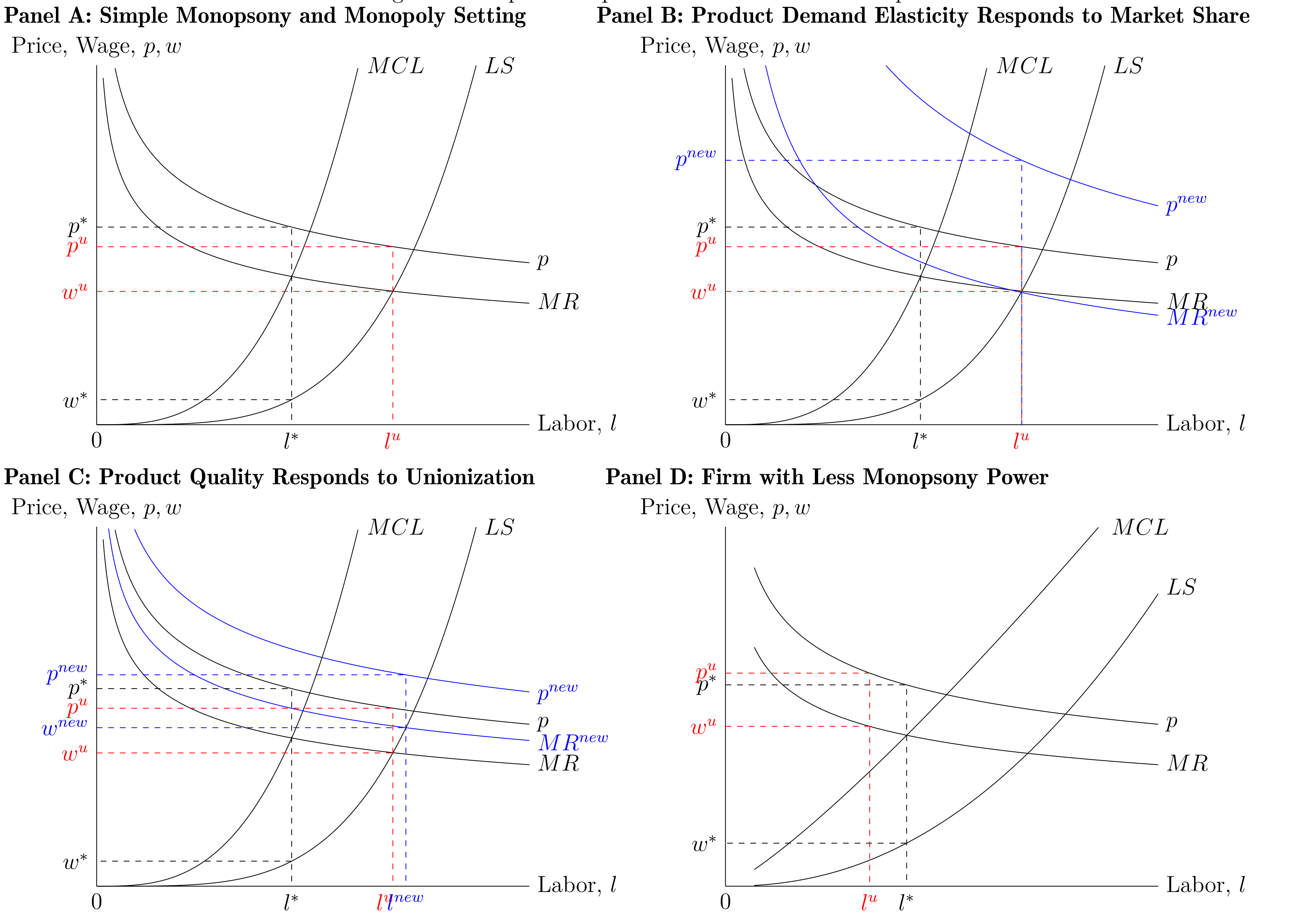
Notes: Trends are residualized on firm fixed effects for our sample of manufacturing firms. "Above-median" corresponds to firms whose reductions in net union dues (after subsidies) were above the median value, while "below-median" corresponds to firms with smaller reductions. Panels C and D are based 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. (2023b).
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.

Figure 6: Graphical Representations of Model Concepts



Source: Authors' graphical demonstration of key model dynamics.

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

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: 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. Standard errors clustered at the firm level.
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: Main Result Incorporating Local Labor Market - Industry Exposure to Instrument

Panel A

	(1) Log(Average Earnings)	(2) Log(Personnel Costs)	(3) Log(Workers)	(4) Log(Capital Costs)	(5) Log(Sales)
Union Density	0.00963***	0.0199***	0.0110**	0.00750	0.0139***
	(0.00193)	(0.00557)	(0.00511)	(0.00519)	(0.00531)
Local Exposure	0.00638	0.00296	-0.00156	0.0218*	0.00170
	(0.00470)	(0.0123)	(0.0112)	(0.0120)	(0.0118)
Observations	43,559	43,559	43,559	43,559	43,559

Panel B

	(1) Labor Share of Costs	(2) Labor Share of Value Added	(3) Log(Value Added Per Worker)	(4) Markup	(5) Markdown
Union Density	0.00277***	-0.0397	0.00992***	0.0190***	-0.0226**
	(0.000848)	(0.0296)	(0.00326)	(0.00687)	(0.00929)
Local Exposure	-0.000647	0.0481	0.00188	-0.00492	-0.00943
	(0.00206)	(0.0607)	(0.00951)	(0.0209)	(0.0241)
Observations	43,559	43,559	43,519	43,559	43,559

Panel C

	(1) Log(Profits)	(2) Prob(Profits<0)	(3) Prob(Exit)	(4) TFP	(5) Log(Industry Revenue Shares)
Union Density	0.0198	-0.00634	-0.00316	0.00566***	0.0163***
	(0.0123)	(0.00397)	(0.00252)	(0.00148)	(0.00625)
Local Exposure	0.00885	0.00869	-0.0104	-0.00675*	-0.00157
	(0.0338)	(0.0102)	(0.00648)	(0.00388)	(0.0177)
Observations	34,127	43,559	43,559	43,541	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 correspond to those in Table 3 but with the added regressor of each firm's exposure to other local firms' instruments. This is defined as the average net union dues for every firm in the local labor market - industry cell (in 1,000s NOK) excluding the firm's own instrument value. That this regressor is not statistically or economically meaningful and does not alter the main estimates suggests that direct spillovers from other firms' exposure to the instrument are not an explanatory factor in our analysis.

Table A3: Correlation Between 2002 Outcomes and Instrument Exposure

	Raw Correlations (1)	Conditional Correlations (2)
Log(Avg Earnings)	-0.122	-0.1260
Log(Personnel Costs)	-0.0131	-0.0306
Log(# Workers)	0.0139	-0.0038
Log(Capital Costs)	0.0080	-0.0052
Log(Materials)	0.1090	0.0747
Log(Sales)	0.0521	0.0155
Labore Share of Value Added	0.0041	0.0008
Log(Firm VA Per Worker)	-0.0721	-0.0903
Log(Profit)	0.0139	0.0045
Pr(Profit<=0)	-0.0101	-0.0172
N	5,147	5,147

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: Column (1) raw correlations correspond to the reduction in net dues and each firm outcome in 2002 (baseline). Column (2) values are first residualized on indicators for manufacturing industry group for each outcome before calculating the correlation between the variables.

Table A4: Tests of Pre-2003 Trends

Panel A: Interacted Fixed Effects Regression			
	(1) Log(Avg Real Earnings)	(2) Log(Value Added Per Worker)	(3) Log(Profits)
Above-Median Reduction Difference	0.00393*	0.00286	-0.00296
	(0.00219)	(0.00724)	(0.0230)
Observations	9,825	9,891	9,220
R-squared	0.940	0.807	0.880

Panel B: Separate Sample Regression			
Time Slope, Above-Median	0.030	0.027	0.008
Time Slope, Below-Median	0.029	0.014	0.002
Slope Difference	0.001	0.013	0.007
P-value of Difference	0.706	0.138	0.766

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

Source: Authors' calculations of Norwegian registry data from 2000 to 2014.
Notes: Panel A regressions measure the difference in linear trends in the 2000-2002 pre-reform period for firms with above-median vs below-median reductions in firm-level net union dues from 2003-2010, as in Figure 4. Models account for firm fixed effects and industry group trends for firms present in the data in 2003 and 2010.
Panel B regressions measure the slope of the 2000-2002 linear time trends within firms (by including a firm fixed effect) separately for firms with above-median reductions and below-median reductions in net union dues. The test for equivalence is done by jointly estimating the models via Seemingly Unrelated Regression.

Table A5: 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 A6: 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. Columns (5) and (6) represent the probability of having any long-term debt or debt to credit institutions (i.e. the extensive margin).

Table A7: 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	0.0110	0.00853	0.0159	0.0119	0.0113	0.0136
	(0.00277)***	(0.00713)	(0.00710)**	(0.00748)	(0.00806)	(0.00693)**
	[0.00166]***	[0.00406]**	[0.00393]***	[0.00445]***	[0.00468]***	[0.00390]***
Observations	21,789	21,789	21,789	21,789	21,789	21,789

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	0.0177	0.0169	-0.0745	0.0287	-0.00628	8.16e-06
	(0.00743)**	(0.00536)***	(0.0569)	(0.0179)	(0.00545)	(0.00310)
	[0.00427]***	[0.00369]***	[0.0558]	[0.0129]**	[0.00431]	[0.00282]
Observations	21,789	21,695	21,789	16,487	21,789	21,789

Clustered standard errors in parentheses; Huber-White robust standard errors in brackets.
*** 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 A8: 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	0.0283	0.0102	0.0174	0.0141
	(0.0165)*	(0.0194)	(0.00998)*	(0.00941)
	[0.0130]**	[0.0169]	[0.00942]*	[0.00889]
Observations	17,762	16,981	97,465	173,845
Firm FE	X	X	X	X
Industry Group by Year	X	X		
Product-by-Year FE			X	X

Clustered standard errors in parentheses; Huber-White robust standard errors in brackets
*** 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 A9: Export Price Changes, by Export Share of Firm Revenue

VARIABLES	(1) Log(Price Per KG)	(2) Log(Price Per KG)
Union Density	0.0257	-0.00470
	(0.0168)	(0.0119)
	[0.0133]*	[0.00848]
Observations	16,772	4,704
Export Share of Firm Revenue	0-25	>25

Clustered standard errors in parentheses; Huber-White robust standard errors in brackets
*** 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. Separate regressions are estimated for firms for whom export revenues make up less than 25% of total revenues (column 1), and for firms for whom export revenues make up more than 25% of total revenues (column 2).

Table A10: Heterogeneity by Firm Size Quartile: Additional Outcomes

	(1)	(2)	(3)	(4)	(5)
	Pr(Profit<0)	Log(TFP)	Log(Avg Hours)	Pr(Any Sick Days)	Log(# Sick Days)
Union Density in Quartile 1	-0.00565	0.00790***	0.00186**	-0.00702**	-0.0247**
	(0.00443)	(0.00102)	(0.000785)	(0.00337)	(0.0119)
Union Density in Quartile 2	-0.00626	0.00594***	0.00109	-0.000891	-0.00872
	(0.0041)	(0.00090)	(0.0007)	(0.0031)	(0.0109)
Union Density in Quartile 3	-0.00634	0.00517***	0.00081	0.00191	0.00528
	(0.0040)	(0.00090)	(0.0007)	(0.0031)	(0.0108)
Union Density in Quartile 4	-0.00653*	0.00472***	0.000922	0.00254	0.0216**
	(0.0039)	(0.00090)	(0.0007)	(0.003)	(0.0105)
Sample Mean	0.226		3.558	0.918	5.258
Observations	43,559	43,541	43,559	43,559	37,443

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 negative profits (Column (1)).

Table A11: Heterogeneity by Firm Size Quartile: Exporter Analysis

	(1) Firm-Level Log(Price Per KG)	(2) Firm-Level Log(Total Weight)	(3) Firm-Level Log(Total Value)	(4) Product-Level Log(Price Per KG)	(5) Product-Level Log(Total Weight)	(6) Product-Level Log(Total Value)	(7) Export Share of Revenue
Union Density in Quartile 1	0.0305	-0.0445	-0.0140	0.0190	-0.0247	-0.00573	-0.00351
	(0.0172)*	(0.0318)	(0.0272)	(0.00923)**	(0.0175)	(0.0146)	(0.00178)**
	[0.0134]**	[0.0223]**	[0.0183]	[0.00863]**	[0.0160]	[0.0132]	[0.00103]***
Union Density in Quartile 2	0.0254	-0.0271	-0.00173	0.0173	-0.0177	-0.000400	-0.00329
	(0.0159)	(0.0292)	(0.0250)	(0.0079)**	(0.0149)	(0.0124)	(0.0016)*
	[0.0124]**	[0.0206]	[0.0169]	[0.0073]**	[0.0136]	[0.0112]	[0.0009]***
Union Density in Quartile 3	0.0225	-0.0147	0.00776	0.0152	-0.0140	0.00119	-0.00278
	(0.0152)	(0.0279)	(0.024)	(0.0072)**	(0.0137)	(0.0114)	(0.0015)*
	[0.0119]*	[0.0197]	[0.0161]	[0.0068]**	[0.0125]	[0.0104]	[0.0009]***
Union Density in Quartile 4	0.0219	-0.00441	0.0175	0.0153	-0.0120	0.00330	-0.00245
	(0.0145)	(0.0266)	(0.0228)	(0.0067)**	(0.0127)	(0.0105)	(0.0014)*
	[0.0113]*	[0.0188]	[0.0154]	[0.0063]**	[0.0116]	[0.00960]	[0.0008]***
Observations	21,789	21,789	21,789	244,322	244,322	244,322	21,806

Clustered standard errors in parentheses; Huber-White robust standard errors in brackets
*** 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 for exporting firms. 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.

Table A12: 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	0.00985***	0.0117**	0.0108***	0.0102*	0.00550	0.0174***	0.0152***
	(0.00198)	(0.00531)	(0.00335)	(0.00528)	(0.00625)	(0.00656)	(0.00549)
UD x >Median Occ Empl. Share	-6.00e-05	0.00168***	-8.81e-06	0.00139***	0.00155***	-0.000530*	0.00142***
	(7.34e-05)	(0.000168)	(0.000146)	(0.000200)	(0.000221)	(0.000284)	(0.000187)
Union Density	0.00989***	0.0107**	0.0108***	0.00945*	0.00461	0.0177***	0.0143***
	(0.00199)	(0.00526)	(0.00337)	(0.00526)	(0.00626)	(0.00662)	(0.00546)
UD x >Median Ind. Empl. Share	-3.91e-05	0.00168***	-1.13e-06	0.00161***	0.00177***	-0.000601**	0.00154***
	(7.90e-05)	(0.000174)	(0.000155)	(0.000218)	(0.000237)	(0.000300)	(0.000197)
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 A13: 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 A14: 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 A15: 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.

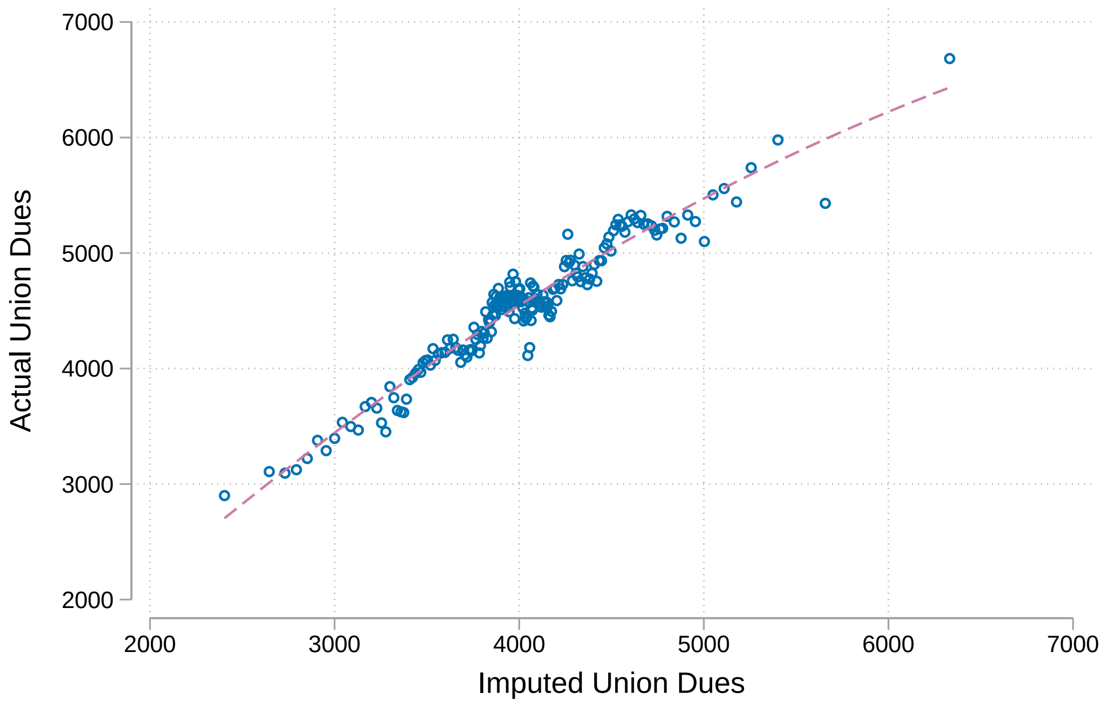
Table A16: Worker Composition by Firm Size

Panel A	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Separation Rate	Hire Rate	Age	Female	BA+ Share	< HS Share	Industry Experience
Union Density in Quartile 1	-0.0111***	-0.00549**	-0.0246	-0.00384***	-0.00305**	-0.00214	-0.125***
	(0.00234)	(0.00280)	(0.0487)	(0.00127)	(0.00120)	(0.00139)	(0.0355)
Union Density in Quartile 2	-0.0083***	-0.00134	-0.0632	-0.00299**	-0.00282**	-0.00164	-0.144***
	(0.0022)	(0.0026)	(0.045)	(0.0012)	(0.0011)	(0.0013)	(0.0327)
Union Density in Quartile 3	-0.00747***	0.000705	-0.0884**	-0.00256**	-0.00271**	-0.00152	-0.160***
	(0.0021)	(0.0026)	(0.0434)	(0.0011)	(0.0011)	(0.0012)	(0.0317)
Union Density in Quartile 4	-0.00697***	0.00222	-0.111***	-0.00231**	-0.00272***	-0.00133	-0.171***
	(0.0020)	(0.0025)	(0.0415)	(0.0011)	(0.0011)	(0.0012)	(0.0304)
Observations	43,559	43,559	43,559	43,559	43,559	43,559	43,559
Panel B							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Worker FE	Worker Occ x Ind FE	New Hire FE	New Hire Occ x Ind FE	Age <25 Share	25-35 Share	35-45 Share
Union Density in Quartile 1	0.00719***	0.00372***	0.0122***	0.00510**	0.00130	-0.00331*	0.00362
	(0.00148)	(0.00100)	(0.00379)	(0.00218)	(0.00101)	(0.00193)	(0.00232)
Union Density in Quartile 2	0.00452***	0.00268***	0.010***	0.00437**	0.00191**	-0.00209	(0.00289)
	(0.0013)	(0.0009)	(0.0036)	(0.0021)	(0.0009)	(0.0018)	0.00220
Union Density in Quartile 3	0.00319**	0.00211**	0.00888**	0.00424**	0.00229**	-0.00154	(0.00277)
	(0.0013)	(0.0009)	(0.0035)	(0.0020)	(0.0009)	(0.0017)	0.00210
Union Density in Quartile 4	0.00228*	0.00159*	0.00853**	0.00398**	0.00258***	-0.000991	(0.00257)
	(0.0013)	(0.0009)	(0.0034)	(0.0020)	(0.0009)	(0.0017)	0.00200
Observations	43,559	43,558	30,524	30,528	43,559	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. 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. 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. 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. Standard errors clustered at the firm level.

Figure A1: Actual Union Dues vs Imputed Union Dues



Source: Authors' calculations of Norwegian registry data from 2001 to 2014.
Notes: Figure presents actual union dues paid vs imputed union dues ($\overline{D^0_{ft}}$) and accounts for year fixed effects.

B Markup and Markdown Estimation

This section outlines in more detail our procedure for separately estimating each firm's product market markups and labor market markdowns, following Yeh et al. (2022).

First, we estimate output elasticities through the IO production function approach (e.g., De Loecker and Warzynski (2012)). Following the notation conventions of Yeh et al. (2022), this is a three-step approach that begins by relating firm output (revenues) to inputs through the following expression:

$$y_{ft} = f(x_{ft}; \beta) + \omega_{ft} + \epsilon_{ft}, \tag{14}$$

in which x_{ft} is a vector containing first- and second-order polynomials and interaction terms between each component of $\tilde{x}_{ft} = (k_{ft}, l_{ft}, m_{ft})'$. This is a vector of firm f's log input costs with respect to capital (k_{ft}), labor (l_{ft}), and materials (m_{ft}), in year t. The parameter 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 (except capital, which can be considered fixed in the short run), which is defined as $\mathbf{z}_{ft}$. This instrumental approach is designed to address any potential endogeneity in the correlation between the unobserved productivity parameter (ω_{ft}) and firm input choices.

The estimation process is in three steps, which we perform separately for each major industry. First, we estimate a third-order polynomial of y_{ft} on x_{ft} and year dummies (to account for systematic differences across time) to acquire parametrically flexible estimates of output while hedging against measurement error that may occur in higher-order interactions of the inputs. Second, we construct productivity estimates, $\omega_{ft}(\tilde{\beta}) = \varphi_{ft} - f(x_{ft}; \tilde{\beta})$, where φ_{ft} is a measure of unobserved total factor productivity. We then estimate a third-order polynomial of productivity on lagged productivity to obtain productivity shocks $\xi_{ft}(\tilde{\beta})$. These shocks help us separately identify the elasticities of each component. Third, we obtain $\hat{\beta}$ of production function parameters through a generalized method of moments system induced by moment conditions involving the $\mathbf{z}_{ft}$ set of instruments: $E(\xi_{ft}(\tilde{\beta}) * \mathbf{z}_{ft}) = \mathbf{0}_{Z\times 1}$.

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 divided by the input share of revenue ($\mu_{ft} = \beta_{ft} \frac{P_{ft} * Q_{ft}}{P^V_{ft} * Q^V_{ft}}$) 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 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.

C 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 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 dues at each firm and condition on year by industry group fixed effects. We then estimate this for different subgroups of firms.

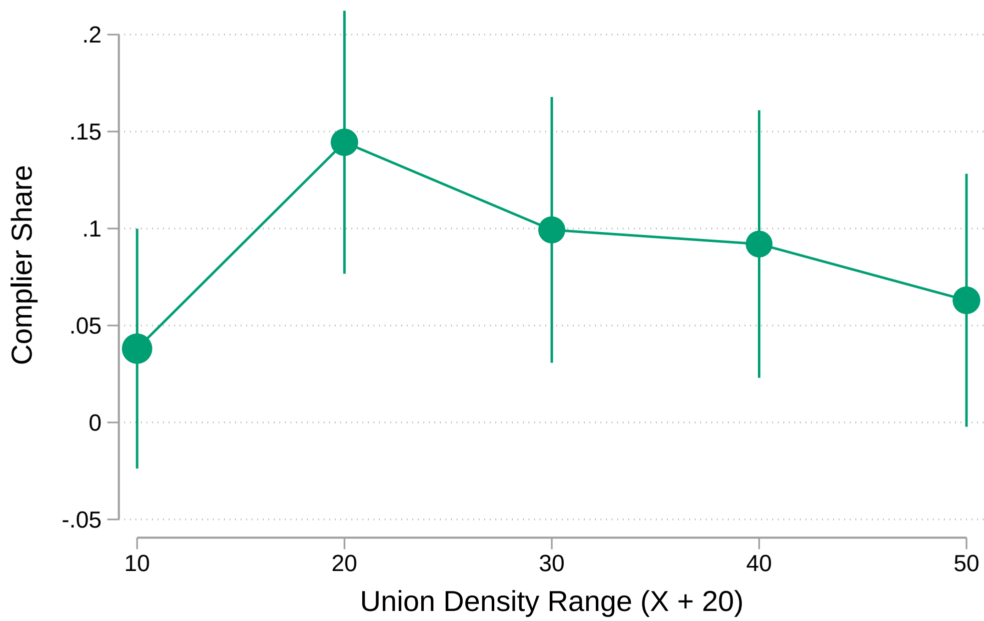
Following Dahl et al. (2014), we adapt our continuous instrument by estimating this adapted "first stage" and comparing predicted treatment take-up (having a positive change in union density in this setup) at the sample's lowest measured three-year change in net union dues (the 1st percentile) versus the highest measured change in net union dues (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 scaled 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.

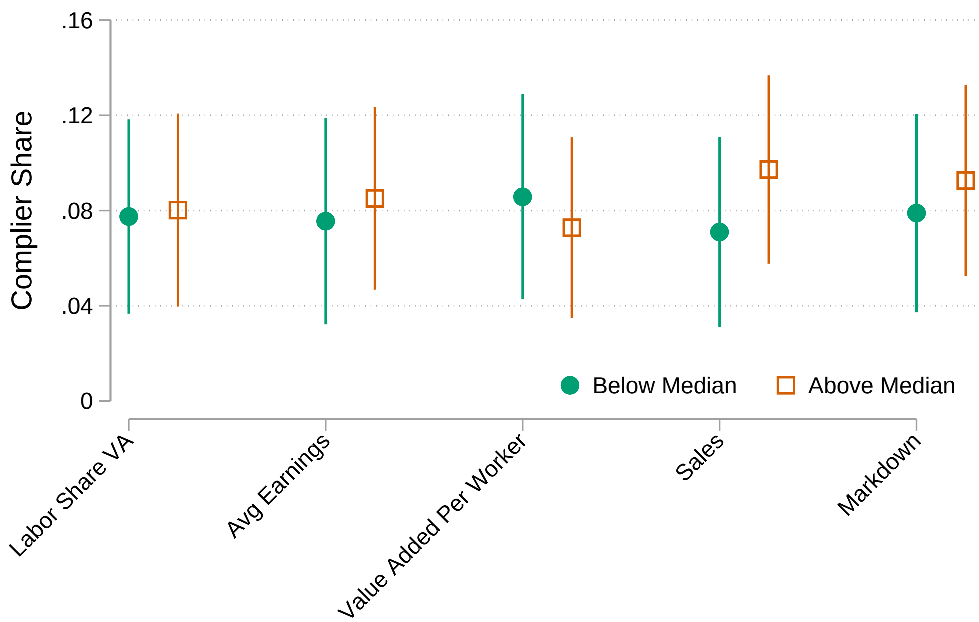
We plot the compliance rates over windows of union density in Panel A of Figure C1 and the compliance rates for different types of firms in Panel B. In both panels, we bootstrap the standard errors with 1,000 replications.

The results in Figure C1 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 C1 suggests that our LATE is represented by a wide variety of firms at different margins representative of the typical Norwegian manufacturing firm.

Figure C1: 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, where the value on the x-axis represents the bottom of the range, and the x-axis value plus 20 is the top of the range (e.g. "10" represents the 10-30 percent range). 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.

D 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) and 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. Specifically, the operating assumption is 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 (the mediator) and firm value added per worker (the outcome) arise from factors that also are likely to affect returns to unionization and union-induced wage increases and not unrelated channels. For example, an unobserved shock to product demand is likely to affect both union density and firm value added per worker through the effect of the shock on prices. It is unlikely that a product demand shock would affect union density without also affecting the relationship between prices and value added per worker. 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 D1 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 (in terms of quantities) productivity penalty associated with higher union density for these exporting firms (albeit small at around 0.0312 log points).[39] The results in Column (2) show that the effect of union density on value added per worker in our full manufacturing

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

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 document. Importantly, an increase in prices may reflect an increase in product *quality* rather than quantity, which would be captured in the unit prices and markups rather than in a quantity-based MPL, so our analysis cannot rule out a productivity increase arising through product quality.

Table D1: Price as a Mediator of Firm Value Added per Worker

	(1)	(2)
	VA per Worker (Exporters)	VA per Worker
Total Effect of Union Density	0.0169***	0.0108***
	(0.00336)	(0.00204)
Direct Effect of Union Density	-0.000312***	-0.000164
	(0.000614)	(0.000204)
Indirect Effect through Mediator	0.0172*	0.0110***
	(0.0117)	(0.00385)
Mediator	Log(Price per KG)	Markup
Mediator Share of Total	101.8 %	101.9 %
Observations	22,952	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.

E The Broader Private Sector

Our analysis in the main text has focused on examining how firms in the manufacturing sector respond to an exogenous increase in union density. Our decision to focus on manufacturing 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., De 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 prevents us from performing our direct pass-through exercise, we 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).[40] 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 E1, and the results from our margins of adjustment analysis are shown in Table E2. 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 exhibit 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). We believe a core explanation for this differential effect relates to labor and product market concentration differences across sectors. Specifically, Dodini et al. (2022) 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), 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 personnel costs. 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

[40]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.

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.[41]

In terms of the second-stage effect for other margins, Table E2 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, the change in labor usage generates a scaling effect across the other inputs, but in this case, it causes a down-scaling 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 the standard errors make strong inferences difficult.

To examine the scaling effect in more detail, Column (5) in Table E2 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 a percentage point increase in union density. 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

[41]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.

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.[42]

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 find 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 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.[43]

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

[42] 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.

[43] 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.

does significantly change.

Table E1: First Stage and Earnings Effect - Whole Private Sector

	First stage	*Earnings effect*	
	(1)	(2)	(3)
	Union density	Log(Average Earnings)	Log(Non-Wage Costs)
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 E2: 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)	Log(TFP)	Log(Industry Revenue Shares)
Union Density	-0.0142	-0.00421	-0.00992**	0.00205	-0.0144*
	(0.0178)	(0.00515)	(0.00436)	(0.00194)	(0.00777)
Observations	183,028	231,703	231,703	231,504	231,703
Dep Var Mean	7.008	0.196	0.0828	0.0117	-7.566

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.

Table E3: 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.

F Model

This simple partial equilibrium model features a firm with market power in both the product and labor market, and a union which cares about both the wage and employment level. The firm and the union bargain over the wage. The outcome of the wage bargain is a wage which is a weighted average of the firm's ideal wage and the union's ideal wage, where the weight is β, the union's bargaining power, which in turn is a function of union density at the firm. The setup is right-to-manage: the union and firm bargain over the wage, and then the firm makes its production decisions (including how much labor to hire) based on this bargained wage.

F.1 Firm problem - no union

In the absence of any union, the firm chooses labor to maximize profits subject to an upward sloping labor supply curve and downward sloping product demand curve:

$$\begin{aligned} max_l \ & p(l)zl - wl \\ & \text{s.t. } l \leq w^{\eta} \qquad \text{(Labor supply)} \\ & \text{s.t. } p(l) = \left(\frac{zl}{Y}\right)^{-\frac{1}{\epsilon}} \qquad \text{(Product demand)} \end{aligned} \tag{15}$$

We have the familiar expression that the optimal wage is marginal revenue product, marked down by both the product markup and labor markdown

$$w^* = \left(\frac{\epsilon - 1}{\epsilon}\right)\left(\frac{\eta}{\eta + 1}\right) p^*(z)z \tag{16}$$

and in terms of primitives, optimal wage and labor use are:

$$\begin{aligned} l^* &= \left(\frac{z}{Y}\right)^{\frac{-\eta}{\epsilon+\eta}} \left(z\left(\frac{\epsilon-1}{\epsilon}\right)\left(\frac{\eta}{\eta+1}\right)\right)^{\frac{\epsilon\eta}{\epsilon+\eta}} \\ w^* &= \left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\left(\frac{\epsilon-1}{\epsilon}\right)\left(\frac{\eta}{\eta+1}\right)\right)^{\frac{\epsilon}{\epsilon+\eta}} \end{aligned} \tag{17}$$

F.2 Firm problem - with union

Now, solve the firm's problem if there is a union: maximize profits by choosing labor, subject to paying the bargained wage $\bar{w}$:

$$
\begin{aligned}
max_l \;\; & p(l)zl - \bar{w}l && (18)\\
& \text{s.t. } \; l \leq \bar{w}^{\eta} && \text{(Labor supply)}\\
& \text{s.t. } \; p(l) = \left(\frac{zl}{Y}\right)^{-\frac{1}{\epsilon}} && \text{(Product demand)}
\end{aligned}
$$

Following Lo Bello and Pesaresi (2022), we note that the amount of labor the firm chooses will depend on how high the union sets wage $\bar{w}$. Specifically, there exists threshold wage w^{thresh} such that if the bargained wage is below this threshold, the firm will be bound by the labor supply curve, and if the bargained wage is above this threshold, the firm will be bound by the labor demand curve. Thus, the firm's labor choice is

$$
\begin{aligned}
& l = \bar{w}^{\eta} && \text{if } \bar{w} < w^{thresh}\\
& l = \bar{w}^{-\epsilon}\left(\frac{Y}{z}\right) z^{\epsilon}\left(\frac{\epsilon-1}{\epsilon}\right)^{\epsilon} && \text{if } \bar{w} > w^{thresh} \qquad (19)
\end{aligned}
$$

where threshold wage w^{thresh} is the wage at which these conditions intersect (the labor supply curve crosses the labor demand (marginal revenue product) curve):

$$
w^{thresh} = \left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\epsilon}{\epsilon+\eta}} \qquad (20)
$$

and the total amount of labor hired is increasing in the wage for $w < w^{thresh}$ (as the firm moves up the labor supply curve) and then decreasing in the wage for $w > w^{thresh}$ (as the firm moves up the labor demand curve).

F.3 Union problem

The union takes the firm's choices as given and chooses its ideal wage w^u to maximize some function of wages and total employment. We specify the union's problem as maximizing utility subject to constraints that (i) employment not fall below some fraction of non-union employment $\kappa_l l^*$ and (ii) the wage not fall below some multiple of the non-union wage $\kappa_w w^*$

where $\kappa_l < 1$ and $\kappa_w > 1$:[44]

$$U = w^{\alpha} l^{(1-\alpha)}$$
$$\text{s.t.} \quad l \geq \kappa_l l^*$$
$$\text{s.t.} \quad w \geq \kappa_w w^*. \tag{21}$$
$$\tag{22}$$

If the union sets a wage below w^{thresh} (in the portion of the firm's problem where the firm is bound by the labor supply curve), we denote the union's utility as U_{LS}. If the union sets a wage above w^{thresh} (in the portion of the firm's problem where the firm is bound by the labor demand curve), we denote the union's utility as U_{LD}. Therefore the union's utility, as a function of the wage it sets, is

$$\begin{aligned} U_{LS} &= (w^u)^{(\alpha+\eta(1-\alpha))} && \text{if } w \leq w^{thresh} \\ U_{LD} &= (w^u)^{(\alpha-\epsilon(1-\alpha))} \left(\frac{Y}{z}\right)^{(1-\alpha)} z^{\epsilon(1-\alpha)} \left(\frac{\epsilon-1}{\epsilon}\right)^{\epsilon(1-\alpha)} && \text{if } w \geq w^{thresh}. \end{aligned} \tag{23}$$

Note that when the wage is less than w^{thresh} utility is increasing in the wage (because wage and employment both increase as the firm moves up its labor supply curve). When the wage is above w^{thresh}, whether utility is increasing in the wage is ambiguous since employment falls as the wage increases: it depends on the union's relative weight on wages vs. employment in the utility function (α) relative to the price elasticity of demand (ϵ). Specifically, utility increases in the wage only if $\frac{\alpha}{1-\alpha} > \epsilon$.[45]

The union's optimal choice of wage also depends on how high its minimum target wage $\kappa_w w^*$ is, relative to w^{thresh}. Specifically, the minimum target wage $\kappa_w w^* \leq w^{thresh}$ iff $\kappa_w \leq \left(\frac{\eta+1}{\eta}\right)^{\frac{\epsilon}{\epsilon+\eta}}$.[46]

[44]The union's employment constraint might reflect a particular concern for the employment level of union members or incumbents with more power in the union. The union's wage constraint might reflect a legitimacy concern with, for example, recouping at least the incremental cost of union dues relative to a non-union case to ensure that workers are weakly better off unionized.

[45]Intuitively, the rationale is as follows: raising the wage means reducing employment and raising prices as the firm moves along the demand curve. The degree to which the firm has to reduce employment as it raises wages (and prices) depends on the price elasticity of demand: the higher the elasticity, the bigger the reduction in employment required for a given increase in the wage. Thus if the union cares sufficiently about employment (α is small), or if the trade-off between employment and wages is stark (ϵ is large), then the union's utility is maximized by setting the wage at w^{thresh}, but if not, then the union may maximize utility by setting a wage greater than w^{thresh}.

[46]This condition illustrates that, for a given desired wage increase above the no-union wage (κ_w), the firm is more likely to choose wage w^{thresh} the greater the firm's monopsony power (the smaller is η). This is because the more monopsony power there is, the further there is to move up the labor supply curve as the wage increases before the firm starts cutting employment in response to additional wage increases.

The union's optimal choice of wage is therefore

$$w^u = w^{thresh} = \left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\epsilon}{\epsilon+\eta}} \qquad \text{if } \frac{\alpha}{1-\alpha} < \epsilon \text{ and } \kappa_w \leq \left(\frac{\eta+1}{\eta}\right)^{\frac{\epsilon}{\epsilon+\eta}}$$
$$w^u = \kappa_l^{\frac{-1}{\epsilon}} \left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\epsilon}{\epsilon+\eta}} \left(\frac{\eta}{\eta+1}\right)^{\frac{-\eta}{\epsilon+\eta}} \qquad \text{if } \frac{\alpha}{1-\alpha} > \epsilon \text{ or } \kappa_w > \left(\frac{\eta+1}{\eta}\right)^{\frac{\epsilon}{\epsilon+\eta}} \tag{24}$$

where the latter wage is the highest wage compatible with the union's employment constraint $l \geq \kappa_l l^*$.[47]

F.4 Bargained wage

Assume that the union and firm reach the bargained wage outcome through a Nash bargaining process, where the union has bargaining power β which is a function of union density at the firm. The wage outcome is a weighted average of the union's optimal wage w^u and the wage the firm would set in the absence of the union w^*:

$$\bar{w} = \beta w^u + (1-\beta) w^* \tag{25}$$

F.5 Case 1: high monopsony power

We now consider two cases separately, which we call "high monopsony power" and "low monopsony power." In the high monopsony power case, the elasticity of labor supply to the firm η is small and the union's optimal wage is $w^u = w^{thresh}$. In this case, the bargained wage is:

$$\begin{aligned}
\bar{w} &= \beta w^{thresh} + (1-\beta) w^* \\
&= \underbrace{\left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\epsilon}{\epsilon+\eta}} \left(\frac{\eta}{\eta+1}\right)^{\frac{\epsilon}{\epsilon+\eta}}}_{w^*} \left(1 + \beta\left(\left(\frac{\eta+1}{\eta}\right)^{\frac{\epsilon}{\epsilon+\eta}} - 1\right)\right)
\end{aligned} \tag{26}$$

The firm solves its problem subject to the bargained wage, leading to labor, prices, and profits as follows:

$$\begin{aligned}
l &= \left(\frac{1}{Y}\right)^{\frac{-\eta}{\epsilon+\eta}} z^{\frac{\eta(\epsilon-1)}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\epsilon\eta}{\epsilon+\eta}} \gamma(\beta)^{\eta} \\
p &= \left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{-\eta-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{-\eta}{\epsilon+\eta}} \gamma(\beta)^{\frac{-\eta}{\epsilon}} \\
\pi &= \left(\frac{1}{Y}\right)^{\frac{-\eta-1}{\epsilon+\eta}} z^{\frac{(\epsilon-1)(\eta+1)}{\epsilon+\eta}} \left(\left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\eta(\epsilon-1)}{\epsilon+\eta}} \gamma(\beta)^{\frac{\eta(\epsilon-1)}{\epsilon}} - \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\epsilon(\eta+1)}{\epsilon+\eta}} \gamma(\beta)^{\eta+1}\right)
\end{aligned} \tag{27}$$

[47] We assume that the union's wage and employment constraints are compatible with each other.

where $\gamma(\beta) = \left(\beta + (1-\beta)\left(\frac{\eta}{\eta+1}\right)^{\frac{\epsilon}{\epsilon+\eta}}\right)$

What happens as union density increases?

$$\begin{aligned}
\frac{\delta \bar{w}}{\delta \beta} &= \left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\epsilon}{\epsilon+\eta}} \left(1 - \left(\frac{\eta}{\eta+1}\right)^{\frac{\epsilon}{\epsilon+\eta}}\right) \quad > 0 \\
\frac{\delta l}{\delta \beta} &= \eta \bar{w}^{\eta-1} \frac{\delta \bar{w}}{\delta \beta} > 0 \\
\frac{\delta p}{\delta \beta} &= -\frac{1}{\epsilon} p \left(\frac{1}{l}\frac{\delta l}{\delta \beta}\right) < 0 \\
\frac{\delta \pi}{\delta \beta} &= \left(\left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon}} z^{\frac{\epsilon-1}{\epsilon}} \left(\frac{\epsilon-1}{\epsilon}\right) l^{\frac{-1}{\epsilon}} - \left(\frac{\eta+1}{\eta}\right) l^{\frac{1}{\eta}}\right) \frac{\delta l}{\delta \beta} < 0
\end{aligned} \tag{28}$$

As worker bargaining power increases, the bargained wage increases, and as the firm moves up the labor supply curve, labor use (and output) also increases. The price therefore decreases, as the firm moves down the product demand curve. The effect on profits is unambiguously negative.[48]

F.6 Case 2: low monopsony power

In the low monopsony power case, the elasticity of labor supply to the firm η is large enough that $\kappa_w > \left(\frac{\eta+1}{\eta}\right)^{\frac{\epsilon}{\epsilon+\eta}}$. In this case, the bargained wage is:

$$\bar{w} = \underbrace{\left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\epsilon}{\epsilon+\eta}} \left(\frac{\eta}{\eta+1}\right)^{\frac{\epsilon}{\epsilon+\eta}}}_{w^*} \left(1 + \beta\left(\kappa_l^{\frac{-1}{\epsilon}}\left(\frac{\eta+1}{\eta}\right) - 1\right)\right) \tag{29}$$

and the responses of firm outcomes to union bargaining power β are:

$$\begin{aligned}
\frac{\delta \bar{w}}{\delta \beta} &= w^* \left(\kappa_l^{\frac{-1}{\epsilon}}\left(\frac{\eta+1}{\eta}\right) - 1\right) > 0 \\
\frac{\delta l}{\delta \beta} &= -\epsilon \bar{w}^{\epsilon-1} \left(\frac{1}{Y}\right)^{-1} z^{\epsilon-1} \left(\frac{\epsilon-1}{\epsilon}\right)^{\epsilon} \frac{\delta \bar{w}}{\delta \beta} < 0 \\
\frac{\delta p}{\delta \beta} &= -\frac{1}{\epsilon} p \left(\frac{1}{l}\frac{\delta l}{\delta \beta}\right) > 0 \\
\frac{\delta \pi}{\delta \beta} &= -l \frac{\delta w}{\delta \beta} < 0
\end{aligned} \tag{30}$$

As worker bargaining power increases, the wage increases, employment falls (and output falls), the price rises, and profits fall.

[48]Note that the term in parentheses is always negative for $l > l^*$.

F.7 Allowing market power ϵ to change as union density increases

Take a firm in Case 1: "high monopsony power." Increased unionization causes this firm to increase its employment and output. Holding all else constant, this will increase its market share (and indeed, if some less monopsonistic firms also experience an increase in unionization, these firms will shrink, exacerbating this effect). If the price elasticity of demand ϵ decreases in a firm's market share, then increased union density β will reduce the price elasticity of demand: $\frac{\delta\epsilon}{\delta\beta} < 0$.

Note that this now generates two countervailing effects of increased union density on the price. Increased union density increases output, which creates downward pressure on the price. However, increased union density also reduces the price elasticity of demand, which pivots the demand curve to become steeper, creating upward pressure on the price for any given amount of output.[49] If the effect of increased market share on the price elasticity of demand is sufficiently large, the latter effect can outweigh the former meaning that increased union density can increase the price:

$$\frac{\delta p}{\delta \epsilon} = -\frac{1}{\epsilon} p \frac{1}{l} \frac{\delta l}{\delta \beta} + \frac{1}{\epsilon^2} p \ln\left(\frac{zl}{Y}\right) \frac{\delta \epsilon}{\delta \beta}. \tag{31}$$

If the positive price effect is sufficiently large, the effect on profits may also be positive.

[49]Noting that $zl < Y$ by definition of aggregate output Y.