

Who Pays for Unions?

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Abstract

If unions raise worker wages, who pays? We provide a comprehensive assessment of firm responses to increased unionization, using changes in the tax deductibility of union dues in Norway as a quasi-exogenous source of variation in firm-level union density. In the average private sector firm, higher union density raises labor costs and leads firms to contract employment and production, lowering profits without increasing the labor share. The incidence is shared: consumers bear part of the cost through higher prices, shareholders through lower profits, and the remainder is offset by productivity improvements. The total wage bill falls, with losses concentrated among less-attached “outsider” workers. Firm responses vary systematically by the degree of market competition. In manufacturing, where firms operate in less competitive product and labor markets, the response is reversed: the average firm expands employment and production, reduces labor markdowns, and does not experience profit declines. Instead, higher labor costs are largely passed on to consumers through higher prices, with the remainder offset by productivity gains. Workers benefit as both wages and employment rise. These patterns suggest that unions can offset employer monopsony power and that firm responses—and therefore who ultimately bears the cost—depend importantly on market structure. Overall, unionization in this setting primarily redistributes from consumers rather than shareholders and has effects that differ sharply across firms, including a reallocation toward larger and more productive firms. We rationalize these patterns using a partial-equilibrium model of union bargaining with product- and labor-market power.

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I Introduction

Trade unions alter how wages and working conditions are determined within firms, creating a major departure from competitive wage setting. A central economic question is how firms respond to these changes. If unionization raises labor costs, firms may reduce employment and scale down production, pass costs on to consumers through higher prices, accept lower profits, or offset the shock through productivity improvements. Which of these margins adjusts determines who ultimately bears the cost of unionization and whether unions reduce or improve economic efficiency.

Even though four decades have passed since the canonical work of Freeman and Medoff (1984), there is still limited evidence on how firms respond to unionization. A key reason is the difficulty of identifying plausibly exogenous shifts in firm-level unionization linked to detailed population-wide employer–employee matched longitudinal data. In this paper, we overcome this challenge to examine who pays for the union wage premium and provide a comprehensive assessment of how firms respond to shifts in union density. We use data from the Norwegian private sector between 1998 and 2014, combining plausibly exogenous shifts in firm-level union density—driven by changes in Norway’s national tax subsidies for union dues—with longitudinal employer-employee linked administrative data on the entire population of workers and firms.

Our identification strategy exploits a series of policy reforms in Norway that quadrupled the maximum tax deduction for union dues between 2003 and 2010. Because the subsidy is a function of contemporaneous union dues, the reform induces heterogeneous changes in the net cost of membership across firms with different baseline dues levels, generating differential incentives for workers to join or remain in unions. Firms whose workers paid higher dues prior to the reform experienced larger increases in the effective subsidy to union membership and, therefore, greater increases in union density. We use this variation to estimate firms’ responses to unionization in an instrumented dose–response difference-in-differences framework. Our first stage confirms that firms more exposed to the reform experienced larger increases in union density. Specifically, firms that experience a 1,000 Kr larger reduction in their average net-of-subsidy dues exhibit an 8.8 percentage point larger increase (or smaller decrease) in firm-level union density. These increases in unionization translate into higher labor costs: a one-percentage-point increase in union density raises labor costs per worker per day by 0.78 log points.

Our empirical setting allows us to trace firms’ responses to unionization across the full set of adjustment margins. We link individual-level information on union membership for the entire population of Norwegian workers to detailed firm-level accounting data, enabling us to examine how firms adjust employment, input use, sales, and profits when union density increases. In the manufacturing sector, we further leverage production function estimation techniques to estimate product price markups, labor wage markdowns, and total factor productivity. For exporting firms, we also observe complete product-level export data from Norwegian customs, which we combine

with country–product level UN Comtrade data for importing markets. Together, these data allow us to directly examine product-level price pass-through of union-induced labor cost increases and to disentangle price effects from productivity changes. We discuss our data and empirical strategy in detail in Section III.

The key takeaways from our analyses of the Norwegian private sector are fourfold. First, for the average firm, increased unionization raises unit labor costs and leads firms to reduce employment, scale down production, and experience lower total profits. Employment responses are highly elastic, so that reductions in employment more than offset higher wages, leading to a lower total wage bill. Despite a reduction in firm profits, we do not find a shift in the labor share, indicating no meaningful redistribution from shareholders to workers at the firm level. Second, firms partially offset higher labor costs through productivity gains from changes in workforce composition (i.e., an increase in the average AKM worker fixed effect of those employed at the firm) and reduced absenteeism via reduced sick leave take-up. Third, employment reductions are concentrated among marginal workers—particularly part-time and non-attached workers—consistent with unions prioritizing insiders, and we see no increase in firm exit, consistent with unions caring about firm survival. Fourth, firm responses are highly heterogeneous: larger firms and those with greater product or labor market power—as proxied by firm size, measures of labor and product market concentration, and separation elasticities—exhibit less or no contraction in employment or sales, while firms facing more competitive conditions adjust with large reductions in employment and sales. We present these analyses in Section IV.

The heterogeneity across firms suggests that the effects of unionization depend importantly on firms’ product and labor market power. To examine the mechanisms underlying these differences more directly, in Section V we turn to the manufacturing sector, where firms exhibit substantial product and labor market power. An additional advantage of this setting is the availability of detailed product-level price data (for exports), which allows us to examine directly whether higher union-induced labor costs are passed on to consumers.

In the manufacturing sector, firms respond very differently to increases in unionization. When union density rises and labor costs increase, the average manufacturing firm expands employment and production rather than contracting, and estimated labor markdowns decline, suggesting that unions partially offset employer monopsony power. Yet the labor share remains unchanged and profits do not fall, indicating that unionization does not redistribute income from shareholders to workers on average. Instead, higher labor costs are largely passed on to consumers through higher prices: specifically, for the (large) subset of manufacturing firms who export, we examine price pass-through using detailed product-level price data from customs, finding that firms raise output prices when union density increases. The ability to raise prices is consistent with significant product market power for Norwegian manufacturing exporters, many of which sell high-priced and specialized goods. Further analysis using UN Comtrade data reveals that products sold in markets

where firms have more market power experience larger price increases or a less steep price-quantity trade-off. We also find that manufacturing firms experience improvements in productivity driven by greater worker retention and changes in workforce composition. We show that the differences in the response to unionization between manufacturing firms and other private sector firms arise because manufacturing firms have greater product and labor market power.

In Section VI, we use our estimates to quantify who ultimately bears the costs of increased unionization across the Norwegian private sector, following in the spirit of other decompositions of labor cost shocks (e.g. Harasztosi and Lindner (2019) on the minimum wage). For the average private sector firm, consumers bear roughly one third of the increase in labor costs through higher prices, while shareholders bear an additional 42 percent through lower profits. The remaining costs are offset by productivity improvements driven by improvements in workforce composition and increases in hours worked via reduced sick leave. As firms contract, other workers who lose their jobs or would have worked there also bear a sizable cost, which is not captured by this decomposition.

For the average manufacturing firm, in contrast, shareholders and other workers do not bear the costs of increased unionization on average: profits do not fall, and employment expands rather than contracts. Instead, four-fifths of the increase in labor costs is passed on to consumers through higher prices, while the remainder is offset by productivity improvements and higher total sales revenue.

Finally, to contextualize our results, we consider a simple partial equilibrium model of a firm with labor and product market power and augment it with union wage bargaining in a right-to-manage framework (Section VII). In relatively competitive settings, a union-induced wage increase leads firms to contract employment and output. This is consistent with the patterns we document for the average firm in the broader Norwegian private sector. In contrast, when firms possess labor market power, the firm may be bound by the labor supply curve rather than the labor demand curve. This means that higher bargained wages can force firms to walk up the labor supply curve, moving wages closer to the marginal product of labor and so leading firms to expand employment while reducing labor markdowns. If firms also possess product market power, they may primarily pass higher labor costs on to consumers through higher prices, rather than absorbing them through reduced profits. This combination of high product and labor market power can explain most of our findings for the average manufacturing firm. Yet these features of imperfect competition alone cannot account for two additional patterns in the manufacturing results: prices increase without a decline in real output, and profits do not fall on average. We provide empirical support for three channels that may explain this: first, as firms expand, their market share increases, which can increase market power (as Lo Bello and Pesaresi (2025) show for the minimum wage); second, competitors face similar union-induced labor cost increases, raising prices and making the firm's own demand less price-elastic; and third, firms may be able to increase prices without reducing

sales if product quality improves.

Our results highlight how the effects of unionization depend heavily upon the dynamic nature of market structure and power in both product and labor markets. If firms have monopsony power in the labor market, unions might increase economic efficiency (reducing monopsony-induced under-production and its concomitant deadweight loss), as well as increasing worker retention and reducing total turnover costs. If firms have product market power, union labor costs may be passed on in higher prices. And, because firms do not operate in isolation, firm responses to their own input cost shocks may further shift product market power dynamics, as firms' own changing market shares and their competitors' behavior can both change firms' own pricing power, as can union effects on product quality.

Contribution to literature. Our core contribution is to provide a comprehensive assessment of the margins along which firms respond to shifts in union density, estimating who bears the cost if a union increases wages.

Our work primarily contributes to a large literature exploring the causal impact of unionization on firm outcomes, including employment, profits, performance, and productivity. Estimates for the effects of unionization on firm productivity are mixed, ranging from large negative to slightly positive productivity effects (e.g., DiNardo and Lee (2004); Sojourner, Frandsen, Town, Grabowski and Chen (2015); Dube, Kaplan and Thompson (2016); Bryan (2017)). Estimates for effects on profits or equity values tend to be negative (e.g. Lee and Mas (2012)). But, as emphasized in reviews by Doucouliagos and Laroche (2009) and Hirsch (2017), this literature has been limited in its ability to study the causal effects of unionization on firms both because of a lack of quasi-exogenous variation in firm union density and because of a lack of comprehensive data on firm outcomes.¹ Our detailed administrative data, coupled with an exogenous union density shock, enables a comprehensive analysis of firms' responses across multiple margins—ranging from accounting profits to productivity, worker composition, markups, and prices. This allows us to answer a central question in the union literature that has yet to be addressed: who ultimately bears the cost of union-induced wage increases? Furthermore, by examining contexts with varying levels of labor and product market competition, and by developing a stylized partial-equilibrium framework (building on Lo Bello and Pesaresi (2025)), we provide a lens for understanding how union effects vary across environments with different degrees of market power (Wong, 2026; Azkarate-Askasua and Zerecero, 2025). By studying the full range of firm adjustment margins—and in particular price pass-through—we broaden the scope of the union literature and shed light on the mechanisms

¹Our work also relates to the larger literature estimating the causal effect of unions on individual workers, including Frandsen (2021); Card and De La Rica (2006); Bryson (2002); Fortin, Lemieux and Lloyd (2022); Farber, Herbst, Kuziemko and Naidu (2021); Dodini, Salvanes and Willén (2022); Finnigan and Hale (2018); Frandsen and Webb (forthcoming); Hagedorn, Paras, Greenwich and Hagopian (2016); Park, Lee and Budd (2019); Dodini, Salvanes, Willén and Zhu (2023). Other relevant work includes Dobbelaere, Hirsch, Müller and Neuschaeffer (2024) who find a negative descriptive relationship between labor markdowns and collective bargaining and works councils in German establishments; and Edin and Topel (1997) and Bustos (2023)'s work on firm responses to sectoral bargains.

through which unions affect workers' outcomes, firm production processes and profitability, and consumers' well-being.

Two other papers are particularly close to ours, in that they use the same exogenous shock from the change in the tax deductibility of union dues in Norway to study the effects of unions. Barth, Bryson and Dale-Olsen (2020) estimate the effect of changes in union density on productivity and wages in Norwegian manufacturing, finding that union density increases both. Dodini, Salvanes and Willén (2022) examine how union density influences worker-level outcomes such as wages, hours, and earnings inequality within firms and within labor markets of varying concentration, finding that the wage premium from union density is higher in more monopsonistic labor markets and ameliorates the negative relationship between concentration and earnings. Our paper takes a different approach to these papers: we explore firm-level effects of increased union density across the entire Norwegian private sector, and explore all margins of adjustment to unionization: not only earnings or nominal productivity, but also employment, labor reallocation, industry revenue share reallocation, worker composition, worker retention, markups, wage markdowns, and accounting profits. Importantly, we also capture direct measures of product-level prices and market power using detailed export data linked to UN Comtrade.²

Our analysis also contributes to a growing literature studying the pass-through of firms' input cost shocks to consumer prices, including work on minimum wage increases (e.g., Harasztosi and Lindner (2019); Ruffini (2024)) and energy price shocks (e.g., Ganapati, Shapiro and Walker (2020); Fontagné, Martin and Orefice (2024); Lafrogne-Joussier, Martin and Mejean (2023)). Studying the price pass-through response to unionization is interesting both in and of itself (since as a firm-level shock, it operates differently to a minimum wage shock), and because it can shed light on responsiveness to firm-level input cost shocks more generally.

II Background

II.A The Norwegian Economy

Our analysis focuses on Norway over 1998–2014. Norway is a high-income, small, open economy with extensive international trade. It has a large public sector and substantial revenues from natural resources, particularly oil and gas. Living standards are among the highest globally, with GDP of roughly USD 486 billion in 2023 and per-capita income around USD 91,900 (in the United States, per-capita income is around USD 89,600). While natural resources play an important role, Norway also has a large and diversified private sector that includes manufacturing, shipping, and seafood production. Manufacturing remains a significant component of the mainland economy

²Barth, Bryson and Dale-Olsen (2020) find that unionization increases nominal labor productivity. Our results substantially reinterpret this finding: roughly 60% of the increase reflects price pass-through to consumers, while most of the remainder reflects changes in workforce composition that improve firm-level productivity without increasing aggregate productivity. Consequently, most of the measured increase in nominal labor productivity does not represent aggregate productivity gains.

and is highly integrated into global markets through exports. The labor market is characterized by low unemployment, high unionization rates, strong collective bargaining institutions, and comprehensive worker protection through unemployment insurance, disability insurance, and sick-leave benefits broadly comparable to other OECD countries.

Our core analyses in this paper look at the Norwegian private sector. We also perform a set of analyses focusing on only the manufacturing sector, since for this sector we are able to estimate pass-through to product prices, as well as measures of market power (markups and markdowns). The manufacturing sector in Norway accounted for approximately 9% of GDP and 14% of employment in 2001, and the typical manufacturing worker earns approximately the national median income. Norway's manufacturing sector is export-driven and specializes in industrial and electrical machinery and equipment, transportation equipment (largely ships), food products, and metal products, minerals, and chemicals. Notably, the manufacturing sector is substantially more concentrated than other sectors in Norway in terms of local occupation employment shares (mean Herfindahl-Hirschman Index ("HHI") of 0.116 in manufacturing compared to 0.043 for the rest of the private sector, for an overall mean of 0.058) and local industry employment shares (mean HHI of 0.238 compared to 0.042 for the non-manufacturing part of the private sector, with an overall mean of 0.081). The concentration of industry revenue shares for the average firm in the manufacturing sector is also much higher (mean HHI of 0.041 compared to 0.015 overall). (See Table A1).

II.B Unions in Norway

Norway has a strong tradition of union representation. Workers have the legal right to join a union regardless of employer, but membership is voluntary and closed-shop agreements are not permitted. Unlike in some countries, such as the United States, union membership is an individual decision and workers must actively opt in.

As in other countries, the stated goals of the Norwegian labor unions are to improve members' rights and work conditions through bargaining. 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. 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.

Approximately 50 percent of the Norwegian workforce are union 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). 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 government

subsidies for union dues, which we use for identification. It has been projected that aggregate union density would have been approximately 5-6 percentage points lower if these subsidies had not been increased (e.g., Barth, Bryson and Dale-Olsen (2025)). In the manufacturing sector, union membership is approximately 55 percent and, after declining in the late 1990s and early 2000s, has remained relatively stable since approximately 2004.

Our analyses of the full Norwegian private sector as well as the manufacturing sector provide insights that likely are transferable to other settings. Lessons from unionization in Norway are most directly applicable to countries with two-tier collective bargaining structures. However, because sectorally bargained minimum wages are relatively low and therefore rarely binding for firms, our findings on firm-level union density are also relevant for countries where collective bargaining occurs predominantly at the firm or establishment level, like the United States. Moreover, Norwegian firms span a range of product market conditions – including manufacturing firms selling highly specialized differentiated products with pricing power, and those selling products more similar to raw materials– enabling us to disentangle when and how firms’ responses to unions depend on their product market power. Similarly, Norwegian firms span a range of labor market conditions, which enables us to disentangle the implications of labor market power for our results on employment, wage markdowns, turnover, and workforce composition.

II.C The Bargaining Process

The Norwegian labor market is characterized by high coverage of national sectoral collective bargaining agreements. However, the ability of firms and unions to adjust individual wages over and above the wage floors set by sectoral agreements is very high (Blandhol, Mogstad, Nilsson and Vestad, 2020).

The most common wage determination process is a two-step bargaining procedure, which covers 50 percent of workers in the private sector (and 90 percent of the manufacturing sector - see Table 4.2 in Dale-Olsen, Strøm, Østbakken and Barth (2018)). 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, establishment-level negotiations take place in which unions and employers discuss not only establishment- and firm-specific wage increases for union members but also have the flexibility to allocate individual-specific wage increases. These negotiations usually take place annually. Non-union employees do not have the right to bargain, and employers retain full discretion over their wage adjustments. Outside this system, about 30 percent of private-sector workers are not covered by industry-level agreements, meaning that any collective bargaining occurs directly at the establishment level. Conversely, roughly 20 percent of workers are covered by agreements where bargaining takes place exclusively at the industry level in a process separate from the typical two-step process (Blandhol et al., 2020).

Thus, for 80 percent of the private sector workforce (the 50 percent covered by the two-step

process and the 30 percent not party to sectoral agreements), establishment-level union bargains can have a substantial influence on wages and work conditions. These establishment-level negotiations are a centrally important venue for wage determination for workers: while the national and sectoral wage agreements have played a key role in setting worker wages in the past, establishment-level negotiations now account for more than 70 percent of total negotiated wage increases (Bhuller, Moene, Mogstad and Vestad, 2022).

Union density is particularly meaningful during the establishment-level negotiations where establishment-level union bargaining power is leveraged to extract concessions from firms. Unlike settings such as the US, where unionization is typically a binary decision for the entire workplace or bargaining unit, union density in Norwegian workplaces is best understood as a continuous variable ranging from 0 to 1. Higher union density values indicate greater union bargaining power, as a larger proportion of workers are union members. The level of union density varies meaningfully across workplaces: across our sample of Norwegian private sector firms 2001-2014, the mean firm-level union density was 21% and the standard deviation was 25%.³

II.D Union Tax Deductions

Union members are required to pay monthly dues. These dues finance a wide variety of union 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. Some unions set dues at a flat monthly rate, and others as a percent or sliding scale of workers' income, with the percentage they charge differing across the unions that do charge on a percentage basis.⁴ Since unions' dues-setting process varies at the union level and also across local branches within unions, there is only a very weak correlation between dues and workers' annual incomes. The correlation is 0.23 in 2002 for actual dues paid by union members and -0.0011 for our imputed union dues that we use to construct our instrument (and 0.188 and 0.0324 respectively in manufacturing). Thus, the bulk of the variation in dues among workers can be thought of as driven by idiosyncratic factors determined by different national and local unions and not driven by variation in workers' own incomes. Union dues are, on average, quite large – in our data, dues typically amount to between 1 and 3.5 percent of a worker's pre-tax income – and are listed on workers' monthly pay statements, making the cost of union membership highly visible.

Union membership is subsidized in Norway, with the government providing a direct tax deduction for union dues up to a legislated maximum (automatically pre-filled on an individual's tax return). Beginning in the early 2000s, the Norwegian government increased the maximum tax

³Our accounting dataset is at the firm level. Only 6-7% of firms in our dataset are multi-establishment firms. In these firms, our analysis can be thought of as an average across the different establishment bargains.

⁴For example, in 2024, NITO, an engineers' union, charged a flat 5,340 NOK. TEKNA, a scientists' union, charged 4,980 for central union dues with an additional 144-300 in local branch dues. The Fellesforbundet union, which spans numerous occupations and industries, charged 1.5% to 2.2% of annual salary, with the exact percentage varying by local branch. Industri Energi, a petroleum, metals, pharmaceuticals, and chemicals workers' union, charged 1.47% capped at 8,602 per year.

deduction for union dues multiple times, effectively quadrupling the maximum from 2003 through 2010 (Appendix Figure A2). At the same time, average union dues rose much more slowly, such that the average value of the subsidy to union membership as a share of union dues in our sample of private sector firms rose from 8% at baseline in 2002 to 25% in 2010. The realized value of the subsidies to workers depends on the union dues required of (prospective) union members and on workers' marginal tax rate.

Our empirical strategy exploits the national changes in the maximum tax deduction for union dues. These changes significantly reduce the monetary cost of being a union member 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 being a union member 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 than those with lower baseline union dues. This distinction generates exogenous variation in predicted unionization rates for workers and, therefore, exogenous variation in predicted union densities across firms.

III Empirical Design

III.A Data

Our main data come from two administrative registers at Statistics Norway. The first is the register-based employment dataset. These data provide us with annual socioeconomic and demographic information on each individual aged 16 through 74 between 2001 and 2014, including information on gender, age, educational attainment, residency location, employment, occupation, industry, and earnings. The second is the “A-scheme” dataset, which collects more limited monthly data for the purposes of welfare program administration. This dataset extends coverage of the annual registers to short-term work relationships, part-time and part-year work, and the length of a worker-firm link not captured in the annual data and allows us to separate “attached” workers who are in the annual registers from “less attached” or “non-attached” workers who are not.⁵ By linking the individual-level data to the union dues database, we collect information on all workers' union status and the amount they pay in dues each year in our sample period, and the extent of their attachment to each firm.

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 (employment and labor costs), output (sales revenue), and accounting profits. We measure firm-level employment as total person-days of work at the firm during the year. We measure unit labor costs as labor costs per person-day worked; we refer to this as “labor costs per worker” (since labor costs per person-day implicitly scales to full-year worker equivalents).

⁵We defined attached workers as those present in the annual employment register who are designated in the register as in the labor force, employed, and earned at least a minimum of approximately \$10,000 per year.

Labor costs include earnings as well as non-wage costs, primarily employers’ social security contributions, pension contributions, and other personnel expenses such as training, subsidized meals, employee facilities, and insurance, making this measure of costs quite unique in the literature: it is comprehensive of all costs dedicated to workers and captures the cost contributions of short-term and less attached workers missing from many labor registers. 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 net value added as sales revenue minus non-personnel operating costs minus depreciation.

For manufacturing firms, we estimate an additional set of outcomes. The firm tax data enable us to estimate wage markdowns, product price markups, and total factor productivity via production functions. Specifically, we estimate each firm’s product price markup and labor markdown following Yeh, Macaluso and Hershbein (2022), who build on the canonical “production function approach” to estimate markups (e.g. De Loecker and Warzynski, 2012), as well as firm-year level measures of TFP estimated as the residual in the production function estimates for revenue. We do not estimate these outcomes for non-manufacturing firms because we cannot assume that they satisfy the estimation condition that at least one major input is competitively supplied. We describe the procedure and its underlying assumptions in detail in Appendix B.

For manufacturing firms, we can also link our firm-level information with data from the Norwegian export register, which contains information on all exports (quantity/weight, product identifiers at the 10-digit HC code level, and prices) for the sample period. (Most non-manufacturing firms do not export goods, so we cannot do the same for our full private sector sample). 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 at the product level for a large share of our sample. These price data also enable us to construct a backward-looking firm-level Laspeyres price index for exports. Specifically, using information for each product code i in time t relative to base year b , we calculate the firm-level price index as $\frac{\sum_i P_{i,t} Q_{i,b}}{\sum_i P_{i,b} Q_{i,b}}$.⁶ We merge the export data with two other external datasets: (1) the UN Comtrade dataset covering the universe of annual imports at the product-by-country level for all countries which import from Norway; and (2), the product classification system of Rauch (1999) to distinguish exports of differentiated and non-differentiated products.

In our main analysis, we focus on firms with at least five attached workers. We include summary statistics on our analytical sample in Table A1, showing the full private sector in columns (1) and

⁶We anchor the base year b for each firm to the firm’s last year in the data to account for new products. Setting the base year to the firm’s first year would result in assigning zero quantity and price weights to new products in the index. For products whose last year occurred before the firms’ last year, we impute the final period prices using the last observed price for the good, which is typically within one year of the firm’s final year.

(2), and the manufacturing sector in columns (3) and (4). The typical manufacturing firm employs more workers at higher earnings and has higher value added per worker than the typical non-manufacturing firm. Importantly, manufacturing firms employ larger shares of their local labor markets (defined by occupation or industry), and account for larger shares of their product markets (as measured by national industry revenue share). In other words, the average manufacturer likely possesses greater labor monopsony power and greater product market power than the average non-manufacturing firm in Norway. This pattern illustrates why the manufacturing sector provides a useful case study for understanding how unions affect firms operating in imperfectly competitive markets - a point we return to in detail below.

III.B Instrument for Union Density

To identify the effects of union density on firm outcomes, we exploit large national increases in the cap on the allowable tax deduction for union dues in Norway between 2003 and 2010, followed by smaller increases between 2011 and 2014. These increases cumulatively quadrupled the total allowable tax deduction, leading to significant changes in the net price of union membership for many workers (Barth, Bryson and Dale-Olsen, 2020; Dodini, Salvanes and Willén, 2022). The magnitude of the change in the price of union membership differed for different workers, depending on whether their prior dues deduction was bound by the cap and by how much.

Figure A1 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 2014.⁷ Note that increases in the maximum dues tax 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 $\tau(c_1 - c_0)$.

A worker's union dues depend predominantly on the job in which they are working, namely, their narrow 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 (1940 in total) in each year. For workers in a union, this eliminates concerns about heterogeneous selection

⁷Applying the average NOK:USD exchange rate over the period (6.6:1), the maximum tax deduction cap rose from approximately \$136 to \$584.

into differently-priced unions and individual determinants of union dues.⁸ For workers who are not union members, this allows us to assign 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, Bryson and Dale-Olsen (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 (1) existing union members being less likely to leave their union if they experience an increase in dues subsidies and (2) by non-members deciding to join a union.

One concern with our approach is that unions may respond endogenously to the changes in union deductions, and that firms may alter their occupation mix in response to unionization. We, therefore fix each firm’s imputed “baseline” union dues, \overline{D}_f^0 , which is the mean of these worker-level imputed dues fixed 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 , which 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 from the tax deduction in a given year t , which is equal to the base tax rate multiplied by the lesser of the legislated maximum deduction ($MaxDeduction_t$) and the average imputed base union dues across all workers at the firm:

$$NetDues_{ft} = \overline{D}_{ft}^0 - T_t * (\min\{\overline{D}_{ft}^0, MaxDeduction_t\}), \quad (1)$$

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

III.C 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 on our predicted union density:

$$Y_{fgt} = \alpha + \beta \widehat{UD}_{fgt} + \delta_f + \tau_{gt} + \varepsilon_{fgt}, \quad (2)$$

⁸However, this imputed value is highly predictive of actual union dues paid in the raw data among individual union members. Specifically, regressing annual dues on imputed dues with a year fixed effect gives a regression coefficient of 1.0041 (Appendix Figure A3).

⁹This 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. If we use the average top marginal rate (42%) rather than the base rate, this shifts the first-stage estimates but not the estimated second-stage coefficients.

¹⁰As discussed in Abadie, Athey, Imbens and Wooldridge (2023), these clustered standard errors are likely conservative.

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

$$UD_{fgt} = \gamma + \theta \text{NetDues}_{ft} + \phi_f + \sigma_{gt} + \eta_{fgt}, \quad (3)$$

with firm fixed effects (δ_f and ϕ_f) and industry-by-year fixed effects (τ_{gt} and σ_{gt}) in all specifications. Our industry-by-year fixed effects are at the level of industry groups. There are 45 industry groups across the whole private sector, and 5 industry groups within the manufacturing sector. These fixed effects account for any time-varying demand shocks specific to each industry, which may be important given the fast demand growth occurring during this period. These also flexibly control for any industry-specific shocks that may have affected the labor market in each industry. 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. Our regressions are unweighted, meaning we capture the average firm’s response to unionization.

III.D Identification Assumptions

Our identification strategy is akin to an instrumented dose-response difference-in-differences design. Identifying variation comes from differences in the baseline dues of each firm – determined by its occupation mix (there are 241 unique occupation codes in the sample) in the base year – combined with changes in the legislated maximum tax deduction over time. Overall, firms with high ex-ante dues have greater exposure to the increases in the tax deduction cap than firms with low ex-ante union dues. The degree of exposure depends both on the ex-ante dues level and the specific change in the tax deduction cap. With industry-by-year and firm fixed effects, our strategy makes use of this differential change in exposure to the effective union dues subsidy each time the cap is raised and compares changes across firms within the same industry and controls for common industry-specific trends and shocks.

Our identifying variation comes from a broad set of industries and occupations. In Panel A of Appendix Figure A4, we present the share of workers in each industry who were in firms with above-median exposure to the instrument (reduction in net dues). As the figure shows, in most industries there is both a meaningful share of firms with high exposure and a meaningful share of firms with low exposure, meaning we have substantial cross-firm within-industry variation in exposure – necessary for our identification with industry-by-year fixed effects. In Panel B, we show that the employment pattern of workers in “high-exposure” firms (as defined by our instrument) generally mirrors the overall employment rates across industries. Similarly, in Appendix Table A3 we present the share of workers in each occupation group who were in firms with above-median exposure to the instrument, both for the full private sector (columns 1-3) and in manufacturing (columns 4-5). There is substantial variation in exposure within each occupation group. Overall, high exposure to the instrument is not confined exclusively to specific industries or occupation

classes.

Our identification strategy rests on a number of assumptions. To provide intuition for the assumptions, consider two firms (A and B) in the same industry in 2002. Firm A employs workers in occupations that happen to have average union dues that were far higher than at firm B in 2002. The increase in the tax deduction cap from 2003-2010 meant that the net cost of union dues declined only marginally at firm B, while at firm A, the cost declined significantly. Firm A is thus treated by a higher “dose” of the policy, and our approach compares the evolution of union density, earnings, prices, and other outcomes over time between the two firms.

A causal interpretation of these differences requires four assumptions. 1) Relevance: workers at firm A join or remain in unions at higher rates than at firm B after the policy change; 2) Monotonicity: firm A’s relative decline in net union dues does not cause it to decrease its union membership rate compared to firm B over the same period; 3) Exclusion restriction: the larger decrease in net union dues in A only affect firm A’s outcomes (as compared to firm B) through the induced change in union membership rates; and 4) Common trends: firm A and firm B would see union membership rates and other outcomes evolve on a similar path if the policy had not been introduced. We discuss whether each of these assumptions is satisfied below.

For the first assumption – relevance – we show that workers are responsive to reductions in their net dues: our first stage estimate finds a large increase in firm level union density when the net cost of union dues falls.¹¹

Regarding the second assumption – monotonicity – the only way for this assumption to be violated would be if union membership within the same firm is a Giffen good at certain prices, which we find highly unlikely.

The third assumption – the exclusion restriction – 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 differences in narrow occupational mix across firms within industries before the policy was implemented, we can think of no other pathway through which the union-dues subsidy may itself impact firm outcomes, other than via increased firm-level union bargaining power.

The fourth assumption – common trends – states that the expected path of potential outcomes of more- and less-treated firms would be the same in the absence of the change in the tax policy and subsequent union density (conditional on our fixed effects). Importantly, since our approach leverages differential cross-sectional exposure within firms to policy changes over time we do not need ex-ante-high-dues firms and ex-ante-low-dues firms to be similar at baseline; we only require that baseline dues are not related to changes in the potential outcomes of these firms over time. In

¹¹Variation in our instrument comes from firms’ variation in their occupation-industry mix. We therefore also show that the relevance assumption holds within occupation-industry cells and within firm-occupation-industry cells in Appendix Tables [A25](#) and [A26](#) respectively.

the example above, firm A and firm B do not need to be identical in 2002, they only need to have the same trends. This assumption would be violated if, absent the tax policy change, firm A would have experienced larger increases (or smaller decreases) in unionization rates and faster earnings and employment growth compared to firm B even within the same manufacturing industry – and that systematically, these differences in potential outcomes correlated with firms’ average union dues at baseline (as predicted by their occupation mix). We have no a priori reason to believe that this would be the case (see below).¹²

We perform three sets of exploratory analyses to support the common trends assumption. First, in Appendix Table A4, we show the relationship between baseline firm characteristics and the reduction in net dues over 2003-2010 (i.e., the firm’s instrument exposure over the period of large increases in the cap). In Panel A, we show the raw and conditional correlations, and in Panel B we show results from regressions of the reduction in net dues on firms’ baseline characteristics. There is little relationship between firms’ baseline characteristics – average earnings, personnel costs, number of workers, capital costs, materials costs, sales, the labor share, productivity, or profitability – and their later exposure to the instrument. While more-exposed firms appear to be slightly larger and slightly lower-wage ex ante, the differences are economically very small: the top percentile of exposure to the instrument (i.e., total reduction in net dues) had only 0.1% more workers, or 0.16% greater sales than the bottom percentile of exposure. Thus, high-exposure and low-exposure firms were very similar at baseline in their observable characteristics.

Second, we examine whether more- and less-exposed firms have parallel trends in core outcome variables in the period before the large changes in the union dues tax deduction. In Figures I and A5, we show event-study plots of eight core outcomes – union density, log labor cost per worker, log employment, log total labor costs, log net value added per worker, labor share of costs, log total costs, and log sales revenue. In this model, we interact a measure of a firm’s instrument exposure (the 2002-2010 reduction in net dues within the firm) with year dummies, and include firm and industry-by-year fixed effects as in our main specification. (Thus, the event studies are analogous to, but not identical to, our main specification). Panel A of Figure I is analogous to the first stage of our analysis, showing that firms with a larger reduction in net dues (1,000 NOK) had no differential pre-trends in unionization rates but saw a large increase in union density after the subsidies increased. In the remaining panels of Figures I and A5, we again find no evidence of differential pre-trends in these outcomes before the reform happened, but large increases in union density and labor costs over the reform period (with analogous results for manufacturing in Figures

¹²A related assumption is that there are no time-varying shocks after 2002 that affect policy-exposed firms differentially. Our net union dues instrument is *not* strongly correlated with base earnings (Appendix Table A4), so income-correlated shocks are not enough to violate the exclusion restriction. Shocks which may violate the exclusion restriction would have to be *occupation-specific*, correlated with the level and time pattern of occupation-level policy exposure, large enough to drive mean firm outcomes across a wide dispersion of occupations, and uncorrelated with industry-wide trends.

II and A6). The fact that we observe parallel pre-trends gives confidence that the paths of potential outcomes for more- and less-exposed firms were similar.

Third, we run a placebo test, estimating our baseline IV regression with dependent variables from the *pre-reform* period before 2003 (Appendix Table A5). In this test, for each pre-reform year we counterfactually shift the policy environment forward six years by replacing the value of the instrument in that year t , $NetDues_{f,t}$, with the value of the instrument for the same firm six years later, $NetDues_{f,(t+6)}$. As shown by the Kleibergen-Paap rk Wald F statistic, the instrument is very weak for the pre-period - our counterfactually time-shifted instrument does not predict changes in union density in the period before 2003 when the dues deduction cap starts to increase - and also does not predict average labor costs per worker, value added per worker, or firm profits.

Having examined relevance, monotonicity, exclusion, and common trends, we turn to the final aspect of our estimation framework that is important to discuss: potential for spillovers between more- and less-treated firms. Our setting is similar to any difference-in-difference setting that estimates *relative* effects across units based on differential exposure to a shock or policy reform. We have no reason to believe that there are spillovers in our first stage across firms (i.e., that union density in firm j is affected by firm i 's exposure to the tax policy). However, there may be spillovers in economic outcomes, depending on (1) the nature of product and/or labor market competition, and (2) the degree to which a firm's competitors are exposed to the subsidy-induced increase in unionization. To the extent that a firm's labor market competitors also experience increases in their union density and wages, this may require the firm to raise its own wages to attract or retain workers; and to the extent that a firm's product market competitors pass on union-induced labor cost increases in output prices, this may enable the firm to increase its own prices. In Section V.C, we directly examine the role of product- and labor-market spillovers in explaining our results, estimating our main specification with an interaction between a firm's own predicted union density and the shock exposure of competitor firms (in the local labor market, industry, or export product market). We focus this analysis on the manufacturing sector, since our product-level export data enables us to measure product markets at a much greater degree of granularity than we can for non-manufacturing. Importantly, examining the nature of any spillovers helps to characterize if the effects we find are facilitated or influenced by a common market-level shock (either labor- or product market) arising from multiple firms increasing their union density at the same time. Uncovering these dynamics are important for better understanding how our results may generalize to other settings and market structures.

Conditional on the assumptions above, our estimates recover 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 results and assess the magnitude and external validity of our estimates, we examine the complier population in Appendix C. Compliers are broadly representative across earnings, sales, labor share, and productivity, with

somewhat higher representation among larger firms and firms with larger markdowns, though the differences across groups are not statistically significant.

IV Results: Whole Private Sector

In this section, we begin by establishing the first stage linking union dues subsidies to firm-level union density (Section IV.A). We then examine how firms adjust along key margins—including labor costs, employment, input use, sales, productivity, factor shares, and profits (Section IV.B). We next assess whether these responses vary systematically with firm size and market power. We conclude by interpreting these patterns and providing key insights from our private sector analysis.

IV.A First Stage

Table I shows our first stage estimate of the effect of union dues subsidies on workers' propensity to unionize. Consistent with prior work (e.g., Barth, Bryson and Dale-Olsen (2020) and Dodini, Salvanes and Willén (2022)), decreases in the net-of-subsidy union dues at the firm induce increases in firm-level union density. Specifically, firms that experience a 1,000 Kr larger reduction in their average net-of-subsidy dues exhibit a 8.8 percentage point larger increase (or smaller decrease) in firm-level union density (Table I, Column 1). Since union density was falling before 2003, it may be appropriate to interpret the union dues subsidies as having slowed the decline in more-exposed firms.

Our first-stage estimate implies a sizable price elasticity of union membership for marginal Norwegian union members. Notably, the magnitude of this estimated responsiveness is extremely similar to Norwegian workers' self-reported responsiveness to union dues, as surveyed in Dodini et al. (2023). 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 A7 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, compared to our first stage estimate of 8.8 percentage points.¹³ Norwegian workers' price sensitivity to union membership is perhaps not surprising, since part of the benefit of being a union member is explicitly financial.

IV.B Main Results

We now present results of our 2SLS approach, using Equations (2) and (3) as described in Section III.C. Each coefficient measures the response to a 1 percentage point increase in firm-level union density.

Unit labor costs. Consistent with Barth, Bryson and Dale-Olsen (2020), increased firm-level union density increases unit labor costs (measured as the log of labor costs per day worked). Specifically, we find that a 1 percentage point increase in firm-level union density leads to a 0.78

¹³The 7-10pp range is calculated by dividing by six the ≈ 40 -60% change in the survey when the dues change was 6,000 NOK annually.

log point increase in average labor costs per worker (Table I Column (2)).¹⁴

Employment. We find that the increase in union density – and associated increase in unit labor costs – pushes the average Norwegian firm to contract employment (measured as total person-days worked per year). Specifically, Table I, Column (3), shows that a 1 percentage point increase in firm-level union density reduces employment by 5.1 log points. The decrease in employment was more than proportional to the increase in unit labor costs, leading to a 4.3 log-point decline in total personnel costs (Table II, Panel A, Column (1)).¹⁵

Input substitution and scaling. As the unit cost of labor increases, firms may substitute capital or other inputs for labor. We find no evidence for this. In fact, the average firm seems to scale down its input use roughly proportionally to its reduction in employment, as expenditure on capital and materials fall by 6.0 and 6.3 log points respectively (Table II, Panel A Columns (2) and (3)).¹⁶ As the firm scales down its labor, capital, and materials use, sales also decrease, by 4.7 log points (Table II, Panel A Column (4)).

Productivity and factor shares. Our results point to an increase in labor productivity: nominal net value added per worker increases by 0.8 log points (Table II Panel A Column (5)). The increase in labor productivity is nearly identical to the increase in labor compensation, implying that firms fully offset higher labor costs through higher nominal labor productivity. As a result, the labor share of value added does not increase (Table II Panel B Column (2)): workers do not claim a larger share of production revenues at higher union densities.

Firm profits. While factor shares stay constant, total firm profits fall: a 1pp increase in firm level union density reduces the average firm’s profits by 3.2 log points (Table II Panel C, Column (1)). Notably, however, it does not increase the probability of negative profits and in fact decreases the probability of exit substantially.

Workforce composition. In Table III, we examine hiring, separations, and workforce composition. Firms shrink primarily by reducing hiring rather than increasing separations; if anything, separations decline, consistent with higher wages reducing workers’ quit propensity.¹⁷ We also find that firms shift their workforce composition away from less-attached and part-time workers. Specifically, we find that a 1pp increase in union density leads to a 4.3 log point reduction in

¹⁴Because our focus is on firms’ responses to increases in average unit labor costs, we are agnostic about whether these arise from concentrated wage gains among marginal union members or from broader wage increases across workers.

¹⁵Our estimates imply a labor demand elasticity of -6.6 for the average Norwegian private sector firm.

¹⁶We assume that capital and materials prices are orthogonal to firm-level exposure to the union dues subsidy conditional on our fixed effects, implying that changes in materials expenditure reflect changes in input use rather than input prices.

¹⁷Because separations and new hires constitute skewed count data and there is a notable share of firms with no separations in a particular year, we use a Poisson model to estimate separations and hires, normalizing exposure by employment at the firm to capture the separation and new hiring rate. To incorporate our instrument, we use a control function approach (Wooldridge, 2010) in which we use the residuals from our linear first-stage regression as a control in a high-dimensional fixed effects Poisson estimation model (Correia, Guimarães and Zylkin, 2020).

person-days worked for attached workers, but a 7 log point reduction for less-attached workers, as well as a 1.4pp reduction in the probability that a firm employs any less-attached workers at all. Moreover, among the attached workers, we find an increase of 0.7pp in the share on a full-time contract (>30 hours per week), suggesting that firms reduce employment of part-time workers more than that of full-time workers.

We also find that firms shift their workforce composition toward higher-productivity workers. Estimating worker and firm fixed effects in an AKM model (regressing log individual annual earnings on firm fixed effects, worker fixed effects, age, and age squared), we find an increase in the average worker fixed effect of workers at the firm, as well as an increase in the average occupation-by-industry fixed effect of the firm's workforce, suggesting that the firm is disproportionately reducing its hiring of lower-productivity workers and of lower-paid occupations. We estimate that the shift in workforce composition is big enough to explain one third of the increase in labor productivity. Specifically, we run a worker-level regression of log value added per worker on firm and worker fixed effects, as well as age and age squared. The estimated residual is the portion of the firm's annual labor productivity that is not explained by worker characteristics or the firm fixed effect. We then construct average residualized log value added per worker at the firm-year level, and regress this on instrumented union density (Panel C Column (3)). We obtain the one-third estimate by comparing this to the (non-residualized) main estimate for labor productivity in Panel C Column (4).¹⁸ Carrying out the same exercise with log unit labor costs as the dependent variable, we also estimate that one third of the increase in unit labor costs can be explained by workforce composition (Panel C Columns (1) and (2)). We also find suggestive evidence of an intensive margin labor response, with a 2% reduction in sick days taken per worker.¹⁹

Heterogeneity by firm size. 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. We re-estimate our main firm outcome regressions with interactions for firm size (employment) quartile, showing results in Table IV, where each coefficient represents the total effect for each quartile (i.e., the coefficients are not relative to another quartile).²⁰ Large and small firms' responses to increased union density are strikingly different. Small firms have somewhat larger increases in unit labor costs in response to a 1pp increase in firm-level union density than large firms, and at the same time see much larger decreases in employment: small firms decrease employment by

¹⁸Identification requires the assumption that workers' average contribution to firm value added can be broken down into an additive component consistent with analogous assumptions to that of AKM wage regressions. Note that we can only estimate this on roughly three-quarters of the full sample of firms because identification of the worker and firm fixed effects requires sufficient movers.

¹⁹3.6% of attached worker days are taken as sick days on average; with a 1pp increase in union density, this falls by 0.07 percentage points, or a fall of 2%.

²⁰To include interactions in our 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 6, 10, and 18 attached workers (8, 11, and 20 workers in manufacturing). Recall that our sample is restricted only to firms with more than 5 attached workers.

7.5 log points, compared to a (non-statistically significant) decrease of 1.2 log points for large firms. The implied labor demand elasticity for the smallest quartile of firms is -8.0, compared to an implied labor demand elasticity of only -2.3 for the largest quartile of firms. Similarly, large firms scale back their other inputs by much less than small firms, and experience almost no decline in revenues, while small firms experience a large decline in revenues. Thus, we find that large firms' market share stays constant while small firms' market share falls substantially (Table IV Panel B Column (7)). Notably, in almost all the cases where there are statistically significant differences in coefficients by firm size quartile, the coefficients scale monotonically with firm size, suggesting that these differential effects reflect a true firm-size pattern.²¹

Heterogeneity by market power. Our finding above - that small firms shrink their employment and sales substantially as labor costs increase, while large firms hardly shrink at all - would be consistent with larger firms having more market power (which allows them to absorb cost increases with smaller adjustments in scale). We explore this further in Table V, estimating whether firms' employment and revenue responses to increased union density differ by other proxies for firm market power (interacting our instrument with an indicator for whether a firm had above median market power in the prior year). We use three proxies for labor market power (firm's employment share in the local 3-digit occupation or local 2-digit industry labor market, and average estimated industry separation elasticity), two proxies for product market power (firm's share of national or local 2-digit industry revenues), and two measures which could reflect both product and labor market power (firm profit margin and firm log value added per worker).²² Consistently across all eight measures of market power, we find that firms with greater market power have smaller decreases in sales as labor costs rise. In seven of the eight measures, more market power generates smaller decreases in employment. We cannot cleanly identify whether responses differ depending on product or labor market power, since our product and labor market power measures are strongly positively correlated with each other (Appendix Table A6).

Interpretation. The results for the full private sector discussed above point to five main insights.

First, the average firm response is broadly consistent with a competitive labor demand framework: increased union density raises earnings, reduces employment, causes firms to scale down production, lowers sales, and ultimately reduces profits. These responses suggest that firms absorb higher labor costs primarily by contracting employment and output.

Second, substantial heterogeneity across firms reveals departures from this benchmark consistent with labor market power. In particular, firms in the largest size quartile show little or no

²¹The only exception to the monotonic pattern is the probability of exit, which is reduced by 1.3-1.5pp across all four firm size quartiles. In robustness checks, we show that differential trends in economic outcomes by firm size play no role in these results (Appendix Tables A8 and A9).

²²The industry separation elasticity is estimated using a matched event study model following Bassier, Dube and Naidu (2022) (see Appendix B.2).

contraction in employment or production, and we find similarly attenuated employment responses among firms with higher market power across seven additional proxies.²³

Third, firms adjust along the workforce composition margin. Consistent with the “illusion” view of unions proposed by Freeman and Medoff (1984), we find higher worker and occupation–industry fixed effects among remaining workers, and estimate that roughly one third of the increase in unit labor costs is driven by higher pay for higher-productivity workers. Similarly, around one third of the increase in labor productivity reflects an improvement in average worker quality.

Fourth, the patterns shed light on union bargaining priorities. Declines in separation rates and the absence of increased firm exit suggest that employment and firm survival are central to union objectives. At the same time, larger employment reductions among less-attached and part-time workers point to prioritization of core workers, consistent with insider–outsider models of union bargaining (Lindbeck and Snower, 2001; Silliman and Willén, 2024).

Fifth, unionization generates important reallocation effects. An increase in union density causes the average affected firm to shrink, reallocating employment and sales from more-unionizing to less-unionizing firms. We also find reallocation even among the firms that are hit by the union density shock: incremental increases in union density reallocate employment and output toward larger, more productive, and more profitable firms (as found in the minimum wage literature (e.g., Dustmann, Lindner, Schönberg, Umkehrer and Vom Berge (2022)), and toward firms with more labor market power.

V Results: Manufacturing Sector

We found in the previous section that firms’ responses to increased unionization vary systematically with market power. The manufacturing sector provides a useful setting for studying these responses because manufacturing firms tend to have greater product and labor market power than the typical private sector firm. The manufacturing data also allow us to decompose the observed increase in nominal productivity. In particular, higher nominal productivity may reflect either higher output prices or genuine productivity improvements, and detailed product-level export price data allow us to examine price pass-through directly. Finally, we exploit the richness of these data to estimate product markups and labor markdowns, providing a granular view of how market power shapes firms’ responses to increased union density.

V.A Main Results

Labor costs, employment, inputs, and scaling. The average manufacturing firm responds very differently than the average private sector firm to an increase in union density: it scales up, instead of scaling down. Specifically, after a union-induced increase in labor costs, the average manufacturing firm expands rather than contracts employment: a 1 percentage point increase in

²³Similarly, smaller employment responses to minimum wage increases are found in more concentrated U.S. labor markets (Azar, Huet-Vaughn, Marinescu, Taska and Von Wachter, 2024).

firm-level union density leads to an increase in unit labor costs of 0.9 log points alongside an increase in employment of 1.1 log points (Table VI Columns 2 and 3).²⁴ The firm also scales up its other inputs, increasing its expenditure on capital and materials by around 0.9 and 0.6 log points (Table VII Panel A, Columns (2) and (3), suggesting no substitution of other inputs for labor), increases its sales, and increases its market share (measured by the share of national sub-industry revenues, as shown in Panel C Column (4)). Thus, in manufacturing, the union density shock reallocates market share away from firms with low exposure to the shock and towards those with high exposure.

Productivity, factor shares, and profits. As in the full private sector, we find an increase in nominal productivity: nominal net value added per worker increases by 1.1 log points (Panel A Column (5)), and estimated nominal TFP increases by 0.5 log points (Panel B Column (5)). As in the full private sector, we find no change in the labor share, suggesting no net reallocation of the proceeds of production from capital to labor as unionization increases. In contrast to the average private sector firm, however, for manufacturing firms we find no evidence of reduced firm profitability.²⁵ Note, however, that unlike for our other outcome variables, the standard errors on these profit outcomes are large – suggesting that increased unionization may increase the variance of manufacturing firm profits even as it does not affect the mean.

Markups and markdowns. For the manufacturing sector, we are also able to estimate product price markups and labor markdowns. The estimated product price markup increases by 1 percentage point, and the estimated labor wage markdown decreases by 1.7 percentage points, in response to a 1 percentage point increase in union density (Panel B columns (3) and (4)).²⁶

Workforce composition. As in the full private sector, we find that firms shift their workforce composition toward higher-productivity workers: the average worker fixed effect increases as does the average fixed effect of the occupational mix at the firm (Table A11). The shift in workforce composition can explain around one-third of the increase in unit labor costs and one-third of the increase in labor productivity.²⁷ And as in the full private sector, we find evidence of substitution toward attached workers: there is a 1.1 log point increase in the employment of attached workers, but no change in the employment of less-attached workers. We find no evidence of increased work on

²⁴Note that since the average manufacturing firm is slightly shrinking its employment over this period, and since these results are relative to firms which receive a smaller union density shock, this employment result can be interpreted in some cases as an increase in union density slowing the average firm's employment contraction, rather than leading to expansion in absolute terms. Table VI Column (1) also shows our first stage estimate for manufacturing.

²⁵There is no evidence of a negative effect on profit volume (log profits), the probability of a negative profit, or the probability of exit (Panel C, Columns (1)-(3)). In fact, the coefficient on log profits is positive, albeit not statistically significant at the 5% level. The magnitude of the coefficient is consistent with output increasing with a roughly constant profit margin.

²⁶Since our markup and markdown estimation methodology estimates elasticities as constant over the period, by construction these changes in markups and markdowns are driven by an increase the ratio of revenues to materials costs, and an increase in labor costs relative to materials costs, respectively.

²⁷Comparing the increase in residualized log value added per worker of 0.78 log points, as compared to 1.1 log points in the baseline regression (Table A11, Panel C, column (4)).

the intensive margin: there is no change in sick leave or the share of workers on full-time contracts. Notably, the average manufacturing firm grows by reducing its separations, not by increasing its hiring.²⁸

Heterogeneity by market power. We find stark differences in the responses of small and large manufacturing firms: small manufacturing firms shrink employment and output after the union-induced increase in labor costs, while large firms expand. Moreover, large firms experience a decline in their labor markdown that is nearly twice as large as that of small firms. More broadly, the manufacturing evidence reinforces the heterogeneity documented in the full private sector: when manufacturing firms have greater market power—based a wide range of proxy measures including employment and sales concentration, separation elasticities, profit margins, and labor markdowns—employment and sales increase by larger amounts as union density rises (Tables A14 and A15).

Difference between manufacturing and the full private sector. Could market power explain the difference in findings between manufacturing and the full private sector? Across various measures of market power, manufacturing firms have more market power on average than the average firm in the service sector (whether in wholesale & retail trade or professional services) or in construction (Table A7): the average manufacturing firm has 42 workers, compared to 20 in construction or wholesale & retail trade and 26 in professional services; the average manufacturing firm has a substantially higher employment share in its local labor market, and a substantially higher revenue share in both its national and local product market. And in the other industries for which we can plausibly estimate a labor markdown – construction, agriculture, and mining – we estimate effectively no labor markdown (0.98), compared to a large labor markdown of 1.6 in manufacturing.

To test whether market power can help explain the differences in findings between manufacturing and the full private sector, we re-estimate Table V which investigated heterogeneity in employment and revenue effects by market power, but incorporating additional interactions with an indicator for whether a firm is in the manufacturing sector. The results indicate that differences in market power largely account for the divergent employment and revenue responses across sectors, with little evidence of inherently different responses among manufacturing firms. Specifically, the coefficients on lagged power are large and strongly statistically significant, while the coefficients on the interaction between union density and manufacturing are small and not statistically significant – there are no differential responses to shocks to union density between zero-market-power manufacturing and non-manufacturing firms (Table A10).²⁹

Interpretation. Our findings for manufacturing firms differ sharply from those for the average

²⁸The separation elasticity implied by our estimates is -5.9, which is consistent with prior literature (Sokolova and Sorensen, 2021).

²⁹And the coefficients on the interaction between union density, market power, and manufacturing are also mostly small and not statistically significant; where the coefficients are statistically significant, they are negative. That is, to the extent that manufacturing firms do respond differently than non-manufacturing firms to the increase in union density, it is in the opposite direction (i.e., it would suggest that high market power manufacturing firms actually grow their employment slightly less than high market power non-manufacturing firms in response to the union density shock).

private sector firm: increased union density raises both earnings and employment in manufacturing. The combination of higher wages and higher employment is inconsistent with a competitive benchmark in which higher wages reduce employment, and instead consistent with the average manufacturing firm having a meaningful degree of monopsony power – and the increase in union power countervailing this monopsony power. The monopsony interpretation is further supported by our finding that the increase in union density shrinks the labor markdown, and by our heterogeneity results: for firms with labor market power, union-induced wage increases would be expected to increase employment and reduce labor markdowns, while for firms with little monopsony power, union-induced wage increases would be expected to reduce employment with little effect on (already small) labor markdowns.

A simple monopsony model however cannot explain all our findings for the average manufacturing firm. We find an increase in sales revenue, suggesting some combination of higher prices and/or higher sales volume.

Since the increase in revenues exceeded the increase in inputs, we also find an increase in nominal productivity, which similarly could be driven either by an increase in output prices or an increase in quantity produced per worker. Finally, the fact that we see no average decline in profits is surprising and could be driven either by an increase in true productivity or an increase in pricing power. We explore the role of prices vs. productivity further in the next sections.

V.B Estimating Price Pass-through Using Export Data

Unlike in the full private sector, we are able to directly estimate price pass-through of higher labor costs for a large subset of manufacturing firms: exporters. To do so, we match our firm-level 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. (Unfortunately, there are no product-level price data for domestic sales.)

We find that firms increase prices in response to higher union-induced labor costs (Table VIII), whether measured as the firm’s average price per kg (Panel A Column (1)) or by a firm-level Laspeyres price index (Panel B Column (1)).³⁰ Most of the increase reflects increases in product-specific prices (a 1.7-2.1pp log point increase in response to a 1pp increase in union density, consistent with (more than) full pass-through of the increase in labor costs, as shown in Panel A Columns (2) and (3)), but also reflects a shift of firms’ product mix toward higher priced products.³¹

The substantial pass-through of union-induced labor costs to export prices may appear surprising given the conventional view that exporters face highly elastic demand and intense international

³⁰We also repeat our baseline firm-level outcomes in Table VII for the exporter-only sample in Appendix Table A17.

³¹Column (3) of Panel B shows that the share of export revenue from above-median-priced products increased by 1.6 percentage points.

competition. But exporters from high-income countries like Norway typically compete more on quality than price (Feenstra and Romalis, 2014; Schetter, 2020), and Norway's main exports are highly-specialized products like machinery, chemicals, and ships, as well as relatively price-inelastic metals and fish (particularly salmon, in which it has a specialty reputation and very large global market share) (Appendix Figure A8).³² Merging our export data with UN Comtrade data on product-level trade between all countries (at 10-digit HC product code level), we find that Norwegian firms have high market share, with the average dollar of imports coming from Norway arrives at a destination in which Norwegian firms control approximately 26% of the import market for that good, and that Norway's exports tend to be higher-priced even within narrow product category, which is suggestive of product differentiation on quality, with Norwegian goods priced 20% higher than the average for imports in the same product code going to the same destination.

Heterogeneity by market power. Across several empirical exercises, we estimate that firms with greater product market power face less steep price-quantity trade-offs, making it easier for them to respond to the union-induced increase in labor costs. First, we find that firms face less steep price-quantity trade-offs if they have higher product market shares, estimating our price pass-through regressions at the level of a firm-product-destination country-year cell and interacting our union density instrument and the firm's market share in that cell (Table IX, Panel A).³³ Second, we find that there is greater price pass-through in differentiated goods, where one would expect firms to have more pricing power: using Rauch (1999)'s classification, we estimate that product-level price pass-through of the increased labor costs associated with unionization is 25%-62% lower for non-differentiated goods than it is for differentiated goods (Appendix Table A18). Third, we find that firms' share of revenues increases in markets where they plausibly have more pricing power: the average firm's export share of revenues declines as union density increases as firms shift revenues toward the domestic market (Appendix Table A17, Panel B, Column (2)); and the share of an exporters' product-specific revenues coming from high-market-share destinations increases (Appendix Table A19). Fourth, we find greater price pass-through in goods exported to the rest of Scandinavia (which is closer to an extension of the Norwegian domestic market, and therefore where Norwegian firms may have more pricing power) than in goods exported to the rest of the world (Appendix Table A20). Fifth, we find that firms for whom exports are a smaller share of revenues exhibit higher price pass-through on those exports, which could be consistent with firms selling to the domestic market facing less price-elastic demand than firms which primarily export

³²Studies estimate relatively low price elasticities of demand for key exported metals, including nickel, zinc, copper, cobalt, and aluminum (Shojaeddini, Alonso and Nassar, 2024; Dahl, 2020; Fally and Sayre, 2018; Fernandez, 2018). In 2006 Norwegian products represented 51% of global salmon exports and 8% of total fish exports, and research suggests substantial short-run market power for Norwegian fish producers (Steen and Salvanes, 1999) and relatively inelastic demand (Xie, Kinnucan and Myrland, 2009).

³³In Panel B, we interact our union density instrument with the firm's market share among Norwegian exports in the product-destination market (under the logic that Norwegian firms sell differentiated products and so are the closest competitors).

(Appendix Table [A21](#)).

V.C Interactions with Competitor Behavior

Our estimation strategies measure the marginal effect of a firm’s exposure to an exogenous increase in union density, accounting for the average market-level shock (we control for national industry-by-year fixed effects). Nevertheless, the magnitude of the average market-level shock may influence a firm’s ability to respond to its individual shock, particularly in pricing. If more of firm j ’s competitors face the same labor cost shock and raise prices, firm j may be able to increase its prices further or experience a smaller decline in sales. This could occur if widespread price increases raise consumer information costs, making demand less price elastic across the market and allowing for higher prices and markups (e.g., Benabou and Gertner, 1993; Scanlon, 2024).

To examine this, we use the export and Comtrade data to test for spillovers among product market competitors. We repeat our product-level price and quantity regressions, with a control the firm’s competitors’ union shock exposure, as well as an interaction between the firm’s own predicted union density and its competitors’ shock exposure (Table [A22](#), columns (5) and (6)).³⁴

We find meaningful evidence of two different kinds of spillovers: the price-quantity trade-off is less steep for firms whose competitors exhibit larger increases in unionization, and there is treatment-effect heterogeneity of union density by market-level treatment intensity, with firms in more-treated markets raising prices by more in response to unionization than firms in less-treated markets (the interaction term). These findings are consistent with firms facing less price-elastic demand when their competitors are raising prices. We can use the estimated coefficients to quantify this: for a firm that experiences the average dues-induced change in union density, our regression results imply that its price elasticity of demand would be around 12% less elastic in the case where its competitors face a one standard deviation greater union density shock, as compared to the case where its competitors face no union density shock.³⁵

Since product market competitors’ shock exposure affects firms’ price elasticity of demand, we may also expect that it affects firms’ aggregate responses to unionization. We explore whether this is the case, constructing the analogous measure of competitors’ exposure to the union density shock for three different market definitions (local labor market, national industry, and average across export markets), and repeating our baseline regressions (from Table [VII](#)), controlling for the average competitor exposure and an interaction term between our instrument for union density and average competitor exposure.

³⁴The exposure measure for each competitor firm j is that firm j ’s cumulative exposure to the instrument (change in net dues) from 2002-2010. Average competitor exposure for focal firm i is constructed as the revenue-weighted average of competitor firms j exposure within each product-destination country export market, multiplied by Norway’s share of imports in that market.

³⁵In the case where firm i experiences the average dues-induced change in union density and no competitors experience a union density shock, and using our estimate that “pure” price pass-through is 15% of the overall unit price increase (from Appendix [E](#)), the inferred price elasticity of demand is -12.2. When the firm’s competitors experience a one standard deviation higher shock to union density, the inferred price elasticity of demand is -10.7.

We show results for four key outcomes – unit labor costs, employment, sales, and industry revenue share – in Appendix Table A23. We find little statistically significant evidence of either kind of spillover. While coefficient signs tend to be consistent with the kinds of spillovers one might expect – when firm i 's competitors receive a unionization shock which causes them to increase wages and employment, firm i sees a larger increase in wages and smaller increases in employment and sales in response to its own unionization shock – the estimates are very noisy and the implied magnitudes are relatively small.

VI Redistributive Effects of Unionization: Who Pays?

When increased unionization increases labor costs, who pays? We perform a decomposition exercise in the spirit of Harasztosi and Lindner (2019) to decompose the degree to which the union-induced increase in costs falls on consumers versus firm owners. We present the decomposition briefly here, with further details in Appendix E. First, note the accounting identity for a change in total labor costs:

$$\Delta LaborCost = \Delta NetValueAdded - \Delta Profits.$$

Denoting w as the unit wage, L as employment, ξ as nominal labor productivity, and Π as total profits, using subscripts 0 and 1 to denote before and after the change in unionization respectively, we can write this identity as:

$$\underbrace{L_1 \Delta w}_{\text{Change in unit labor costs}} = \underbrace{(\xi_0 - w_0) \Delta L}_{\text{Margin on increased/reduced sales as firm grows/shrinks}} + \underbrace{L_1 \Delta \xi}_{\text{Change in nVA/worker (prices or productivity)}} - \underbrace{\Delta \Pi}_{\text{Change in profits}}. \quad (4)$$

The increase in nominal labor productivity ξ , however, could result from an increase in unit prices or an increase in productivity. We attempt to disentangle these in the next section.

VI.A Disentangling Price and Productivity Effects

Consider three different channels by which nominal revenues per worker might rise: increased productivity via higher quantity produced, increased productivity via higher quality per unit, or a pure price increase (for a unit of a given quality). Formally, express revenues as $p q L = \pi \phi q L$: the product of workers L , the quantity of units produced per worker q , the quality of each unit ϕ , and the price per quality-unit π (such that the price per unit of output $p = \pi \cdot \phi$). The change in average revenue productivity per worker in response to unionization can thus be expressed as $\frac{\partial \ln(\pi)}{\partial u} + \frac{\partial \ln(\phi)}{\partial u} + \frac{\partial \ln(q)}{\partial u}$. Defining value added as revenues minus non-labor costs $VA = pY - cM$, and $\gamma = \frac{pY}{VA}$, the change in average net value added per worker ξ in response to unionization can therefore be expressed as a function of three changes: a pure price change per quality unit, a quality

change per physical unit, and a change in physical unit value added produced per worker:

$$\frac{\partial \ln(VA/L)}{\partial u} = \underbrace{\gamma \frac{\partial \ln(\pi)}{\partial u}}_{\text{Pure price change per quality unit}} + \underbrace{\gamma \frac{\partial \ln(\phi)}{\partial u}}_{\text{Quality change per physical unit}} + \underbrace{\gamma \frac{\partial \ln(q)}{\partial u} + (1 - \gamma) \frac{\partial \ln(cM/L)}{\partial u}}_{\text{Change in physical unit value added per worker}}.$$

There are four labor-side channels through which increased union density may increase productivity: improved workforce composition, reduced separation rates, increased hours worked per worker, and increased within-worker productivity per hour worked.³⁶ We can test the first three empirically, but are not able to test the fourth channel. As such, our estimates of the effects of unionization on productivity may capture a lower bound.

For the average private sector firm we find evidence for all three empirically-testable channels: our results in Section V.A (Table III) show that the average private sector firm experiences an increase in the average “quality” of workers at the firm as proxied by the worker fixed effect, a substantial reduction in the separation rate, and a reduction in sick days (i.e., an increase in actual hours worked). Overall, we estimate that increased productivity can explain 38% of the union-induced increase in log net value added per worker: specifically, we estimated in Section IV.B that the shift in workforce composition could explain 31% of the increase in log net value added per worker, and we estimate that 7% of the increase in net value added per worker can be explained by the increase in hours worked as a result of reduced absenteeism (the reduction in sick days). We do not quantify the productivity effect of the decline in the separation rate, since the firm is shrinking and we assume any productivity benefits from reduced quits are outweighed by the need to shrink employment. We show the details of these calculations in Appendix E.1.

For the average manufacturing firm, we find evidence for two of the three empirically-testable channels: improved workforce composition and reduced separation rate. We estimated in Section V.A that the workforce composition channel can explain 29% of the increase in log value added per worker. To quantify the effects of the decline in separations, we must estimate the cost of turnover. Separations are costly, and so a reduction in turnover can improve a firm’s efficiency. Modeling this cost as incurred in terms of lost output, and taking a conservative estimate of the average cost of replacing a skilled worker of 20% of the worker’s average annual salary (Blatter, Muehleemann and Schenker, 2012), we estimate that a 1 percentage point increase in union density reduces the separation rate by around 0.5 percentage points, and the reduced costs arising from this lower turnover increase value added per worker by 0.13 log points – or a further 12% of the increase in value added per worker that we estimate as a result of a 1pp increase in union density. Thus, we

³⁶Improved workforce composition may occur if higher wages and/or greater worker voice increase firms’ ability to recruit and retain high-productivity workers. Separation rates may fall if higher wages reduce quit propensity. Increased hours per worker, or increased within-worker productivity per hour, may come from efficiency wage or work intensification mechanisms.

estimate that for the average manufacturing firm, increased productivity from improved workforce composition and reduced turnover explains 41% of the increase in net value added per worker.

These estimates could be thought of as lower bounds of the impact on productivity, since they do not take into account the fourth channel, any improvements in within-worker per-hour labor productivity. Nonetheless, we use these estimates as benchmarks for the “true” increase in productivity and assume that the remainder of the increase in net value added per worker – 62% for the average private sector firm, and 59% for the average manufacturing firm – reflects a pure price increase.

For manufacturing firms, we can go one step further to decompose the degree to which the productivity increase reflects increases in the number of units produced per worker (quantity productivity q) as compared to improvements in the quality per unit (quality productivity ϕ). We can do this using our estimates of product-level price increases from the export data in Section V.B. Our estimated product-level price increase after a 1 percentage point increase in union density was 1.7 log points. For the average exporter, the increase in sales revenue was 1.77 log points (Appendix Table A17). Since $\frac{\partial \ln(pqL)}{\partial u} = \frac{\partial \ln(p)}{\partial u} + \frac{\partial \ln(qL)}{\partial u}$, this suggests that at most, the average firm increased its quantity sold by 0.07 log points. Since employment also grew as a consequence of increased union density, this implies that the average quantity produced per worker – “quantity productivity” – fell.³⁷ That is, product-level price increases are more than large enough to account for the entire increase in nominal productivity – under the assumption that firms increase their domestic prices by a similar magnitude to their increases in export prices.³⁸ Thus, our findings imply that the increase in value added per worker induced by increased unionization results entirely from changes in product-level prices $\frac{\partial \ln(p)}{\partial u}$, and not changes in the quantity produced per worker $\frac{\partial \ln(q)}{\partial u}$: in fact, quantity productivity declined.

Thus, the increase in productivity from improved workforce composition and reduced separations must come entirely from the quality margin (which is big enough to more than outweigh a decrease in quantity productivity). The resulting adjustment could be thought of, for example, as the firm responding to an increase in unionization by changing its product mix on the margin to focus on fewer, but higher quality and higher margin, units of output. Our results on product composition from the export price regressions support this, since they show firms shifting to a higher-priced product mix (Table A17) and to destinations in which the firm controls greater shares

³⁷ Among exporters, quantity produced per worker fell by around 0.49 log points for every 1 percentage point increase in union density, since the estimated increase in employment was 0.56 log points, and $\frac{\partial \ln(q)}{\partial u} = \frac{\partial \ln(qL)}{\partial u} - \frac{\partial \ln(L)}{\partial u}$. A decline in quantity produced per worker could be driven by a decline in true quantity productivity, by decreasing returns to scale, or by a diminishing marginal physical product of labor.

³⁸ While we cannot directly examine prices on domestic goods, this assumption is a priori plausible, since export markets for manufactured goods are likely to be more competitive than domestic markets (Atkeson and Burstein, 2008). Our results on firm revenue shares and price pass-through (discussed above) also suggest that firms’ domestic prices were increased by weakly more than their export prices. Moreover, we find bigger increases in markups for the full sample than for exporters, consistent with larger price increases at firms selling domestically.

of the destination-product market (Table A19). We estimate that quality improvements can explain the majority (around 85%) of the unit price increase. We show these calculations in more detail in Appendix E.

VI.B Who Pays for Firms' Increased Labor Costs?

We next use these estimates of the role of productivity vs. prices in explaining the increase in nominal net value added per worker to decompose whether consumers or shareholders bear the cost of increased unionization, or whether it is partly paid for via higher productivity. Specifically, we augment the decomposition in equation (4), denoting the share of the increase in nominal net value added per worker accounted for by productivity as x :

$$\underbrace{L_1 \Delta w}_{\text{Change in unit labor costs}} = \underbrace{(\xi_0 - w_0) \Delta L}_{\text{Increased/reduced margin as firm grows/shrinks}} + \underbrace{(1-x)L_1 \Delta \xi}_{\text{Change in nVA/worker from higher prices}} + \underbrace{xL_1 \Delta \xi}_{\text{Change in nVA/worker from higher productivity}} - \underbrace{\Delta \Pi}_{\text{Change in profits}}. \quad (5)$$

We then use our estimates to implement this decomposition separately for the average private sector firm and for the average manufacturing firm.

For the average private sector firm, the increase in costs borne by the firm can be thought of in two components: both the increase in unit labor costs for the workers that remain, as well as the reduction in margin (net value added) earned by the firm on the units that are no longer sold as the firm scales down. Our decomposition suggests that the firm pays for this increase in costs in three ways: 36% of the increase in costs is passed on to consumers in the form of higher prices, 42% is borne by firm owners in the form of lower profits, and the remaining 22% pays for itself via higher labor productivity (through improved workforce composition and more hours worked). The decomposition is shown in Appendix Table E3.

For the average manufacturing firm, which scales up rather than down as unionization increases, the union-induced increase in costs must be conceived of slightly differently. In this case, the increase in costs borne by the firm can be thought of as the increase in unit labor costs for both existing and new workers. We estimate that 82% of the increase in labor costs is passed on to consumers in the form of higher prices.³⁹ The remainder of the increase in labor costs is paid for by increased productivity (through improved workforce composition and lower turnover), and by generating margin on new sales. Collectively, the increase in prices, increase in sales, and improvement in productivity are actually large enough to increase revenues by more than the increase in labor costs. In the decomposition, some of the proceeds of this productivity improvement thus also accrue to the firm owners in the form of higher profits – but, it is important to note that our coefficient estimate for profits in our main regression analyses in Table VII were not statistically

³⁹For the average manufacturing firm, the revenue share of exports is around 7.5%, meaning 6% of the union-induced increase in labor costs for the average firm is borne by higher prices for foreign consumers, while 76% is borne by higher prices for domestic consumers.

significantly different from zero. The decomposition is shown in Appendix Table E4.

Note that while the increases in productivity in part pay for the increase in labor costs from the perspective of the firm, we would not expect them to generate a similar aggregate increase in productivity because much of the productivity improvement we estimate comes from the affected firm improving its workforce composition, meaning other firms lose high-productivity workers even as the firm in question gains them. The (much smaller) portions of the productivity improvement which come from reducing turnover costs or increasing hours worked per worker, in contrast, do reflect aggregate productivity improvements.

VII A Synthesizing Model

For the average private sector firm, higher union density leads to increased wages, falling employment and sales, and reduced profits. For the average manufacturing firm, higher union density leads to increased wages, employment, sales, nominal productivity, and prices, with no drop in profits. We can explain most of these findings in a simple partial equilibrium model with heterogeneous firm market power in product and labor markets, as outlined in Section VII.A (with the full model in Appendix D). Our results would be consistent with the average private sector firm having little market power in either product or labor markets, while the average manufacturing firm has power in both markets: labor market power allows rising wages to boost employment and output, while product market power enables firms to pass labor costs into prices with very little reduction in demand. However, this model cannot account for all our findings for the average manufacturing firm, and we discuss plausible extensions which would reconcile our findings in Section VII.B.

VII.A Simple Model

Firm problem and wage bargaining process. Consider a firm with a linear production function in labor. 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, a downward-sloping product demand curve, and the bargained wage:

$$\max_l \pi = p(l)zl - wl \quad \text{s.t.} \quad l \leq w^\eta, \quad p(l) = \left(\frac{zl}{Y}\right)^{-\frac{1}{\epsilon}}, \quad w = \bar{w} \quad (6)$$

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^f): $\bar{w} = \beta w^u + (1 - \beta)w^f$.

Firm optimization subject to bargained wage. Once the bargained wage is determined, the firm chooses its employment level l . Following Lo Bello and Pesaresi (2025), 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^c 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. This threshold wage is the point at which the labor supply curve crosses the firm's marginal revenue product curve. The amount of labor hired is increasing in the wage for $w < w^c$ (as the firm moves up the labor supply curve) and then decreasing in the wage for $w > w^c$ (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^f 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:

$$w^f = \left(\frac{\epsilon - 1}{\epsilon} \right) \left(\frac{\eta}{\eta + 1} \right) p^*(z)z. \quad (7)$$

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 $\kappa_l l(w^f)$ and (ii) the wage not be lower than some multiple of the non-union wage $\kappa_w w^f$ (where $\kappa_l < 1$ and $\kappa_w > 1$):⁴⁰

$$\max_w U = w^\alpha l^{(1-\alpha)} \quad \text{s.t.} \quad l \geq \kappa_l l^* \quad , \quad w \geq \kappa_w w^f. \quad (8)$$

The union's optimal wage will either be (i) $w^u = w^c$, which is the highest wage consistent with maximizing employment (the wage that fully offsets the employment-suppressive effect of the firm's monopsony power), (ii) the highest wage w^u such that employment does not fall below the union employment constraint $l(w^u) \geq \kappa_l l(w^f)$, or (iii) the lowest wage $w^u = \kappa_w w^f$ which is compatible with the union wage constraint. Which one of these is the union's optimal wage depends on the relative weight the union places on wages vs. employment, as well as the degree to which

⁴⁰The 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. We assume that the union's wage and employment constraints are compatible with each other.

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).

This simple model with firm monopsony and monopoly power, as laid out above, can explain our findings for the average private sector firm: if the average private sector firm has little labor market monopsony power, then as unit labor costs rise, the firm will reduce employment and profits will fall. This simple model can also explain our findings on wages and employment for the average manufacturing firm: if the average manufacturing firm has significant labor market monopsony power, then the equilibrium is on the labor supply curve. This means that as union density increases, boosting union bargaining power β , wages and employment both increase as the firm moves up its labor supply curve.⁴¹ And if the average manufacturing firm has product market monopoly power then, as labor costs increase, the firm is able to pass some higher costs on in higher prices without much loss of demand. This simple model can also reconcile our findings on heterogeneity by firm size and by other proxies for firm market power: smaller firms saw employment fall as union density increased, consistent with having little labor market monopsony power, while larger firms saw employment rise. We illustrate the simple model for the average manufacturing firm with monopsony and monopoly power in Figure III Panel A, and the average private sector firm (or small manufacturing firm) with less monopsony power in Panel B.

VII.B Explaining Manufacturing Price and Profit Findings

However, this simple model alone cannot fully explain our findings on prices or profits for the average manufacturing firm: in the model, as employment increases the firm increases output and the price falls as the firm moves down the product demand curve, and profits must fall, since the firm was profit-maximizing beforehand. To explain the facts that prices and output both rise at the same time, and that profits do not fall, we need a modification to our model that increases product demand at a given price. We outline three possibilities below and show that they are empirically meaningful in our setting.

i. Increased market power via increased market share. As union density increases, affected firms expand, increasing their market share relative to the firms which were less affected by the shock to union density (Table VII). In models of market power, price elasticity of demand (ϵ) often depends on market share (e.g., Atkeson and Burstein, 2008). Lo Bello and Pesaresi (2025) suggest that when economic activity shifts from smaller to larger firms due to minimum wage increases, larger firms' market power strengthens. A similar dynamic could apply here: as union density increases, market share expands, reducing price elasticity of demand ($\frac{\partial \epsilon}{\partial \beta} < 0$). This shift creates a countervailing effect on prices: while greater unionization raises output, which would typically

⁴¹An efficient bargain model could also explain increases in wages and employment as union bargaining power increases (e.g. McDonald and Solow, 1981). We think this is a less likely explanation, both because our heterogeneity results are strongly suggestive of labor market monopsony power and because Norwegian firm-level bargaining is better described by a right-to-manage model.

lower prices, reduced price elasticity steepens the demand curve, putting upward pressure on prices. If this effect is strong enough, it can outweigh the downward pressure, leading to higher prices. Figure III, Panel C, illustrates this mechanism. This channel is quantitatively meaningful: for the largest quartile of manufacturing firms, we estimate that the average increase in market share could plausibly explain around one fifth of the observed markup increase.⁴²

ii. Increased pricing power as a result of competitors' price increases. All our estimates control for any national market-level price increase induced by the reform, since we include manufacturing industry-by-year fixed effects. But, as discussed in Section V.C, the magnitude of the average price increase might matter: to the extent that more of firm i 's product market competitors were hit with a labor cost shock and induced to raise prices, this could enable firm i to raise prices by more than otherwise (or reduce quantities by less) if a wider atmosphere of price increases increases the information costs to consumers, making demand less price elastic and thus enabling higher prices and markups (as posited, e.g., in Benabou and Gertner, 1993; Scanlon, 2024; Ruffini, 2024). This, too, would show up as a reduction in the price elasticity of demand and therefore an improvement in the price-quantity trade-off (as illustrated in Figure III, Panel C). Our empirical estimates again suggest that this channel is quantitatively plausible. We estimated that the average exporting manufacturing firm faces an effective price elasticity of demand which is about 12% smaller in absolute terms when its competitors face a one standard deviation union density shock, as compared to when its competitors are unaffected by the shock (Table A22), which would predict a 1 percentage point increase in the markup – the same magnitude as the 1 percentage point increase we estimate.⁴³

iii. Improved product quality. A third 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. In Figure III Panel D, 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 prices rise alongside employment as unionization increases. If the improvement in quality generates a sufficiently large price increase, the net effect of increased union density on profits may even be

⁴²We estimate this as follows: for the largest quartile of manufacturing firms, we estimate that the firm's share of national four-digit industry revenues increases by 0.13 percentage points in response to each 1pp increase in union density. 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 : $\epsilon = (\frac{1}{\rho}(1-s) + \frac{1}{\eta}s)^{-1}$. Thus, $\frac{\partial \mu}{\partial s} = (\frac{1}{\eta} - \frac{1}{\rho})\mu^2$, and $\frac{\partial \mu}{\partial u} = \frac{\partial \mu}{\partial s} \frac{\partial s}{\partial u}$. For the largest quartile of firms, our estimate of μ is 1.324, and our estimate of $\frac{\partial s}{\partial u}$ is 0.13. We follow Atkeson and Burstein (2008) in calibrating $\eta = 1$ and $\rho = 10$. Thus, the increase in market share we estimate would be predicted to lead to an increase in the markup of 0.2 percentage points ($\frac{\partial \mu}{\partial u} = 0.0021$). Our empirical estimate of this parameter for the largest quartile of firms, from Table A12, is 0.00973. Thus, the average large manufacturing firm's increase in the market share could explain around one fifth of the markup increase we observe in the data.

⁴³Specifically, we estimated in Section V.C an implied price elasticity of demand of -12.2 for firms which face the average union density shock but have no competitors facing this shock, and -10.7 for firms whose competitors face a one standard deviation greater union density shock. Applying these to the markup formula $\mu = \frac{|\epsilon|}{|\epsilon|-1}$ predicts an increase in the markup from 1.09 to 1.10.

positive. In Section [V.B](#), we showed evidence that increased unionization improved worker quality and reduced turnover, both of which would be expected to improve productivity. Indeed, our estimates suggested that productivity improvements via improved product quality could explain the large majority of the observed unit price increase (around 85%: see calculation in [Appendix E](#)).

VIII Conclusion

To assess who ultimately bears the cost of unionization, we examine how firms respond to increases in union density. For the average private sector firm, increased unionization raises wages but leads firms to contract employment, production, and profits, consistent with a competitive labor demand framework in which higher labor costs are absorbed by firm owners and workers through contraction. However, these responses vary systematically with firms' product and labor market power, indicating that market structure plays a central role in determining who ultimately bears the cost of unionization. In the manufacturing sector—where firms tend to possess greater product and labor market power—we find that at the average firm employment and production expand, prices rise, nominal value added per worker increases, and profits remain stable.

Our findings highlight the central role of market structure in shaping the distributional consequences of unionization. In the high-market-power manufacturing environment, unionized workers are unambiguously better off, with wage and employment gains, while those consumers who are not also unionized workers bear most of the cost of unionization (and shareholders are unaffected). In this context of high monopsony power, increased unionization likely provides countervailing power against employer monopsonies, reducing labor markdowns and lowering deadweight loss. In the lower-market-power environment of the broader private sector, there is a more conventional trade-off between wages and employment opportunities, particularly for less-attached “outsider” workers whose employment outcomes worsen substantially more than those of attached “insiders.”, and shareholders also bear some of the cost of unionization in the form of lower profits, alongside consumers via higher prices.

Our finding of the strikingly differential effects of unionization across firm size imply an important reallocation of economic activity. Unionization shifts employment and production toward larger, more productive, and more profitable firms, as well as toward firms with greater ex ante market power. The welfare implications of this reallocation are ambiguous. On the one hand, the movement of economic activity from lower- to higher-productivity firms may increase aggregate productivity. On the other hand, a reallocation toward larger firms and firms with greater market power may have implications for the long-run competitive environment of the economy.

Although our analysis focuses on unionization, the patterns we document have broader implications for understanding the effects of other labor-cost shocks. The variation we exploit combines a common national shock with heterogeneous firm-level exposure, generating both market-wide and firm-specific changes in labor costs. Our results suggest that firm-specific wage increases may

be partially offset through improved worker recruitment and retention, which raise productivity via better workforce composition and lower separation rates. In contrast, when labor costs rise for all firms in a market, this labor-market adjustment channel is less available, but firms may be better able to pass the shock through to prices because competitors face similar cost increases.

To what extent are our results specific to unionization? Most of the mechanisms we identify could also apply to other exogenous wage increases, but two aspects are likely specific to unionization. First, the wage shock in our setting is determined through bargaining, and unions are unlikely to negotiate wage increases that substantially reduce worker welfare through very large employment losses or firm exit. In contrast, exogenous wage shocks like minimum wage increases are not tailored to firms' economic conditions, and so may lead to stronger contraction or exit among less productive firms. Indeed, research on minimum wages often finds that smaller firms are more likely to exit following wage increases, whereas we find no evidence of increased firm exit even among the smallest firms in our sample. Second, unionization may influence productivity through channels beyond wage increases themselves. Higher wages may improve workforce composition and reduce turnover, but increased union power may also improve worker voice, communication, and job satisfaction, thereby increasing productivity independently of wages. As a result, productivity effects from unionization may be larger than those generated by comparable exogenous wage shocks.

Finally, our manufacturing results raise the question: if unions do not harm profits on average, should we expect manufacturing firms to support unionization? We note that although the average profit effect in manufacturing is close to zero, the estimates are relatively noisy, suggesting that increased unionization may raise the variance of profits even if the mean effect is limited. If owners or managers are risk averse, this increased uncertainty may discourage support for unionization. Moreover, increased union power may impose constraints on managerial flexibility or introduce operational rigidities that limit firms' ability to respond to negative shocks. Finally, part of firms' ability to raise prices without losing large amounts of demand may depend on the fact that competing firms face similar labor-cost shocks; unilateral unionization at a single firm might therefore generate more negative profit effects.

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Tables

Table I
First Stage, Earnings, and Employment - Whole Private Sector

<i>Dep var:</i>	<i>First Stage</i>	<i>IV estimates</i> <i>Effects on Pay and Employment</i>	
	(1) Union Density	(2) Log(Labor Costs Per Worker)	(3) Log(Employment)
Net dues (1,000 Kr)	-8.819*** (1.457)		
Union density		0.00776*** (0.00271)	-0.0509*** (0.0106)
Observations	453,645	453,645	453,645
Dep Var Mean	21.16	6.961	8.517
K-P 1st Stage F Stat	36.61		

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: First stage estimates shown in Column (1), based on Equation 3. IV estimates shown in Columns (2) and (3), based on Equation 2. Sample is all private sector firms with at least five attached workers. Models include fixed effects for firm and industry-by-year. Standard errors clustered at the firm level. Regressions are unweighted.

Table II
Firm Outcomes in the Whole Private Sector

Panel A				
<i>Dep Var:</i>	(1) Log(Labor Costs)	(2) Log(Capital Costs)	(3) Log(Material Costs)	(4) Log(Sales)
Union Density	-0.0431*** (0.00955)	-0.0597*** (0.0119)	-0.0628*** (0.0168)	-0.0471*** (0.0111)
Observations	453,645	449,020	329,037	442,635
Dep Var Mean	8.570	8.033	8.862	9.771
Panel B				
<i>Dep Var:</i>	(1) Log(Net Value Added Per Worker)	(2) Labor Share of Net Value Added	(3) Labor Share of Costs	
Union Density	0.00819* (0.00432)	0.000780 (0.00373)	0.00944 (0.00895)	
Observations	446,861	453,643	453,637	
Dep Var Mean	7.11	0.881	0.363	
Panel C				
<i>Dep Var:</i>	(1) Log(Profits)	(2) Pr(Profits<0)	(3) Pr(Exit)	(4) Log(Industry Revenue Shares)
Union Density	-0.0318** (0.0145)	-0.00290 (0.00374)	-0.0139*** (0.00273)	-0.0471*** (0.0111)
Observations	338,596	453,645	453,645	442,632
Dep Var Mean	6.909	0.240	0.0282	-8.479

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: All estimates are from IV regressions as specified in Equations 3 and 2. Dependent variables are shown in column titles. Models include fixed effects for firm and industry-by-year. Standard errors clustered at firm level. Regressions are unweighted.

Table III
Worker Composition, Hours in the Whole Private Sector

Panel A					
<i>Dep Var:</i>	(1)	(2)	(3)	(4)	(5)
	Log(Employment), Attached	Log(Employment) Non-Attached Workers	Pr(Any Non- Attached)	% of Attached Workers >30 Hours/Week	% of Attached Worker Days Out Sick
Union Density	-0.0429*** (0.00952)	-0.0701*** (0.0163)	-0.0144*** (0.00410)	0.00732*** (0.00117)	-0.000716** (0.000359)
Observations	453,577	385,915	453,645	453,645	453,577
Dep Var Mean	8.285	6.818	0.858	0.821	0.0361
Panel B					
<i>Dep Var:</i>	(1)	(2)	(3)	(4)	(5)
	Log(Share At- tached with Govt Sick Leave)	Separations	New Hires	Avg Worker FE	Worker Occ x Ind FE
Union Density	-0.0105 (0.0110)	-0.0688*** (0.0253)	-0.102*** (0.0203)	0.00802*** (0.00292)	0.00375*** (0.000978)
Observations	353,972	410,326	417,856	453,645	453,634
Dep Var Mean	-3.578	7.128	8.035	0.0785	0.00940
Panel C					
<i>Dep Var:</i>	(1)	(2)	(3)	(4)	
	Residualized Log Labor Cost per Worker	Log Labor Cost per Worker in Residual Sample	Residualized Log Net VA per Worker	Net VA/Worker in Residual Sample	
Union Density	0.00694*** (0.00230)	0.00999*** (0.00317)	0.00958*** (0.00362)	0.0139*** (0.00488)	
Observations	356,093	356,093	353,101	353,101	
Dep Var Mean	0.0123	6.951	0.0137	7.106	

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: All estimates are from IV regressions as specified in Equations 3 and 2. Dependent variables are shown in column titles. Models include fixed effects for firm and industry-by-year. Standard errors clustered at firm level. Regressions are unweighted. Panel C Columns (1) and (3) are firm-level outcomes after residualizing the firm-level outcome on fixed effects for individual workers and firm fixed effects and controls for age and age squared and using these residuals as the dependent variable in our main IV estimation framework. For example, we take firm level net value added per worker VA_{jt} and assign this to every worker who works at firm j in year t . Then, we run a worker-level regression of value added per worker on firm and worker fixed effects and worker age and age squared: $VA_{ijt} = \alpha_i + \phi_j + \beta_1 Age_{it} + \beta_2 Age_{it}^2 + \epsilon_{ijt}$. The estimated residual ϵ_{ijt} is the portion of the firm's value added per worker that is not explained by the worker's productivity (worker fixed effect) or the firm's time-invariant characteristics (firm fixed effect). We then construct residualized value-added per worker at the firm level as the mean of residuals ϵ_{ijt} across all workers i at firm j for each year t . This residualized value-added per worker, denoted $\tilde{v}a_{jt}$, is what we then use as the dependent variable in Panel C Column (3). We do the same exercise for labor cost per worker in Column (1). Separation and new hire rates (Panel B Columns (2) and (3)) are based on a control function approach in a Poisson regression using the residuals of our first stage as controls. Average worker fixed effects (Panel B Column (4)) are the average at the firm level of the worker fixed effects in the model above, weighted by time at the firm. The occupation by industry effects are from a model of attached workers' annual earnings on occupation by industry and firm fixed effects, and the occupation-industry effects are averaged at the firm level.

Table IV
Effects by Firm Size

<i>Dep Var:</i>	(1) Log(Labor Costs per Worker)	(2) Log(Employment)	(3) Log(Labor Costs)	(4) Log(Capital Costs)	(5) Log(Materials Costs)	(6) Log(Sales)
Union Density in Q1	0.00940*** (0.00281)	-0.0751*** (0.00932)	-0.0657*** (0.00831)	-0.0776*** (0.0111)	-0.0864*** (0.0164)	-0.0664*** (0.00994)
Union Density in Q2	0.008*** (0.0027)	-0.0563*** (0.0089)	-0.0483*** (0.008)	-0.0638*** (0.0107)	-0.0697*** (0.0157)	-0.0505*** (0.0095)
Union Density in Q3	0.0066*** (0.0026)	-0.0331*** (0.0085)	-0.0265*** (0.0076)	-0.0457*** (0.0101)	-0.0485*** (0.0149)	-0.0298*** (0.009)
Union Density in Q4	0.0053** (0.0024)	-0.0124 (0.0081)	-0.0071 (0.0072)	-0.029*** (0.0096)	-0.0297** (0.0142)	-0.0114 (0.0086)
Observations	453,645	453,645	453,645	449,020	329,037	442,635

Panel B

<i>Dep Var:</i>	(1) Log(Net Value Added Per Worker)	(2) Labor Share of Net Value Added	(3) Labor Share of Costs	(4) Log(Profits)	(5) Pr(Profit<0)	(6) Pr(Exit)	(7) Industry Revenue Share
Union Density in Q1	0.0101** (0.00448)	0.000445 (0.00393)	0.00951 (0.00930)	-0.0440*** (0.0145)	-0.00266 (0.00394)	-0.0147*** (0.00282)	-0.0664*** (0.00994)
Union Density in Q2	0.0082* (0.0043)	0.0007 (0.0038)	0.0095 (0.0091)	-0.0317** (0.0139)	-0.0027 (0.0038)	-0.014*** (0.0027)	-0.0505*** (0.0095)
Union Density in Q3	0.0066 (0.0041)	0.0009 (0.0036)	0.0094 (0.0087)	-0.0169 (0.0132)	-0.0032 (0.0036)	-0.0134 (0.009)	-0.0298*** (0.009)
Union Density in Q4	0.005 (0.0039)	0.0014 (0.0034)	0.0092 (0.0083)	-0.004 (0.0126)	-0.0033 (0.0034)	-0.0128*** (0.0025)	-0.0114 (0.0086)
Observations	446,861	453,643	453,637	338,596	453,645	453,645	442,632

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

Notes: This table replicates the IV regressions in Table II, but with interactions for firm size quartile, with Q1 being the smallest firms. Dependent variables are shown in column titles. Models include fixed effects for firm and industry-by-year. Standard errors clustered at firm level. Regressions are unweighted. 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 V
Heterogeneous Treatment Effects by Indicators of Market Power

Panel A								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Market Power Measure:</i>	Log(Workers)		Local Occupation Employment Shares		Local Industry Employment Shares		National Industry Shares	Revenue
<i>Dep Var:</i>	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)
Union Density	-0.0957*** (0.0130)	-0.0711*** (0.0130)	-0.0172* (0.00937)	-0.00905 (0.0105)	-0.0187* (0.00958)	-0.00974 (0.0106)	-0.0154* (0.00924)	-0.00829 (0.0104)
Un. Dens. x Power (t-1)	0.0271*** (0.000899)	0.0222*** (0.000898)	0.0392*** (0.00258)	0.0302*** (0.00264)	0.0207*** (0.00138)	0.0161*** (0.00144)	0.0512*** (0.0101)	0.0682*** (0.0140)
Observations	362,035	353,665	362,035	353,665	362,035	353,665	362,035	353,665
Panel B								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Market Power Measure:</i>	Local Shares	Industry Revenue	Industry Separation (<0)	Elasticity	Profit Margins		Productivity: VA/Worker)	Log(Net
<i>Dep Var:</i>	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)
Union Density	-0.0175* (0.00950)	-0.0108 (0.0105)	-0.00985 (0.0116)	0.00852 (0.0128)	-0.0158* (0.00934)	-0.00956 (0.0104)	-0.00848 (0.00909)	-0.0328*** (0.00954)
Un. Dens. x Power (t-1)	0.0126*** (0.000869)	0.0190*** (0.00109)	0.000723** (0.000293)	0.000621* (0.000328)	0.00254*** (0.000478)	0.0111*** (0.000771)	-0.00182*** (0.000174)	0.00567*** (0.000215)
Observations	361,957	353,618	152,956	148,945	361,325	353,124	356,212	348,427
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: This table replicates the IV regressions in Table II and Equations 3 and 2, but with additional interactions between instrumented union density and each measure of market power in year $t - 1$. Dependent variables are shown in column titles. Models include fixed effects for firm and industry-by-year. Standard errors clustered at firm level. Regressions are unweighted. Market power measures are firm size (employment), firm's employment share in the local labor market (defined as 3-digit occupation by local labor market or as industry by local labor market), firm's share of national 2-digit industry revenues, firm's share of local industry revenues, the average estimated industry separation elasticity, firm profit margin, and firm labor productivity. Local employment and revenue shares are calculated over 160 geographic areas. Industry separation elasticity is estimated using a matched event study model following Bassier, Dube and Naidu (2022), which we describe in detail in Appendix B.2.

Table VI
First Stage, Earnings, and Employment - Manufacturing

	<i>First Stage</i>	<i>IV estimates</i> <i>Effects on Pay and Employment</i>	
	(1)	(2)	(3)
	Union Density	Log(Labor Costs per Worker)	Log(Employment)
Net dues (1,000 Kr)	-16.60*** (2.712)		
Union density		0.00899*** (0.00219)	0.0110** (0.00509)
Observations	42,692	42,692	42,692
Dep Var Mean	32.22	7.048	8.881
K-P 1st Stage F Stat	37.50		

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: This table replicates table I, but limiting the sample only to the manufacturing sector. First stage estimates shown in Column (1), based on Equation 3. IV estimates shown in Columns (2) and (3), based on Equation 2. Sample is all manufacturing-sector firms with at least five attached workers. Models include fixed effects for firm and industry-by-year. Standard errors clustered at the firm level. Regressions are unweighted.

Table VII
Main Firm Outcomes - Manufacturing

Panel A					
<i>Dep Var:</i>	(1) Log(Labor Costs)	(2) Log(Capital Costs)	(3) Log(Material Costs)	(4) Log(Sales)	(5) Log(Net Value Added Per Worker)
Union Density	0.0195*** (0.00561)	0.00932* (0.00522)	0.00621 (0.00619)	0.0146*** (0.00540)	0.0110*** (0.00392)
Observations	42,737	42,737	42,737	42,737	42,342
Dep Var Mean	9.024	8.450	9.456	10.23	7.203
Panel B					
<i>Dep Var:</i>	(1) Labor Share of Net Value Added	(2) Labor Share of Costs	(3) Markup	(4) Markdown	(5) TFP
Union Density	-0.00115 (0.00316)	0.00234*** (0.000802)	0.00955** (0.00486)	-0.0174** (0.00814)	0.00521*** (0.00144)
Observations	42,737	42,737	42,737	42,737	42,719
Dep Var Mean	0.882	0.339	1.419	1.582	0.00690
Panel C					
<i>Dep Var:</i>	(1) Log(Profits)	(2) Pr(Profits<0)	(3) Pr(Exit)	(4) Log(Industry Revenue Shares)	
Union Density	0.0222* (0.0120)	-0.00673* (0.00400)	-0.00403 (0.00259)	0.0193*** (0.00656)	
Observations	32,497	42,737	42,737	42,737	
Dep Var Mean	7.379	0.227	0.0727	-6.410	

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: This table replicates the IV regressions in Table II, but limiting the sample only to the manufacturing sector. Dependent variables are shown in column titles. Sample is all manufacturing-sector firms with at least five attached workers. Models include fixed effects for firm and industry-by-year. Standard errors clustered at the firm level. Regressions are unweighted.

Table VIII
Price pass-through (Exports Only)

<i>Panel A</i>	(1)	(2)	(3)
<i>Dep Var:</i>	Firm-Level Avg. Log(Price Per KG)	Product-Level Avg. Log(Price Per KG)	Product-Level Avg. Log(Price Per KG)
Union Density	0.0236 (0.0153) [0.0119]**	0.0169 (0.00726)** [0.00678]**	0.0206 (0.00958)** [0.00878]**
Observations	21,789	244,322	157,467
Firm FE	X	X	
Industry-by-Year FE	X		
Product-by-Year FE		X	X
Firm-by-Product FE			X
<i>Panel B</i>	(1)	(2)	(3)
<i>Dep Var:</i>	Firm-Level Price Index	Export Share of Revenue	% Revenues, Above Median Priced
Union Density	1.228 (0.731)* [0.418]***	-0.00272 (0.00149)* [0.0009]***	0.0163 (0.00635)** [0.00480]***
Observations	21,583	21,806	22,134
Firm FE	X	X	X
Industry-by-Year FE	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: Table shows IV regressions based on Equations 3 and 2. Models are estimated on a sample of manufacturing firms with matched export data. Dependent variables are shown in column titles. Unit of analysis is the firm level for Panel A Column (1) and for all regressions in Panel B, and is the firm-by-product level for Panel A Columns (2) and (3). 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. Fixed effects for each specification are shown in the table. Regressions are unweighted.

Table IX
Export Price Changes, by Product and Destination Revenue Shares

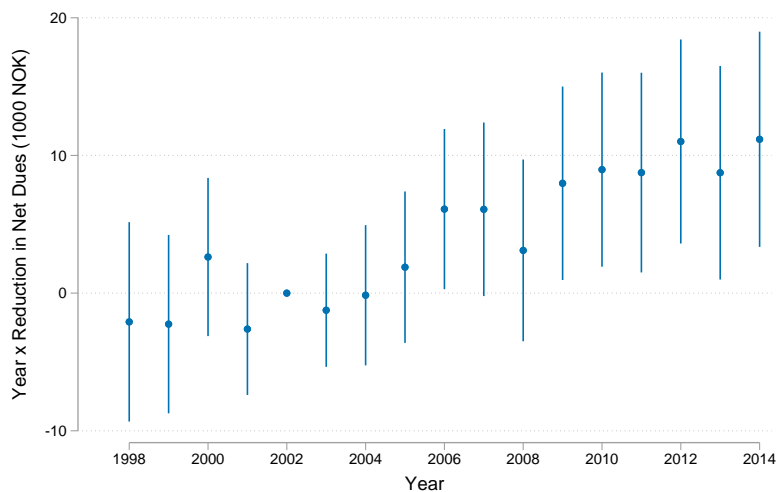
Panel A: Market Share defined as Firm's Share of all Imports (at product-destination level)				
<i>Dep Var:</i>	(1)	(2)	(3)	
	Log(Price per KG)	Log(KG)	Log(Total Value)	
Union Density	0.0233*	-0.0402*		-0.0169
	(0.0127)	(0.0229)	(0.0207)	UD x Firm's Market Share
0.000431	0.0455***	0.0459***		
	(0.000885)	(0.00426)		(0.00399)
Observations	824,219	824,219		824,219
Panel B: Market Share defined as Firm's Share of Norway's Exports (at product-destination level)				
<i>Dep Var:</i>	(1)	(2)	(3)	
	Log(Price per KG)	Log(KG)	Log(Total Value)	
Union Density	0.0254**	-0.0654***		-0.0400**
	(0.0130)	(0.0201)		(0.0158)
UD x Firm's Market Share	-0.00183***	0.0521***		0.0503***
	(0.000531)	(0.00149)		(0.00128)
Observations	857,389	857,389		857,389
Firm FE	X	X		X
Import Country FE	X	X		X
Product by Year FE	X	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.

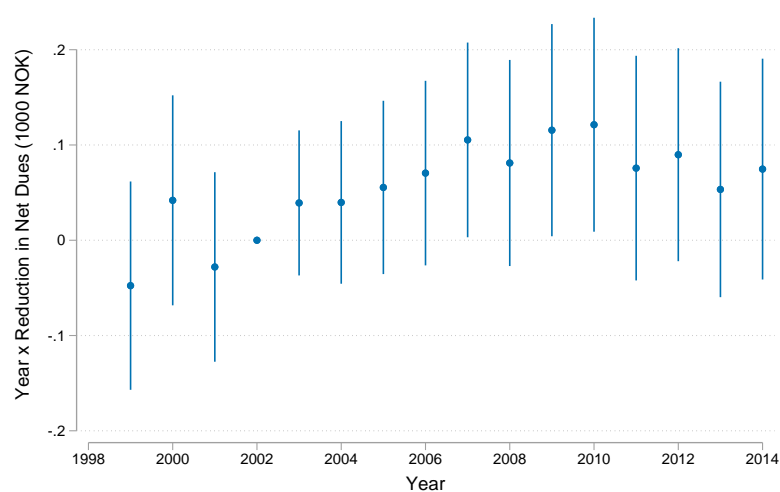
Notes: Table shows IV regressions based on Equations 3 and 2. Unit of analysis is firm by product by destination country by year. "U" is union density. Models include fixed effects for firm, import country, and product by year. Estimates in Column (1) are for export price per KG of goods sold in the customs data among exporting manufacturers, in Column (2) are for the weight or volume of goods sold, and in Column (3) are for the value of goods sold (the product of price per KG and KG). Standard errors clustered at the firm-product level. Regressions are unweighted. In Panel A, the Firm's Market Share is defined as the ratio of total revenues for HS code X from firm Y to country Z (in the Norwegian exporter data) as a share of destination country Z's total import values of HS code X in a calendar year. In Panel B, the Firm's Market Share is defined as the ratio of a firm's total exports of HS code X to country Z as a share of only Norwegian exporters' total revenues for exports of HS code X to country Z. If a firm controls the entirety of a destination's import market for the product type, the quantity responses are not statistically different from zero in both specifications.

Figures

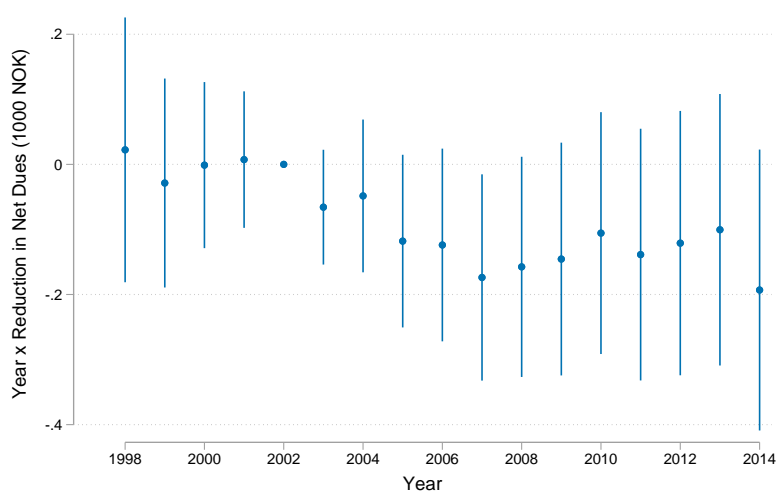
Panel A: Firm Union Density



Panel B: Log Labor Costs Per Worker



Panel C: Log Employment (Person-Days)



Panel D: Log Labor Costs

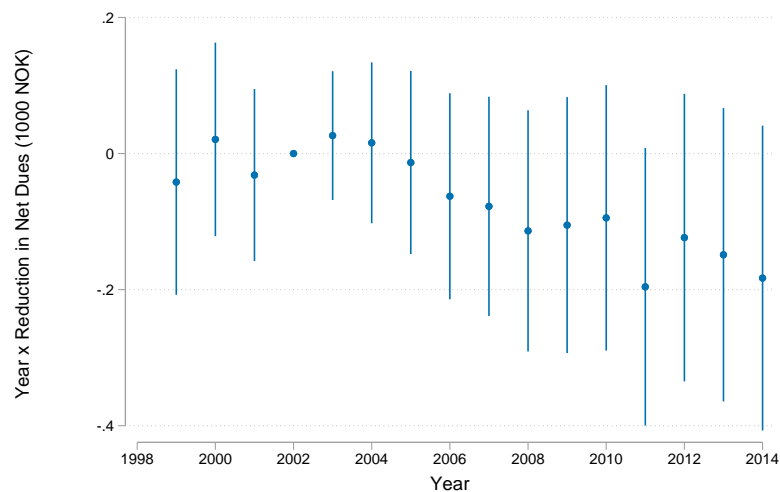


Figure I

Event Studies by Net Dues Reduction Intensity, Full Private Sector

Source: Authors' calculations of Norwegian registry data.

Notes: In each panel, the figure shows coefficients from a regression of the dependent variable listed in the panel title on the interaction between a measure of instrument intensity (the 2002-2010 reduction in net dues within the firm (1000s NOK)) and year dummies. The model includes fixed effects for firm and industry-by-year as in Equations 3 and 2. Estimates are unweighted. Standard errors are clustered at firm level. Sample is all private sector firms with at least five attached workers.

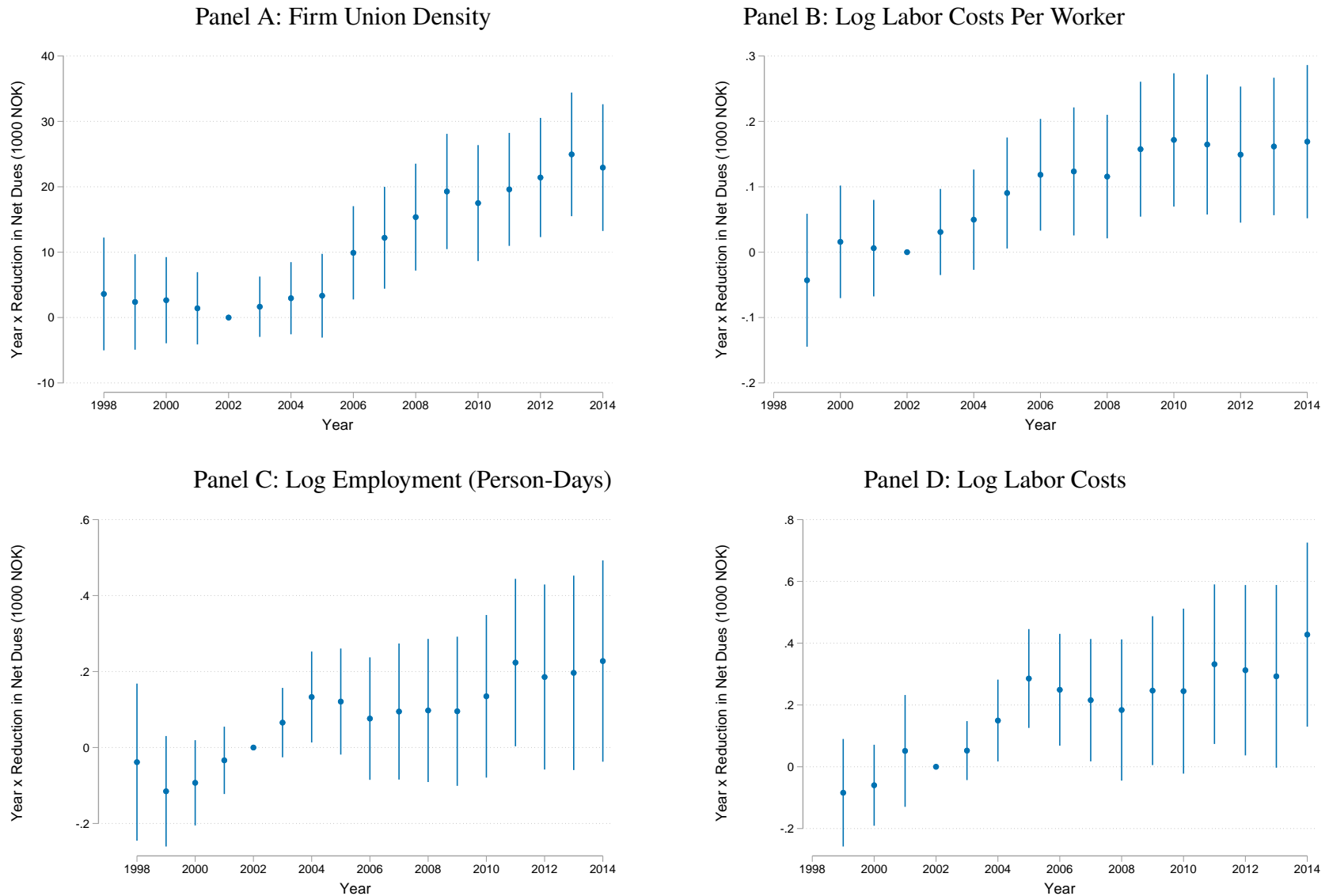


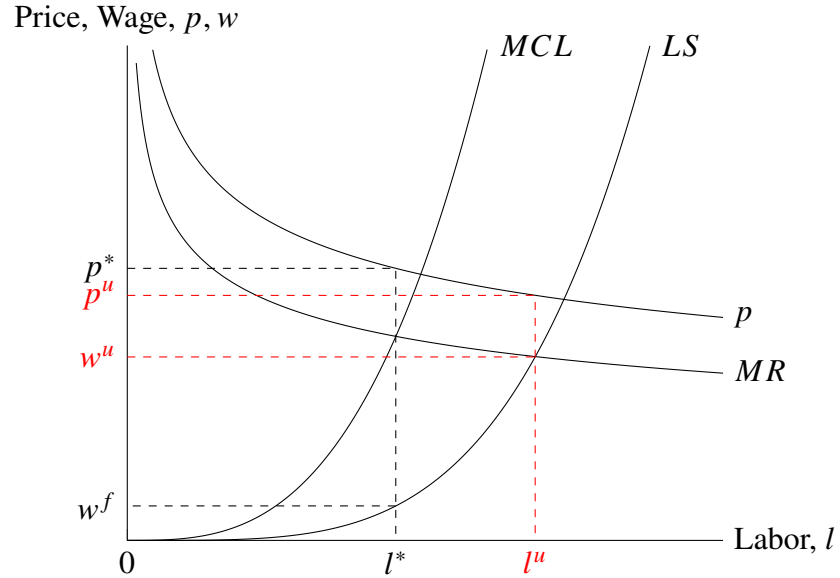
Figure II

Event Studies by Net Dues Reduction Intensity, Manufacturing

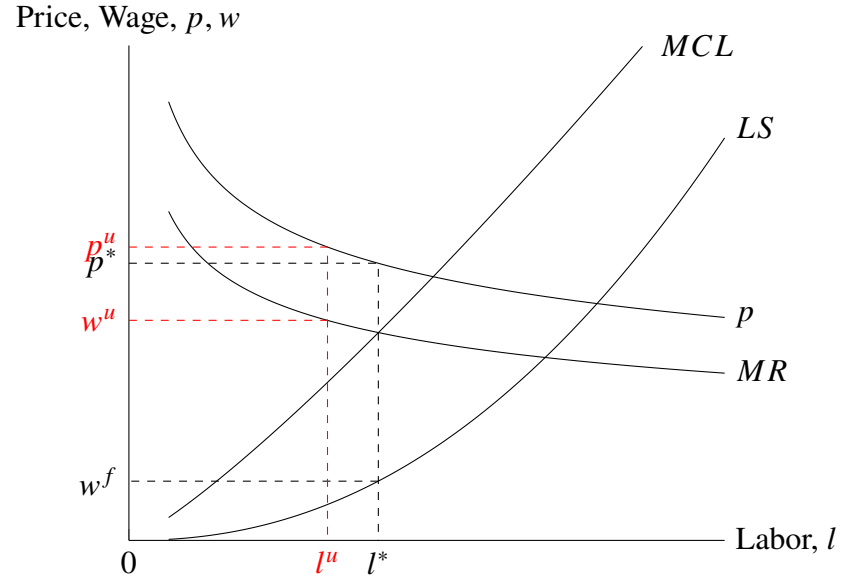
Source: Authors' calculations of Norwegian registry data.

Notes: This figure replicates Figure I, but restricting the sample only to the manufacturing sector. In each panel, the figure shows coefficients from a regression of the dependent variable listed in the panel title on the interaction between a measure of instrument intensity (the 2002-2010 reduction in net dues within the firm (1000s NOK)) and year dummies. The model includes fixed effects for firm and industry-by-year as in Equations 3 and 2. Estimates are unweighted. Standard errors are clustered at firm level. Sample is all manufacturing sector firms with at least five attached workers.

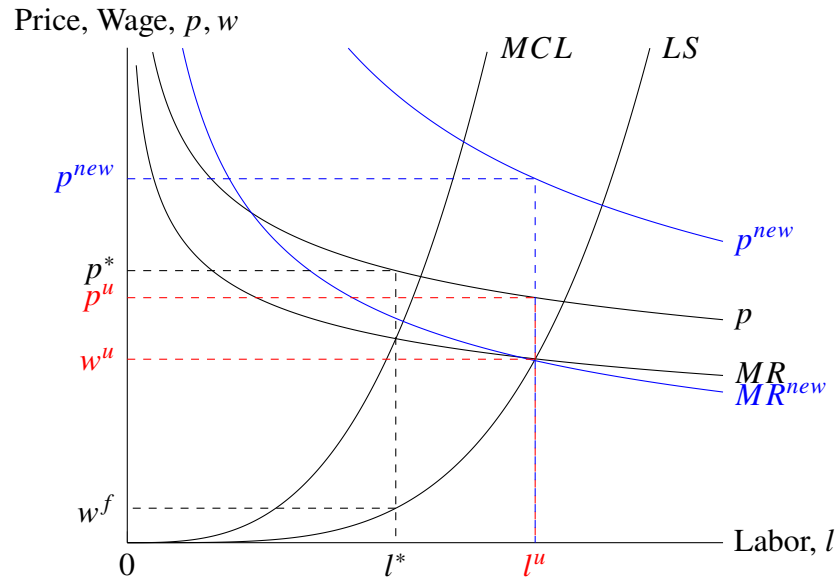
Panel A: Simple Monopsony and Monopoly Setting



Panel B: Firm with Less Monopsony Power



Panel C: Product Demand Elasticity Responds to Market Share



Panel D: Product Quality Responds to Unionization

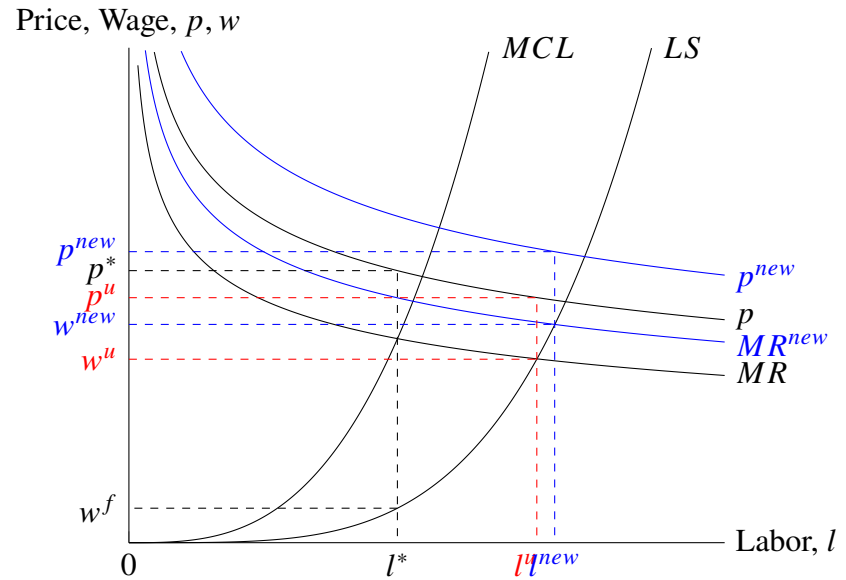


Figure III

Graphical Representations of Model Concepts

Source: Authors' graphical demonstration of key model dynamics.

Who Pays for Unions?

Samuel Dodini
Anna Stansbury
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Online Appendix

June 2026

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A Additional Tables and Figures

Table A1
Summary Statistics by Sector

	(1)	(2)	(3)	(4)
	Full Private Sector	Manufacturing		
	Mean	SD	Mean	SD
Union Density	21.16	24.61	32.22	29.12
Log(Average Earnings 1,000s)	5.863	0.357	5.912	0.274
Log(Labor Costs per Worker)	6.961	0.467	7.050	0.358
Log(Employment)	8.517	0.939	8.882	1.000
Log(Attached Workers)	2.529	0.906	2.910	0.999
Log(Labor Costs)	8.571	1.065	9.024	1.109
Log(Firm Net Value Added per Worker)	7.112	0.633	7.203	0.511
Log(Capital Costs)	8.033	1.261	8.450	1.266
Log(Material Costs)	8.847	1.979	9.456	1.484
Labor Share Net Value Added	0.881	0.421	0.882	0.372
Labor Share of Costs	0.363	2.855	0.339	0.129
Log(Sales)	9.770	1.331	10.231	1.263
Log(Profits)	6.885	1.759	7.358	1.738
Log(Total Costs)	9.792	1.252	10.191	1.256
Pr(Negative Profits)	0.240	0.427	0.227	0.419
Pr(Exit)	0.028	0.166	0.073	0.260
Labor HHI - Occupation Empl. Share	0.058	0.089	0.116	0.136
Labor HHI - Industry Empl. Share	0.081	0.145	0.238	0.238
Product HHI - Natl Industry Rev. Share	0.015	0.034	0.036	0.055
Observations	453,645		42,737	

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 the manufacturing sector, the sample is limited to firms for whom we have enough data to estimate production functions.

Table A2
Instrument Exposure Intensity by Sub-Industry (Manufacturing) in 2003

Sub-Industry	(1) Share of Sub-Industry's Workers with High Exposure	(2) Share of High- Exposure Workers in Sub-Industry	(3) Share of To- tal Workers in Sub-Industry	(4) Share of High- Exposure Workers in Sub-Industry (Manufacturing)	(5) Share of Man- ufacturing Workers in Sub-Industry
Food Products	0.615	0.043	0.038	0.233	0.166
Textiles	0.789	0.005	0.004	0.029	0.002
Wearing Apparel, Dressing, Dyeing Fur	0.840	0.002	0.001	0.008	0.004
Tanning, Leather, Luggage, Footwear	0.505	0.000	0.000	0.002	0.001
Wood, Cork (excl furniture), Plaiting	0.743	0.018	0.013	0.098	0.058
Pulp, Paper	0.007	0.000	0.008	0.001	0.034
Publishing, Printing, Recorded Media	0.027	0.001	0.026	0.007	0.112
Coke, Refined Petroleum, Nu- clear Fuel	0.100	0.000	0.000	0.000	0.000
Chemicals and Chemical Products	0.704	0.016	0.013	0.089	0.055
Rubber and Plastic Products	0.704	0.007	0.006	0.040	0.025
Other Non-Metallic Mineral Products	0.257	0.005	0.010	0.026	0.044
Basic Metals	0.021	0.000	0.011	0.002	0.048
Fabricated Metals Products (excl machinery)	0.607	0.019	0.017	0.103	0.075
Machinery and Equipment (misc)	0.476	0.018	0.021	0.098	0.091
Office Machinery and Com- puters	0.245	0.000	0.000	0.000	0.001
Electrical Machinery (misc)	0.412	0.005	0.006	0.025	0.027
Radio, TV, Communication Equipment	0.688	0.006	0.005	0.031	0.020
Medical, Precision, Optical Instruments	0.487	0.006	0.007	0.033	0.029
Motor Vehicles, Trailers	0.353	0.003	0.005	0.017	0.021
Other Transport Equipment	0.290	0.015	0.029	0.082	0.124
Furniture	0.729	0.013	0.010	0.071	0.043
Recycling	0.494	0.001	0.001	0.004	0.004
Overall in Manufacturing	0.586	0.184	0.230	1.00	1.00

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

Notes: "High exposure" is defined as firms that experienced an above-median reduction in their net dues from 2003 to 2010. Column (1) presents the share of a sub-industry's workers in the manufacturing sector who are in high-exposure firms. Column (2) calculates the share of all high-exposure workers working within each sub-industry. Column (3) is the overall share in the private sector employed in each sub-industry. Column (4) is the share of high-exposure workers in the manufacturing sector employed in each sub-industry. Column (5) shows the share of total manufacturing employment working in each sub-industry.

Table A3
Instrument Exposure Intensity by Occupation Group in 2003

Occupation Group	(1) Share of Occupation's Workers with High Exposure	(2) Share of High-Exposure Workers in Occupation	(3) Share of Total Workers in Occupation	(4) Share of High-Exposure Workers in Occupation (Manufacturing)	(5) Share of Manufacturing Workers in Occupation
Managers	0.584	0.106	0.100	0.103	0.095
Professionals	0.615	0.084	0.075	0.057	0.051
Technicians and Associate Professionals	0.602	0.180	0.164	0.145	0.138
Clerical Support Workers	0.635	0.130	0.112	0.086	0.076
Service and Sales Workers	0.652	0.239	0.201	0.059	0.051
Skilled Agricultural, Forestry, Fishery Workers	0.545	0.005	0.005	0.001	0.002
Craft and Related Trade Workers	0.278	0.077	0.152	0.147	0.201
Plant and Machine Operators	0.496	0.124	0.137	0.367	0.341
Elementary Occupations	0.559	0.055	0.054	0.037	0.046
Overall	0.577	1.00	1.00	1.00	1.00

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

Notes: "High exposure" is defined as firms that experienced an above-median reduction in their net dues from 2003 to 2010. Column (1) presents the share of an occupation group's workers who are in high-exposure firms. Column (2) calculates the share of all high-exposure workers working within each occupation group. Column (3) is the overall share in the private sector employed in each occupation group. Column (4) is the share of high-exposure workers in the manufacturing sector employed in each occupation group. Column (5) shows the share of total manufacturing employment working in each occupation group.

Table A4
Correlation Between 2002 Outcomes and Instrument Exposure

	(1) Raw Correlations		(3) Conditional Correlations	
	All Industries	Manufacturing	All Industries	Manufacturing
Log(Avg Earnings)	-0.156	-0.121	-0.0282	-0.126
Log(Labor Costs)	-0.0827	-0.0118	0.0204	-0.0294
Log(# Workers)	-0.0404	0.0153	0.0286	-0.00234
Log(Capital Costs)	0.0734	0.00887	0.069	-0.00431
Log(Materials)	0.131	0.109	0.0893	0.0752
Log(Sales)	0.0691	0.0530	0.0587	0.0163
Labor Share Costs	-0.221	-0.153	-0.096	-0.128
Labor Share VA	-0.141	0.00456	-0.0373	0.00108
Log(Firm VA Per Worker)	-0.0190	-0.0722	-0.00441	-0.0906
Log(Profit)	0.000378	0.0147	0.0293	0.00523
Pr(Profit<=0)	0.0166	-0.0108	0.0147	-0.0179
N	32,006	5,148	31,986	5,148

Panel B: Regression Test of Conditional Correlations

	(1)	(2)
	All Industries	Manufacturing
Log(Avg Earnings)	-0.00511	-0.0554
Log(Labor Costs)	0.000865*	-0.00233*
Log(# Workers)	0.00138**	-0.000204
Log(Capital Costs)	0.00252***	-0.000301
Log(Materials)	0.00255***	0.00444
Log(Sales)	0.00213***	0.00111
Labor Share Costs	-0.0298***	-0.0897
Labor Share VA	-0.00778	0.000558
Log(Firm VA Per Worker)	-0.000326	-0.0172
Log(Profit)	0.000752**	0.000213
Pr(Profit<=0)	0.00153	-0.00394

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: Panel A raw correlations correspond to the reduction in net dues and each firm outcome in 2002 (baseline). Residualized correlations are calculated by first residualizing variables on indicators for industry for each outcome before calculating the correlation between the variables. Panel B reflects bivariate regressions of later instrument exposure (the change in net dues from 2002-2010 in 1,000s NOK) on each baseline characteristic, including industry fixed effects, with standard errors clustered at the industry level.

Table A5
Placebo Test During the Pre-Treatment Period

<i>Dep Var:</i>	(1) Log(Labor Costs Per Worker)	(3) Log(Net VA per Worker)	(4) Log(Profit)
Union Density	-0.0173 (0.0803)	-0.0355 (0.0807)	-0.118 (0.886)
First Stage Coefficient	-1.56 (4.432)	-2.622 (4.485)	0.87 (5.093)
Observations	74,692	73,786	55,108
1st Stage K-P rF Wald F-stat	0.123	0.342	0.0292
Robust standard errors in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

Source: Authors' calculations of Norwegian registry data from 1997 to 2002 before the tax reform. Data for the outcomes in Columns 1, 3, and 4 are only available after 1999. Standard errors clustered at the firm level.

Notes: All estimates are from IV regressions as specified in Equations 3 and 2, for the years 1997-2002. To construct the placebo test, for each firm we replace the values of the instrument $NetDues_{ft}$ with the values $NetDues_{f(t+6)}$, i.e. the instrument for 1998 would be assigned the instrument value of the same firm in 2004, 1999 assigned the value for 2005, and so on. Models include fixed effects for firm and industry-by-year. Kleibergen-Paap rK Wald F statistics are in bold and reveal no relationship between changes in union density prior to 2003 and our placebo instrument and no relationship with our main outcomes. Dependent variables are shown in column titles. Models include fixed effects for firm and industry-by-year. Standard errors clustered at firm level. Regressions are unweighted.

Table A6
Correlations of Measures of Market Power, 2002

	Workers	Firm Occ-LLM Empl Share	Firm Occ-LLM Empl Share, Private	Firm Ind-LLM Empl Share	Firm Ind-LLM Rev Share	Firm Ind Empl Share	Firm Ind Rev Share	Ind. Sep Elasticity (<0)	Occ-LLM Empl HHI
Workers	1.000								
Firm Occ-LLM Empl Share	0.258	1.000							
Firm Occ-LLM Empl Share, Private	0.239	0.982	1.000						
Firm Ind-LLM Empl Share	0.315	0.854	0.860	1.000					
Firm Ind-LLM Rev Share	0.304	0.813	0.819	0.953	1.000				
Firm Ind Empl Share	0.720	0.342	0.328	0.548	0.523	1.000			
Firm Ind Rev Share	0.651	0.274	0.259	0.456	0.565	0.886	1.000		
Ind. Sep. Elasticity (<0)	-0.155	0.055	0.071	0.002	0.035	-0.151	-0.073	1.000	
Occ-LLM Empl HHI	0.062	0.638	0.654	0.589	0.558	0.210	0.153	0.006	1.000

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

Notes: Table shows firm-level correlations of measures of market power in 2002, for our sample of private sector firms.

Table A7
Measures of Market Power, by Major Industry

	Manufacturing		Construction		Professional Services	Ser-	Wholesale & Retail		All Manufacturing	Non-
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Workers	41.756	141.943	19.617	85.811	25.823	133.958	19.838	79.000	24.945	157.812
Firm Occ-LLM Empl Share	0.079	0.141	0.042	0.086	0.023	0.065	0.012	0.039	0.027	0.073
Firm Occ-LLM Empl Share, Private	0.093	0.159	0.051	0.104	0.036	0.091	0.018	0.053	0.040	0.098
Firm Ind-LLM Empl Share	0.174	0.267	0.024	0.066	0.035	0.107	0.022	0.072	0.044	0.124
Firm Ind-LLM Rev Share	0.170	0.274	0.023	0.070	0.034	0.110	0.022	0.076	0.042	0.125
Firm Ind Empl Share	0.004	0.017	0.000	0.001	0.001	0.005	0.000	0.001	0.001	0.010
Firm Ind Rev Share	0.004	0.021	0.000	0.001	0.001	0.006	0.000	0.002	0.001	0.011
Ind. Sep. Elasticity (<0)	-2.649	0.893	-1.935	0.086	-2.460	0.443	-2.261	0.727	-2.205	0.642
Occ-LLM Empl HHI	0.111	0.132	0.059	0.079	0.040	0.062	0.028	0.045	0.049	0.075
Ind-LLM Empl HHI	0.235	0.235	0.031	0.049	0.040	0.081	0.027	0.059	0.054	0.099
Markups	1.464	1.118	1.338	0.957	-	-	-	-	-	-
Markdowns	1.838	2.514	1.034	0.924	-	-	-	-	-	-

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

Notes: Table shows unweighted mean and standard deviation of each market power measure across firms for all years in the data, by sector. Occupation-LLM employment shares are based on each firm's share of total occupational employment in each of the 160 the local labor markets. Similarly, industry-LLM shares are based on each firm's share of employment in the 2-digit industry in each local labor market. Firm industry and revenue employment shares are based on national 2-digit employment and revenue shares. Industry-specific separation elasticities are measured based on the modified Bassier, Dube and Naidu (2022) event study approach, which we explain in Appendix B.2. HHI is based on the sum of squared firm employment shares. Markups and markdowns are estimated for those industries in which materials act as a flexibly and competitively supplied input following Yeh, Macaluso and Hershbein (2022), as detailed in Appendix B, which prevents us from reliably estimating for the larger private sector outside of manufacturing, construction, etc.

Table A8
Effects by Firm Size with Firm Size Linear Time Trends

Panel A										
<i>Dep Var:</i>	(1)	(2)	(3)	(4)	(5)	(6)	(7)			
	Log(Labor Costs per Worker)	Log(Employment)	Log(Labor Costs)	Log(Capital Costs)	Log(Materials Costs)	Log(Sales)				
Union Density in Q1	0.01000*** (0.00283)	-0.0689*** (0.00866)	-0.0589*** (0.00763)	-0.0733*** (0.0106)	-0.0816*** (0.0156)	-0.0616*** (0.00951)				
Union Density in Q2	0.0085*** (0.0027)	-0.0513*** (0.0083)	-0.0429*** (0.0073)	-0.0604*** (0.0102)	-0.0658*** (0.0149)	-0.0467*** (0.0091)				
Union Density in Q3	0.007*** (0.0026)	-0.0292*** (0.0079)	-0.0222*** (0.0069)	-0.043*** (0.0096)	-0.0455*** (0.0142)	-0.0268*** (0.0086)				
Union Density in Q4	0.0057** (0.0025)	-0.0087 (0.0075)	-0.0029 (0.0066)	-0.0264*** (0.0093)	-0.0265* (0.0136)	-0.0083 (0.0083)				
Observations	453,645	453,645	453,645	449,020	329,037	442,635				

Panel B										
<i>Dep Var:</i>	(1)	(2)	(3)	(4)	(5)	(6)	(7)			
	Log(Net Value Added Per Worker)	Labor Share of Net Value Added	Labor Share of Costs	Log(Profits)	Pr(Profit<0)	Pr(Exit)	Industry Revenue Share			
Union Density in Q1	0.00965** (0.00447)	0.00116 (0.00393)	0.00955 (0.00875)	-0.0432*** (0.0145)	-0.00214 (0.00393)	-0.0141*** (0.00274)	-0.0616*** (0.00951)			
Union Density in Q2	0.0079* (0.0043)	0.0013 (0.0038)	0.0096 (0.0087)	-0.0317** (0.0139)	-0.0023 (0.0038)	-0.0134*** (0.0026)	-0.0467*** (0.0091)			
Union Density in Q3	0.0063 (0.0041)	0.0014 (0.0036)	0.0095 (0.0083)	-0.0168 (0.0132)	-0.0029 (0.0036)	-0.0129*** (0.0025)	-0.0268*** (0.0086)			
Union Density in Q4	0.0048 (0.0039)	0.0018 (0.0034)	0.0093 (0.008)	-0.0034 (0.0126)	-0.003 (0.0034)	-0.0124*** (0.0024)	-0.0083 (0.0083)			
Observations	446,861	453,643	453,637	338,596	453,645	453,645	442,632			

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

Notes: This replicates Table IV with additional controls for time trends by firm size quartile. Specifically, we add additional interactions between firm size quartile and a linear time trend. Firm size quartile is based on each firm's baseline employment in its first year in the data. Standard errors clustered at the firm level. Regressions are unweighted.

Table A9
Effects by Firm Size with Firm Size Non-Parametric Time Trends

Panel A										
<i>Dep Var:</i>	(1)	(2)	(3)	(4)	(5)	(6)	(7)			
	Log(Labor Costs per Worker)	Log(Employment)	Log(Labor Costs)	Log(Capital Costs)	Log(Materials Costs)	Log(Sales)				
Union Density in Q1	0.0102*** (0.00285)	-0.0682*** (0.00858)	-0.0580*** (0.00753)	-0.0731*** (0.0106)	-0.0800*** (0.0154)	-0.0604*** (0.00938)				
Union Density in Q2	0.0086*** (0.0027)	-0.0506*** (0.0082)	-0.042*** (0.0072)	-0.0602*** (0.0102)	-0.0642*** (0.0147)	-0.0455*** (0.009)				
Union Density in Q3	0.0071*** (0.0026)	-0.0284*** (0.0078)	-0.0213*** (0.0068)	-0.0427*** (0.0096)	-0.0439*** (0.014)	-0.0256*** (0.0085)				
Union Density in Q4	0.0059** (0.0025)	-0.0079 (0.0075)	-0.0021 (0.0066)	-0.0261*** (0.0092)	-0.0249* (0.0134)	-0.0072 (0.0082)				
Observations	453,645	453,645	453,645	449,020	329,037	442,635				
Panel B										
<i>Dep Var:</i>	(1)	(2)	(3)	(4)	(5)	(6)	(7)			
	Log(Net Value Added Per Worker)	Labor Share of Net Value Added	Labor Share of Costs	Log(Profits)	Pr(Profit<0)	Pr(Exit)	Industry Revenue Share			
Union Density in Q1	0.0101** (0.00449)	0.000892 (0.00393)	0.0106 (0.00986)	-0.0405*** (0.0144)	-0.00280 (0.00395)	-0.0141*** (0.00273)	-0.0604*** (0.00938)			
Union Density in Q2	0.0083* (0.0043)	0.001 (0.0038)	0.0107 (0.0098)	-0.0291** (0.0138)	-0.0029 (0.0038)	-0.0134*** (0.0026)	-0.0455*** (0.009)			
Union Density in Q3	0.0066 (0.0041)	0.0011 (0.0036)	0.0104 (0.0094)	-0.0141 (0.0131)	-0.0035 (0.0036)	-0.0129*** (0.0025)	-0.0256*** (0.0085)			
Union Density in Q4	0.0052 (0.0039)	0.0015 (0.0034)	0.0101 (0.009)	-0.0008 (0.0125)	-0.0037 (0.0034)	-0.0123*** (0.0024)	-0.0072 (0.0082)			
Observations	446,861	453,643	453,637	338,596	453,645	453,645	442,632			

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

Notes: This replicates Table IV with additional non-parametric controls for differential time effects by firm size quartile. Specifically, we add additional interactions between firm size quartile and year dummies. Firm size quartile is based on each firm's baseline employment in its first year in the data. Standard errors clustered at the firm level. Regressions are unweighted.

Table A10

Heterogeneous Treatment Effects by Indicators of Market Power, and Manufacturing Sector Indicator

Panel A	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Market Power Measure:</i>	Log(Workers)		Local Occupation Employment Shares		Local Industry Employment Shares		National Industry Revenue Shares	
<i>Dep Var:</i>	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)
Union Density	-0.0762*** (0.0253)	-0.0375 (0.0350)	-0.0125 (0.0186)	0.00914 (0.0243)	-0.0175 (0.0193)	0.00582 (0.0235)	-0.00918 (0.0179)	0.00974 (0.0228)
Union Density x Manuf.	-0.0134 (0.0257)	-0.0357 (0.0413)	-0.00512 (0.0152)	-0.0215 (0.0234)	-0.000600 (0.0154)	-0.0180 (0.0221)	-0.00723 (0.0147)	-0.0216 (0.0216)
Un. Dens. x Power (t-1)	0.0268*** (0.00181)	0.0208*** (0.00254)	0.0476*** (0.00415)	0.0340*** (0.00513)	0.0260*** (0.00341)	0.0176*** (0.00406)	0.0422*** (0.0119)	0.0581*** (0.0166)
Un. Dens. x Power x Manuf.	-0.00240 (0.00279)	0.000217 (0.00441)	-0.0166*** (0.00520)	-0.00787 (0.00732)	-0.0102*** (0.00378)	-0.00434 (0.00483)	0.0226 (0.0202)	0.0268 (0.0276)
Observations	362,035	353,665	362,035	353,665	362,035	353,665	362,035	353,665
Panel B	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Market Power Measure:</i>	Local Industry Shares	Revenue	Industry Separation Elasticity (<0)		Profit Margins		Productivity: VA/Worker)	Log(Net
<i>Dep Var:</i>	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)
Union Density	-0.0135 (0.0186)	0.00372 (0.0224)	-0.0146 (0.0147)	0.0134 (0.0155)	-0.00958 (0.0184)	0.00857 (0.0230)	-0.000707 (0.0174)	-0.0132 (0.0217)
Union Density x Manuf.	-0.00399 (0.0150)	-0.0164 (0.0208)	0.00676 (0.00766)	-0.00670 (0.00875)	-0.00718 (0.0149)	-0.0210 (0.0213)	-0.0179 (0.0140)	-0.0190 (0.0208)
Un. Dens. x Power (t-1)	0.0149*** (0.00185)	0.0222*** (0.00243)	0.000624* (0.000366)	0.000576 (0.000410)	0.00239*** (0.000761)	0.0121*** (0.00136)	-0.00245*** (0.000275)	0.00626*** (0.000345)
Un. Dens. x Power (t-1) x Manuf.	-0.00494** (0.00227)	-0.00727** (0.00311)	0.000275 (0.000569)	0.000140 (0.000641)	0.00109 (0.00128)	-0.00210 (0.00215)	0.00252*** (0.000296)	-0.00133*** (0.000406)
Observations	361,957	353,618	152,956	148,945	361,325	353,124	356,212	348,427
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: This table replicates the IV regressions in Table V, but with additional indicators for whether the firm is in the manufacturing sector. Dependent variables are shown in column titles. Models include fixed effects for firm and industry-by-year. Standard errors clustered at firm level. Regressions are unweighted.

Table A11
Worker Composition, Hours in Manufacturing

Panel A					
<i>Dep Var:</i>	(1)	(2)	(3)	(4)	(5)
	Log(Employment), Attached	Log(Employment) Non-Attached Workers	Pr(Any Attached)	Non- % of Attached Workers >30 Hours/Week	% of Days Sick
Union Density	0.0111** (0.00526)	-0.00365 (0.0104)	0.00546 (0.00341)	0.00201* (0.00109)	-0.000155 (0.000301)
Observations	42,684	37,878	42,737	42,737	42,684
Dep Var Mean	8.716	6.884	0.892	0.895	0.0348
Panel B					
<i>Dep Var:</i>	(1)	(2)	(3)	(4)	(5)
	Log(Share At- tached with Govt Sick Leave)	Separations	New Hires	Avg Worker FE	Worker Occ x Ind FE
Union Density	-0.000575 (0.00960)	-0.0534*** (0.0190)	-0.0179 (0.0147)	0.00243 (0.00176)	0.00216** (0.000869)
Observations	36,604	38,818	41,905	42,692	42,736
Dep Var Mean	-3.626	4.717	5.730	0.125	-0.00100
Panel C					
<i>Dep Var:</i>	(1)	(2)	(3)	(4)	
	Residualized Log Labor Cost per Worker	Log Labor Cost per Worker in Residual Sample	Residualized Log Net VA per Worker	Net VA/Worker in Residual Sam- ple	
Union Density	0.00598*** (0.00166)	0.00857*** (0.00223)	0.00780*** (0.00302)	0.0110*** (0.00392)	
Observations	42,692	42,692	42,342	42,342	
Dep Var Mean	0.00880	7.050	0.00930	7.203	

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: This table replicates Table III, but limiting the sample to the manufacturing sector. All estimates are from IV regressions as specified in Equations 3 and 2. Dependent variables are shown in column titles. Models include fixed effects for firm and industry-by-year. Standard errors clustered at firm level. Regressions are unweighted. Panel C Columns (1) and (3) are firm-level outcomes after residualizing the firm-level outcome on fixed effects for individual workers and firm fixed effects and controls for age and age squared and using these residuals as the dependent variable in our main IV estimation framework. For example, we take firm level net value added per worker VA_{jt} and assign this to every worker who works at firm j in year t . Then, we run a worker-level regression of value added per worker on firm and worker fixed effects and worker age and age squared: $VA_{ijt} = \alpha_i + \phi_j + \beta_1 Age_{it} + \beta_2 Age_{it}^2 + \epsilon_{ijt}$. The estimated residual ϵ_{ijt} is the portion of the firm's value added per worker that is not explained by the worker's productivity (worker fixed effect) or the firm's time-invariant characteristics (firm fixed effect). We then construct residualized value-added per worker at the firm level as the mean of residuals ϵ_{ijt} across all workers i at firm j for each year t . This residualized value-added per worker, denoted $\bar{v}a_{jt}$, is what we then use as the dependent variable in Panel C Column (3). We do the same exercise for labor cost per worker in Column (1). Separation and new hire rates (Panel B Columns (2) and (3)) are based on a control function approach in a Poisson regression using the residuals of our first stage as controls. Average worker fixed effects (Panel B Column (4)) are the average at the firm level of the worker fixed effects in the model above, weighted by time at the firm. The occupation by industry effects (Panel B Column (5)) are from a model of attached workers' annual earnings on occupation by industry and firm fixed effects, and the occupation-industry effects are averaged at the firm level.

Table A12
Heterogeneity by Firm Size Quartile, Manufacturing

Panel A							
	(1) Log(Labor Costs per Worker)	(2) Log(Employment Costs)	(3) Log(Labor Costs)	(4) Log(Capital Costs)	(5) Log(Materials Costs)	(6) Log(Sales)	(7) Log(Net Value Added Per Worker)
Union Density in Q1	0.0105*** (0.00259)	-0.0146*** (0.00462)	-0.00372 (0.00491)	-0.00766 (0.00533)	-0.0152** (0.00633)	-0.00647 (0.00516)	0.0122*** (0.00440)
Union Density in Q2	0.0091*** (0.0024)	-0.00140 (0.0042)	0.0079* (0.0045)	0.0015 (0.0049)	-0.0044 (0.0059)	0.0043 (0.0048)	0.0115*** (0.004)
Union Density in Q3	0.0087*** (0.0023)	0.009** (0.0042)	0.0178*** (0.0045)	0.0078 (0.0048)	0.0048 (0.0057)	0.013*** (0.0047)	0.0112*** (0.004)
Union Density in Q4	0.0081*** (0.0022)	0.0203*** (0.0041)	0.0283*** (0.0043)	0.0157*** (0.0047)	0.0139** (0.0055)	0.0224*** (0.0045)	0.0104*** (0.0038)
Observations	42,692	42,692	42,737	42,737	42,737	42,737	42,342
Panel B							
	(1) Labor Share of Net Value Added	(2) Markups	(3) Markdowns	(4) Log(Profits)	(5) Pr(Profit<0)	(6) Pr(Exit)	(7) Log Industry Revenue Share
Union Density in Q1	-8.92e-05 (0.00349)	0.0105* (0.00542)	-0.0122 (0.00896)	0.00559 (0.0135)	-0.00614 (0.00444)	-0.000151 (0.00290)	-0.000902 (0.00659)
Union Density in Q2	-0.00120 (0.0032)	0.0101** (0.005)	-0.0145* (0.0083)	0.0156 (0.0122)	-0.0067 (0.0041)	-0.00270 (0.0027)	0.0096 (0.0061)
Union Density in Q3	-0.0012 (0.0032)	0.0093* (0.0049)	-0.0169** (0.0081)	0.0222* (0.0119)	-0.0066* (0.004)	-0.0039 (0.0026)	0.0179*** (0.0059)
Union Density in Q4	-0.001 (0.0031)	0.0097** (0.0048)	-0.0198** (0.0078)	0.029** (0.0116)	-0.0069* (0.0039)	-0.0049* (0.0025)	0.0265*** (0.0058)
Observations	42,737	42,737	42,737	32,497	42,737	42,737	42,737
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: This table replicates Table IV, but with the sample limited to the manufacturing sector. Regressions are IV regressions with additional interactions for firm size quartiles, with Q1 being the smallest firms. Dependent variables are shown in column titles. Models include fixed effects for firm and industry-by-year. Standard errors clustered at firm level. Regressions are unweighted. 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 A13
Effects by Firm Size with Firm Size Linear Time Trends, Manufacturing

Panel A							
<i>Dep Var:</i>	(1) Log(Labor Cost per Worker)	(2) Log(Employment)	(3) Log(Labor Costs)	(4) Log(Capital Costs)	(5) Log(Material Costs)	(6) Log(Sales)	(7) Log(Net Value Added Per Worker)
Union Density in Quartile 1	0.0103*** (0.00233)	-0.0138*** (0.00493)	-0.00312 (0.00487)	-0.00781 (0.00525)	-0.0151** (0.00624)	-0.00639 (0.00508)	0.0120*** (0.00433)
Union Density in Quartile 2	0.0091*** (0.0023)	-0.001 (0.0043)	0.00823* (0.0045)	0.00115 (0.0049)	-0.00442 (0.0058)	0.00421 (0.0047)	0.0114*** (0.004)
Union Density in Quartile 3	0.0086*** (0.0023)	0.0092** (0.0041)	0.0179*** (0.0044)	0.00758 (0.0048)	0.00463 (0.0056)	0.0129*** (0.0046)	0.0111*** (0.0039)
Union Density in Quartile 4	0.0081*** (0.0022)	0.0205*** (0.004)	0.0285*** (0.0043)	0.0157*** (0.0047)	0.0141** (0.0055)	0.0225*** (0.0045)	0.0104*** (0.0038)
Observations	42,692	42,692	42,737	42,737	42,737	42,737	42,342
Panel B							
<i>Dep Var:</i>	(1) Labor Share of Net Value Added	(2) Markup	(3) Markdown	(4) Log(Profits)	(5) Pr(Profit<0)	(6) Pr(Exit)	(7) Log(Industry Revenue Shares)
Union Density in Quartile 1	-0.000235 (0.00345)	0.0107** (0.00538)	-0.0135 (0.00886)	0.00439 (0.0132)	-0.00604 (0.00438)	0.00177 (0.00280)	-0.00176 (0.00645)
Union Density in Quartile 2	-0.0012 (0.0032)	0.0103** (0.005)	-0.0153* (0.0082)	0.015 (0.012)	-0.00661 (0.0041)	-0.00159 (0.0026)	0.00864 (0.0059)
Union Density in Quartile 3	-0.0012 (0.0031)	0.0094* (0.0048)	-0.0176** (0.008)	0.0215* (0.0118)	-0.00660 (0.004)	-0.00332 (0.0025)	0.0171*** (0.0058)
Union Density in Quartile 4	-0.001 (0.0031)	0.00978** (0.0048)	-0.020** (0.0078)	0.0291** (0.0115)	-0.00690 (0.0039)	-0.00443* (0.0025)	0.0263*** (0.0057)
Observations	42,737	42,737	42,737	32,497	42,737	42,737	42,737

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

Notes: This replicates Table A12 with additional controls for time trends by firm size quartile. Specifically, we add additional interactions between firm size quartile and a linear time trend. Firm size quartile is based on each firm's baseline employment in its first year in the data. Standard errors clustered at the firm level. Regressions are unweighted.

Table A14
Heterogeneous Treatment Effects by Indicators of Market Power, Manufacturing Sector

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Market Power Measure:</i>	Log(Workers)		Local Occupation Employment Shares		Local Industry Employment Shares		National Industry Revenue Shares	
<i>Dep Var:</i>	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)
Union Density	-0.0494*** (0.00514)	-0.0347*** (0.00608)	0.0101* (0.00568)	0.0118** (0.00585)	0.00967* (0.00546)	0.0116** (0.00571)	0.0114** (0.00549)	0.0129** (0.00570)
Un. Density x Power (t-1)	0.0195*** (0.000654)	0.0152*** (0.000659)	0.0169*** (0.00231)	0.0125*** (0.00216)	0.0104*** (0.00107)	0.00722*** (0.00106)	0.0684** (0.0318)	0.118** (0.0473)
Observations	43,095	43,140	43,095	43,140	43,095	43,140	43,095	43,140
Panel B								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Market Power Measure:</i>	Local Industry Revenue Shares		Industry Separation Elasticity (<0)		Profit Margins		Productivity: Log(Net VA/Worker)	
<i>Dep Var:</i>	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)	Log(Emp)	Log(Revenue)
Union Density	0.00975* (0.00546)	0.0107* (0.00565)	0.0124 (0.00873)	0.0139 (0.00883)	0.0104* (0.00545)	0.0106* (0.00557)	0.0107** (0.00544)	-0.00801 (0.00588)
Un. Density x Power (t-1)	0.00704*** (0.000872)	0.00942*** (0.00104)	0.00109*** (0.000403)	0.000878** (0.000430)	0.00517*** (0.000735)	0.0125*** (0.000999)	0.000183 (0.000210)	0.00474*** (0.000334)
Observations	43,095	43,140	19,397	19,414	43,091	43,136	42,629	42,658
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: This table replicates the IV regressions for the manufacturing sector in Table VII, but with additional interactions for each measure of market power in year $t - 1$. Dependent variables are shown in column titles. Models include fixed effects for firm and industry-by-year. Standard errors clustered at firm level. Regressions are unweighted. Market power measures are firm size (employment), firm's employment share in the local labor market (defined as 3-digit occupation by local labor market or as industry by local labor market), firm's share of national 2-digit industry revenues, firm's share of local industry revenues, the average estimated industry separation elasticity, firm profit margin, and firm labor productivity. Local employment and revenue shares are calculated over 160 geographic areas. Industry separation elasticity is estimated using a matched event study model following Bassier, Dube and Naidu (2022), which we describe in detail in Appendix B.2.

Table A15

Heterogeneous Treatment Effects by Markups, Markdowns, Export Market Shares, Manufacturing Sector

<i>Market Power Measure:</i>	(1) Markups	(2)	(3) Labor	(4) Markdowns	(5) Export	(6) Destination Market Shares
<i>Dep Var:</i>	Log(Employment)	Log(Revenue)	Log(Employment)	Log(Revenue)	Log(Employment)	Log(Revenue)
Union Density	0.0131** (0.00641)	0.0165*** (0.00637)	0.0131** (0.00642)	0.0139** (0.00653)	0.00604 (0.00649)	0.0146** (0.00711)
Un. Density x Power (t-1)	-3.68e-05 (0.000192)	-0.00170*** (0.000257)	-0.000154 (0.000105)	0.000656* (0.000381)	0.00497*** (0.00144)	0.00803*** (0.00168)
Observations	33,774	33,804	33,774	33,804	21,923	21,943

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: This table replicates the IV regressions for the manufacturing sector in Table VII, but with additional interactions for each measure of market power in year $t - 1$. Dependent variables are shown in column titles. Models include fixed effects for firm and industry-by-year. Standard errors clustered at firm level. Regressions are unweighted. Market power measures are estimated firm-level product markup, labor markdown, and (for exporters only), average product-destination market shares.

Table A16
Effects when Including Baseline Union Density Quartile Time Trends

Panel A				
<i>Dep Var:</i>	(1)	(2)	(3)	(4)
	Log(Labor Costs per Worker)	Log(Employment)	Log(Labor Costs)	Log(Capital Costs)
Union Density	0.0216** (0.0105)	-0.136** (0.0574)	-0.115** (0.0491)	-0.152** (0.0625)
Observations	453,645	453,645	453,645	449,020
Panel B				
<i>Dep Var:</i>	(1)	(2)	(3)	(4)
	Log(Material Costs)	Log(Sales)	Log(Net Value Added Per Worker)	Labor Share of Net Value Added
Union Density	-0.152** (0.0743)	-0.122** (0.0541)	0.0251* (0.0138)	-0.000613 (0.00945)
Observations	329,037	442,635	446,861	453,643
Panel C				
<i>Dep Var:</i>	(1)	(2)	(3)	(4)
	Log(Profits)	Pr(Profits<0)	Pr(Exit)	Log(Industry Revenue Shares)
Union Density	-0.0609* (0.0346)	-0.00941 (0.0101)	-0.0345** (0.0143)	-0.122** (0.0541)
Observations	338,596	453,645	453,645	442,632

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

Notes: This table replicates our IV regressions in Tables I and II, with additional controls for linear time trends by quartiles of baseline union density, where the quartiles are based on each firm's first year in the data. Dependent variables are shown in column titles. Models include fixed effects for firm and industry-by-year. Standard errors clustered at firm level. Regressions are unweighted. Estimates are similar when we use baseline union density quartile by year fixed effects. The standard errors cannot rule out effects that include our baseline model in Tables I and II.

Table A17
Main Estimates, Manufacturing Exporter Sample

<i>Dep Var:</i>	(1)	(2)	(3)	(4)	(5)
	Log(Labor Costs per Worker)	Log(Employment)	Log(Labor Costs)	Log(Capital Costs)	Log(Material Costs)
Union Density	0.0105 (0.00315)*** [0.00216]***	0.00556 (0.00673) [0.00378]	0.0158 (0.00708)** [0.00391]***	0.0118 (0.00745) [0.00443]***	0.0114 (0.00805) [0.00467]**
Observations	21,765	21,765	21,789	21,789	21,789
Panel B					
<i>Dep Var:</i>	(1)	(2)	(3)	(4)	(5)
	Log(Sales)	Log(Net Value Added Per Worker)	Labor Share of Net Value Added	Markup	Labor Mark-down
Union Density	0.0177 (0.00742)** [0.00426]***	0.0189 (0.00650)*** [0.00449]***	-0.00657 (0.00493) [0.00404]	0.00536 (0.00629) [0.00423]	-0.0102 (0.0112) [0.00719]
Observations	21,789	21,464	21,789	21,789	21,789
Panel C					
<i>Dep Var:</i>	(1)	(2)	(3)	(4)	
	Log(Profits)	Pr(Profits<0)	Pr(Exit)	Log(Industry Revenue Shares)	
Union Density	0.0293 (0.0179) [0.0128]	-0.00629 (0.00544) [0.00431]**	2.46e-06 (0.00310) [0.00283]	0.00453 (0.00894) [0.00480]	
Observations	16,487	21,789	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: This table replicates the IV regressions in Table VII, but limiting the sample only to the manufacturing firms which record exports. Dependent variables are shown in column titles. Sample is all manufacturing-sector firms with at least five attached workers. Models include fixed effects for firm and industry-by-year. Standard errors clustered at the firm level. Regressions are unweighted.

Table A18
Export Price Changes, by Differentiated Goods Status

<i>Dep Var:</i>	Clustered SE		Huber-White SE	
	(1) Log(Price KG)	(2) Per Log(Price KG)	(3) Log(Price KG)	(4) Log(Price KG)
Union Density, Differentiated	0.0170** (0.00725)	0.0234** (0.00914)	0.0170** (0.00678)	0.0234*** (0.00812)
Un. Dens., Other Relative to Differentiated	-0.00425** (0.00198)	-0.0144 (0.0135)	-0.00425*** (0.00165)	-0.0144 (0.0106)
Observations	244,322	173,806	244,322	173,806
Firm FE	X		X	
Product-by-Year FE	X		X	
Firm by Product FE		X		X
Industry by Year FE		X		X

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

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

Notes: Table shows IV regressions as in Equations 3 and 2. Observations are at the firm-product-year level. Fixed effects as noted in the table. Dependent variables are shown in column titles. Standard errors clustered at the firm-product level (Columns 1-2) and Huber-White standard errors (Columns 3-4). Regressions are unweighted. Classifications of differentiated and other goods are defined for 3- and 4-digit SITC codes as in Rauch (1999).

Table A19

Shifts in Export Revenues to More Dominant Locations

Panel A					
<i>Dep Var:</i> Share of Firm's Product-Specific Export Revenue from Countries where Firm Controls $\geq X\%$ of Country-Product Cell					
<i>X (Share %)</i>	(1) Own Share $\geq 2\%$	(2) Own Share $\geq 5\%$	(3) Own Share $\geq 10\%$	(4) Own Share $\geq 15\%$	(5) Own Share $\geq 20\%$
Union Density	0.00110** (0.000505)	0.000609* (0.000331)	0.000229 (0.000241)	0.000147 (0.000196)	0.000161 (0.000169)
Observations	413,722	413,722	413,722	413,722	413,722
Mean	0.041	0.023	0.013	0.009	0.007
Panel B					
<i>Dep Var:</i> Share of Firm's Product-Specific Export Revenue from Countries where Norwegian Firms Control $\geq X\%$ of Country-Product Cell					
<i>X (Share %)</i>	(1) NOR Share $\geq 2\%$	(2) NOR Share $\geq 5\%$	(3) NOR Share $\geq 10\%$	(4) NOR Share $\geq 15\%$	(5) NOR Share $\geq 20\%$
Union Density	0.00526*** (0.00134)	0.00551*** (0.00113)	0.00383*** (0.000726)	0.00241*** (0.000563)	0.00183*** (0.000469)
Observations	413,722	413,722	413,722	413,722	413,722
Mean	0.219	0.134	0.074	0.053	0.041
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 are from IV regressions based on Equations 3 and 2. Observations are at the firm-product-year level. The dependent variables are constructed by calculating the share of a firm's product-specific total revenues coming from different destination countries. Destination countries are stratified by whether or not the firm (Panel A) controls $> X\%$ of the whole product-destination cell or whether Norwegian firms (Panel B) collectively control $> X\%$ of the product-destination cell. The dependent variables are the shares of the firm's total product-specific export revenues generated from destinations within these classifications each year.

In Panel A, to calculate each percentage bin, each firm's share of the destination country's import market for each product is calculated by multiplying the share of the product's imports to arriving from Norway (in Comtrade) with each firm's export shares of each product among Norwegian exporters in the Norwegian customs data. For example, for product A in country B, if Norwegian producers control 25% of the market for A in B and firm Y controls 20% of the Norwegian exports of A to B, firm Y controls 5% of the whole market for product A in country B. The shares of firm Y's total product A revenues coming from product A in country B enter the " $\geq 2\%$ " and " $\geq 5\%$ " buckets in the dependent variable.

In Panel B, to define each $X\%$ bin, we use only Norway's share of each country's import market for each product in the Comtrade data. Models include fixed effects for firm and product-by-year. Standard errors clustered at the firm-product level. Regressions are unweighted.

Table A20
Exports by Destination

<i>Dep Var:</i>	(1) Scandinavia Log(Price Per KG)	(2) All Log(Price KG)	Others Per	(3) Scandinavia Log(Price Per KG)	(4) All Log(Price KG)	Others Per
Union Density	0.0285 (0.0165)* [0.0130]**	0.0106 (0.0195) [0.0171]		0.0185 (0.0101)* [0.00955]*	0.0147 (0.00955) [0.00902]	
Observations	17,762	16,981		97,465	173,845	
Firm FE	X	X		X	X	
Industry-by-Year FE	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 IV regressions based on Equations 3 and 2. Models include fixed effects for firm and industry-by-year. Models are estimated on a sample of manufacturing firms with matched export data at the firm-year level (columns (1) and (2)) or firm-by-product-by-year level (columns (3) and (4)), 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. Regressions are unweighted. 21% of Norwegian exports by value go to the rest of Scandinavia; for the median exporting firm, 46% of export revenues come from sales to the rest of Scandinavia.

Table A21**Export Price Changes, by Export Share of Firm Revenue**

	(1)	(2)
<i>Dep Var:</i>	Log(Price Per KG)	Log(Price Per KG)
Union Density	0.0257 (0.0167) [0.0132]*	-0.00409 (0.0122) [0.00869]
Observations	16,772	4,704
Export Shares	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 IV regressions based on Equations 3 and 2. Unit of observation is firm-by-year, with dependent variable the average log price per KG of the firm's exports. Models include fixed effects for firm and industry-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. Regressions are unweighted. 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 A22
Export Price Spillovers, Competitor Instrument Exposure

<i>Dep Var:</i>	(1) Log(Price Per KG)	(2) Log(KG)	(3) Log(Price Per KG)	(4) Log(KG)	(5) Log(Price Per KG)	(6) Log(KG)
Union Density	0.0333*** (0.0126)	-0.0598*** (0.0221)	0.0332*** (0.0126)	-0.0602*** (0.0221)	0.0332*** (0.0126)	-0.0608*** (0.0223)
Un. Dens. x 1 SD Prod.-Dest. Cumul. Exposure x Norway Import %	0.000142** (5.89e-05)	0.000107 (0.000276)			-6.68e-05 (0.000338)	-0.00656** (0.00272)
1 SD Prod.-Dest. Cumul. Exposure x Norway Import %			0.00702** (0.00298)	0.0175 (0.0149)	0.0101 (0.0168)	0.324** (0.130)
Observations	616,338	616,338	616,338	616,338	616,338	616,338
Clustered 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 IV regressions based on Equations 3 and 2. Unit of observation is firm-by-product-by-destination country-by-year. Models include fixed effects for firm, import country and product-by-year. Standard errors are clustered at the firm-product level. Regressions are unweighted. Estimates are for export prices per KG of goods sold in the customs data among exporting manufacturers. Product-destination cumulative exposure is the cumulative change in the instrument from 2002-2010 among competitors in the product-destination country cell and is weighted by firm-product-destination revenues, and then rescaled in standard deviation units. For interpretation, we multiply the cumulative changes by -1 such that positive numbers align with increased unionization. We interact this cumulative exposure among Norwegian exporters with Norwegian exporters' share of destination imports of a product on a [0,1] scale. This is defined as the ratio of total revenues for HS code X coming to country Z in the Norwegian exporter data as a share of destination country Z's total import values of HS code X in that calendar year.

Table A23

Main Result Incorporating Local Labor Market, Industry, and Close Export Competitor Exposure to Instrument

Panel A: Local Labor Market				
<i>Dep Var:</i>	(1) Log(Labor Costs per Worker)	(2) Log(Employment)	(3) Log(Sales)	(4) Log(Industry Revenue Shares)
Union Density	0.00844*** (0.00219)	0.0108** (0.00504)	0.0144*** (0.00533)	0.0294*** (0.00746)
UD x 1 SD Leave-Out LLM Cumul. Exp.	-0.000158 (0.000442)	0.000557 (0.000998)	0.000831 (0.000964)	0.000178 (0.00130)
1 SD Leave-Out LLM Cumul. Exp.	0.00990 (0.0229)	-0.0330 (0.0489)	-0.0430 (0.0489)	-0.00819 (0.0656)
Observations	42,526	42,526	42,571	42,571
Panel B: Industry				
<i>Dep Var:</i>	(1) Log(Labor Costs per Worker)	(2) Log(Employment)	(3) Log(Sales)	(4) Log(Industry Revenue Shares)
Union Density	0.00960*** (0.00307)	0.0124* (0.00673)	0.0153** (0.00732)	0.0802*** (0.0180)
UD x 1 SD Leave-Out Ind. Cumul. Exp.	0.000314 (0.000917)	0.000429 (0.00148)	-0.000286 (0.00182)	0.0217*** (0.00683)
1 SD Leave-Out Ind. Exp.	-	-	-	-
Observations	41,571	41,571	41,616	41,616
Panel C: Close Export Competitors				
<i>Dep Var:</i>	(1) Log(Labor Costs per Worker)	(2) Log(Employment)	(3) Log(Sales)	(4) Log(Industry Revenue Shares)
Union Density	0.00996*** (0.00330)	0.00448 (0.00710)	0.0179** (0.00794)	0.0190* (0.00993)
UD x 1 SD Leave-Out Close Comp. Exp.	-0.000324 (0.000407)	0.000963 (0.000867)	0.000302 (0.000911)	-0.000433 (0.00104)
1 SD Leave-Out Close Comp. Exp.	0.0133 (0.0160)	-0.0382 (0.0333)	-0.0123 (0.0356)	0.0120 (0.0409)
Observations	20,246	20,246	20,264	20,264

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 VII but with the added interaction and control for a measure of others' exposure to the instrument: the inverse of leave-out cumulative change from 2002 to 2010 in the instrument for all firms in the local labor market cell (Panel A), industry cell (Panel B) excluding the focal firm. In Panels A and B, exposure is weighted by employment. In Panel C, close competitor exposure is multiplied by Norway's share of the destination-product market cell revenues. Panel C exposure is weighted by the share of exporters' revenues coming from the same destination country-product code cell. For interpretation, we invert the instrument, so exposure predicts greater reductions in net dues and, therefore, higher union density. We omit the baseline coefficient in Panel B because the industry by year fixed effects subsume the baseline variation in industry-level cumulative exposure. Standard errors clustered at the firm level. Regressions are unweighted.

Table A24
Heterogeneity by Firm Size Quartile: Exporter Analysis

<i>Dep Var:</i>	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Firm-Level Log(Price Per KG)	Firm-Level Log(Total Weight)	Firm-Level Log(Total Value)	Product-Level Log(Price Per KG)	Product-Level Log(Total Weight)	Product-Level Log(Total Value)	Export Share of Revenue
Union Density in Quartile 1	0.0309 (0.0172)* [0.0134]**	-0.0432 (0.0318) [0.0223]	-0.0123 (0.0272) [0.0183]	0.0154 (0.00903)* [0.00845]*	-0.0236 (0.0172) [0.0157]	-0.00825 (0.0143) [0.0130]	-0.0034 (0.00176)* [0.00102]***
Union Density in Quartile 2	0.0257 (0.0159) [0.0124]**	-0.0259 (0.0292) [0.0206]	-0.000166 (0.0250) [0.0169]	0.0139 (0.0076)* [0.0071]*	-0.0158 (0.0145) [0.0132]	-0.00180 (0.0120) [0.0109]	-0.00319 (0.0016)** [0.0009]***
Union Density in Quartile 3	0.0228 (0.0152) [0.0119]*	-0.0135 (0.0279) [0.0196]	0.00926 (0.0240) [0.0161]	0.0120 (0.0071)* [0.0066]*	-0.0120 (0.0134) [0.0123]	-4.55e-06 (0.0112) [0.0101]	-0.00269 (0.0015)* [0.0009]***
Union Density in Quartile 4	0.0222 (0.0145) [0.0113]**	-0.00327 (0.0267) [0.0188]	0.0190 (0.0228) [0.0154]	0.0125 (0.0065)* [0.0061]**	-0.0102 (0.0124) [0.0113]	0.00232 (0.0103) [0.00940]	-0.00236 (0.0014)* [0.0008]***
Observations	21,789	21,789	21,789	239,031	239,031	239,031	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 IV regressions based on Equations 3 and 2, with additional interactions for firm size quartiles. Sample is limited to exporting firms in the manufacturing sector. Unit of observation is the firm-by-year for columns (1), (2), (3), and (7), and firm-by-product-by-year for columns (4), (5), and (6). Models include fixed effects for firm and industry-by-year in columns (1), (2), (3), and (7) and product-by-year fixed effects in columns (4), (5), and (6). Standard errors clustered at the firm level. Regressions are unweighted. 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 A25Occupation-Industry Level Analysis: Effect of Unionization
on Labor Costs and Employment

Panel A: Occupation-Industry Cells, All Private Sector		
	(1)	(2)
	Log(Labor Costs per Worker)	Log(Employment)
Union Density	0.0181* (0.0109)	-0.0463 (0.0416)
Observations	53,614	53,614
Dep Var Mean	6.836	9.242
Panel B: Occupation-Industry Cells, Manufacturing		
	(1)	(2)
	Log(Labor Costs per Worker)	Log(Employment)
Union Density	0.0421 (0.0346)	0.0671 (0.0749)
Observations	16,566	16,566
Dep Var Mean	6.887	8.953
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 IV regressions based on Equations 3 and 2. Unit of observation is the occupation-industry-year level (rather than firm-year level as in our baseline results). Models include fixed effects for occupation-by-industry and year. Standard errors are clustered at occupation-industry level.

Table A26

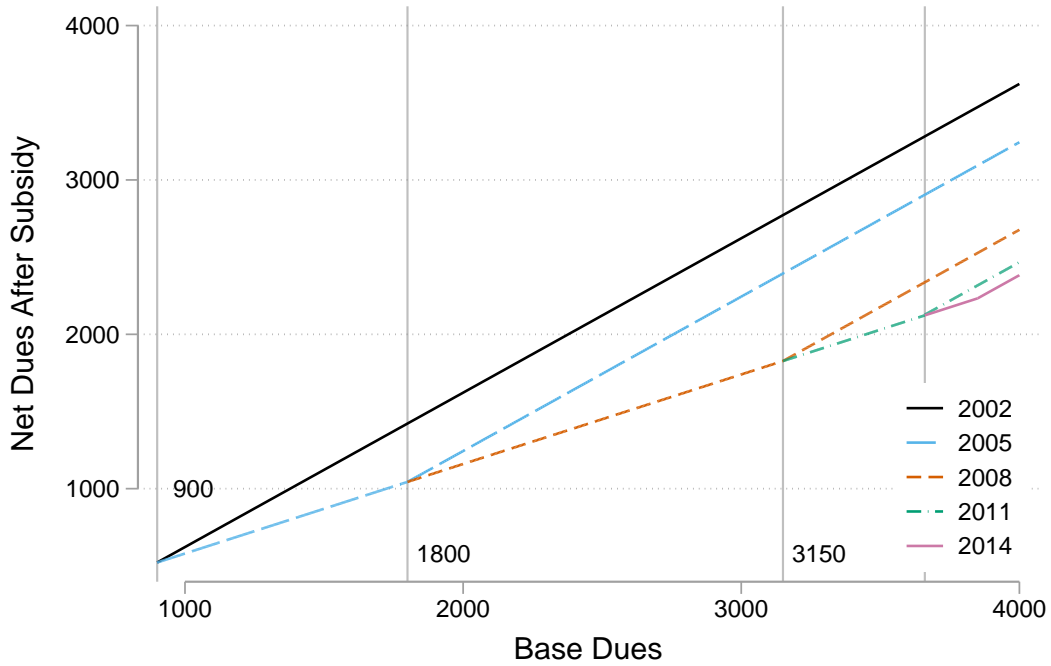
Firm-Occupation-Industry Level Analysis: Effect of Unionization on Labor
Costs and Employment

Panel A: Full Private Sector				
	(1)		(2)	(3)
	Log(Labor Costs		Log(Employment)	Pr(Cutting Occupa-
	per Worker)			tion)
Union Density	0.0163** (0.00665)		-0.0487 (0.0349)	0.0128* (0.00767)
Observations	2,929,902		2,929,902	2,929,902
Dep Var Mean	6.846		6.680	0.219
Panel B: Manufacturing				
	(1)		(2)	(3)
	Log(Labor Costs		Log(Employment)	Pr(Cutting Occupa-
	per Worker)			tion)
Union Density	0.0343*** (0.00836)		0.0269** (0.0136)	0.00588 (0.00375)
Observations	491,027		491,027	491,027
Dep Var Mean	6.927		6.670	0.198
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: Notes: Estimates come from IV regressions based on Equations 3 and 2. Unit of observation is the firm-occupation-industry-year level (rather than firm-level as in our baseline results). Models include fixed effects for firm-occupation-industry cell and year. Standard errors clustered at the occupation-industry level. Dependent variable "Pr(Cutting Occupation)" is the probability an occupation is "cut" from the firm, using a binary dependent variable equal to one if an occupation is "cut" from the firm—that is, does not appear in the following year.

Panel A: Assuming a 42% Tax Rate



Panel B: Assuming a 28% Tax Rate

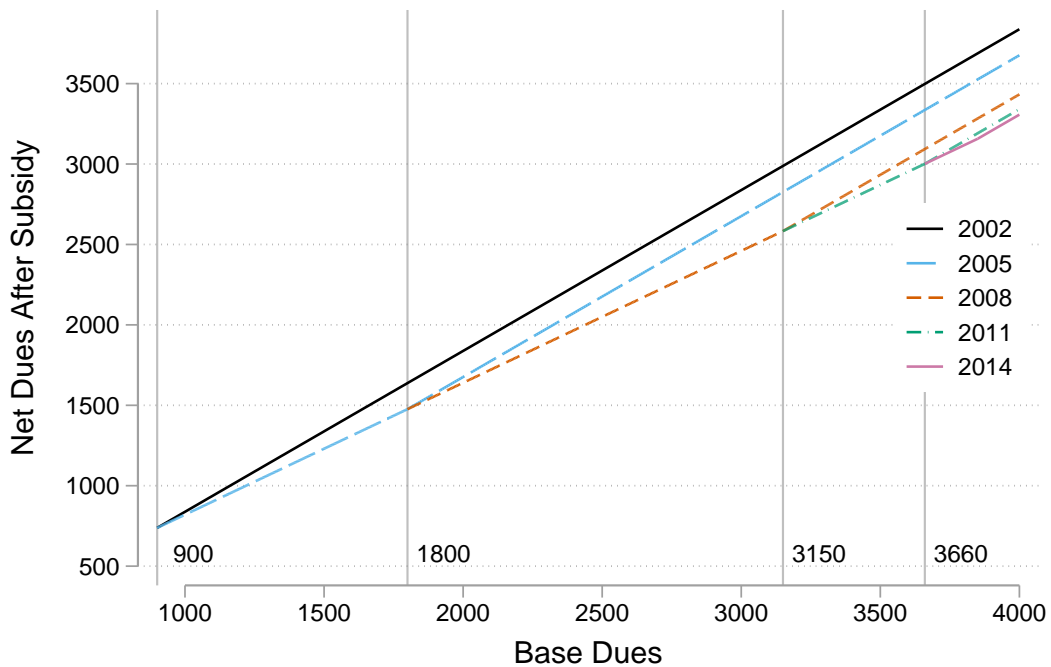


Figure A1

Net Union Dues After Subsidy vs Base Dues Over Time

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.

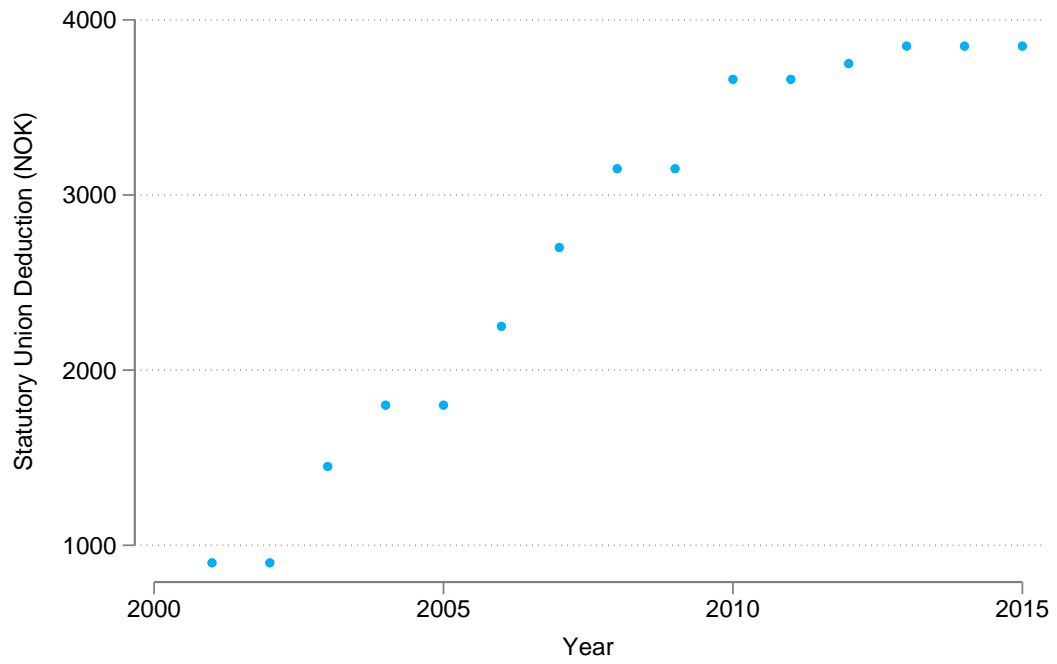


Figure A2

Statutory Maximum Tax Deduction for Union Dues by Year

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

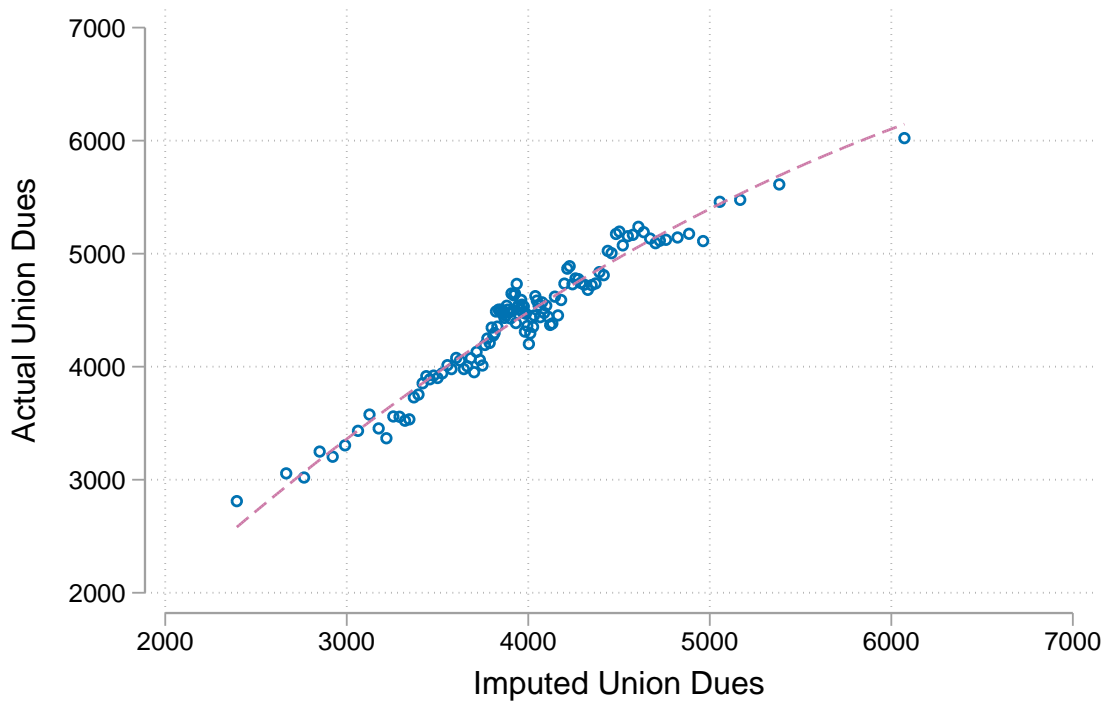


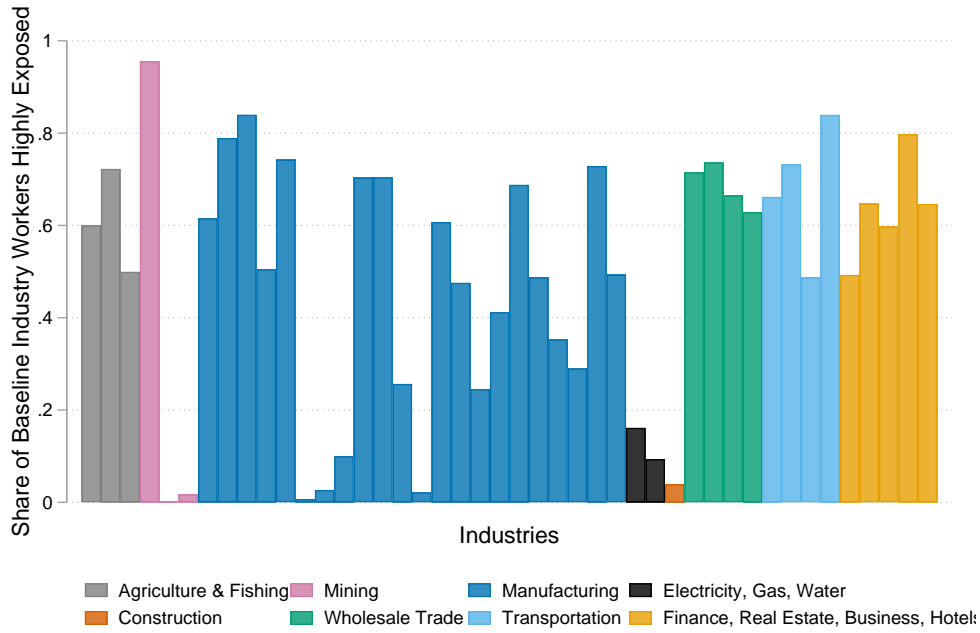
Figure A3

Actual Union Dues vs Imputed Union Dues

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

Notes: Figure presents a binned scatterplot of individual workers' actual union dues paid vs imputed union dues ($\overline{D_{ft}^0}$) and accounts for year fixed effects.

Panel A: Share of Industry Workers in High-Exposure Firms



Panel B: Share of High-Exposure Employment In Industry vs Total Employment Shares

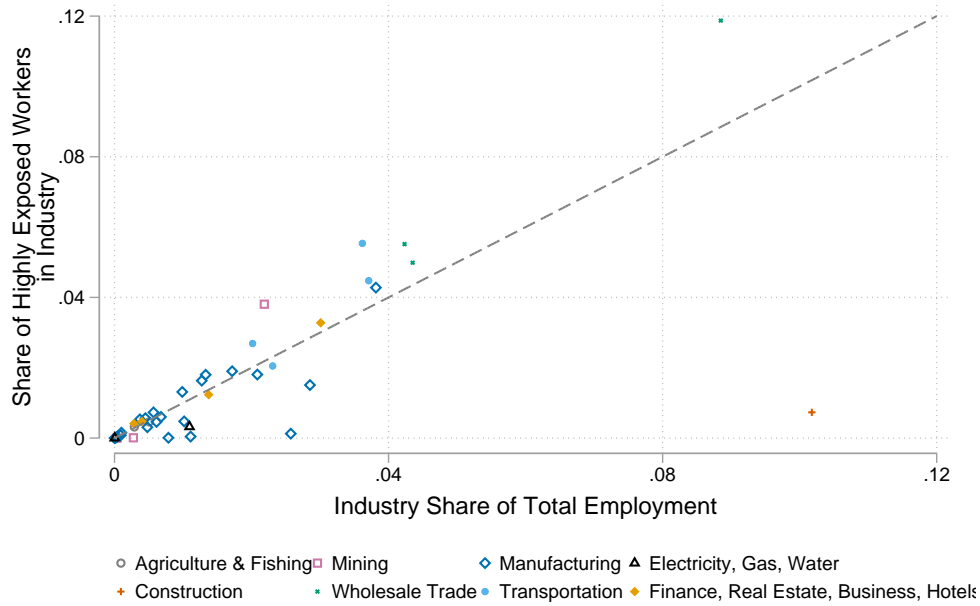
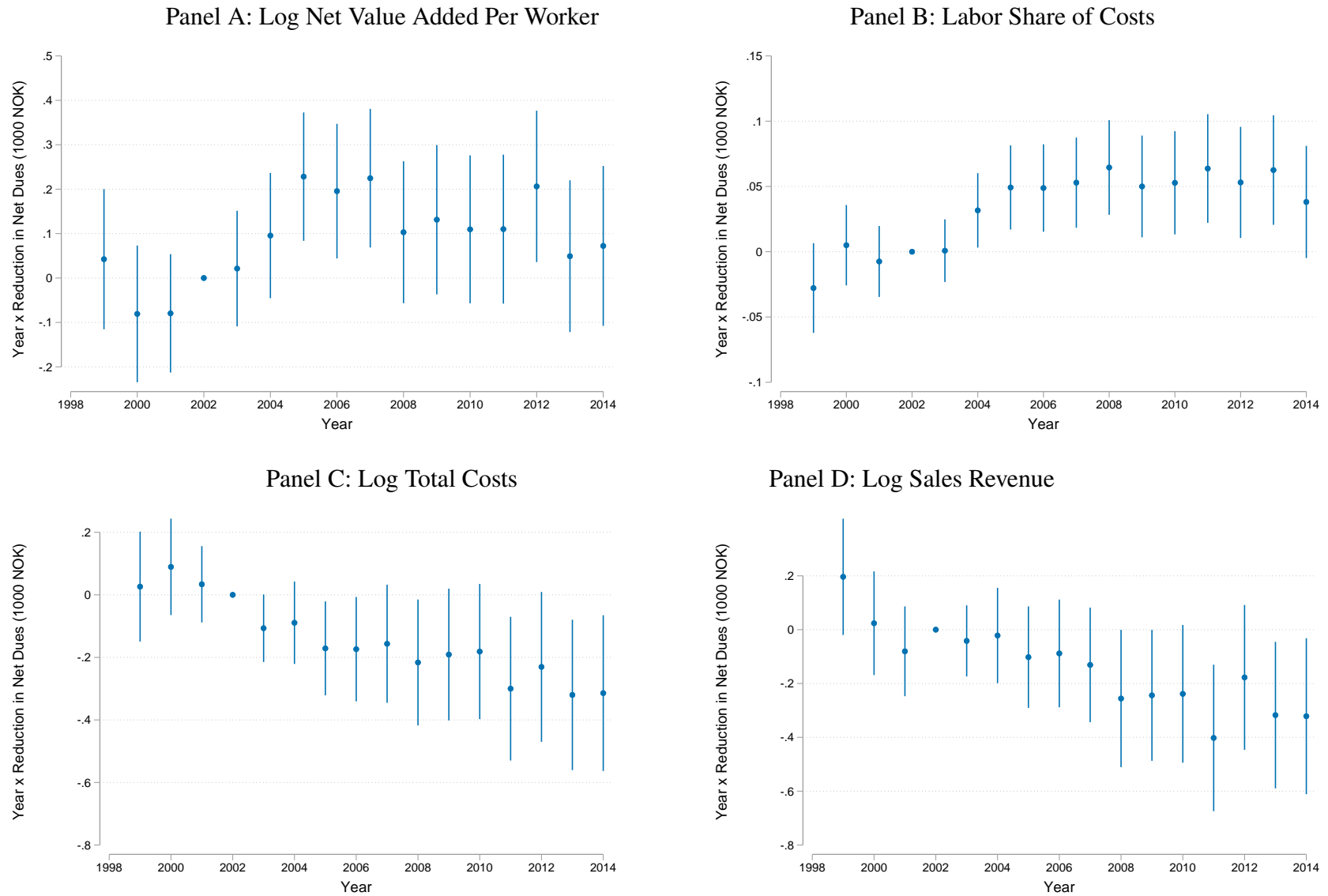


Figure A4

Distribution of High Exposure to Instrument by Industry

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

Notes: "High exposure" is defined as firms that experienced an above-median reduction in their net dues from 2003 to 2010. Panel A presents the share of an industry's workers who are in high-exposure firms in 2003. Panel B presents the share of all high-exposure workers working within each industry in 2003 (the y-axis) plotted against that industry's share of total baseline employment (the x-axis). Each marker represents a 2-digit industry within each broader industry group.

**Figure A5****Additional Event Studies by Net Dues Reduction Intensity, Full Private Sector**

Source: Authors' calculations of Norwegian registry data.

Notes: In each panel, the figure shows coefficients from a regression of the dependent variable listed in the panel title on the interaction between a measure of instrument intensity (the 2002-2010 reduction in net dues within the firm (1000s NOK)) and year dummies. The model includes fixed effects for firm and industry-by-year as in Equations 3 and 2. Estimates are unweighted. Standard errors are clustered at firm level. Regressions are unweighted.

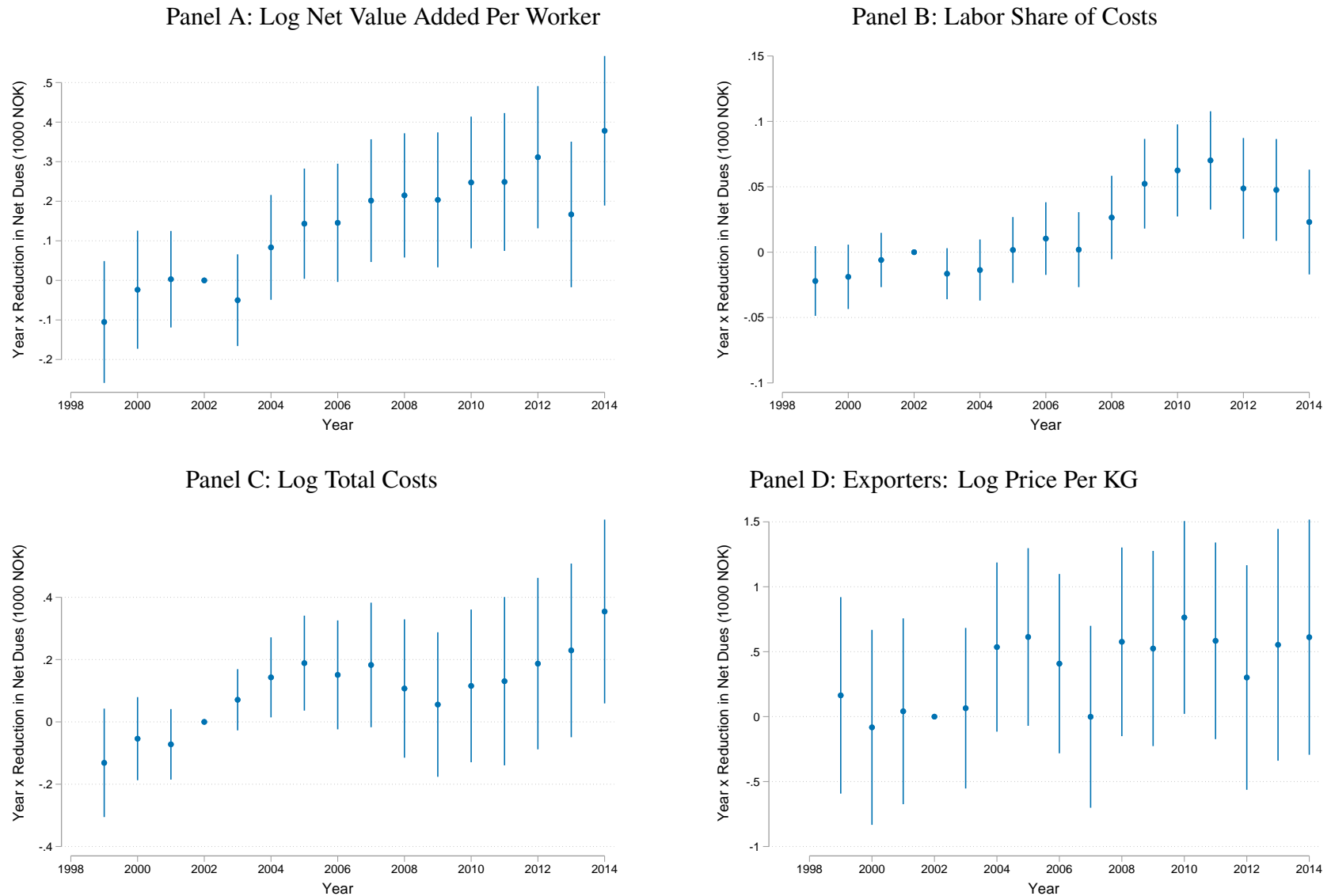


Figure A6

Additional Event Studies by Net Dues Reduction Intensity, Manufacturing

Source: Authors' calculations of Norwegian registry data.

Notes: In each panel, the figure shows coefficients from a regression of the dependent variable listed in the panel title on the interaction between a measure of instrument intensity (the 2002-2010 reduction in net dues within the firm (1000s NOK)) and year dummies, but limited to the manufacturing sector. The model includes fixed effects for firm and industry-by-year as in Equations 3 and 2. Estimates are unweighted. Standard errors are clustered at firm level. Regressions are unweighted.

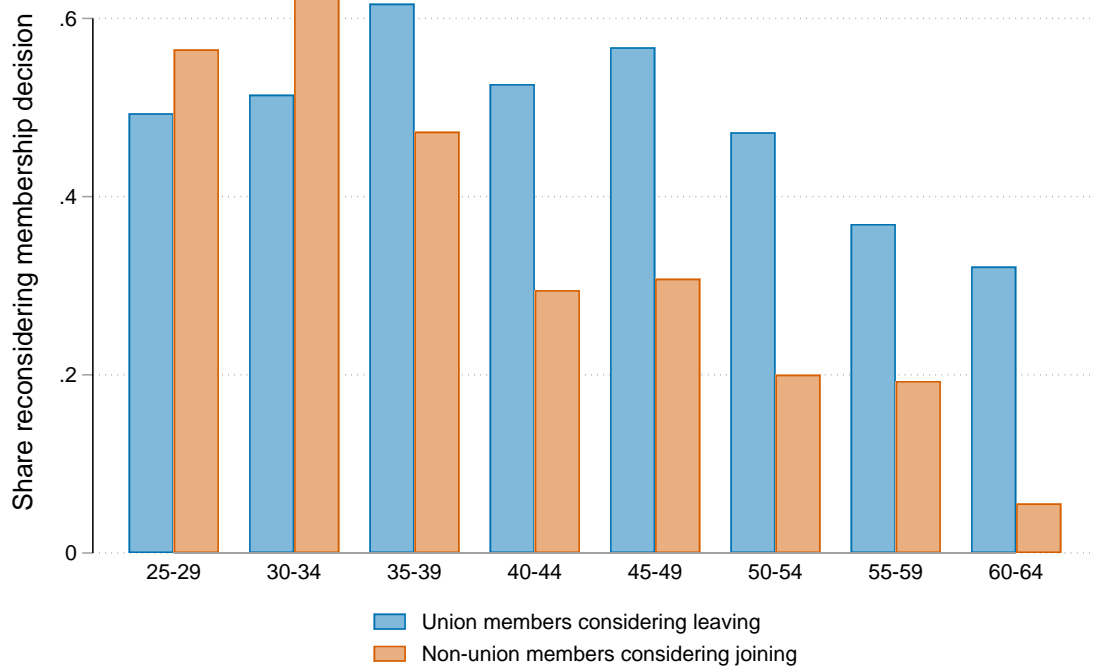


Figure A7

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. (2023).

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.

B Markup and Markdown, Separation Elasticity Estimation

This section outlines in more detail our procedure for separately estimating each firm’s product market markups and labor market markdowns, and for estimating industry-specific separation elasticities.

B.1 Markup and Markdown Estimation

Our methodology for estimating markups and labor markdowns directly follows that of Yeh, Macaluso and Hershbein (2022) (“YMH”). Their methodology follows De Loecker and Warzynski (2012) (“DLW”)’s production approach for estimating firm-specific markups. YMH’s contribution over and above DLW is to augment DLW’s method to allow separate estimation of the labor markdown from the product market markup.

The key advantage of the YMH approach to estimating markups and labor markdowns is its generality. The theoretical logic of the approach to separately obtaining product price markups and labor markdowns is outlined in section A of their paper. We provide a brief summary here. A firm has a labor markdown - it pays a wage lower than the marginal revenue product of labor - if the firm has a finite labor supply elasticity. (This can arise from a number of different sources of monopsony power, including employer concentration, job differentiation, search frictions, or explicit restrictions on labor market mobility). But estimating this labor markdown is difficult if a firm has power in both the labor market and the product market. YMH note that the wedge between the output elasticity of labor and labor’s revenue share reflects the gap between the gain from an additional unit of labor as compared to the cost of an additional unit of labor; if this wedge is greater than 1, then the firm “must be capturing margins through either markups on its output or markdowns on its [labor] input”.

YMH further note that with only a few plausible assumptions, it is possible to derive a simple expression for the labor markdown, distinguishing it from the product price markup. The core assumptions are (i) cost minimization by the firm; (ii) competitive and flexible supply of a major variable input of production (i.e. that it has no adjustment costs, is not subject to monopsony forces, is chosen statically, and is used only for the production of output). YMH argue that in the manufacturing sector, materials satisfies these assumptions.

YMH show that these conditions generate a simple expression for the product price markup,

$$\mu_{it} = \frac{\theta_{it}^V}{\alpha_{it}^V},$$

where μ_{it} is the markup, θ_{it}^V is the output elasticity with respect to variable input X^V , and $\alpha_{it}^V = \frac{P_{it}^V X_{it}^V}{P_{it} Q_{it}}$ is the input cost share of revenues for variable input X^V . Using materials as variable input V , the product price markup is thus equal to the wedge between the output elasticity with respect to materials and materials costs as a share of revenues. Since materials are supplied competitively

and flexibly, this wedge must come from product market pricing power and thus the product price markup, rather than a markdown on these inputs.

These conditions also generate a simple expression for the labor markdown,

$$v_{it} = \frac{\theta_{it}^L}{\alpha_{it}^L} \cdot \mu_{it}^{-1},$$

where v_{it} is the labor markdown, θ_{it}^L is the output elasticity of labor, and α_{it}^L is the labor share of revenues. This estimates the wedge between the output elasticity with respect to labor and the labor share of revenues, which may be comprised of both a product markup and a labor markdown, and then removes the estimated product markup from that expression, leaving only the labor markdown.

How can these objects be estimated empirically? The cost shares for materials and labor can be observed from firm accounting data. Thus to estimate the markup μ_{it} and the labor markdown v_{it} we need to estimate two parameters: the output elasticity of materials inputs and the output elasticity of labor.

We estimate these using production function estimation. We follow YMH and DLW in using the canonical IO “proxy variable” method to estimate production functions (Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Akerberg, Caves and Frazer, 2015). YMH give detail on this method in section B of their paper; we provide a brief summary here. Specifically (following the notation conventions of YMH), the production function estimation process is a three-step approach that begins by relating firm output (revenues) to inputs through the following expression:

$$y_{ft} = f(x_{ft}; \beta) + \omega_{ft} + \epsilon_{ft}, \quad (9)$$

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 directly following Yeh, Macaluso and Hershbein (2022), which we perform separately for each major industry. First, we estimate y_{ft} as a function of a third-order polynomial of 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 first-stage predicted output net of measurement error. 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, the estimated β represents the output elasticities with respect to each input.

B.2 Separation Elasticity Measurement

To measure separation elasticities as another proxy of labor market power, we adapt to our setting the logic of the matched event study model of Bassier, Dube and Naidu (2022). Our estimation approach proceeds in three steps.

First, we estimate an AKM model of log earnings on worker and firm fixed effects. We use the standard AKM framework with age and age squared controls. This AKM model is estimated on the entire sample of workers, and the firm fixed effect represents “firm pay policies” applied across workers.

The second and third steps are performed for each industry separately, allowing us to calculate an industry-specific separation elasticity. In step two, we instrument the change in earnings for movers between firm f_0 and f_1 as the difference in their firm effects between the two firms. Following Bassier, Dube and Naidu (2022), we match on several variables: we control in this model for prior earnings at firm f_0 , a fixed effect for firm f_0 , and ventiles of the distribution of worker fixed effects.

In step three, we estimate the probability of separating from firm f_1 the following year (because our data are annual) as a function of this instrumented change in earnings. Again, we estimate this third step while controlling for baseline earnings the prior year (at f_0), a fixed effect for firm in the prior year (f_0) and ventiles of the distribution of worker fixed effects to ensure that no unobserved fixed worker quality or baseline sorting measures affect the estimates. Thus, our event study model estimates the probability of separation at a new firm as a function of the instrumented changes in earnings between firms matching workers on unobserved quality, baseline firm sorting, and prior earnings.

Each industry’s elasticity measure is the coefficient of the instrumented change in earnings in step three divided by the mean separation rate in that industry. We then use these elasticities in our IV strategy for the firms for which we have estimable elasticities. Because the exercise is data-intensive and requires several years of data for firms, movers to identify the AKM firm effects, and subsequent moves from firm f_1 , the sample size is smaller than in our main specifications.

This approach helps to identify cross-sectional differences in industry-level separation elasticities as a metric of market power and relies on firm-to-firm transitions for identification. Because

of this difference in approach, assumptions, and complier populations, comparisons to separation elasticities from our union density shock should be made with caution.

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 industry-by-year fixed effects. We then estimate this for different subgroups of firms.

Following Dahl, Kostøl and Mogstad (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) within each subgroup. 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 exposed to each group and allows us to characterize compliers in the sample as in the common binary instrument case.

To analyze complier rates for types of firms, we estimate our adapted first stage regression for separate samples splitting the sample based on 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 different types of firms in Figure C1. We find that the complier shares are relatively similar across each of the splits, and that none of the differences are statistically significant. Taken together, Figure C1 suggests that our LATE is represented by a wide variety of firms at different margins representative of the typical Norwegian firm, with somewhat higher representation among larger firms and firms with larger markdowns (which is only estimated in the manufacturing sector). However, the differences in compliance across groups are not statistically significant.

Treatment = Three-Year Δ Union Density > 0

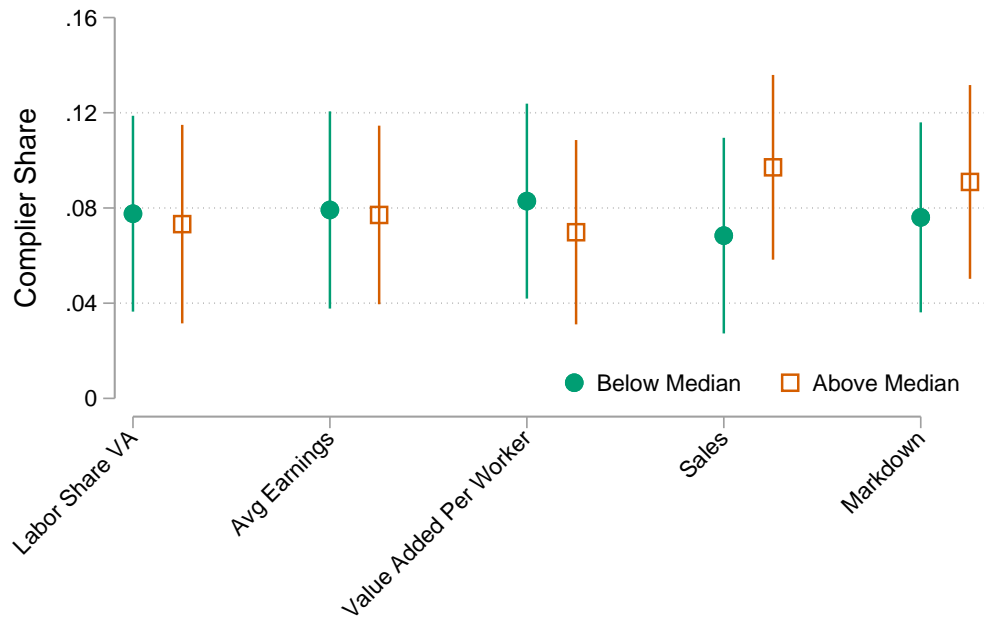


Figure C1

Compliers by Attribute Median Split

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

Notes: "Median splits" 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, Kostøl and Mogstad (2014). Bars represent the 95% confidence interval from bootstrapped standard errors with 1,000 replications.

D Model

We outlined our model in Section VII and lay it out in more detail here. 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.

D.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:⁴⁴

$$\begin{aligned} \max_l \quad & p(l)zl - wl & (10) \\ \text{s.t.} \quad & l \leq w^\eta & \text{(Labor supply)} \\ \text{s.t.} \quad & p(l) = \left(\frac{zl}{Y}\right)^{-\frac{1}{\epsilon}} & \text{(Product demand)} \end{aligned}$$

We have the familiar expression that the optimal wage is marginal revenue product, marked down by both the product markup and labor markdown.⁴⁵

$$w^f = \left(\frac{\epsilon - 1}{\epsilon}\right) \left(\frac{\eta}{\eta + 1}\right) p^*(z)z \quad (11)$$

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

$$\begin{aligned} w^f &= \left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\left(\frac{\epsilon-1}{\epsilon}\right) \left(\frac{\eta}{\eta+1}\right)\right)^{\frac{\epsilon}{\epsilon+\eta}} \\ l^* &= (w^f)^\eta = \left(\frac{1}{Y}\right)^{\frac{-\eta}{\epsilon+\eta}} z^{\frac{\eta(\epsilon-1)}{\epsilon+\eta}} \left(\left(\frac{\epsilon-1}{\epsilon}\right) \left(\frac{\eta}{\eta+1}\right)\right)^{\frac{\epsilon\eta}{\epsilon+\eta}}. \end{aligned} \quad (12)$$

⁴⁴An upward sloping labor supply curve reflects labor market power, and may arise from search frictions, idiosyncratic worker preferences over jobs, or the firm making up a large share of its local labor market. A downward sloping product demand curve reflects product market power, and may similarly arise from differentiated products, search frictions, or the firm making up a large share of its product market.

⁴⁵The labor markdown is generated by the wedge between the upward-sloping labor supply curve and the marginal cost of labor curve. This wedge arises because the firm is assumed to be constrained, to some degree, away from the corner solution of perfect wage discrimination: specifically, to hire the N -th marginal worker at wage W , the firm must also increase the wages paid to (some fraction of) the $N - 1$ inframarginal workers. In our model, the firm is assumed to pay a uniform wage to all workers, consistent with the basic monopsony framework. However, the intuition extends to any scenario in which spillovers from the wage of a new hire affect the wages of existing workers. This, in turn, increases the firm's incentive to under-hire and mark down wages below the marginal revenue product of labor.

D.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} :

$$\begin{aligned} \max_l \quad & p(l)zl - \bar{w}l & (13) \\ \text{s.t.} \quad & l \leq \bar{w}^\eta & \text{(Labor supply)} \\ \text{s.t.} \quad & p(l) = \left(\frac{zl}{Y}\right)^{-\frac{1}{\epsilon}} & \text{(Product demand)} \end{aligned}$$

Following Lo Bello and Pesaresi (2025), 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^c 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

$$\begin{aligned} l &= \bar{w}^\eta & \text{if } \bar{w} < w^c \\ l &= \bar{w}^{-\epsilon} \left(\frac{1}{Y}\right)^{-1} z^{\epsilon-1} \left(\frac{\epsilon-1}{\epsilon}\right)^\epsilon & \text{if } \bar{w} > w^c \end{aligned} \quad (14)$$

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

$$w^c = \left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\epsilon}{\epsilon+\eta}} \quad (15)$$

and the total amount of labor hired is increasing in the wage for $w < w^c$ (as the firm moves up the labor supply curve) and then decreasing in the wage for $w > w^c$ (as the firm moves up the labor demand curve). Note that the threshold wage is the wage which exactly offsets the monopsony markdown relative to the firm's optimal wage w^f :

$$w^c = w^f \left(\frac{\eta}{\eta+1}\right)^{\frac{-\epsilon}{\epsilon+\eta}} \quad (16)$$

D.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 $\kappa_w w^f$ where $\kappa_l <$

1 and $\kappa_w > 1$.⁴⁶

$$\begin{aligned} \max_{w^u} U &= (w^u)^\alpha l^{(1-\alpha)} \\ \text{s.t. } l &\geq \kappa_l l^* \\ \text{s.t. } w^u &\geq \kappa_w w^f. \end{aligned} \tag{17}$$

$$\tag{18}$$

If the union sets a wage below w^c (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^c (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

$$\begin{aligned} U_{LS} &= (w^u)^{(\alpha+\eta(1-\alpha))} && \text{if } w^u \leq w^c \\ U_{LD} &= (w^u)^{(\alpha-\epsilon(1-\alpha))} \left(\frac{Y}{z}\right)^{(1-\alpha)} z^{\epsilon(1-\alpha)} \left(\frac{\epsilon-1}{\epsilon}\right)^{\epsilon(1-\alpha)} && \text{if } w^u \geq w^c. \end{aligned} \tag{19}$$

Note that when the wage is less than w^c 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^c , 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 $\frac{\alpha}{1-\alpha} > \epsilon$.⁴⁷ The union's optimal choice of wage also depends on how high its minimum target wage $\kappa_w w^f$ is, relative to w^c . Specifically, the minimum target wage $\kappa_w w^f \leq w^c$ iff $\kappa_w \leq \left(\frac{\eta+1}{\eta}\right)^{\frac{\epsilon}{\epsilon+\eta}}$.⁴⁸

The union has three possible optimal wages. Which optimal wage is chosen depends on the union's objective function (α , the relative weight on wages vs. employment, as well as κ_w , the minimum wage constraint), the slope of the product demand curve (ϵ , which indexes the trade-off

⁴⁶The 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. We assume that the union's wage and employment constraints are compatible with each other, meaning that we assume κ_l and κ_w are not set "too high": that there exist wage and employment combinations which are acceptable to the union which are also acceptable to the firm (aka. they result in non-negative profits).

⁴⁷Intuitively, 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^c , but if not, then the union may maximize utility by setting a wage greater than w^c .

⁴⁸This condition illustrates that, for a given desired wage increase above the no-union wage (κ_w), the union is more likely to choose wage w^c 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.

between wages and employment), and the degree of monopsony power (indexed by labor supply elasticity η). Specifically:

Condition (i): If the union values employment relatively highly over wages (α is low), and the firm has meaningful monopsony power (η is low), the union's optimal choice of wage is the threshold wage w^c which is the point at which the wage is maximized without any decline in employment:

$$w^u = w^c = \left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\epsilon}{\epsilon+\eta}} \quad \text{if } \frac{\alpha}{1-\alpha} < \epsilon \text{ and } \kappa_w \leq \left(\frac{\eta}{\eta+1}\right)^{\frac{-\epsilon}{\epsilon+\eta}}. \quad (20)$$

Condition (ii): If the union is not willing to sacrifice much employment for higher wages (α is low relative to ϵ), and the firm has limited monopsony power (η is high, meaning there is little ability to increase both wages and employment by walking up the labor supply curve - the employment-wage trade-off bites sharply), the union's optimal choice of wage is their lowest possible wage $\kappa_w w^f$ which satisfies their wage constraint, as this wage maximizes feasible employment:

$$w^u = \kappa_w w^f \quad \text{if } \frac{\alpha}{1-\alpha} < \epsilon \text{ and } \kappa_w > \left(\frac{\eta}{\eta+1}\right)^{\frac{-\epsilon}{\epsilon+\eta}}. \quad (21)$$

Condition (iii): Finally, if the union are willing to sacrifice a lot of employment for higher wages (α is high relative to ϵ), the union's optimal choice of wage is the highest wage compatible with the union's employment constraint $l \geq \kappa_l l^*$:

$$\begin{aligned} w^u &= \kappa_l^{\frac{-1}{\epsilon}} \left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\epsilon}{\epsilon+\eta}} \left(\frac{\eta}{\eta+1}\right)^{\frac{-\eta}{\epsilon+\eta}} \\ &= \kappa_l^{\frac{-1}{\epsilon}} \left(\frac{\eta}{\eta+1}\right)^{\frac{-\eta}{\epsilon+\eta}} w^c \quad \text{if } \frac{\alpha}{1-\alpha} > \epsilon. \end{aligned} \quad (22)$$

Note that across all three conditions, the union's optimal wage is weakly greater than threshold wage w^c : in the first case, the optimal wage is equal to w^c , but the union does not want to raise the wage higher since that would decrease employment; in the second and third cases, the optimal wage is strictly higher than w^c . There is never a case where the union would choose a wage less than w^c because it could increase welfare by increasing both wages and employment.

D.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^f :

$$\bar{w} = \beta w^u + (1 - \beta)w^f \quad (23)$$

D.5 Case 1: high monopsony power (equilibrium on labor supply curve)

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 therefore the equilibrium bargained wage is below threshold wage $\bar{w} < w^c$, meaning the equilibrium outcome for wages and employment is bound by the labor supply curve. As union bargaining power β increases, the equilibrium moves up the labor supply curve, increasing employment and output.

D.5.1 Condition (i)

First, consider condition (i), where the union’s optimal wage is $w^u = w^c$, and so the bargained wage \bar{w} is always below threshold wage w^c . Specifically, the bargained wage is

$$\begin{aligned} \bar{w} &= \beta w^c + (1 - \beta)w^f \\ &= \underbrace{\left(\frac{1}{Y} \right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon} \right)^{\frac{\epsilon}{\epsilon+\eta}} \left(\frac{\eta}{\eta+1} \right)^{\frac{\epsilon}{\epsilon+\eta}}}_{w^f} \left(1 + \beta \left(\left(\frac{\eta}{\eta+1} \right)^{\frac{-\epsilon}{\epsilon+\eta}} - 1 \right) \right). \end{aligned} \quad (24)$$

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

$$\begin{aligned} l &= \left(\frac{1}{Y} \right)^{\frac{-\eta}{\epsilon+\eta}} z^{\frac{\eta(\epsilon-1)}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon} \right)^{\frac{\epsilon\eta}{\epsilon+\eta}} \gamma(\beta)^\eta \\ p &= \left(\frac{1}{Y} \right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{-\eta-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon} \right)^{\frac{-\eta}{\epsilon+\eta}} \gamma(\beta)^{\frac{-\eta}{\epsilon}} \\ \pi &= \left(\frac{1}{Y} \right)^{\frac{-\eta-1}{\epsilon+\eta}} z^{\frac{(\epsilon-1)(\eta+1)}{\epsilon+\eta}} \left(\left(\frac{\epsilon-1}{\epsilon} \right)^{\frac{\eta(\epsilon-1)}{\epsilon+\eta}} \gamma(\beta)^{\frac{\eta(\epsilon-1)}{\epsilon}} - \left(\frac{\epsilon-1}{\epsilon} \right)^{\frac{\epsilon(\eta+1)}{\epsilon+\eta}} \gamma(\beta)^{\eta+1} \right) \end{aligned} \quad (25)$$

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

What happens as union density increases?

$$\begin{aligned}
\frac{\delta \bar{w}}{\delta \beta} &= \left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\epsilon}{\epsilon+\eta}} \left(1 - \left(\frac{\eta}{\eta+1}\right)^{\frac{\epsilon}{\epsilon+\eta}}\right) > 0 \\
\frac{\delta l}{\delta \beta} &= \eta \bar{w}^{\eta-1} \frac{\delta \bar{w}}{\delta \beta} > 0 \\
\frac{\delta p}{\delta \beta} &= -\frac{1}{\epsilon} p \left(\frac{1}{l} \frac{\delta l}{\delta \beta}\right) < 0 \\
\frac{\delta \pi}{\delta \beta} &= \left(\left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon}} z^{\frac{\epsilon-1}{\epsilon}} \left(\frac{\epsilon-1}{\epsilon}\right) l^{\frac{-1}{\epsilon}} - \left(\frac{\eta}{\eta+1}\right)^{-1} l^{\frac{1}{\eta}}\right) \frac{\delta l}{\delta \beta} < 0
\end{aligned} \tag{26}$$

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.⁴⁹

D.5.2 Condition (ii)

The “high monopsony power” case where the outcome is bound by the labor supply curve can also exist under the other two conditions for the union’s optimal wage, as long as the bargained wage \bar{w} is below threshold wage w^c . Since in each case the bargained wage can be written as $\bar{w} = w^c \gamma_j(\beta)$ for an appropriately defined $\gamma_j(\beta)$, the equilibrium is bound by the labor supply curve whenever $\gamma_j(\beta) < 1$, and the expressions for labor, prices, and profits in equation (??) hold with $\gamma(\beta)$ replaced by $\gamma_j(\beta)$.

Now, consider condition (ii). The union’s optimal wage is $\kappa_w w^f$, so the bargained wage is $\bar{w} = w^f (1 + \beta(\kappa_w - 1)) = w^c \gamma_{ii}(\beta)$ where $\gamma_{ii}(\beta) = \left(\frac{\eta}{\eta+1}\right)^{\frac{\epsilon}{\epsilon+\eta}} (1 + \beta(\kappa_w - 1))$. The equilibrium is bound by the labor supply curve if the degree of monopsony power is high (small η), the union’s target wage is not too high (κ_w not too large), and union bargaining power is not too large (small β), i.e. when:

$$\gamma_{ii}(\beta) = \left(\frac{\eta}{\eta+1}\right)^{\frac{\epsilon}{\epsilon+\eta}} (1 + \beta(\kappa_w - 1)) < 1. \tag{27}$$

⁴⁹Note that the term in parentheses is always negative for $l > l^*$.

In this case, the responses of firm outcomes to union bargaining power β are:

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

D.5.3 Condition (iii)

The union's optimal wage is $\kappa_l^{\frac{-1}{\epsilon}} \left(\frac{\eta+1}{\eta} \right) w^f$, so the bargained wage is $\bar{w} = w^f \left(1 + \beta \left(\kappa_l^{\frac{-1}{\epsilon}} \left(\frac{\eta+1}{\eta} \right) - 1 \right) \right) = w^c \gamma_{iii}(\beta)$ where $\gamma_{iii}(\beta) = \left(\frac{\eta}{\eta+1} \right)^{\frac{\epsilon}{\epsilon+\eta}} \left(1 + \beta \left(\kappa_l^{\frac{-1}{\epsilon}} \left(\frac{\eta+1}{\eta} \right) - 1 \right) \right)$. The equilibrium is bound by the labor supply curve if the degree of monopsony power is high (small η) and union bargaining power is not too large (small β), i.e. when:

$$\gamma_{iii}(\beta) = \left(\frac{\eta}{\eta+1} \right)^{\frac{\epsilon}{\epsilon+\eta}} \left(1 + \beta \left(\kappa_l^{\frac{-1}{\epsilon}} \left(\frac{\eta+1}{\eta} \right) - 1 \right) \right) < 1. \tag{29}$$

In this case, the responses of firm outcomes to union bargaining power β are identical in form to those under condition (ii), with $\frac{\delta \bar{w}}{\delta \beta} = w^f \left(\kappa_l^{\frac{-1}{\epsilon}} \left(\frac{\eta+1}{\eta} \right) - 1 \right) > 0$.

In both sub-cases, the qualitative comparative statics are the same as under condition (i): as union bargaining power increases, wages, employment, and output rise, prices fall, and profits fall.

D.6 Case 2: low monopsony power (equilibrium on labor demand curve)

In the low monopsony power case, the bargained wage is above threshold wage $\bar{w} > w^c$, such that the equilibrium is on the labor demand curve. As the bargained wage increases, employment falls.

This case can arise under condition (ii) or condition (iii) for the union's optimal wage, whenever the degree of monopsony power and/or union bargaining power are sufficiently large that the bargained wage exceeds w^c : that is, whenever $\gamma_j(\beta) > 1$, the reverse of the conditions in expressions (27) and (29). We derive the bargained wage and comparative statics for each in turn.

D.6.1 Condition (ii)

Under condition (ii), the union's optimal wage is $w^u = \kappa_w w^f$, so the bargained wage is $\bar{w} = w^c \gamma_{ii}(\beta)$ where $\gamma_{ii}(\beta) = \left(\frac{\eta}{\eta+1}\right)^{\frac{\epsilon}{\epsilon+\eta}} (1 + \beta(\kappa_w - 1))$:

$$\bar{w} = \underbrace{\left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\epsilon}{\epsilon+\eta}} \left(\frac{\eta}{\eta+1}\right)^{\frac{\epsilon}{\epsilon+\eta}}}_{w^f} (1 + \beta(\kappa_w - 1)) \quad (30)$$

and the equilibrium is on the labor demand curve whenever

$$\gamma_{ii}(\beta) = \left(\frac{\eta}{\eta+1}\right)^{\frac{\epsilon}{\epsilon+\eta}} (1 + \beta(\kappa_w - 1)) > 1. \quad (31)$$

The responses of firm outcomes to union bargaining power β are:

$$\begin{aligned} \frac{\delta \bar{w}}{\delta \beta} &= w^f (\kappa_w - 1) > 0 \\ \frac{\delta l}{\delta \beta} &= -\epsilon \bar{w}^{-\epsilon-1} \left(\frac{1}{Y}\right)^{-1} z^{\epsilon-1} \left(\frac{\epsilon-1}{\epsilon}\right)^{\epsilon} \frac{\delta \bar{w}}{\delta \beta} < 0 \\ \frac{\delta p}{\delta \beta} &= -\frac{1}{\epsilon} p \left(\frac{1}{l} \frac{\delta l}{\delta \beta}\right) > 0 \\ \frac{\delta \pi}{\delta \beta} &= -l \frac{\delta \bar{w}}{\delta \beta} < 0 \end{aligned} \quad (32)$$

D.6.2 Condition (iii)

Under condition (iii), the union's optimal wage satisfies $w^u = \kappa_l^{\frac{-1}{\epsilon}} \left(\frac{\eta}{\eta+1}\right)^{-1} w^f$, so the bargained wage is $\bar{w} = w^c \gamma_{iii}(\beta)$ where $\gamma_{iii}(\beta) = \left(\frac{\eta}{\eta+1}\right)^{\frac{\epsilon}{\epsilon+\eta}} \left(1 + \beta \left(\kappa_l^{\frac{-1}{\epsilon}} \left(\frac{\eta}{\eta+1}\right)^{-1} - 1\right)\right)$:

$$\bar{w} = \underbrace{\left(\frac{1}{Y}\right)^{\frac{-1}{\epsilon+\eta}} z^{\frac{\epsilon-1}{\epsilon+\eta}} \left(\frac{\epsilon-1}{\epsilon}\right)^{\frac{\epsilon}{\epsilon+\eta}} \left(\frac{\eta}{\eta+1}\right)^{\frac{\epsilon}{\epsilon+\eta}}}_{w^f} \left(1 + \beta \left(\kappa_l^{\frac{-1}{\epsilon}} \left(\frac{\eta}{\eta+1}\right)^{-1} - 1\right)\right) \quad (33)$$

and the equilibrium is on the labor demand curve whenever

$$\gamma_{iii}(\beta) = \left(\frac{\eta}{\eta+1}\right)^{\frac{\epsilon}{\epsilon+\eta}} \left(1 + \beta \left(\kappa_l^{\frac{-1}{\epsilon}} \left(\frac{\eta}{\eta+1}\right)^{-1} - 1\right)\right) > 1. \quad (34)$$

The responses of firm outcomes to union bargaining power β are identical in form to those under condition (ii), with $\frac{\delta \bar{w}}{\delta \beta} = w^f \left(\kappa_l^{\frac{-1}{\epsilon}} \left(\frac{\eta}{\eta+1} \right)^{-1} - 1 \right) > 0$.

In both sub-cases, as worker bargaining power increases, the wage increases, employment falls (and output falls), the price rises, and profits fall.

D.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.⁵⁰ 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:

$$\frac{\delta p}{\delta \beta} = -\frac{1}{\epsilon} p \frac{1}{l} \frac{\delta l}{\delta \beta} + \frac{1}{\epsilon^2} p \ln \left(\frac{zl}{Y} \right) \frac{\delta \epsilon}{\delta \beta}. \quad (35)$$

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

⁵⁰Noting that $zl < Y$ by definition of aggregate output Y .

E Decomposition: Who Pays? Further Details

In Section VI, we estimate the degree to which the average firm’s union-induced cost increase is borne by different parties – workers, consumers, or firm owners – or whether it pays for itself in improved productivity. We explain our procedures in more detail in this appendix.

E.1 Decomposing price and productivity effects

In Section VI.A we decompose the average private sector firm’s increase in nominal value added per worker into price and productivity components. For the average manufacturing firm, we go further and decompose the increase in nominal value added per worker into the portion attributable to changes in quantity productivity, the portion attributable to changes in quality per unit produced, and the portion attributable to pure price pass-through (changes in price per quality unit). In this appendix section we explain our calculations in more detail than in the main text.

Quantifying productivity effects using workforce data: private sector. In Section VI.A we estimate the productivity effects of increased unionization on several margins. For the average private sector firm, we find evidence for increased productivity via two channels: improved workforce composition and reduced absenteeism. Specifically, for the average firm we estimate a 0.82 log point increase in nominal net value added per worker. We estimate that 31% of the increase in value added per worker can be accounted for by improved workforce composition: we estimate this by comparing the estimated increase in value added per worker residualized on worker fixed effects of 0.96, and the estimated increase in value added per worker on the same sample of firms for which worker and firm fixed effects can be calculated of 1.39.

We also estimate that 7% of the increase in value added per worker can be accounted for by reduced absenteeism as a result of the decline in sick days worked. Specifically, we estimate a decrease in the share of attached worker days out sick of 0.07 percentage points (Table III). Assuming a linear production function in labor, and noting that 81.4% of person-days worked at the average private sector firm are worked by attached workers, we can estimate that the share of the productivity increase accounted for by reduced sick days was 7%.⁵¹ (Note that we also estimate an increase in the share of workers with full-time vs. part-time contracts, which would further increase hours worked, but we are insufficiently confident in the quality of the hours data to use this to benchmark a productivity increase).

For the average private sector firm, we estimate a total of 38% of the increase in nominal net value added per worker was a result of measurable productivity improvements, while the remaining 62% was likely accounted for by price pass-through. These calculations are shown in Panel A of Table E1 below.

⁵¹This is calculated as follows: first, estimate how much additional work is actually done for a given number of person-days registered as worked in the employment register (assuming that the change in sick days only applies to attached workers, we estimate that $81.4\% \times 0.0716\%$ more work is done = 0.0583% more person-days actually worked per person-day registered as worked), and second, compare this to the estimated increase in net value added per person-day worked of 0.819 log points $\approx 0.819\%$. This gives us $0.0583/0.819 = 7\%$.

Quantifying productivity effects using workforce data: manufacturing sector. For the average manufacturing firm, we find evidence for a meaningful increase in productivity via two channels: improved workforce composition, and reduced turnover. Specifically, for the average manufacturing firm we estimate a 1.1 log point increase in nominal net value added per worker for each 1pp increase in union density. When we estimate the increase in value added per worker, residualized on worker fixed effects (i.e. removing the effect of any change in workforce composition), we estimate an increase in nominal value added per worker of 0.78 log points. This means that 0.32 log points of the increase in nominal value added per worker (29%) was due to improved workforce composition.

We also calculate that an additional 0.13 log points of the increase in nominal value added per worker could plausibly be attributed to the reduced efficiency costs arising from lower turnover. This is estimated as follows. Assume the cost of separations is borne in terms of lost output (for example, because of the time it takes to find and train a new worker). Denote the cost of separations as a share of a worker's output as c and the separation rate as s . The change in revenues per worker arising as a result of a change in separations is $\frac{\partial \ln(pY/L)}{\partial s} \frac{\partial s}{\partial u} \approx -c \frac{\partial s}{\partial u}$. The change in net value added per worker arising as a result of a change in separations is therefore $\frac{\partial \ln(nVA/L)}{\partial s} \frac{\partial s}{\partial u} \approx -\left(\frac{pY}{nVA}\right) c \frac{\partial s}{\partial u}$. We have estimated that $\frac{\partial \ln(s)}{\partial u} = -0.0534$, and note that the average separation rate in manufacturing is 0.121. We therefore can estimate that $\frac{\partial s}{\partial u} = s \frac{\partial \ln(s)}{\partial u} = 0.121 * -0.0534 = -0.00646$. For the average manufacturing firm, $\frac{pY}{nVA} = 3.1$. Take a conservative estimate of the cost of a separation at 20% of a full-time worker's annual salary (Blatter, Muehleemann and Schenker (2012) estimates the cost of replacing skilled workers at 21-35% of the worker's annual salary, and estimates from worker deaths suggest substantially larger costs at 1-3 years of a worker's salary (Jäger and Heining, 2022; Bloesch, Larsen and Taska, 2022)). Then the cost expressed as a share of a full-time worker's annual output is $0.2 * 0.32 = 0.064$ (since 0.32 is the average firm's labor share of revenues). Using these three values in the expression above, we have $\frac{\partial \ln(nVA/L)}{\partial s} \frac{\partial s}{\partial u} \approx -3.1 * 0.064 * -0.00646 = 0.0013$. This reflects 12% of the increase in nominal net value added per worker.

Thus, the share of the increase in nominal value added per worker accounted for by these two sources of productivity improvements is 41%, and the share accounted for by pure price pass-through is 59%. These calculations are shown in Panel A of Table E2 below.

Using export price data to decompose price vs. quantity response: manufacturing sector. Our next step is to use our estimates of the changes in unit prices, from export data, to decompose the price vs. quantity response to the increase in union density. In Table VIII we estimate that the unit price of the average exported product increases by 1.7 log points in response to a 1pp increase in union density. Among exporters, total revenues go up by 1.77 log points in response to the same shock (Appendix Table A17). Thus, assuming that the price increase on domestic sales is the same as the price increase on exports, 96% of the increase in revenues represents a price increase, and only 4% represents an increase in quantity sold.

Since these estimates come from exporting firms only, we are interested in applying these estimates to the universe of manufacturing firms, including those which do not export. We therefore assume that we can apply this 96% figure to the universe of domestic firms. Among this group, revenues increase by 1.46 log points in response to a 1pp increase in union density (Table VII), and multiplying this by 96% we therefore estimate that the unit price increase on average among this group was 1.4 log points. This implies an increase in quantity sold of 0.06 log points. Since employment increased in response to the same shock by 1.1 log points, this implies a decrease in quantity productivity (physical units sold per worker of labor) of 1.04 log points. These calculations are shown in Panel B of Table E2 below.

Price, quality productivity, and quantity productivity effects: manufacturing sector. The change in nominal value added per worker can be decomposed as follows:

$$\begin{aligned} \frac{\partial \ln(VA/L)}{\partial u} &= \underbrace{\gamma \frac{\partial \ln(p)}{\partial u}}_{\text{Price change per unit}} + \underbrace{\gamma \frac{\partial \ln(Q/L)}{\partial u} + (1 - \gamma) \frac{\partial \ln(cM/L)}{\partial u}}_{\text{Change in physical unit value added per worker}} \\ &= \underbrace{\gamma \frac{\partial \ln(\pi)}{\partial u}}_{\text{Pure price change per quality unit}} + \underbrace{\gamma \frac{\partial \ln(\phi)}{\partial u}}_{\text{Quality change per physical unit}} + \underbrace{\gamma \frac{\partial \ln(Q/L)}{\partial u} + (1 - \gamma) \frac{\partial \ln(cM/L)}{\partial u}}_{\text{Change in physical unit value added per worker}}, \end{aligned}$$

where $\gamma = \frac{pY}{VA}$. We can use the estimates above to estimate each of these objects.

First, note that we have already estimated above the share of the increase in value added per worker accounted for by pure price pass-through for the average manufacturing firm: 59%, implying $\gamma \frac{\partial \ln(\pi)}{\partial u}$ is 59% of $\frac{\partial \ln(VA/L)}{\partial u}$. Since $\gamma = 3.1$ on average in our data, and the increase in value added per worker is 1.1, we can therefore estimate that pure price pass-through $\frac{\partial \ln(\pi)}{\partial u} = (1/3.1) \cdot 0.59 \cdot 1.1 = 0.21$. That is, the price of a unit of constant quality increases by 0.21 log points for every 1pp increase in union density.

Next, note that the overall unit price increase $\frac{\partial \ln(p)}{\partial u} = 1.4$, as estimated in Table E2 Panel A. Since $\frac{\partial \ln(p)}{\partial u} = \frac{\partial \ln(\pi)}{\partial u} + \frac{\partial \ln(\phi)}{\partial u}$, this implies that the quality improvement per unit $\frac{\partial \ln(\phi)}{\partial u} = 1.4 - 0.21 = 1.19$. Thus, the share of the unit price increase accounted for by pure price pass-through is 15% and the share accounted for by unit quality improvement is 85%.

Finally, we can back out the value of the change in physical unit value added per worker: $\gamma \frac{\partial \ln(Q/L)}{\partial u} + (1 - \gamma) \frac{\partial \ln(cM/L)}{\partial u} = \frac{\partial \ln(VA/L)}{\partial u} - \gamma \frac{\partial \ln(\pi)}{\partial u} - \gamma \frac{\partial \ln(\phi)}{\partial u} = 1.1 - 0.65 - 3.69 = -3.2$. Thus, the increase in productivity is accounted for by a large improvement in unit quality which more than outweighs a large decrease in physical quantity produced per worker. We summarize the above in Panel C of Table E2.

E.2 Incidence of increase in labor costs

In this section, we explain in detail our approach to decomposing the incidence of the increase in labor costs, creating a decomposition of minimum wage incidence in the spirit of Harasztosi and Lindner (2019)'s decomposition for the incidence of the minimum wage.

First, note the accounting identity for value added (net of depreciation):

$$NetValueAdded = LaborCost + Profit = Revenue - Materials - OtherOperatingCosts - Depreciation.$$

Rearranging this identity gives us an accounting identity for a change in total labor costs:

$$\Delta LaborCost = \Delta NetValueAdded - \Delta Profits.$$

This is the version of the decomposition that is used by Harasztosi and Lindner (2019).

Decomposition for average private sector firm. In our setting, in contrast to Harasztosi and Lindner (2019), the average private sector firm does not see an increase in overall labor costs: with elastic labor demand, as unit labor costs go up, the average firm decreases employment more than proportionally, seeing a decline in overall labor costs. We therefore conceptualize the cost to the firm of the increase in unionization as a combination of two factors: the increase in unit labor cost on the workers who remain, plus the lost profit margin on the sales that are lost as the firm is forced to shrink. The firm can pay for this cost in three ways: increased unit prices on remaining sales, increased labor productivity, and/or reduced profits. Denoting w as the unit wage, L as employment, ξ as nominal labor productivity, and Π as total profits, we can therefore write the decomposition as follows

$$\Delta(wL) = \Delta(\xi L) - \Delta\Pi,$$

which can be written as follows, using subscripts 0 and 1 to denote before and after the change respectively:

$$\underbrace{L_1 \Delta w}_{\text{Change in unit labor costs}} + \underbrace{w_0 \Delta L}_{\text{Change in labor costs as firm shrinks}} = \underbrace{\xi_0 \Delta L}_{\text{Change in nVA as firm shrinks}} + \underbrace{L_1 \Delta \xi}_{\text{Change in nVA/worker (prices or productivity)}} - \underbrace{\Delta \Pi}_{\text{Change in profits}}.$$

To infer the share of the change in net value added per worker which is accounted for by true productivity vs pure price pass-through, we use our estimates from Section E that 38% of the increase in net value added per worker represented productivity improvements (from improved workforce composition and reduced absenteeism) and the remaining 62% therefore represented pure price pass-through. Thus, we write the decomposition as follows, taking x as the share of the

increase in net value added per worker reflecting productivity improvements:

$$\underbrace{L_1 \Delta w}_{\text{Change in unit labor costs}} - \underbrace{(\xi_0 - w_0) \Delta L}_{\text{Lost margin as firm shrinks}} = \underbrace{x L_1 \Delta \xi}_{\text{Change in labor productivity}} + \underbrace{(1 - x) L_1 \Delta \xi}_{\text{Change in unit output price}} - \underbrace{\Delta \Pi}_{\text{Change in profits}} .$$

We estimate these quantities in the data as shown in Table E3. We estimate that the average firm sees an increase in costs of 81,951 NOK, of which roughly half is the increased unit labor cost for the workers that remain at the firm, and roughly half is the loss of margin on products no longer sold as the firm shrinks. To bear this cost, the firm responds in three ways: 36% of the cost is borne by consumers in higher prices for products sold, 42% is borne by the firm owners in the form of lower profits, and the remaining 22% pays for itself in the form of improved labor productivity.

Decomposition for average manufacturing firm. For the average manufacturing firm, we can estimate all the same components of the decomposition, but the question of what the increased costs are to the firm is slightly different: the average private sector firm scales down, meaning that it bears increased labor costs on remaining workers but also the loss of the margin from downsizing, while the average manufacturing firm scales up as a result of the increase in unionization. The cost of unionization can thus be conceived of in different ways. We conceptualize the cost to the firm of unionization as the increase in labor costs for both existing and new workers $L_1(w_1 - w_0)$ (but not the cost of employing those new workers at the old wage, $w_0(L_1 - L_0)$). Our decomposition is therefore:

$$\underbrace{L_1 \Delta w}_{\text{Change in unit labor costs}} = \underbrace{(\xi_0 - w_0) \Delta L}_{\text{Increased margin on new sales}} + \underbrace{x L_1 \Delta \xi}_{\text{Change in labor productivity}} + \underbrace{(1 - x) L_1 \Delta \xi}_{\text{Change in unit output price}} - \underbrace{\Delta \Pi}_{\text{Change in profits}} .$$

Using our estimates from Section E that 41% of the increase in nominal net value added per worker reflects productivity improvements and the remaining 59% reflects pure price pass-through, we estimate that the firm pays for the union-induced labor cost by increasing prices (82% of the increase in labor costs), increasing productivity (57% of the increase in labor costs), and by selling more units (16% of the increase in labor costs). Since these factors more than offset the increase in labor costs the firm also sees an increase in profits (although note that in our regressions, the increase in profits is very noisy and therefore not statistically significantly different from zero for the average manufacturing firm). We show this in Table E4.

For the average manufacturing firm, the revenue share of exports is around 7.5%, meaning that we can further decompose this to say that 6.2% of the union-induced increase in labor costs for the average firm is borne by higher prices for foreign consumers, while 76.8% is borne by higher prices for domestic consumers. Note that while the average manufacturing *firm* exports a relatively small share of its revenue, the total share of Norwegian manufacturing revenues which are exported is much higher at 29%

Table E1

Decomposing price and productivity responses to increased unionization for the average private sector firm

A: Quantifying productivity effects using workforce data			
Change in Value Added per Worker (Full sample)	$\frac{\partial \ln(VA/L)}{\partial u}$	0.82	<i>Estimated: Table II</i>
Change in VA/L, Residualized on Worker Fixed Effects		0.96	<i>Estimated: Table III</i>
Change in Value Added per Worker (residual sample)	$\frac{\partial \ln(VA/L)}{\partial u}$	1.39	<i>Estimated: Table III</i>
Share of VA/L Increase Accounted for by Workforce Composition		31%	<i>Calculated: (1.39-0.96)/1.39</i>
Productivity Impact of Reduced Turnover		–	<i>Assumed zero</i>
Productivity Impact of Reduced Absenteeism		0.06	<i>Calculated: Section E.1</i>
Share of VA/L Increase Accounted for by Reduced Absenteeism		7%	<i>Calculated: 0.06/0.82</i>
Share of VA/L Increase Accounted for by Improved Productivity		38%	<i>Calculated: 31% + 7%</i>
Share of VA/L Increase Accounted for by Price Pass-through		62%	<i>Calculated: 100% - 38%</i>

Table E2

Decomposing price and productivity responses to increased unionization for the average manufacturing firm

A: Quantifying productivity effects using workforce data			
Change in Value Added per Worker	$\frac{\partial \ln(VA/L)}{\partial u}$	1.1	<i>Estimated: Table VII</i>
Change in VA/L, Residualized on Worker Fixed Effects		0.78	<i>Estimated: Table A11</i>
Share of VA/L Increase Accounted for by Workforce Composition		29%	<i>Calculated: (1.1-0.78)/1.1</i>
Productivity Impact of Reduced Turnover		0.13	<i>Calculated: Section E.1</i>
Share of VA/L Increase Accounted for by Reduced Turnover		12%	<i>Calculated: 0.13/1.1</i>
Productivity Impact of Reduced Absenteeism		–	<i>Estimated zero</i>
Share of VA/L Increase Accounted for by Productivity		41%	<i>Calculated: 29% + 12%</i>
Share of VA/L Increase Accounted for by Price Pass-through		59%	<i>Calculated: 100% - 41%</i>
B: Using export price data to decompose price vs. quantity response			
Change in Revenue (Exporters)	$\frac{\partial \ln(pQ)}{\partial u}$	1.77	<i>Estimated: Table A17</i>
Change in Unit Price (Exporters)	$\frac{\partial \ln(p)}{\partial u}$	1.7	<i>Estimated: Table VIII</i>
Share of Revenue Increase Accounted for by Price Increase		96%	<i>Calculated: 1.7/1.77</i>
Change in Revenue (Full Sample)	$\frac{\partial \ln(pQ)}{\partial u}$	1.46	<i>Estimated: Table VII</i>
Change in Unit Price (Full Sample)	$\frac{\partial \ln(p)}{\partial u}$	1.4	<i>Calculated: 96% x 1.46</i>
Change in Quantity	$\frac{\partial \ln(Q)}{\partial u}$	0.06	<i>Calculated: 1.46-1.4</i>
Change in Employment	$\frac{\partial \ln(L)}{\partial u}$	1.1	<i>Estimated: Table VI</i>
Change in Quantity Sold per Worker	$\frac{\partial \ln(Q/L)}{\partial u}$	-1.04	<i>Calculated: 0.06 - 1.1</i>
C: Decomposing price, quality productivity, and quantity productivity effects			
Pure Price pass-through	$\frac{\partial \ln(\pi)}{\partial u}$	0.21	<i>Calculated: (1/3.1) x 0.59 x 1.1</i>
Quality Change Per Unit	$\frac{\partial \ln(\phi)}{\partial u}$	1.19	<i>Calculated: 1.4-0.21</i>
Share of Price Increase Accounted for by Price Pass-through		15%	<i>Calculated: 0.21/1.4</i>
Share of Price Increase Accounted for by Quality Improvement		85%	<i>Calculated: 1.19/1.4</i>

Table E3

Who pays for the cost of unions? Decomposition for the average private sector firm

		Amount (NOK)	Percent
Firm increase in costs		81,951	100%
Increased unit labor costs (for stayers)	$L_1 \Delta w$	38,831	47%
Lost margin as firm shrinks	$-(\xi_0 - w_0) \Delta L$	43,119	53%
Paid for by...			
Higher prices	$(1 - x) L_1 \Delta \xi$	29,455	36%
Higher productivity	$x L_1 \Delta \xi$	18,114	22%
Lower profits	$-\Delta \Pi$	34,383	42%

Table E4

Who pays for the cost of unions? Decomposition for the average manufacturing firm

		Amount (NOK)	Percent
Firm increase in costs		75,229	100%
Increased unit labor costs	$L_1\Delta w$	75,229	100%
Paid for by...			
Increased margin on new sales	$(\xi_0 - w_0)\Delta L$	12,020	16%
Higher prices	$(1 - x)L_1\Delta\xi$	61,573	82%
Higher productivity	$xL_1\Delta\xi$	42,628	57%
Lower profits	$-\Delta\Pi$	-40,992	-54%