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The Effect of Centrally Bargained Wages on Firm Growth

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Abstract

I study how firms adapt to exogenous changes in labor costs induced by collective bargaining agreements. I use data on collective bargaining agreements in Sweden and study the impact of the nationwide bargaining that took place in 2004. I make a difference-in-differences analysis and compare firms in the same industry that have a different initial skill composition of their workers and thus face different bargained wage increases. Higher centralized wage increases cause the average firm to increase average wages (1.3%) and to grow faster (2.7%) both in terms of employment and sales, while profitability decreases. Firms increase both investments and substitute low-skilled for high-skilled labor. Moreover, the effects are more pronounced for firms with more labor market power and easier access to external finance. This suggests that the results are affected by labor market power, and the ease of input factor substitution.

Keywords: Collective Wage Bargaining, Firm Growth, Labor Market Power, Job Polarization

JEL Codes: D22, J23, J31, J42, J51

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1 Introduction

Motivation This paper studies how firms respond to labor cost changes, an issue essential for understanding shifts in the labor market. Collective bargaining plays an important role in determining labor costs in most OECD countries (Cazes et al., 2019; Bhuller et al., 2022). Therefore, it is essential to study how collectively bargained wages affect wages, employment, and technology. Previous research on this topic includes studies on the declining influence of unions (Stansbury and Summers, 2020), the role of unions in shaping employment and wages (Farber et al., 2021), and the behavior of employers during collective bargaining (Prager and Schmitt, 2021), among others. This strand of research informs academics and policy-makers on the role of wage-setting institutions in shaping labor market outcomes.

This Paper I examine the impact of collective wage bargaining on Swedish firms' labor and investment decisions. I do a difference-in-differences analysis around the conclusion of a significant revision of collective bargaining agreements in 2004. I compare firms in the same industry that have different skill compositions and thus face different bargained wage increases. I find that firms with higher centrally bargained wage increases had similar growth trends before 2004 but experienced faster employment, capital, and sales growth after 2004.

Setting I aim to understand the causal effects of higher centrally bargained wages on firms. To do this, I focus on collective bargaining in Sweden, where wages are typically negotiated at the industry level and apply to all firms within the industry. These negotiations usually take place on a three-year basis. We use the outcomes of the 2004 collective bargaining round as a natural experiment, as it covered a large portion of the private sector workforce and involved negotiations in all major sectors (Medlingsinstitutet, 2004). This bargaining round, therefore, provides an opportunity to study the effects of higher centrally bargained wages on firms.

Empirical Strategy I use data on Swedish workers and firms and unique data on collective bargaining agreements to investigate the effects of higher centrally bargained wages on firms. I link the agreements to firms in each industry and classify them by the skill level of the workers they cover. Based on the skill composition of each firm in the previous year, I calculate the predicted centrally bargained wage increase for each firm. I then divide the firms into two groups: those in the top quartile of bargained wage increases (treated group) and those in the bottom half (control group). Using a difference-in-differences approach, I compare the outcomes of these two groups and find that firms with higher and lower bargained wage increases within the same industry had similar pre-trends for key variables such as labor costs and employment.

Main Results Firms in the treated group (i.e., those in the top quartile of bargained wage increases) experience higher labor cost growth in the years following the collective bargaining round. Sales increased for these firms by 2.7%. This effect was driven by changes in labor and capital, with total employment increasing by 2.7% and physical capital increasing by 3.7%. Additionally, these firms change their labor composition to include a higher proportion of skilled labor. The results are robust to the inclusion of controls such as industry-year fixed effects, the exclusion of small and large firms, and different definitions of the treatment group.

Extensions To gain a deeper understanding of the results, I examine the results from two perspectives: the role of labor market power in the results and the impact of input factor substitution on the results.

First, I interpret the results through the lens of labor market power. I measure market power as local labor market concentration or gross flows at the firm. Using both measures, firms with relatively more labor market power increase employment more when facing higher bargained wages. Treated firms with high market power are on average 3.5% larger than control firms with high market power, while the estimates decline to 2% for firms with low market power. This suggests that some firms had market power and found it

profitable to reduce size in favor of offering lower wages.

Secondly, I study the role of input factor substitution, both in terms of job polarization and increased investments. Treated firms face higher bargained wages for low-skilled labor, incentivizing firms to shift their skill mix towards more high-skilled workers. Firms increase the share of high-skilled labor by 1.2 percentage points. Moreover, I find that firms operating in industries and areas with a higher relative supply of skilled labor grow faster, which shows the importance of labor-labor substitution. These results align with the literature finding an important role for within-firm changes in job composition.

Finally, to better understand the investment channel, I investigate how limited access to external finance impacts a firm's ability to grow its capital stock when labor costs rise. I show that treated firms that should have better access to external finance, older and less leveraged firms, increase investments more compared to control firms. These findings indicate that financial constraints are a significant factor in determining a firm's ability to invest in its capital stock and make its workforce more productive.

Contribution The key contribution of this paper is to demonstrate empirically that collectively bargained changes in labor cost induces firms to change their optimal use of input factors. In particular, I show that firms which face higher bargained substitute low-skilled for high-skilled labor, increase investments as well as sales. Thus, this paper relates to the empirical literature analyzing how changes in labor costs affect firm choices. This literature usually focuses on minimum wage changes, which mainly affect workers with the lowest wage levels[1]. This paper contributes by focusing on collectively bargained wages that affect a majority of workers. Similar papers include Card and Cardoso (2021); Devicienti and Fanfani (2021) that study similar setups in Portugal and Italy, respectively. This paper is also related to other work using the Swedish setting on collective bargaining[2].

[1]See Dube (2019); Manning (2021); Clemens (2021) for international reviews and Calmfors et al. (2016) for a Swedish review.

[2]Eliasson and Nordström Skans (2014) study a reform in Sweden, where public sector establishments had to increase their wages relatively more if they had more low-paid women. This reform had a positive effect on wages and also caused reduced separations for workers with higher grades. At the same time, new hires declined. Other papers include Björklund et al. (2019); Olsson (2020) which study how wage

Next, I contribute to the literature on labor market power by showing empirically that labor market power mediates the response of firms' to changes in labor costs. In particular, this paper provides new insights on how labor market power affects low-skilled and high-skilled workers. In this setting, higher wage increases for low-skilled workers induce firms to tilt their operations towards high-skilled workers.[3]

Moreover, this paper contributes to the literature regarding how labor costs affect technological change. There is a large literature discussing the interaction between technical change and the labor market, notably through automation[4] Conversely, labor market institutions also affect firm choices[5]. I contribute by linking variation in labor costs to job polarization and investments.

Finally, this paper contributes to the literature on the Swedish model of centralized wage bargaining. Agell and Lommerud (1993) provide a theoretical background for the model. The core idea is that there is an added social benefit of increasing production in more productive sectors. Thus, by compressing wages across the board, the "Swedish model" indirectly subsidizes fast-growing, productive sectors and thus reallocates labor towards them. The Swedish labor market model has further been studies in (Edin and Topel, 1997; Hibbs Jr and Locking, 2000).

Roadmap This paper continues as follows. Section 2 presents a conceptual framework relating centrally bargained wage increases to firms' wages and employment decisions. Next, in Section 3, I present the institutional details about wage bargaining in Sweden, as well as the data and sample I use. Section 5 presents the econometric framework and discusses the identifying assumptions. In Section 6 I present the main results and in Section 7 I discuss extensions. Finally, Section 8 concludes.

rigidity interacts with other economic shocks.

[3]There is a large literature on labor market power, for instance (Manning, 2003; Mertens, 2021; Marinescu et al., 2021; Sokolova and Sorensen, 2021; Yeh et al., 2022; Berger et al., 2022; Bassanini et al., 2022; Azar et al., 2022; Benmelech et al., 2022; Rinz, 2022).

[4] Acemoglu (2010); Autor (2015); Acemoglu and Restrepo (2018); Acemoglu et al. (2018); Acemoglu and Restrepo (2019); Hershbein and Kahn (2018); Grossman et al. (2021); Blundell et al. (2022); Acemoglu and Restrepo (2022).

[5]See Aaronson and Phelan (2019); Samwer and Chen (2020); Parolin (2020); Haapanala et al. (2022); Aaronson and Phelan (2022).

2 Conceptual Framework: Pay Increase Constraint and Labor Market Power

2.1 Setup and Optimality Conditions

I present a simple conceptual framework that explains how the Swedish wage-setting quasi-experiment can be understood within the context of a common model of production with labor market power. This model is based on the standard framework of labor market power, as previously described in literature (Manning, 2003).

We consider a representative firm that produces output (denoted by Y) using three inputs: low-skilled labor (L), high-skilled labor (H), and capital (K). We denote the production function by $Y(L, H, K)$. The firm has market power over the labor inputs, meaning that it can influence the wages it pays to low-skilled and high-skilled workers. The inverse labor supply curves for these inputs are given by $w_L = L^{\eta_L}$ and $w_H = H^{\eta_H}$, respectively. η_L and η_H denote the associated inverse labor supply elasticities. The firm takes the price of capital (r) as given and not subject to its influence. The production function used by the firm is continuously differentiable, supermodular, and has a negative semi-definite Hessian matrix.

To simplify the analysis, I study a two-period setup. During the first period, the firm is assumed to optimize its decision without any constraints on wage increases. In the second period, a constraint is introduced on the increase in the wage bill for each skill group. This constraint is meant to model the Swedish system of wage bargaining described in Section 3. Specifically, the constraint is modeled as an unexpected minimum increase in the wage bill.

First-Period Choices This means that the firm's optimization problem can be written as follows:

$$\max_{\{L,H,K\}} \quad Y(L,H,K) - L^{1+\eta_L} - H^{1+\eta_H} - rK, \tag{1}$$

$$\tag{2}$$

The first period choices are pinned-down by the associated first-order conditions:

$$L^{\eta_L} = Y_L \frac{1}{1+\eta_L}, \tag{3}$$

$$H^{\eta_H} = Y_H \frac{1}{1+\eta_H}, \tag{4}$$

$$r = Y_K. \tag{5}$$

For the labor inputs, the firm equates the average wage for each skill group to the marginal prouct, multiplied by a markdown. These markdowns are given by the inverse labor supply elasticities. Notably, these elasticities give rise to market power. Similarly, the firm buys capital until the marginal product is equal to the rental price.

Second-Period Choices and Firm Growth In the second period, there is a (binding) shock to bargained wages, denoted by $b > 1$. For simplicity, we assume it only applies to low-skilled workers,

$$w_{L1} \geq b w_{L0}. \tag{6}$$

Thus, the log-changes in low-skilled wages, and employment, are:

$$\Delta \ln(w_{L1}) = b, \tag{7}$$

$$\Delta \ln(L_1) = \frac{b}{\eta_L}. \tag{8}$$

Solving for the log-changes in high-skilled worker and capital, we have:

$$\eta_H \Delta \ln(H_1) = \Delta \ln(y_{1H}). \tag{9}$$

To solve for the change in H_1, we do a first-order approximation around the first-period values. For convenience, I define an elasticity that measures how complementary two inputs are in production. Denote this elasticity of technical complementarity by α_{ji} and let it be defined as $\alpha_{ji} = Y_{ji}\frac{x_i}{x_j}$,

$$\eta_H \Delta \ln(H_1) \approx \alpha_{HL}\frac{b}{\eta_L} + \alpha_{HH}\Delta \ln(H_1) + \alpha_{HK}\Delta \ln(K_1), \tag{10}$$

$$(\eta_H - \alpha_{HH})\Delta \ln(H_1) + (-\alpha_{HK})\Delta \ln(K_1) \approx \alpha_{HL}\frac{b}{\eta_L}, \tag{11}$$

$$\Delta \ln(H_1) \approx \underbrace{\frac{\alpha_{HL}}{\eta_H - \alpha_{HH}}\frac{b}{\eta_L}}_{\text{Complementarity with Low-Skilled Labor}} + \underbrace{\frac{\alpha_{HK}}{\eta_H - \alpha_{HH}}}_{\text{Complementarity with Capital}} \Delta \ln(K_1). \tag{12}$$

The change in the number of high-skilled workers is determined by the sum of the changes in the number of low-skilled workers and capital, scaled by the ratios of the elasticity of technical complementarity the sum of the inverse labor supply elasticity and the elasticity of the concavity of the production function with respect to high-skilled labor.

To clarify, the elasticity of technical complementarity refers to the degree to which the productivity of high-skilled workers depends on the number of low-skilled workers and capital. The inverse labor supply elasticity is a measure of the responsiveness of the supply of labor to changes in wage rates. The concavity of the production function with respect to high-skilled labor refers to the curvature of the production function as the number of high-skilled workers changes. All of these factors are used to calculate the change in the number of high-skilled workers.

Similarly, we can approximate the change in capital as, recognizing that the rental rate is

unchanged,

$$0 \approx \alpha_{KL}\frac{b}{\eta_L} + \alpha_{KH}\Delta\ln(H_1) + \alpha_{KK}\Delta\ln(K_1), \tag{13}$$

$$(-\alpha_{KK})\Delta\ln(K_1) + (-\alpha_{KH})\Delta\ln(H_1) \approx \alpha_{KL}\frac{b}{\eta_L} \tag{14}$$

2.2 Solution

The equations determining the changes in capital and high-skilled labor are given by,

$$\begin{pmatrix} \eta_H - \alpha_{HH} & -\alpha_{HK} \\ -\alpha_{KH} & -\alpha_{KK} \end{pmatrix} \times \begin{pmatrix} \Delta\ln(H_1) \\ \Delta\ln(K_1) \end{pmatrix} = \begin{pmatrix} \alpha_{HL}\frac{b}{\eta_L} \\ \alpha_{KL}\frac{b}{\eta_L} \end{pmatrix} \tag{15}$$

We can thus solve for the changes in quantities as,

$$\Delta\ln(H_1) = \frac{b}{\eta_L}\frac{\alpha_{HL}(-\alpha_{KK}) + \alpha_{KL}\alpha_{HK}}{(\eta_H - \alpha_{HH})(-\alpha_{KK}) - \alpha_{HK}^2}, \tag{16}$$

$$\Delta\ln(K_1) = \frac{b}{\eta_L}\frac{(\eta_H - \alpha_{HH})\alpha_{KL} + \alpha_{KH}\alpha_{HL}}{(\eta_H - \alpha_{HH})(-\alpha_{KK}) - \alpha_{HK}^2}. \tag{17}$$

Notably, both the changes in high-skilled workers and in capital are positive. First, Y is assumed to be supermodular, which implies that $\alpha_{ij} \geq 0$ for $i \neq j$. This means that the numerator in the expression is always positive. Secondly, the Hessian matrix of the production function is assumed to be negative semi-definite. This means that the denominator is also positive. As a result, it follows that the changes in capital and high-skilled labor are both positive. In other words, an increase in either of these inputs leads to an increase in output.

2.3 Interpretation

Let us now interpret the expressions for the changes in high-skilled labor and capital. Since they are similar, I focus on the one for capital. The change in capital can be thought of as having three components:

1. A labor market power effect ($\frac{b}{\eta}$) that arises from the change in the number of low-skilled workers and the low-skilled labor supply elasticity facing the firm.

2. A direct effect ($\frac{(\eta_H-\alpha_{HH})\alpha_{KL}}{(\eta_H-\alpha_{HH})(-\alpha_{KK})-\alpha_{HK}^2}$) on capital that is determined by the degree of complementarity in the production function between capital and low-skilled labor.

3. An indirect effect ($\frac{\alpha_{KH}\alpha_{HL}}{(\eta_H-\alpha_{HH})(-\alpha_{KK})-\alpha_{HK}^2}$) that arises from the degree of complementarity between high-skilled labor, low-skilled labor, and capital.

In other words, the change in capital is influenced by the firm's market power over labor, the productivity-enhancing effect of capital on low-skilled labor, and the productivity-enhancing effect of high-skilled labor on capital and low-skilled labor.

$$\underbrace{\Big(\frac{b}{\eta_L}\Big)}_{\text{Labor Market Power Effect}} \times \Big(\underbrace{\frac{\alpha_{KH}\alpha_{HL}}{(\eta_H-\alpha_{HH})(-\alpha_{KK})-\alpha_{HK}^2}}_{\text{Indirect Technical Substitution}} + \underbrace{\frac{(\eta_H-\alpha_{HH})\alpha_{KL}}{(\eta_H-\alpha_{HH})(-\alpha_{KK})-\alpha_{HK}^2}}_{\text{Direct Technical Substitutions}} \Big) \tag{18}$$

To simplify the exposition further, I will denote the direct technical substitution by β_i, and the indirect technical substitution by γ_i.

2.4 Additional Results

We can approximate changes in other variables between period zero and one.

Sales

$$\Delta\ln(Y_1) \approx \alpha_L\Delta\ln(L_1) + \alpha_H\Delta\ln(H_1) + \alpha_K\Delta\ln(K_1), \tag{19}$$

$$\Delta\ln(Y_1) \approx \frac{b}{\eta_L}\Big(\alpha_L + \alpha_H\frac{\alpha_{HL}(-\alpha_{KK})+\alpha_{KL}\alpha_{HK}}{(\eta_H-\alpha_{HH})(-\alpha_{KK})-\alpha_{HK}^2} + \alpha_K\frac{(\eta_H-\alpha_{HH})\alpha_{KL}+\alpha_{KH}\alpha_{HL}}{(\eta_H-\alpha_{HH})(-\alpha_{KK})-\alpha_{HK}^2}\Big), \tag{20}$$

$$\Delta\ln(Y_1) \approx \frac{b}{\eta_L}\Big(\alpha_L + \alpha_{HL}\frac{\alpha_H(-\alpha_{KK})+\alpha_{KH}\alpha_K}{(\eta_H-\alpha_{HH})(-\alpha_{KK})-\alpha_{HK}^2} + \alpha_{KL}\frac{\alpha_K(\eta_H-\alpha_{HH})+\alpha_{KH}\alpha_H}{(\eta_H-\alpha_{HH})(-\alpha_{KK})-\alpha_{HK}^2}\Big). \tag{21}$$

The change in sales is positive, and is the product of the labor market effect, and a technical substitution effect, driven by the strength of complementarity between low-skilled and high-skilled labor, as well as low-skilled labor and capital.

Total Employment Denote total employment by N and employment shares by skill group by e_i,

$$\Delta \ln(N_1) \approx e_L \Delta \ln(L_1) + e_H \Delta \ln(H_1), \tag{22}$$

$$\Delta \ln(N_1) \approx \frac{b}{\eta_L}\Big(e_L + e_H(\beta_H + \gamma_H)\Big). \tag{23}$$

The effect on employment is positive since the effect is positive for both skill groups. This result comes from the fact that we assume that it is optimal for the firm to hire on the labor supply curve when it faces a small change in wages. As the firm increase the wage, more workers want to work for the firm. However, this assumption is only plausible for small changes in the wage.

Total Wage Bill Denote total wage bill by $W = w_L L + w_H H = L^{1+\eta_L} + H^{1+\eta_H}$, and wage bill shares by skill group by θ_i,

$$\Delta \ln(W_1) \approx \theta_L \frac{1+\eta_L}{\eta_L} b + \theta_H (1+\eta_H) \frac{b}{\eta_L} \Delta \ln(H_1), \tag{24}$$

$$\Delta \ln(W_1) \approx \frac{b}{\eta_L}\Big(\theta_L(1+\eta_L) + \theta_H(1+\eta_H)(\beta_H + \gamma_H)\Big). \tag{25}$$

Similarly, the effect on the total wage bill is positive, since the effect on wages is an increasing function of the change in employment.

Average Wages Denote average wages by $w = \frac{W}{N}$.

$$\Delta \ln(w) = \Delta ln(W) - \Delta ln(N), \tag{26}$$

$$\Delta \ln(w) \approx \frac{b}{\eta_L}\Big(\theta_L(1+\eta_L) + \theta_H(1+\eta_H)(\beta_H+\gamma_H)\Big) - \Big(e_L + e_H(\beta_H+\gamma_H)\Big), \tag{27}$$

$$\Delta \ln(w) \approx \frac{b}{\eta_L}\Big((\beta_H+\gamma_H)\eta_H + \theta_L[1-(\beta_H+\gamma_H)\eta_H] + \Big(1-\beta_H-\gamma_H\Big)(\theta_L - e_{L0})\Big). \tag{28}$$

The change in average wages is positive unless there is a large increase in low-skilled workers compared to high-skilled workers. In particular, a sufficient condition is that the sum of the direct and indirect effects of technical substitution exceeds unity.

2.5 Relationship to Empirical Quantities

The empirical analysis will focus on firms within the same industry that share the same bargained wage changes. In practice, wage changes might be binding for one or more worker skill groups.

We separate firms based on the implied change in total wage bill. We can find these from the first-order conditions:

$$Y(Y_i'(\cdot)\frac{x_i}{Y}) = (1+\eta_i)x_i^{1+\eta_i} \tag{29}$$

$$Y\alpha_i = (1+\eta_i)x_i^{1+\eta_i} \tag{30}$$

$$x_i^{1+\eta_i} = Y\frac{\alpha_i}{1+\eta_i} \tag{31}$$

Thus, optimal spending on labor input i is a fraction of total output. We then define the wage bill share of labor input i,

$$\theta_i = \frac{\frac{\alpha_i}{1+\eta_i}}{\sum_s \frac{\alpha_s}{1+\eta_s}}. \tag{32}$$

The implied minimum change in the total wage bill is given by,

$$b = \sum_i b_i \theta_i \tag{33}$$

The key identification assumption is that there is no selection on the period zero labor mix. In the empirical analysis, this translates into an assumption about parallel trends. Index treated firms with T and control with C.

Denote the within-firm change in some quantity as follows, with γ_i denoting the technical substitution effect, and η_i the labor market power effect,

$$\Delta ln(x_i) = \sum_i \frac{\gamma_i}{\eta_i} b_i. \tag{34}$$

We can then write the difference-in-differences estimate D as:

$$D(ln(x_i)) = \sum_i \Big(\frac{\gamma_i^T}{\eta_i^T} - \frac{\gamma_i^C}{\eta_i^C} \Big) b_i \tag{35}$$

The estimated effect is thus the difference between treated and control firms in both the technical substitution and the labor market power effect.

3 Collective Bargaining in Sweden

3.1 Labor Market Institutions

The Swedish labor market is known for its strong trade unions, and relatively low frequency of strike activity, even compared to other countries in the Nordic region. Trade unions and employers' associations in Sweden negotiate wages at the national level, Subsequently, firms, local trade unions, and workers determine wages locally.[6]

Sweden has strong trade unions and employers' associations. Around 75% of workers in the private sector belonged to a trade union in 2001 (80% of all workers). Moreover, around 90% of the workers work for firms with a collective bargaining agreement (in 2005). On the employer side, slightly more than 30% of all employers have collective bargaining agreements. However, most large firms sign collective bargaining agreements. Around 70% of employers with 5–19 employees have collective bargaining agreements, and 90% of employers with at least 20 employees.

Sweden's trade unions and employers' associations coordinate collective wage bargaining with minimal government involvement. The government has indirectly granted these organizations the authority to regulate the labor market since the early 20th century. As a result, there is no statutory minimum wage and no requirement for firms to sign collective agreements. However, there are limits to this freedom. Collective bargaining agreements still cover non-unionized workers, and many firms, not members of employers' associations, sign substitute agreements with trade unions, agreeing to the same terms as regular agreements. Trade unions and employers' associations then coordinate their members to implement centralized wage increases.

In Sweden, collective bargaining occurs at three levels. First, infrequent peak negotiations take place between trade union confederations and employers' associations, covering

[6]For more information on this topic, see Medlingsinstitutet (2001, 2004); Kjellberg (2019); Bhuller et al. (2022).

issues such as insurance and pensions. Next, centralized bargaining occurs within each industry, addressing pay increases, working hours, working time, and workplace conditions. These negotiations typically happen every three years, and the agreements reached in the manufacturing sector coordinate other sectors. Finally, annual local firm-level bargaining occurs, usually involving the distribution of pay increases, and may also include negotiations between individual workers and the firm. The scope for firm-level bargaining varies by industry, with some sectors having defined wage increases, a guaranteed minimum wage increase, or no defined wage increases.

I focus on industry-level (central) bargaining, specifically pay increases. During these negotiations, trade unions and employers' associations negotiate annual pay increases. These agreements usually regulate the increase in total labor costs. In 2004, such agreements covered 93% of private sector employees. Sometimes, agreements also include minimum increases in individual wages. 73% had agreements that guaranteed some minimum increase (Medlingsinstitutet, 2004). However, some industries do not have defined wage increases and are therefore not included in the sample.

Several factors can contribute to differences in centrally bargained wage increases. Economic conditions can affect the outcomes of bargaining negotiations (Medlingsinstitutet, 2001). Agreements may also vary in their emphasis on centralized versus localized wage bargaining. Moreover, they may differ in their focus on average wage increases versus other issues like particular increases for low-wage occupations, minimum wages, working hour flexibility, or working environment regulations. Additionally, industries may differ in wage increases distribution over the agreement's duration. These factors, along with others, can contribute to differences in centrally bargained wage increases in Sweden (Medlingsinstitutet, 2004; NIER, 2010).

Table 1: Bargained and Actual Wage Increases, Official Statistics

	2001–2003		2004–2006	
	Bargained	Outcome	Bargained	Outcome
Manufacturing	2.4	3.7	2.0	3.1
Construction	2.6	4.1	2.3	3.0
Services	2.7	3.8	2.1	3.1
Private Sector	2.6	3.8	2.1	3.1

Notes: The table shows centrally bargained and actual increases inn hourly pay for selected sectors in Sweden for the years 2001–2006. The data comes from NIER (2007) and is based on data from Statistics Sweden and the National Mediation Office.

3.2 The 2004 Bargaining Round

In 2004, extensive negotiations took place in Sweden, covering nearly all private sector employees and about half of the workforce. The majority of private sector agreements, 88%, were valid for three years. The agreements reached in the manufacturing sector coordinated other sectors. However, there was some variation due to further revisions in other clauses and because some low-paid sectors negotiated absolute wage increases. On average, blue-collar workers covered by three-year agreements received pay increases, including working time reduction, totaling 7.8% over three years, while white-collar workers received 6.8%. Within the manufacturing sector, the bargained increases were slightly lower (Medlingsinstitutet, 2004).

Firms provided wage increases that exceeded the agreed-upon rates. According to the National Institute for Economic Research, a government agency, average private sector hourly wages increased by 3.8% in 2001-2003, while the bargained wage increases were only 2.6%. For 2004-2005, the corresponding values were 3.1% for average hourly wages and 2.1% for bargained wage increases. This trend can be attributed to increased labor demand, among other factors (NIER, 2007).

Similarly, there are also differences between sectors. In Table 1, we see that there are differences in both bargained wage growth and actual wage growth between major sectors (NIER, 2007).

4 Data on Firms, Workers and Collective Bargaining Agreements

4.1 Data on Firms and Workers

Sources This study uses data on firms' inputs and output. To obtain the firm-level variables, I accessed the Serrano database, which includes information on all Swedish limited liability companies and stems from administrative records from Statistics Sweden and the Swedish Companies Registration Office (Bolagsverket). In addition, I utilize data on job changes, wages, occupation, and education from the matched employer-employee data, which comes from the LISA database from Statistics Sweden. This database contains annual data on individuals' income, occupation, education, and similar variables. It is important to note that the Serrano and LISA databases do not fully overlap, as the Serrano database contains accounting data, and the LISA database contains information on individuals. For more information on the sources and construction of the sample, please see Online Appendix C.

Sample To create my sample, I use the Serrano database of Swedish companies and the years 2000-2006. To refine my sample, I implement the following restrictions. First, I remove firms that do not have an identifier and firms with zero, negative, or missing data on sales, value-added, labor costs, total assets, or employment. Next, I only include privately-owned limited liability companies. Finally, I remove firms in the finance, public administration, education, care, culture, other services, household production, and embassies sectors. To further narrow my sample, I impose the implicit restrictions that the firm must have workers with wages and occupation codes in the LISA database and be in industries with centrally bargained wage increases for 2004.

I implement some additional restrictions. First, I limit the sample to firms with at least SEK 10 million in revenues and at least 10 employees in 2004. I do this to reduce the

influence of small firms, which are less likely to have collective bargaining agreements (Kjellberg, 2019). Additionally, I only include firms with centrally bargained wage increases of at least 1% to minimize measurement error. The final sample consists of 10,633 firms. I also restrict the event window to the years 2001–2005. In the appendix, I demonstrate that the results are robust to different sample restrictions.

4.2 Data on Collective Bargaining Agreements

Sources I use data on collective bargaining agreements in Sweden. The primary dataset comes from the archives of the National Mediation Office (Medlingsinstitutet), with some additional missing agreements added later. The National Mediation Office is a government agency responsible for monitoring the labor market and collecting collective agreements.

Collective bargaining agreements are contracts signed between an employers' association and a trade union for one or more groups of workers. These agreements include many provisions, but the main ones are wage increases and, in some cases, reductions in working times.

For 2004-2006, I manually reviewed the outcomes of bargained agreements and recorded the different bargained increases in average wages. These increases are typically referred to as "general wage increase" (*generell löneökning*) or "wage pot" (*lönepott*). To avoid the financial crisis and the steady decline in the use of agreements with centralized wage increases, I have limited my data collection to the years 2001–2006. I describe this process more detail in Online Appendix C.

Assigning Collective Bargaining Agreements to Industries I have manually linked each collective agreement to one or more industries. I have linked each industry (3-digit SNI code)[7] to one or more agreements. However, I have not been able to link agreements to individual firms. Instead, I had to match based on the industry of the

[7] I am using the 2007 version of the *svensk näringsgrensindelning* or SNI system. The SNI system is the Swedish version of the European Union industry classification "Statistical Classification of Economic Activities in the European Community," or NACE Revision 2.

employers' association, the trade union, and the type of workers involved. It is important to note that many firms may have the same assigned collective agreement even if they belong to different 3-digit SNI codes.

As an example, industry number 171, "Manufacturing of Pulp, Paper, and Cardboard," receives two agreements: the agreement between the employer organization for the forestry firms (*Skogsindustrierna*) and the Pulp and Cardboard Workers' trade union (*Svenska Pappersindustriarbetareförbundet*) regarding workers in the pulp and cardboard industries, and the agreement between the forestry firms and the white-collar workers' union (*Svenska industritjänstemannaförbundet*) regarding employees in the pulp and cardboard industries.

I categorize each collective bargaining agreement into a skill group based on the type of trade union involved in the negotiation. The three main skill groups in Sweden are blue-collar (LO or *arbetare*) workers, white-collar workers (TCO or *tjänstemän*), and skilled white-collar workers (*akademiker*). I define these as low-skilled, mid-skilled, and high-skilled. The assignment is primarily based on the type of trade union negotiating. If the agreement explicitly mentions white-collar workers or tjänstemän, I assign it to the white-collar group. If the agreement applies to mid-skilled workers and others, I assign it to the mid-skilled group. I adjust the classification using the occupation codes if the agreement is misclassified based on these rules compared to the occupation codes from Statistics Sweden (SSYK 96). I define codes 111–242 as high-skilled, 243-348 as mid-skilled, and 400– as low-skilled. I exclude military occupations.

Assigning Workers to Skill Groups For workers, I use the same system as above and let workers with SSYK 96 codes 111–242 be high-skilled, 243-348 be mid-skilled, and 400– as low-skilled, and also exclude military occupations. I then group workers based on their skill group and sum each firm's total wage bill (using primary employers). For the year 2003, I call the wage bill weights ω^k_{i2003}, with $k = \{\text{Low}, \text{Mid}, \text{High}\}$.

5 Estimating the Effects of Centrally Bargained Wages

5.1 Defining Treatment and Control Firms

For each firm in the sample, I predict their centrally bargained wage increase for 2004 based on the weighted average of all wage increases relevant to their industry and skill group, using the shares of each skill group in the firm's workforce in 2003 as weights.

I define the firm-level predicted centrally bargained wage increase B_i as

$$B_{i2004} = \sum_{k=1}^{K_j} \omega_{i2003}^{k} B^{k(j)}, \tag{36}$$

where i indexes firms, j industries, and k skill groups. Let ω_i^k denote the wage bill share of skill group k, K_j denote the skill groups (1, 2, or 3) and $B^{k(j)}$ denote the bargained wage increase for skill group k. Note that this can be zero if there is no relevant wage increase for a particular skill group in some sector.

I classify firms as treated or control based on whether their predicted wage increase is in the top or bottom of the distribution within their 3-digit industry. Treated firms are in the top quartile, and control firms are below the median.[8] Denote the associated cutoffs $B_{j(i)}^{50}$ and $B_{j(i)}^{75}$,

$$\text{Treated}_i = \begin{cases} 0 & \text{if} \quad B_{i2004} \leq B_{j(i)}^{50} \\ 1 & \text{if} \quad B_{i2004} \geq B_{j(i)}^{75}. \end{cases} \tag{37}$$

5.2 Estimating Equations

Basic Difference-in-Differences I estimate a difference-in-differences model where I compare firms that have centrally bargained wage increases in the top quartile in their

[8] I show in the Appendix that the results are robust to varying the treatment definition.

industry in 2004, with those that have bargained wage increases in the bottom half. I cluster standard errors on the level where treatment varies, that is, on the firm level. The main equation is:

$$\ln(y_{it}) = \alpha + \beta \text{Treated}_i \times \text{Post}_t + \lambda_i + \lambda_t + u_{it}, \tag{38}$$

In Equation (38) the coefficient β can be interpreted as the average difference in percent between treated (high bargained wage increases) and control (low bargained wage increases) firms.

Dynamic Difference-in-Differences I also estimate a dynamic difference-in-differences model, where I interact the treatment variable with an indicator for each year. This equation is of the form,

$$\ln(y_{it}) = \alpha + \sum_{k=2000}^{2007} \beta_k \text{Treated}_i \times \mathbb{1}\{\text{Year}_t = k\} + \lambda_i + \lambda_t + v_{it}. \tag{39}$$

Now, the coefficients $\{\beta_k\}$ are the annual differences in percent between treated and control firms. I choose the pre-treatment year 2003 as the baseline.

5.3 Summary Statistics

Table 2 compares the characteristics of treated firms (those in the top quartile of their industry in terms of centrally bargained wage increases) to control firms (those below the median of their industry in terms of centrally bargained wage increases) in 2003. Treated firms are generally smaller: For instance, the average treated firm has 38 employees, while the average control firm has 73 employees. Similarly, treated firms have roughly SEK 70 million in sales, while control firms have sales of SEK 170 million.

Treated firms have more low-skilled workers but fewer mid-skilled and high-skilled workers. This holds both when we study wage bill shares and employment shares. The average

(lagged) low-skill wage bill is about 80%, against 60% for control firms. The employment shares are instead 81% for treated firms against 68% for control firms.

Finally, we see that treated firms, on average, face centrally bargained wage increases of 2.0% against 1.6% for control firms.

Table 2: Summary Statistics for Treated and Control Firms

	Control	Treated	Difference	P-Value
Mean Labor Costs	364	343	21	0.00
Labor Costs	29,851	14,001	15,850	0.00
Employees	73	38	35	0.00
Total Assets	130,256	47,906	82,349	0.00
Physical Capital	32,074	16,872	15,202	0.02
Sales	172,117	67,204	104,913	0.00
Value Added	42,276	19,172	23,104	0.00
Total Debt	79,209	28,395	50,815	0.00
Low-Skill Employment Share	68	81	-13	0.00
Mid-Skill Employment Share	15	8	7	0.00
High-Skill Employment Share	17	10	6	0.00
Low-Skill Wage Bill Share	60	80	-20	0.00
Mid-Skill Wage Bill Share	17	9	8	0.00
High-Skill Wage Bill Share	24	12	12	0.00
Centrally Bargained Wages	1.583	1.998	-0.415	0.000

Notes: The table shows average values for the control and treated groups, their difference and the associated p-value of the two-sided t-test. The unit of observation is the firm-year. All values are for 2003 except for centrally bargained wages, which is for 2004. The monetary values are expressed in SEK 1,000 and are deflated using the GDP Deflator from Statistics Sweden.

Next, we look at summary statistics for the entire sample. We see that the average firm is medium-sized, with a mean number of employees of 61 and a median of 20. Still, there is an extensive range, from 1 to almost 20,000. The average firm has sales of SEK 140 million, with a median of SEK 30 million.

We see that the average bargained wage increase is roughly 2%, corresponding to the official estimates from Table 1. Moreover, we note that actual wage increases often exceeded the bargained ones by more than one percentage point.

Table 3: Descriptive Statistics for Firms With High and Low Bargained Wages

	N	Mean	Median	SD	Min	Max
Labor Costs	51,664	24,105	7,155	140,583	1	8,000,000
Employees	51,664	61	20	334	1	19,000
Total Assets	51,664	102,203	13,425	1,065,898	22	57,000,000
Physical Assets	51,663	27,066	2,028	308,995	0	18,000,000
Total Debt	51,662	62,324	7,929	677,857	-3,715	41,000,000
Sales	51,664	137,891	29,099	1,324,454	6	100,000,000
Value Added	51,664	34,388	9,067	227,480	5	19,000,000
Bargained Wage Increase	37,854	2	2	1	0	4

Notes: The table shows summary statistics for the sample firms. The unit of observation is the firm-year. The monetary values are expressed in SEK 1,000 and are deflated using the GDP Deflator from Statistics Sweden. Maximum values are rounded to preserve confidentiality.

5.4 Identifying Variation and Validity Checks

Identifying Variation I use the variation induced in predicted centrally bargained wage increases within industries that stem from firms having different initial skill mixes. Table 4 shows the share treated within each industry and the associated cutoffs (median) of the centrally bargained wage increases. We see that the sample contains 150 industries.

First, we see that the share of treated firms is on average 38%, with a median of 33%. We expect this value to be 33% (top 25% and the bottom 50%), but it varies somewhat since some industries have very few firms. Indeed, six industries only have only firm, hence the share treated is 100%. We see that there are on average 71 firms per industry, with a median of 21 firms. The range goes from 1 to 686 firms.

Table 4: Share Treated and Median Bargained Wages by Industry

	N	Mean	Median	Min	Max
Share Treated	150	0.38	0.33	0.33	1.00
Median Centrally Bargained Wage Increase (%)	150	1.68	1.61	1.10	2.70
Difference in Centrally Bargained Wages (%)	144	0.46	0.44	0.00	1.13
Low-Skill Wage Increase (%)	133	2.26	2.20	1.10	3.50
Mid-Skill Wage Increase (%)	78	1.93	1.80	1.60	2.50
High-Skill Wage Increase (%)	23	1.78	1.60	1.60	2.20
Number of Firms	150	71	21	1	686

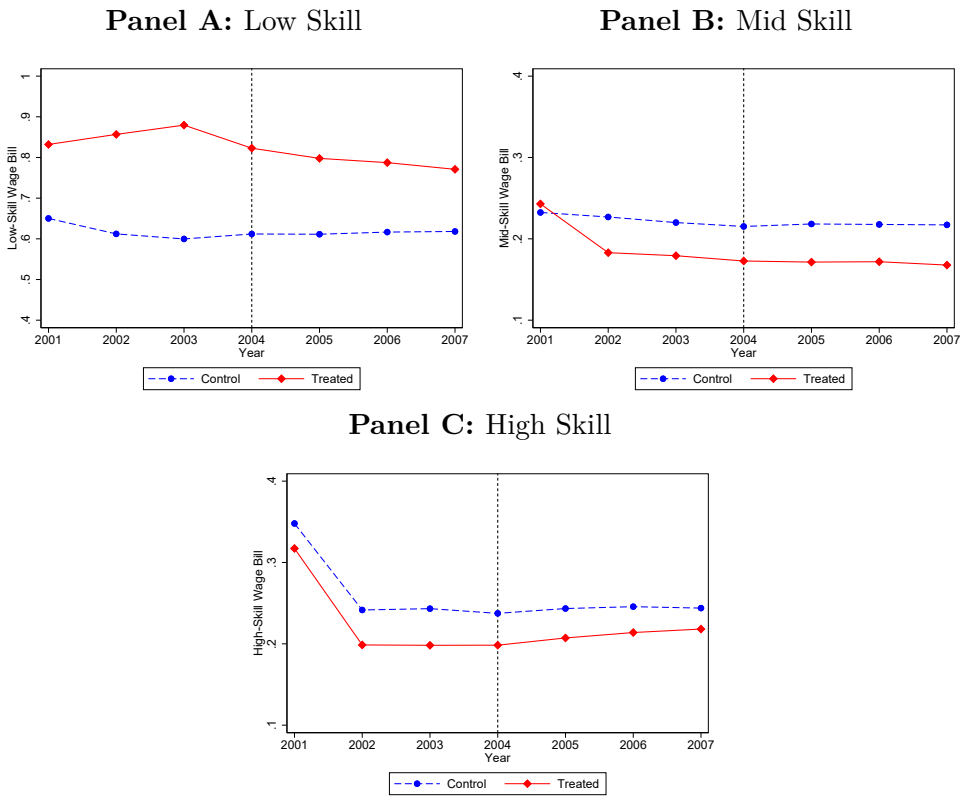
Notes: The table shows the sources of variation. Row one shows the distribution of the share treated firms across bargaining industries. Row two shows the distribution of median predicted centrally bargained wage increases, the cutoff for treatment, for each bargaining industry. Row three shows the difference in centrally bargained wages between treated and control groups. Rows four through six shows the centrally bargained wages for low-skilled, mid-skilled, and high-skilled workers. Row seven shows the number of firms in each industry.

Next, we study the cutoff (median) level of centrally bargained wage increases: the mean cutoff is 1.68%, with a range between 1.10% and 2.70%. This suggests that there is variation between industries. We also study the average difference in centrally bargained wages between treated and control firms. The mean value is 0.46 percentage points, with a median value of 0.44 percentage points. Still, there is a range from almost zero to 1.13 percentage points.

We then focus on the wage increases for each skill group. We see that low-skilled workers on average see higher bargained wage increases. The average values are 2.26 for low-skilled workers, 1.93 for mid-skilled workers, and 1.78 for high-skilled workers. 133 industries have a bargained wage increase for low-skilled workers, 78 for mid-skilled workers, and 23 for high-skilled workers.

Next, we see in that the skill wage bill shares are relatively constant over time within treated and control groups. Figure 1 plots the wage bill weights for treated and control groups. First, we see that there are persistent differences in levels: treated firms pay a larger share of their wage bill to low-skill workers, about the same to mid-skill workers, and somewhat less to high-skill workers. However, there are no large observable swings. This suggests that skill shares are persistent over time and related to long-run factors unrelated to the expected or actual outcomes of the 2004 bargaining round.

Figure 1: Skill Group Wage Bill Shares by Treated and Control



Notes: The figure shows average shares of low-skilled, mid-skilled and high-skilled lagged wage bills for treated and control firms for the years 2001–2007.

Validity Checks I take advantage of the differences in centrally bargained wage increases caused by initial differences in the mix of skills among workers in each industry. My core identification assumption is that companies in the treatment and control groups have parallel trends. In other words, firms within each industry, whose mix of skills resulted in higher bargained wage increases, did not also expect higher growth in the future.

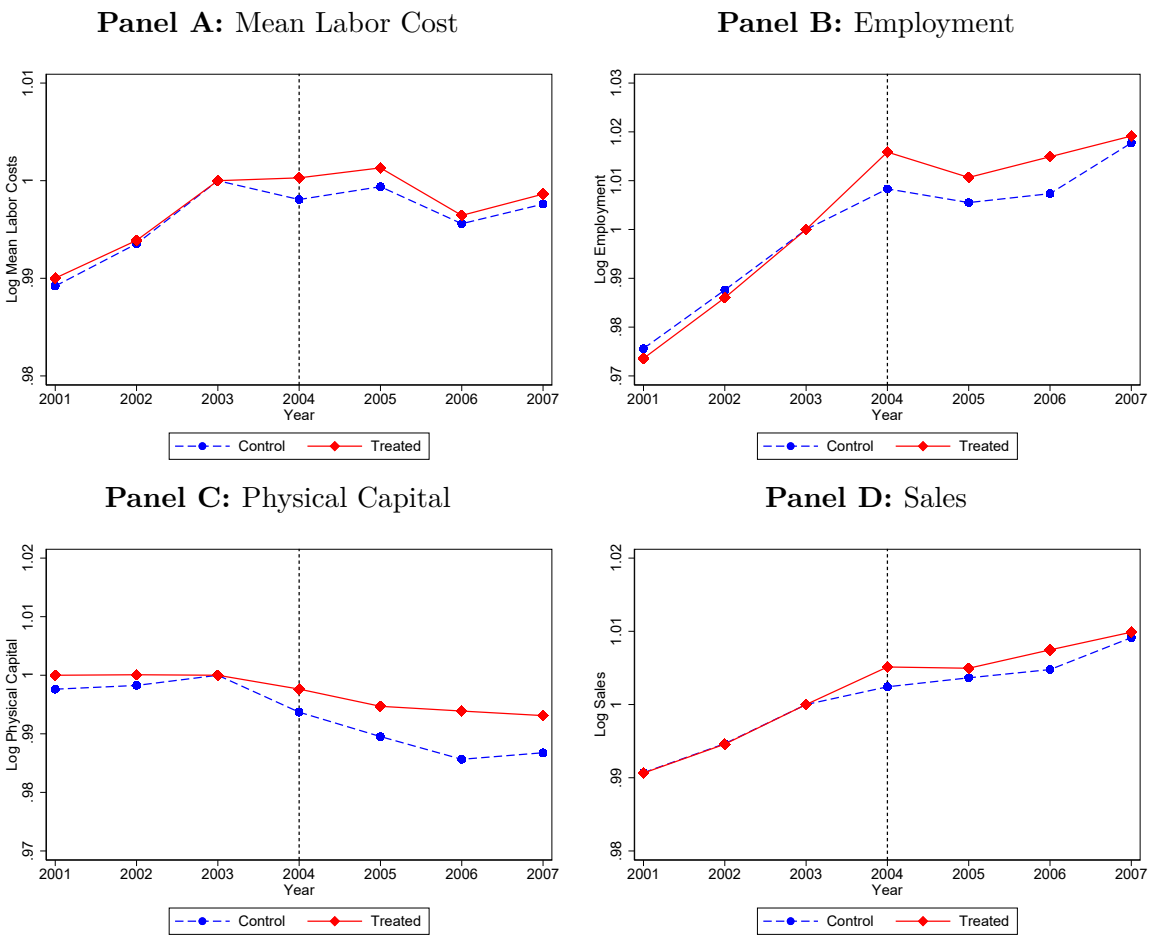
Although this assumption cannot be directly tested, I offer several ways to confirm it. For example, Figure 3 shows that there are no pre-trends in labor costs, employment, physical capital, or sales for either group. This indicates that both the treatment and control groups were on similar trends before the 2004 negotiation round. Therefore, it is likely that companies with higher negotiated wage increases would have had the same growth rate trend if they had not received the higher increases.

6 Effects of Centrally Bargained Wages on Firm Growth

6.1 Graphical Evidence

I begin by showing group averages for the treated and control firms. Figure 2 shows the evolution between 2001 and 2007 for both groups for the logs of mean labor costs, employment, physical capital, and sales. The base year is set to 2003. We see that firms are on parallel trends before 2004 and then there is a jump in 2004, which is persistent over time.

Figure 2: Firm Outcomes for Treated and Control Firms



Notes: The figure shows average labor cost (A) and employment (B) growth for firms with above-median centrally bargained wage increases (treated) and those below (control) for the years 2001–2008. The monetary values are deflated using the GDP Deflator from Statistics Sweden. Growth rates are expressed as the log-difference.

6.2 Dynamic Difference-in-Differences Results

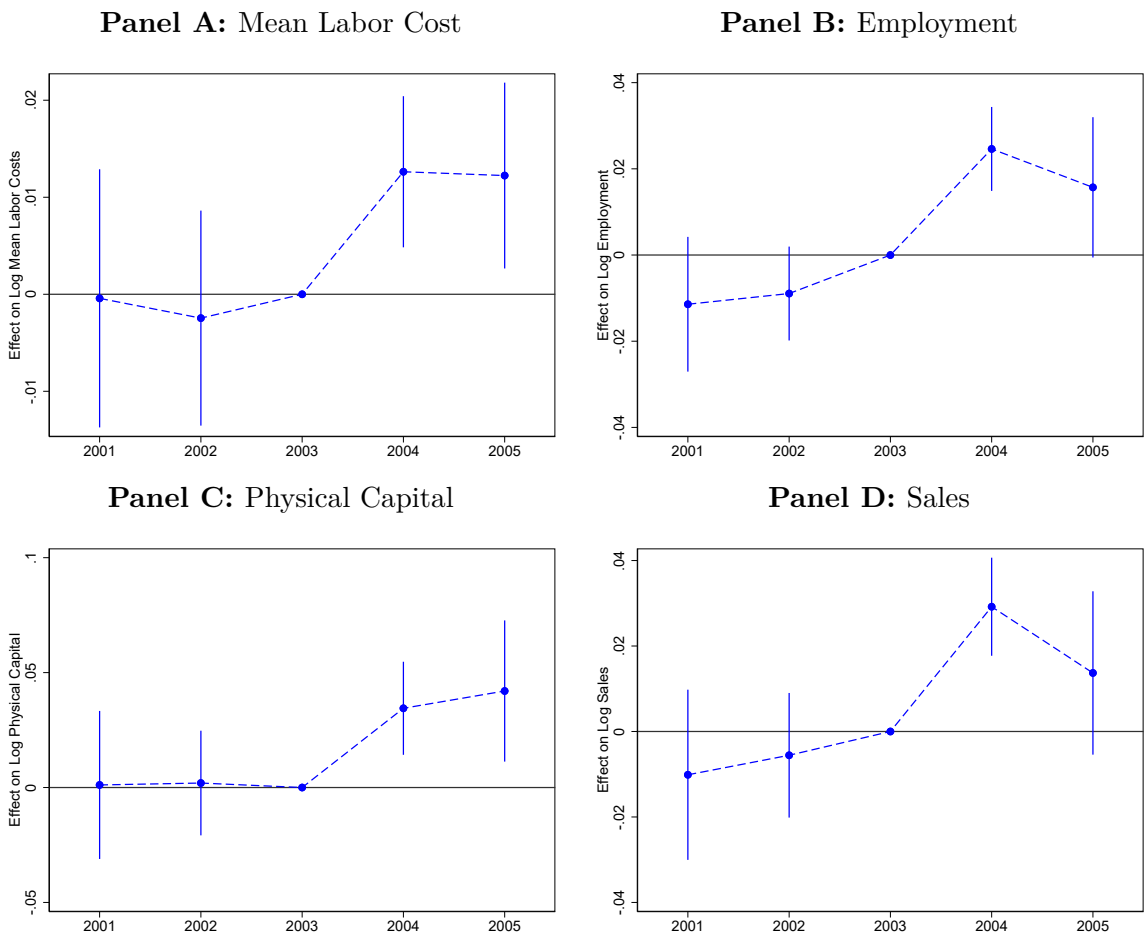
I then turn to the dynamic specification from Equation (39). In Figure 3, we see the results for mean labor costs, employment, assets, and sales. I set 2003 as the base year and thus express all results relative to that year.

We see that firms that eventually face relatively high and low bargained wage increases were on parallel trends in the years 2001–2003. This supports the central assumption that the groups were on parallel trends also from 2004–2005. I show the corresponding estimates in Table B.10.[9]

We see a similar pattern for all four outcome variables: There is a clear jump in 2004 and an effect that persists in the subsequent years. Mean labor costs increase by 1.5%, employment by 2.5%, physical capital by 3%–4%, and sales by roughly 3%. Notably, we see that the effect on assets builds up over time, consistent with capital being slow to adjust.

[9]The results are similar when we extend the post-treatment window to the year 2010. I show this in Figure B.1 and in Table B.16.

Figure 3: Effects of Higher Centrally Bargained Wages Increases on Firm Outcomes (Event Study)



Notes: The figure shows event study estimates on the logs labor costs, employment, assets and sales of having a high centrally bargained wage increases. I compare firms that have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half.

Table 5: Effects of Higher Centrally Bargained Wages Increases on Labor Costs and Employment

	Log Labor Costs		Log Net Wages		Employment		
	(1) Mean	(2) Total	(3) Mean	(4) Total	(5) Log Employment	(6) Log Hires	(7) Log Separations
Treated × Post	0.013***	0.040***	0.014***	0.041***	0.027***	0.056***	0.042***
	(0.004)	(0.008)	(0.004)	(0.008)	(0.007)	(0.014)	(0.013)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.690	0.931	0.665	0.931	0.943	0.758	0.816
N	51,658	51,658	51,653	51,653	51,658	48,721	46,364

Notes: The table shows difference-in-differences (OLS) estimates of the effect of higher centrally bargained wage increases on firm-level outcomes. The outcomes are the logs of mean labor costs, total labor costs, mean net wages and total net wages, employment, hires and separations. Firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

6.3 Effects on Labor Costs

I study the impact of facing higher predicted centrally negotiated wage increases on various labor cost measures, similar to a first stage analysis. Table 5 shows the results for the log of the average labor cost (column 1), total labor costs (column 2), average net wages (column 3), and total net wages (column 4). The results are consistent across the columns. The estimated coefficients are statistically significant at the 1% level. On average, labor costs and net wages increase by 1.3% and 1.4%, respectively, while total labor costs and net wages rise by 4.0% and 4.1%. Unsurprisingly, firms facing higher wage increases also increase wages more than control firms.

Additionally, we see that the effect on labor costs is larger than the difference in centrally negotiated wages (roughly 0.4 percentage points). In the context of the framework in Section 2, these companies also increase the wages of high-skilled workers and potentially change their mix of inputs to benefit from complementarities in production. These results indicate a positive and statistically significant relationship between centrally negotiated wages and actual company outcomes. These results align with previous research that has found a positive effect of unions on wages.[10].

[10]See Fitzenberger et al. (2013); Breda (2015); Barth et al. (2020); Stansbury and Summers (2020); Devicienti and Fanfani (2021); Dodini et al. (2021)

6.4 Effects on Employment

When firms face a change in wages, they choose to increase employment if it remains profitable to do so. This happens when they sufficient initial labor market power and thus large markdowns. This case is more plausible for smaller rather than large imposed wage changes.The framework in Section 2 suggests that we explain the results in terms of labor market power and the extent to which companies can re-optimize their production.

As expected, in column (5) of Table 5, we see that the effect on employment is positive and estimated to be 0.027, and it is statistically significant at the 1% level. Companies facing higher wage increases had 2.7% higher employment in the years following the 2004 negotiation round. One potential concern is that higher wages do not affect the stock of jobs as much as they affect the flow of hires and separations: companies might reduce the number of job openings they advertise (Kudlyak et al., 2022). However, in columns (6) and (7), we see a positive effect on both hires and separations, with the effect being larger for hires.

The effect of unions on employment is theoretically ambiguous: they might excessively increase labor costs but also help to reduce turnover through improved management (Dale-Olsen, 2021; Laroche, 2020). Similarly, higher minimum wages have ambiguous effects on employment.[11] Notably, Azar et al. (2019) find positive effects of higher minimum wages for highly concentrated local labor markets in the United States, Clemens and Strain (2021) find positive effects for small increases, and Eliasson and Nordström Skans (2014) find reduced separations for skilled labor and lower hiring rates when bargained minimum wages increase. These results are broadly in line with my findings.

[11] See Meer and West (2016); Cengiz et al. (2019); Clemens and Wither (2019); Harasztosi and Lindner (2019); Gopalan et al. (2021); Clemens (2021); Devicienti and Fanfani (2021); Card and Cardoso (2021); Dustmann et al. (2022)

6.5 Effects on Investments and Financing

Next, I examine investments. Following the framework in Section 2, the effect on capital comes from the degree of complementarity between capital and low-skilled labor and capital and high-skilled labor. Table 6 shows the effect on different capital variables. In column (1), we see that the estimated coefficient for physical capital is 0.037, which is statistically significant at the 5% level. We see a similar and larger effect when looking at the impact on machines (column 2).

I also study how firms finance their investment. The effect is negative, but statistically insignificant, for financial assets (column 3). Next, I study how firms finance their expansion. Column (4) shows that treated firms increase their stock of debt by 2%, while the effect is negative and statistically insignificant for both equity and cash (columns 5 and 6). This suggests that firms finance primarily by taking on more debt.

These results provide additional insight into the causes of automation and technological change. Previous research suggests that automation contributes to job polarization. Böckerman et al. (2019) shows that using ICT at the firm level drives polarization within companies. Cortes and Salvatori (2019) studies the demand-side mechanisms behind polarization and finds that occupational specialization within companies is an important driver. Gregory et al. (2022) finds that digital technologies both destroy and create jobs in Europe between 1999-2010. Similarly, work by Battisti et al. (2022) suggests that technological and organizational changes lead to routine-biased changes within companies and skill upgrading. More broadly, Graetz (2020) shows that the Swedish labor market has handled automation relatively well during recent decades.

Table 6: Effects of Higher Centrally Bargained Wages Increases on Investments

	(1) Log Physical Capital	(2) Log Machines	(3) Log Financial Assets	(4) Log Total Debt	(5) Log Equity	(6) Log Cash
Treated × Post	0.037**	0.052***	-0.022	0.020**	-0.003	-0.029
	(0.015)	(0.015)	(0.036)	(0.010)	(0.012)	(0.031)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.941	0.928	0.880	0.942	0.941	0.773
N	50,788	50,699	32,595	51,650	50,700	50,140

Notes: The table shows difference-in-differences (OLS) estimates of the effect of higher centrally bargained wage increases on firm-level outcomes. The outcomes are the logs of physical capital (material assets), machines, financial assets, total debt, book value of equity and cash. Firms are treated if they have centrally bargained wages in the top quartile in their industry in 2004, with those that have bargained wage increases in the bottom half. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

6.6 Effects on Output and Profitability

I investigate the effect on sales and value added. We expect sales to increase since we found a positive impact on employment and capital. In Table 7, column (1), we see that companies facing higher wage increases had 2.7% higher sales; in column (2), they had 2.8% higher value added. These estimates are statistically significant at the 1% level.

In terms of my model, the induced changes in labor supply and investment should also translate into higher output. More generally, these results complement the literature that explore the relationship between trade unions and productivity. While some studies find negative effects (Laroche et al., 2017; Laroche, 2020; Svarstad and Kostøl, 2022), other papers point towards unions being able to direct technological change towards more productivity (Bryson and Dale-Olsen, 2021), alleviate information and agency concerns[12], or increase rent-sharing (Breda, 2015; Barth et al., 2020)

Finally, we look at the effect on profitability. If higher negotiated wages increase sales and employment, why would it not be in the owners' interest to do this without union-negotiated wages? In columns (3)-(5), we see that the effects on profits to value added, profits per worker, and EBIT per worker is negative but only marginally statistically significant for the last two outcomes. Thus, the owners of the companies facing higher

[12] Freeman (1976); Freeman and Medoff (1984); Vroman (1990); Mueller (2012); Sojourner et al. (2015); Addison et al. (2017); Barth et al. (2020).

Table 7: Effects of Higher Centrally Bargained Wages Increases on Sales and Profitability

	(1) Log Sales	(2) Log Value Added	(3) Profits to Value Added	(4) Profits per Worker	(5) EBIT per Worker
Treated × Post	0.027***	0.028***	-0.186	-19.221	-44.371*
	(0.009)	(0.009)	(0.191)	(13.144)	(22.840)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
R-Squared	0.939	0.919	0.219	0.312	0.251
N	51,658	51,658	51,643	51,643	51,651

Notes: The table shows difference-in-differences (OLS) estimates of the effect of higher centrally bargained wage increases on firm-level outcomes. The outcomes are the logs of sales, value added, as well as profits to value added, profits per worker and earnings before interests and taxes (EBIT) per worker. Firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

wage increases may be worse off. Generally, studies find that trade unions are associated with lower profits (Lee and Mas, 2012; Laroche, 2020; Devicienti and Fanfani, 2021) and the same is true for minimum wages (Draca et al., 2011; Bell and Machin, 2018; Clemens, 2021). My results conform the findings of earlier papers.

6.7 Robustness Checks

I provide a large set of robustness checks to the main results. The results are robust to varying the sample definition, the control variables included, and the treatment definition.

Sample Variations First, I show that the results are robust to varying the sample inclusion restriction (Table B.2, Table B.4, Table B.6, and Table B.8).

First, I show that the results are robust to including smaller firms. We might be concerned that small firms might be hit much worse by the labor costs shocks induced by collective bargaining. I thus re-define the treatment by lowering the threshold to 5 employees and SEK 5 million in sales and then redefine the treatment and control groups for each industry. We see in columns (1) of the table that the results for mean labor costs and employment are robust, and even get larger in magnitude, when we include the smaller firms.

Next, I show that the results for mean labor costs and employment are robust to including firms with lower bargained wage increases. I lower the threshold from 1% to 0.5% and calculate new treatment and control groups for each industry. We see in columns (2) of the tables that the results are robust to this change.

I show in columns (3) that the results for mean labor costs and employment are robust to excluding either one-digit sectors with few observations (below 500), and in columns (4) that they are robust to excluding regions (län) with few observations (below 250).

We might also be concerned that larger firms can influence the outcome of the bargaining process, either directly or indirectly since their growth prospects might affect bargaining outlooks. I show that the results for mean labor costs and employment are robust to excluding firms with more than 100 employees in any year or to excluding industries with employment concentration levels greater than or equal to 0.15 in any year.

Additional Controls Moreover, I show that the results are robust to varying the fixed effects included, in Table B.3, Table B.5, Table B.7 and Table B.9.

First, we might be worried that the relationship between the firm-level skill mix and future growth rates is varying between industries. I thus show in columns (1) that the results are robust when we include industry-year fixed effects.

Similarly, we might be concerned about local-level shocks. These might for example be local demand shocks that correlate with firms' skill composition. In addition, firms' sorting might affect local labor market tightness and thus affect the control group. I show in columns (2) that the results are robust when we include municipality-year fixed effects.

Finally, to limit the role of outliers, I show in columns (3) that the results for mean labor costs and employment are robust to winsorizing the dependent variables on the 1% level.

Treatment Definition I also show in Table B.3 and Table B.5 that the results are robust to changing the treatment definitions. First, in columns (4), I compare firms with

the top 20% of bargained wage increases with those in the bottom 40%, and in columns (5), I compare those with the top 10% with those in the bottom 30%. We see that the results for mean labor costs and employment are robust to changing the treatment definitions.

Medium-Run Estimates I show that the results are persistent in the medium-run. Figure B.1 shows the estimated effects for mean labor costs, employment, physical capital and sales up to 2010. We see that there is a jump at 2004 and then a persistent effect for labor costs, employment sales, while the effect for physical capital slowly builds up over the years. The estimates are of similar magnitude as the ones shown in Figure 3.

Firm Entry and Exit We might be concerned that the estimates are affected by firms entering or exiting the sample, and this is related to treatment status. I show in Table B.18 that this is unlikely. First, in column (1), we see that the effect of treatment on bankruptcy status is 0.1% and statistically insignificant. Moreover, I re-estimate the effect on the main outcomes, but replace missing values with zero. Columns (2)–(5) show that the estimated effects are positive and statistically significant even when we impute values. Notably, the effect sizes are larger than the baseline estimates. This is partly mechanical, since a value of zero corresponds to sales of SEK 1,000 for instance.

7 Channels of Firm Response to Centralized Wage Changes

7.1 Labor Market Power

Analysis I study the role of labor market power to understand how higher centrally bargained wage changes affect employment changes. Firms with more labor market power should grow faster when faced with higher bargained wage increases, since they can give up rents and still be profitable.

To investigate this, I estimate the difference-in-differences models separately for firms in markets with either high or low labor market concentration (calculating the Herfindahl-Hirschmann indices). Labor market concentration is commonly used as a proxy for labor market power (Arnold, 2021; Azar et al., 2022; Benmelech et al., 2022; Rinz, 2022). In particular, I compare firms above and below the median in 2003. Table B.11 shows the results. Columns (1) and (2) use define market using 3-digit industries and regions, while columns (3) and (4) define markets using 1-digit industries and regions. In both cases, we see that the treatment effect on employment is larger in more concentrated industries. The effect is 3.3% in concentrated industries versus 2% in less concentrated ones (in both cases).

As additional robustness, I also proxy labor market power using gross flows in and out of the firm. Similar to Sorkin (2018); Arnold (2021), I use pre-treatment gross flows in and out of the firm as another measure. In particular, I calculate the sum of hires and separations and divide it by last year's employment for the period 2000-2003 and split the sample based on this measure. I use the average over these years to reduce the role of year-to-year variation. Table B.12 shows the results. In columns (1) and (2), I split the sample into below and above median mean flows in the sample. We see that the effect of higher bargained wages is 3.5% for firms with low gross flow, and 2% (and marginally

statistically significant) for firms with a high gross flow. In columns (3) and (4), I split the sample into below and above median flows within each three-digit industry. Finally, in columns (5) and (6), I divide the sample into below and above median flows in each region. The results are similar to those in columns (1) and (2).

Interpretation These results indicate that labor market power plays a crucial role in understanding how companies respond to changes in labor costs. This means that the availability of labor is limited in the initial equilibrium. Given this, it is expected that companies in concentrated industries or with low employee turnover will experience larger employment effects when they increase wages. Furthermore, these results support a growing body of literature that shows that companies have some market power in the labor market[13]. Moreover, it indicates that labor market institutions, such as trade unions, can counter-weight such market power.

7.2 Job Polarization

Analysis I study how centralized wage increases change the relative demand for different skill groups. Given that low-skilled wage increases are usually higher than the ones for high-skilled workers, which are often zero, we indeed expect substitution towards skilled workers.

I re-visit this question using the difference-in-differences design. Table B.13 shows that treated firms change their demand toward high-skilled labor. In columns (1)–(3), I study the effect across the wage distribution within the firm. We see that the effect is small for the low-earning workers and larger for the high-earning workers.

Next, I study the effect on wage bill shares for low-skilled, mid-skilled, and high-skilled workers, as well as the associated employment shares. First, we see that total wage bills increase for all groups (columns 4–6). We see that the effect is larger for low-skilled than

[13] Manning (2003); Mertens (2021); Marinescu et al. (2021); Sokolova and Sorensen (2021); Yeh et al. (2022); Berger et al. (2022); Bassanini et al. (2022); Azar et al. (2022); Benmelech et al. (2022); Rinz (2022)

mid-skilled, and the highest for high-skilled. Higher bargained wages thus make firms increase demand across the board, but they choose to increase the relative demand for high-skilled labor.

We also see this in columns (7)–(9). Here, we study the effect on employment shares. There is a negative and statistically significant effect on low-skilled workers, roughly a null result for mid-skilled workers, and a positive and statistically significant effect on high-skilled workers. Firms increase the share of high-skilled workers by 1.2 percentage points.

Interpretation These results suggest that labor cost changes are an important determinant of job polarization within firms. There is sizable literature demonstrating the importance of job polarization in Western countries in recent decades (Goos et al., 2009; Autor and Dorn, 2013; Goos et al., 2014; Harrigan et al., 2021). However, the evidence is mixed for Sweden: Adermon and Gustavsson (2015); Heyman (2016); Berglund et al. (2020) find evidence in favor of polarization, while Corin et al. (2021); Berglund et al. (2022) find the opposite. On a related note, recent work has find that minimum wages induce firms to do labor-labor substitution (Aaronson and Phelan, 2019; Winters, 2022). I find that job polarization happens also within firms.

Furthermore, these results emphasize the importance of changes within companies. There is mixed evidence on polarization within companies versus between companies. Pekkala Kerr et al. (2016) argue that both factors are essential in Finland. Kerr et al. (2020) find that changes within companies matter most for highly-paid abstract jobs. Harrigan et al. (2021) study polarization in France from 1994-2007 and find that polarization within companies played a minor role. In Sweden, Heyman (2016) find evidence of within-company polarization in Sweden 1996–2013. Nilsson Hakkala et al. (2014) show that multinational companies affect the demand for non-routine tasks in Sweden. Similarly, Edin et al. (2022) find a rising return to non-cognitive skills in Sweden from 1992-2013.

Additional Validation: Supply of High-Skilled Labor We see in Table B.13 that treated firms change their labor mix towards more skilled labor. To further explore the role of this channel, I split the sample into region-industry cells with a larger or smaller share of high-skilled labor.

In Table B.11, columns (5) and (6), we see that the treatment effect is larger in areas with a high relative supply of high-skilled labor. The treatment effect for firms in areas with an above-median relative supply, the effect is 4.3% and only 1.2% and statistically insignificant for firms in areas with low relative supply.

These results suggest that input factor substitution is important in understanding the job polarization identified in this study. When firms face challenges in finding high-skilled workers, it becomes more difficult to adjust their operations and worker mix.

7.3 Financing Constraints

Analysis To further understand the importance of increased investments in changing firms' operations, I proceed to study the role of financing constraints. We expect firms with more difficulties in accessing external finance to increase their assets less when faced with higher centralized wage increases (Fazzari et al., 1988).

First, I compare firms with a debt-to-asset ratio above the median in their 1-digit industry in 2003. This proxy captures the intuition that the marginal cost of debt is increasing (Fazzari et al., 1988; Farre-Mensa and Ljungqvist, 2016). Table B.14, columns (1) and (2) show the results. We see that firms with below-sector median leverage see an increase in asset growth of 6.6%. This estimate is statistically significant on the 1% level. In contrast, firms with high leverage (column 2) increase their investments by only 2.4% (but statistically insignificant).

To check the robustness of this sample split, I also use firm age as a proxy for financing constraints (Hadlock and Pierce, 2010; Farre-Mensa and Ljungqvist, 2016; Saez et al., 2019). In columns (3) and (4), we see that the estimated coefficient is higher for above-

median old firms in each sector: the estimated effect is 3.5%, against a 3% effect for younger firms. The former effect is statistically significant on the 10% level, while the latter is statistically insignificant.

Interpretation These results suggest once again that input factor substitution is important in explaining the results that higher bargained wage changes spur job polarization. This time, we see that access to external finance is important in explaining which firms can increase their investments.

7.4 Product Market Power

I then study the role of product market power. Firms with more product market power usually have better opportunities to pass on higher labor costs to customers by raising prices (Weyl and Fabinger, 2013; Mrázová and Neary, 2017; Pless and van Benthem, 2019; Ritz, 2019). We should thus expect these firms to grow faster.

To test this, I use three measures of sales concentration, estimated with the Hirschmann-Hirfendahl index. I calculate the index using both the 3-digit industry and region combinations, as well as the 1-digit industry and region combinations.

Table B.15 shows the results. In all cases, we see that the firms in more concentrated industries have faster employment growth, suggesting that product market power indeed allows firms to give up additional rents to hire more people.

8 Conclusion

I study how firms change their hiring and investment behavior after being hit by a labor cost shock induced by collective bargaining agreements. I compare firms in 2004 that are in the same industry but have different initial skill mix of workers, which thus need to increase wages by different amounts. Firms that need to increase wages more increase hiring and investments. In particular, this is driven by a shift in the labor mix towards more skilled labor. This results in increased sales but lower profitability. Taken together, my results suggest that higher wages in this context are associated with higher worker surplus.

In addition, the heterogeneity analysis shed additional light on which mechanisms are at play. The effects on employment are more pronounced for firms with higher market power, both in the product and labor markets. This suggests that these firms have larger leeway to share rents while still obtaining a positive value from keeping their workers. Similarly, I find that financially constrained firms invest less when hit by the labor cost shock. This points toward the importance of firms' being able to change their labor input mix in response to shocks.

In brief, this paper shows that trade unions play an important role in the labor market, and it is crucial to understand the interaction between employers and workers to understand both average and heterogeneous outcomes.

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A Additional Descriptives

Table B.1: Distribution of Sectors

	Frequency	%
Manufacturing	3,507	32.98
Wholesale and Retail Trade	2,755	25.91
Construction	1,912	17.98
Information and Communication	831	7.82
Accommodation and Food Service Activities	595	5.60
Professional, Scientific and Technical Activities	498	4.68
Administrative and Support Service Activities	166	1.56
Real Estate Activities	146	1.37
Agriculture, Forestry and Fishing	104	0.98
Electricity, Gas and Steam	46	0.43
Mining and Quarrying	38	0.36
Transportation and Storage	26	0.24
Water Supply, Sewerage and Waste Management etc	9	0.08
N	10.633	

Notes: The table shows the distribution of level 1 SNI sectors among sample firms. The unit of observation is the firm-year.

B Additional Results

B.1 Robustness Checks

Table B.2: Centralized Wage Increases and Mean Labor Costs (Sample Variations)

	Log Mean Labor Costs					
	(1)	(2)	(3)	(4)	(5)	(6)
	Include Smaller Firms	Include Lower CBW	Exclude Small Sectors	Ecxclude Small Regions	Exclude Large Firms	Exclude Concentrated Industries
Treated × Post	0.028***	0.012***	0.018***	0.013***	0.014***	0.015***
	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.688	0.700	0.675	0.689	0.695	0.688
N	102,520	57,611	46,544	47,935	47,257	50,081

Notes: The table shows difference-in-differences (OLS) estimates of the effect of higher centrally bargained wage increases on the log of mean labor costs. Column (1) redefines treatment and control groups by including firms in 2004 that have at least five employees. Column (2) redefines treatment and control groups by including firms with centrally bargained wage increases of at least 0.5%. Column (3) excludes firm-year observations in first-level SNI sector with less than 500 observations. Column (4) excludes firm-year observations where the firm is located in regions (län) with less than 250 observations. Column (5) excludes firm-year observations where the firm has more than 100 employees. Column (6) excludes firm-year observations where the firm is in an industry with an employment Herfindahl–Hirschman Index in excess of 0.15. Firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

Table B.3: Centralized Wage Increases and Mean Labor Cost (Different Controls and Treatment Definition)

	Log Mean Labor Costs				
	(1)	(2)	(3)	(4)	(5)
	Industry-Year FE	Municipality-Year FE	Winsorized	40-80	30-90
Treated × Post	0.014***	0.013***	0.013***	0.014***	0.025***
	(0.004)	(0.004)	(0.004)	(0.005)	(0.007)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	No	No	Yes	Yes	Yes
Industry-Year Fixed Effects	Yes	No	No	No	No
Municipality-Year Fixed Effects	No	Yes	No	No	No
R-Squared	0.699	0.717	0.714	0.694	0.697
N	51,598	51,636	51,658	41,882	29,896

Notes: The table shows difference-in-differences (OLS) estimates of the effect of higher centrally bargained wage increases on the log of mean labor costs. The table provides variations of the control variables and treatment definitions. Column (1) includes three-digit SNI code-by-year fixed effects. Column (2) includes municipality-by-year fixed effects. Column (3) winsorizes the outcome variable at the 1% level. In columns (1)–(3), firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Column (4) defines the treated group to be the top 20% in each industry and the control group to be the bottom 40%. Column (5) defines the treated group to be the top 10% in each industry and the control group to be the bottom 30%. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

Table B.4: Centralized Wage Increases and Employment (Sample Variations)

	Log Employment					
	(1)	(2)	(3)	(4)	(5)	(6)
	Include Smaller Firms	Include Lower CBW	Exclude Small Sectors	Ecxclude Small Regions	Exclude Large Firms	Exclude Concentrated Industries
Treated × Post	0.044***	0.021***	0.023***	0.026***	0.022***	0.026***
	(0.005)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.947	0.942	0.949	0.944	0.880	0.939
N	102,520	57,611	46,544	47,935	47,257	50,081

Notes: The table shows difference-in-differences (OLS) estimates of the effect of higher centrally bargained wage increases on the log of employment. Column (1) redefines treatment and control groups by including firms in 2004 that have at least five employees. Column (2) redefines treatment and control groups by including firms with centrally bargained wage increases of at least 0.5%. Column (3) excludes firm-year observations in first-level SNI sector with less than 500 observations. Column (4) excludes firm-year observations where the firm is located in regions (län) with less than 250 observations. Column (5) excludes firm-year observations where the firm has more than 100 employees. Column (6) excludes firm-year observations where the firm is in an industry with an employment Herfindahl–Hirschman Index in excess of 0.15. Firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

Table B.5: Centralized Wage Increases and Employment (Different Controls and Treatment Definition)

	Log Employment				
	(1)	(2)	(3)	(4)	(5)
	Industry-Year FE	Municipality-Year FE	Winsorized	40-80	30-90
Treated × Post	0.027***	0.024***	0.025***	0.029***	0.057***
	(0.007)	(0.007)	(0.007)	(0.008)	(0.010)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	No	No	Yes	Yes	Yes
Industry-Year Fixed Effects	Yes	No	No	No	No
Municipality-Year Fixed Effects	No	Yes	No	No	No
R-Squared	0.947	0.947	0.920	0.939	0.935
N	51,598	51,636	51,658	41,882	29,896

Notes: The table shows difference-in-differences (OLS) estimates of the effect of higher centrally bargained wage increases on the log of employment. The table provides variations of the control variables and treatment definitions. Column (1) includes three-digit SNI code-by-year fixed effects. Column (2) includes municipality-by-year fixed effects. Column (3) winsorizes the outcome variable at the 1% level. In columns (1)–(3), firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Column (4) defines the treated group to be the top 20% in each industry and the control group to be the bottom 40%. Column (5) defines the treated group to be the top 10% in each industry and the control group to be the bottom 30%. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

Table B.6: Centralized Wage Increases and Physical Capital (Sample Variations)

	Log Physical Capital					
	(1)	(2)	(3)	(4)	(5)	(6)
	Include Smaller Firms	Include Lower CBW	Exclude Small Sectors	Ecxclude Small Regions	Exclude Large Firms	Exclude Concentrated Industries
Treated × Post	0.052***	0.043***	0.028*	0.028*	0.035**	0.035**
	(0.011)	(0.014)	(0.015)	(0.015)	(0.015)	(0.015)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.936	0.939	0.938	0.942	0.925	0.939
N	100,924	56,634	45,804	47,106	46,434	49,232

Notes: The table shows difference-in-differences (OLS) estimates of the effect of higher centrally bargained wage increases on the log of physical capital. Column (1) redefines treatment and control groups by including firms in 2004 that have at least five employees. Column (2) redefines treatment and control groups by including firms with centrally bargained wage increases of at least 0.5%. Column (3) excludes firm-year observations in first-level SNI sector with less than 500 observations. Column (4) excludes firm-year observations where the firm is located in regions (län) with less than 250 observations. Column (5) excludes firm-year observations where the firm has more than 100 employees. Column (6) excludes firm-year observations where the firm is in an industry with an employment Herfindahl–Hirschman Index in excess of 0.15. Firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

Table B.7: Centralized Wage Increases and Physical Capital (Different Controls and Treatment Definition)

	Log Physical Capital				
	(1)	(2)	(3)	(4)	(5)
	Industry-Year FE	Municipality-Year FE	Winsorized	40-80	30-90
Treated × Post	0.037**	0.024	0.033**	0.044***	0.061***
	(0.014)	(0.015)	(0.015)	(0.016)	(0.021)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	No	No	Yes	Yes	Yes
Industry-Year Fixed Effects	Yes	No	No	No	No
Municipality-Year Fixed Effects	No	Yes	No	No	No
R-Squared	0.944	0.944	0.932	0.940	0.937
N	50,725	50,768	50,788	41,186	29,376

Notes: The table shows difference-in-differences (OLS) estimates of the effect of higher centrally bargained wage increases on the log of physical capital. The table provides variations of the control variables and treatment definitions. Column (1) includes three-digit SNI code-by-year fixed effects. Column (2) includes municipality-by-year fixed effects. Column (3) winsorizes the outcome variable at the 1% level. In columns (1)–(3), firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Column (4) defines the treated group to be the top 20% in each industry and the control group to be the bottom 40%. Column (5) defines the treated group to be the top 10% in each industry and the control group to be the bottom 30%. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

Table B.8: Centralized Wage Increases and Sales (Sample Variations)

	Log Sales					
	(1)	(2)	(3)	(4)	(5)	(6)
	Include Smaller Firms	Include Lower CBW	Exclude Small Sectors	Ecxclude Small Regions	Exclude Large Firms	Exclude Concentrated Industries
Treated × Post	0.063***	0.023***	0.025***	0.024***	0.025***	0.029***
	(0.006)	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.937	0.942	0.943	0.941	0.893	0.936
N	102,520	57,611	46,544	47,935	47,257	50,081

Notes: The table shows difference-in-differences (OLS) estimates of the effect of higher centrally bargained wage increases on the log of sales. Column (1) redefines treatment and control groups by including firms in 2004 that have at least five employees. Column (2) redefines treatment and control groups by including firms with centrally bargained wage increases of at least 0.5%. Column (3) excludes firm-year observations in first-level SNI sector with less than 500 observations. Column (4) excludes firm-year observations where the firm is located in regions (län) with less than 250 observations. Column (5) excludes firm-year observations where the firm has more than 100 employees. Column (6) excludes firm-year observations where the firm is in an industry with an employment Herfindahl–Hirschman Index in excess of 0.15. Firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

Table B.9: Centralized Wage Increases and Sales (Different Controls and Treatment Definition)

	Log Sales				
	(1)	(2)	(3)	(4)	(5)
	Industry-Year FE	Municipality-Year FE	Winsorized	40-80	30-90
Treated × Post	0.028***	0.021**	0.031***	0.033***	0.064***
	(0.008)	(0.008)	(0.008)	(0.010)	(0.013)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	No	No	Yes	Yes	Yes
Industry-Year Fixed Effects	Yes	No	No	No	No
Municipality-Year Fixed Effects	No	Yes	No	No	No
R-Squared	0.943	0.945	0.923	0.936	0.931
N	51,598	51,636	51,658	41,882	29,896

Notes: The table shows difference-in-differences (OLS) estimates of the effect of higher centrally bargained wage increases on the log of sales. The table provides variations of the control variables and treatment definitions. Column (1) includes three-digit SNI code-by-year fixed effects. Column (2) includes municipality-by-year fixed effects. Column (3) winsorizes the outcome variable at the 1% level. In columns (1)–(3), firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Column (4) defines the treated group to be the top 20% in each industry and the control group to be the bottom 40%. Column (5) defines the treated group to be the top 10% in each industry and the control group to be the bottom 30%. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

B.2 Extensions

Table B.10: Event Study Estimates

	(1)	(2)	(3)	(4)
	Log Mean Labor Costs	Log Employees	Log Material Assets	Log Sales
Treated × 2001	-0.000	-0.011	0.001	-0.010
	(0.007)	(0.008)	(0.016)	(0.010)
Treated × 2002	-0.002	-0.009	0.002	-0.006
	(0.006)	(0.006)	(0.012)	(0.007)
Treated × 2003	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
Treated × 2004	0.013***	0.025***	0.034***	0.029***
	(0.004)	(0.005)	(0.010)	(0.006)
Treated × 2005	0.012**	0.016*	0.042***	0.014
	(0.005)	(0.008)	(0.016)	(0.010)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
R-Squared	0.690	0.943	0.941	0.939
N	51,658	51,658	50,788	51,658

Notes: The table shows event study (OLS) estimates of the effect of higher centrally bargained wage increases on firm-level outcomes. The outcomes are the logs of mean labor costs, employment, material assets, and sales. Firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

Table B.11: Heterogeneity: Labor Market Concentration

	3-Digit Industry and Region		1-Digit Industry and Region		High-Skilled Labor Supply	
	(1)	(2)	(3)	(4)	(5)	(6)
	Low Concentration	High Concentration	Low Concentration	High Concentration	Low Supply	High Supply
Treated × Post	0.020**	0.033***	0.020**	0.033***	0.012	0.043***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.009)	(0.011)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.910	0.957	0.937	0.947	0.946	0.940
N	25,647	25,833	25,479	26,001	25,211	26,447

Notes: The table shows difference-in-differences (OLS) estimates of the effect of higher centrally bargained wage increases on the log of employment. Columns (1) and (2) separate the sample into above and below median employment Herfindahl-Hirschman indices in 2003. Columns (1) and (2) use industries on the 3-digit SNI level and regions (län). Columns (3) and (4) use industries on the first-level and regions. Columns (5) and (6) instead split the sample based on the relative employment level of high-skilled worker within each 3-digit industry and region in 2003. Firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

Table B.13: Effects of Higher Centrally Bargained Wages Increases on Labor Composition

	Wage Quartile			Wage Bill			Employment Shares		
	(1) First	(2) Median	(3) Third	(4) Low	(5) Mid	(6) High	(7) Low	(8) Mid	(9) High
Treated × Post	0.002	0.013**	0.018***	0.112***	0.084***	0.137***	-0.009***	-0.003*	0.012***
	(0.009)	(0.005)	(0.004)	(0.015)	(0.027)	(0.018)	(0.002)	(0.002)	(0.002)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.809	0.850	0.800	0.791	0.818	0.849	0.867	0.806	0.800
N	51,317	51,317	51,317	48,857	30,733	41,728	50,778	50,778	50,778

Notes: The table shows difference-in-differences (OLS) estimates of the effect of higher centrally bargained wage increases on firm-level outcomes. The outcomes are the logs of the 25th, 50th and 75th percentile wages in the firm, low-skilled wage bill, mid-skilled wage bill, high-skilled wage bill and the share of employment for low-skill, mid-skill and high-skill workers. Firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

Table B.12: Heterogeneity: Labor Market Flows

	Full Sample		Within 3-Digit Industry		Within Region	
	(1) Low Gross Flow	(2) High Gross Flow	(3) Low Gross Flow	(4) High Gross Flow	(5) Low Gross Flow	(6) High Gross Flow
Treated × Post	0.035***	0.020*	0.034***	0.024**	0.035***	0.018
	(0.009)	(0.011)	(0.009)	(0.011)	(0.009)	(0.011)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.965	0.913	0.962	0.922	0.965	0.911
N	26,420	25,238	26,166	25,492	26,377	25,281

Notes: The table shows difference-in-differences (OLS) estimates of the effect of higher centrally bargained wage increases on the log of employment. The sample is separated based on the average level of gross flows (sum of hires and separations) divided by last year's employment for the years 2000–2003, mean flows. Columns (1) and (2) separate the sample into above and below median flows in the working sample. Columns (3) and (4) separate the sample into above and below median flows in each three-digit industry. Columns (5) and (6) separate the sample into above and below median flows in each region (län). Firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

Table B.14: Heterogeneity: Leverage and Age

	Debt to Assets		Age	
	(1)	(2)	(3)	(4)
	Low	High	Young	Old
Treated × Post	0.066***	0.024	0.030	0.035*
	(0.025)	(0.018)	(0.023)	(0.019)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
R-Squared	0.954	0.932	0.921	0.953
N	15,927	34,861	23,330	26,995

Notes: The table shows difference-in-differences (OLS) estimates of the effect of higher centrally bargained wage increases on the log of physical capital. Columns (1) and (2) separate the sample into above and below median debt to assets levels within each first-level SNI industry in 2003. Columns (3) and (4) split the sample into above and below median age within each first-level SNI industry in 2003. Firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

Table B.15: Heterogeneity: Sales Concentration

	3-Digit Industry and Region		1-Digit Industry and Region	
	(1)	(2)	(3)	(4)
	Low	High	Low	High
Treated × Post	0.020*	0.034***	0.026***	0.028***
	(0.010)	(0.010)	(0.010)	(0.010)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
R-Squared	0.911	0.957	0.933	0.949
N	25,601	25,879	25,627	25,853

Notes: The table shows difference-in-differences (OLS) estimates of the effect of higher centrally bargained wage increases on the log of employment. Columns (1) and (2) separate the sample into above and below median sales Herfindahl-Hirschman indices in 2003. Columns (1) and (2) use industries on the 3-digit SNI level and regions (län). Columns (3) and (4) use industries on the first-level and regions. Firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

Table B.16: Medium-Run Event Study Estimates

	(1)	(2)	(3)	(4)
	Log Mean Labor Costs	Log Employees	Log Material Assets	Log Sales
Treated × 2001	0.001	-0.006	0.010	-0.004
	(0.007)	(0.008)	(0.017)	(0.011)
Treated × 2002	-0.001	-0.005	0.008	-0.000
	(0.006)	(0.006)	(0.012)	(0.008)
Treated × 2003	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
Treated × 2004	0.013***	0.024***	0.034***	0.028***
	(0.004)	(0.005)	(0.010)	(0.006)
Treated × 2005	0.013***	0.015*	0.039**	0.012
	(0.005)	(0.008)	(0.016)	(0.010)
Treated × 2006	0.008	0.016	0.047**	0.018
	(0.006)	(0.011)	(0.020)	(0.012)
Treated × 2007	0.008	0.009	0.044*	0.011
	(0.006)	(0.012)	(0.023)	(0.015)
Treated × 2008	0.011*	0.011	0.060**	0.012
	(0.006)	(0.013)	(0.025)	(0.015)
Treated × 2009	0.011*	0.015	0.102***	0.028
	(0.006)	(0.015)	(0.028)	(0.017)
Treated × 2010	0.011	0.019	0.123***	0.031*
	(0.007)	(0.016)	(0.030)	(0.018)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
R-Squared	0.635	0.881	0.892	0.885
N	97,196	97,196	95,155	97,196

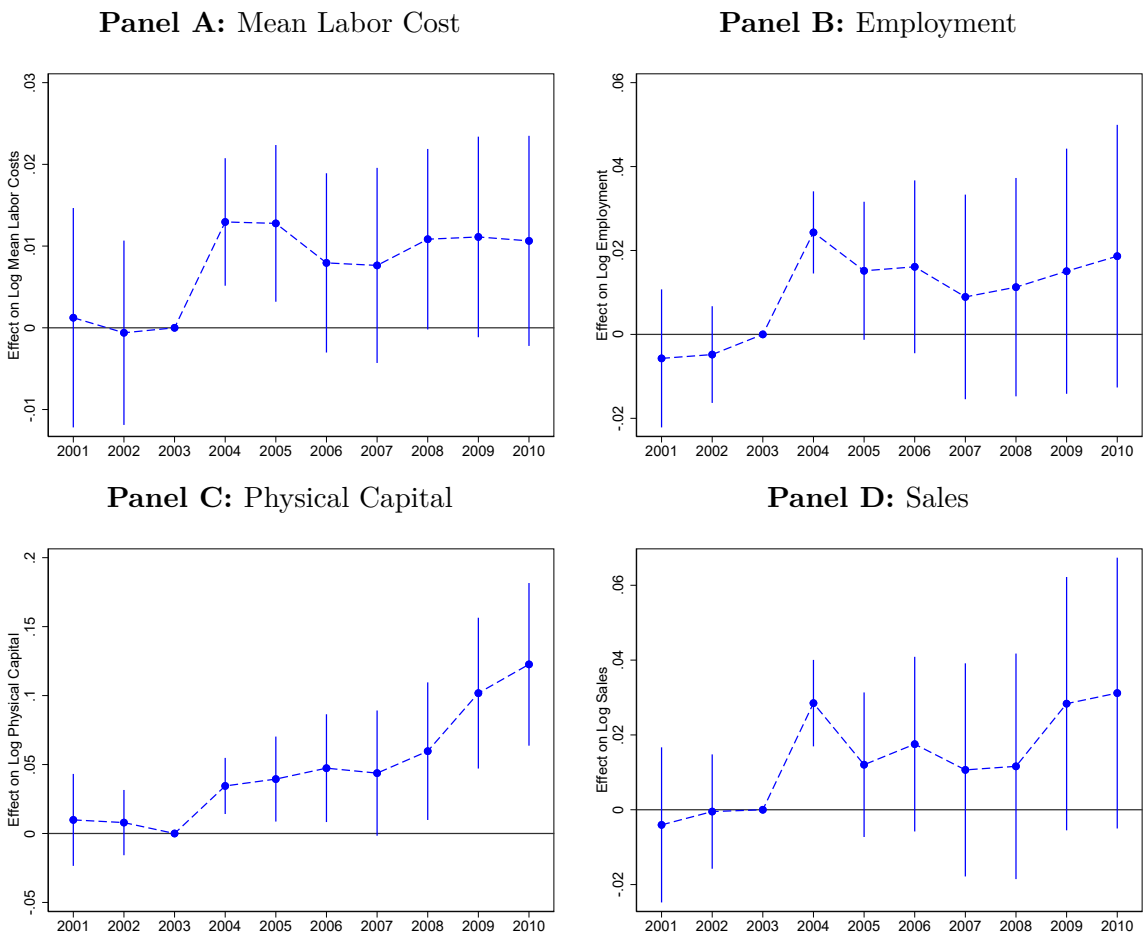
Notes: The table shows event study (OLS) estimates of the effect of higher centrally bargained wage increases on firm-level outcomes. The outcomes are the logs of mean labor costs, employment, material assets, and sales. The sample covers the years from 2001 to 2010. Firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

Table B.17: Additional Results by Skill Group

	Mean Wage by Skill Groups			Skill Ratio		
	(1)	(2)	(3)	(4)	(5)	(6)
	Low	Mid	High	High-Mid	Mid-Low	High-Low
Treated × Post	0.019***	0.045***	0.046***	0.086***	0.006	0.064***
	(0.006)	(0.016)	(0.011)	(0.026)	(0.021)	(0.016)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.655	0.679	0.665	0.791	0.881	0.865
N	48,857	30,733	41,728	27,814	29,359	39,924

Notes: The table shows event study (OLS) estimates of the effect of higher centrally bargained wage increases on firm-level outcomes. The outcomes are the logs of mean wages for low-skilled (1), mid-skilled (2), and high-skilled (3) workers, as well as the ratios of high-skilled to mid-skilled (4), mid-skilled to low-skilled (5), and high-skilled to low-skilled (6) workers. The sample covers the years from 2001 to 2010. Firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

Figure B.1: Effects of Higher Centrally Bargained Wages Increases on Firm Outcomes (Medium-Run Event Study)



Notes: The figure shows event study estimates on the logs labor costs, employment, assets and sales of having a high centrally bargained wage increases. I compare firms that have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. The sample covers the years 2001–2010.

Table B.18: Effects of Higher Centrally Bargained Wages Increases on Bankruptcy

	Base Sample	Imputed Sample			
	(1)	(2)	(3)	(4)	(5)
	Bankruptcy	Log Mean Labor Costs	Log Employment	Log Physical Capital	Log Sales
Treated × Post	0.001	0.084***	0.057***	0.113***	0.146***
	(0.001)	(0.021)	(0.014)	(0.033)	(0.038)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
R-Squared	0.244	0.378	0.782	0.764	0.521
N	51,658	53,165	53,165	53,165	53,165

Notes: The table shows difference-in-differences (OLS) estimates of the effect of higher centrally bargained wage increases on firm-level outcomes. The outcomes are an indicator if the firm is bankruptcy, the logs of mean labor costs, employment, physical capital, and sales. Firms are treated if they have centrally bargained wage increases in the top quartile in their industry in 2004, with those that have bargained wages in the bottom half. In columns (2)–(5), missing values are replaced by zero. Monetary values are deflated using the GDP Deflator from Statistics Sweden. Standard errors clustered on the firm level in parentheses. * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$.

C Sample Construction

C.1 Defining Centralized Wage Increases

For the years from 2001 to 2003, I take the data from Medlingsinstitutet (2001). They list bargained wage increases in private sector collective bargaining agreements. I define the centralized wage increase to be the sum of increases in wage and reduced working time for each agreement and year. For the years from 2004 to 2006, I collected the data manually from Medlingsinstitutet. I collected data from all collective agreements that they had available in the summer of 2020.

In these agreements, I look for stipulated increases in average wages. Often these are called "höjning av utgående löner", "generell löneökning", "individgaranti" or "lönepott". For instance, the agreement for inventory workers, signed between *Tjänsteförbunden - Almega* and *Handelsanställdas förbund* guarantees wage increases for full-time workers of SEK per hour of 2.76 (2004), 2.87 (2005) and 2.99 (2006). Another example is the agreement for laundry workers, signed between *Industri- och kemigruppen* and *Tvättindustrin*. In that agreement, workers are given an increase in hourly wages of SEK 2.73 (2004),2.97 (2005) and 2.77 (2006).

I do not have data on which firms are part of which agreement. However, this is a minor issue, as most firms are either member of an employers' association or have other agreements tied to the collective agreements. Finally, firms outside the collective bargaining system still face competitive pressures from firms inside the system.

My measure of centralized wage increase include increases in wages as well as reductions in working hours, where that is defined in the agreement. I do not include pensions and insurances, since these are determined by peak-level bargaining. Still, central agreements also cover other issues, such as overtime pay and workplace environment. These factors should not introduce much noise into my measure, First, overtime pay is a small part of total labor costs: in 2005, men worked 0.4 hours with paid overtime on average every

week and women 0.2 hours (Statistiska centralbyrån, 2020). Costs related to workplace environment are difficult to quantify. However, the costs are likely to be modest. For instance, the industry association for occupational health firms estimates that employers spent on average SEK 1,300 (roughly USD 160) on each worker and year in 2021 (Sveriges företagshälsor, 2021).

I exclude some agreements. One reason is that they do not contain any information on wage growth. Another reason is that they have unusual measures for wage increases. For instance, the agreement for private direct mail only defines wage increases based on the weight of mail delivered and the number of houses.

Those agreements that have wage increases either specify them in relative or absolute increases. For instance, an agreement might stipulate a minimum increase in wages by SEK 500, rather than by 2%. To make agreements comparable I convert absolute increases to relative increases. I do this by comparing the increase in 2004 to a measure of average wages for 2003 for the occupation. I then use the implied centralized wage increase to calculate the benchmark wage for the years 2004 and 2005. I do this either using trade union wage statistics Landsorganisationen (2004), or using data on average monthly wages for workers in the entire economy by 3-digit occupation code[14] from Statistics Sweden (Statistiska centralbyrån, 2014).

For each 3-digit SNI (industry) code, I link the code with one or several agreements. I do this based on which type of workers might be hired by the firm. By 3-digit SNI codes, I give each code the mean bargained wage increase. I then group together all codes that share the same sequence of bargained wage increases. These are called industries.

C.2 Sources and Sample Restrictions

I base my sample on the Serrano and LISA databases of Swedish firms and workers.

The Serrano database is a database containing historical financial statements of Swedish

[14] I use the *Standard för svensk yrkesklassificering*.

firms. It is created by the company Bisnode and is based on official statistics on balance sheet and income statements, as well as additional data on ownership. Bisnode takes the official statistics and harmonizes the data for firms with different fiscal years and missing financial statements. From the Serrano database, I obtain records on items such as sales and employment.

LISA (*Longitudinell integrationsdatabas för sjukförsäkrings- och arbetsmarknadsstudier*), is a database created by Statistics Sweden that contains information on labor market and welfare benefit for each individual and year. It is based on official records. From the LISA database, I obtain information on hirings and separations, the skill composition of firms' workforces, as well as the wage distribution within firms.

I deflate all nominal variables with the 2001 GDP Deflator (from Statistics Sweden). Since the centralized wage increase is already a growth rate, I deflate it with the log difference of the GDP Deflator.

I merge workers to firms in the LISA database using firm identifiers, and then merge from LISA to Serrano using the same firm identifiers. These firm identifiers are based off the official company identifiers held by Statistics Sweden and other government agencies.

I base my sample on the Serrano database of Swedish companies. I impose the following restrictions.

- drop if the firm has no identifier
- drop if the firm has zero sales, total wages, total assets or less than two employees, for any year from 2001 to 2007
- drop if he firm has missing sales, total wages, total assets or employees
- keep if the is a limited liability company
- keep if the firm is privately owned

- drop if the firm is in finance, public administration, education, care, culture, other services, household production or embassies

Finally, I use firms that are active for the years between 2001 and 2007 and for which I have data on centrally bargained wages for the years from 2001 to 2006.

I summarize the variables I use in Tables C.1 and C.2.

D Model: Pay Raise Constraint and Labor Market Monopsony

D.1 Relationship to the Literature

D.2 Additional Derivations

Properties of the Hessian Matrix The Hessian matrix of the production function is assumed to be negative semi-definite, thus we have:

$$Y_{HH} f_{KK} - Y_{HK}^2 \geq 0 \tag{40}$$

$$\frac{Y_{HH}}{Y_H}\frac{Y_{KK}}{Y_K} - \frac{Y_{HK}}{Y_H}\frac{Y_{KH}}{Y_K} \geq 0 \tag{41}$$

$$\frac{Y_{HH}}{Y_H} H \frac{Y_{KK}}{Y_K} K - \frac{Y_{HK}}{Y_H} K \frac{Y_{KH}}{Y_K} H \geq 0 \tag{42}$$

$$\alpha_{HH}\alpha_{KK} - \alpha_{HK}^2 \geq 0 \tag{43}$$

Average Wages Denote average wages by $w = \frac{w_L L + w_H H}{N} = w_L e_L + w_H e_H$.

$$\Delta\ln(w_1) \approx \theta_L\Big(\Delta\ln(w_{L1}) + \Delta\ln(e_{L1})\Big) + \theta_H\Big(\Delta\ln(w_{H1}) + \Delta\ln(e_{H1})\Big), \tag{44}$$

$$\Delta\ln(w_1) \approx \theta_L\Delta\ln(w_{L1}) + \theta_H\Delta\ln(w_{H1}) + \theta_L\Delta\ln(e_{L1}) + \theta_H\Delta\ln(e_{H1}). \tag{45}$$

The change in average wages can be seen as the sum of average wages per skill group, and the change in skill shares, weighted by the initial wage bill shares.

Table C.1: List of Variables

Variable Name	Notation	Description	Swedish Name	Source
Identifiers etc				
Firm Identifier	i	Firm Identifier	Löpnummer	Serrano
Year	t	Year	År	-
Sector	s	SNI code (Level 1)	SNI-kod (första nivån)	SCB
Industry	j	Three-digit SNI codes sharing centralized wage increases	- SNI-kod	-
Basic Firm Variables				
Sales	q	Sales	Nettoomsättning	Serrano
Value Added	q	Value added	Förädlingsvärde	Serrano
Employment	L	Annual full-time employees	Antal anställda	Serrano
(Mean) Labor Costs	w	Total labor costs / employment	-	Serrano
Centralized Wage Increases	CWI	Average bargained wage increase	-	MI
Employment Variables				
Hires		Hires	-	SCB
Separations		Separations	-	SCB
Share Skilled		Share of workers with post-secondary education	-	SCB
Skilled Hires		Hires of workers with post-secondary education	-	SCB
Unskilled Hires		Hires of workers without post-secondary education	-	SCB
Skilled Separations		Separations of workers with post-secondary education	-	SCB
Unskilled Separations		Separations of workers without post-secondary education	-	SCB
p25 Wage		25th percentile of wages of workers who have the firm as primary employer	-	SCB
Median Wage		Median wage of workers who have the firm as primary employer	-	SCB
p75 Wage		75th percentile of wages of workers who have the firm as primary employer	-	SCB
Standard Deviation		Standard deviation of wages at the firm level	-	SCB

Notes: The table shows the variables used in the paper, notation, description, Swedish name and source. The sources are Serrano, Statistiska centralbyrån (SCB) or Medlingsinstitutet (MI). Nominal variables are deflated using the 2001 GDP Deflator. However, the centralized wage increase is deflated using the log-difference of the 2001 GDP Deflator. All variables are on an annual basis.

Table C.2: List of Variables (Continued)

Variable Name	Notation	Description	Swedish Name	Source
Employment Variables				
Mean Skilled Wage		Mean wage of skilled workers	-	SCB
Mean Unskilled Wage		Mean wage of unskilled workers	-	SCB
Wage (Stayer)		Mean wage of workers staying at the firm	-	SCB
Wage (Skilled Stayer)		Mean wage of skilled workers staying at the firm	-	SCB
Wage (Unskilled Stayer)		Mean wage of unskilled workers staying at the firm	-	SCB
Wage (Hires)		Mean wage of newly hired workers	-	SCB
Wage (Skilled Hires)		Mean wage of newly hired skilled workers	-	SCB
Wage (Unskilled Hires)		Mean wage of newly hired unskilled workers	-	SCB
Additional Firm Variables				
Assets	–	Total book value of assets	Tillgångar	Serrano
Long Debt	-	Total long debt	Långfristiga skulder	Serrano
Equity	-	Total book value of equity	Eget kapital	Serrano
Payables	-	Accounts payables	Leverantörsskulder	Serrano
Receivables	-	Accounts receivables	Kundfordringar	Serrano
Material Assets	-	Book value of material assets	Materiella anläggningstillgångar	Serrano
Financial Assets	-	Book value of financial assets	Finansiella anläggningstillgångar	Serrano
Patents / Licences	-	Book value of patents, licenses etc	Patent, licenser och liknande	Serrano
Short Debt	-	Total short debt	Kortfristiga skulder	Serrano
Cash	-	Cash and bank holdings	Kassa och bank	Serrano
Dividends	-	Dividends paid to shareholders	Utdelningar	Serrano
Profit Margin	-	Operating profits divided by sales	Vinstmarginal	Serrano
Labor Share	-	Labor costs divided by value added	Löneandel	Serrano
Net Margin	-	Profits divided by value added	Nettovinstmarginal	Serrano

Notes: The table shows the variables used in the paper, notation, description, Swedish name and source. The sources are Serrano or Medlingsinstitutet (MI). Nominal variables are deflated using the 2001 GDP deflator. However, the centralized wage increase is deflated using the log-difference of the 2001 GDP Deflator. All variables are on an annual basis.

The first part can be simplified as follows,

$$\theta_L \Delta \ln(w_{L1}) + \theta_H \Delta \ln(w_{H1}), \tag{46}$$

$$= \theta_L \frac{b}{\eta_L} + \theta_H \frac{b}{\eta_L}(\beta_H + \gamma_H)\eta_H, \tag{47}$$

$$= \frac{b}{\eta_L}\Big(\theta_L + \theta_H(\beta_H + \gamma_H)\eta_H\Big), \tag{48}$$

$$= \frac{b}{\eta_L}\Big(\theta_L + (1 - \theta_L)(\beta_H + \gamma_H)\eta_H\Big), \tag{49}$$

$$= \frac{b}{\eta_L}\Big((\beta_H + \gamma_H)\eta_H + \theta_L[1 - (\beta_H + \gamma_H)\eta_H]\Big). \tag{50}$$

Notably, this expression is positive since $(\beta_H + \gamma_H)\theta_H > 0$ and $\theta_L \in [0, 1]$.

The second part can be simplified as follows. First, we simplify the expression for the changes in the employment shares. Since the employment shares sum to one, we have:

$$\frac{e_{H1} - e_{H0}}{e_{H0}} = \frac{(1 - e_{L1}) - (1 - e_{L0})}{e_{H0}} = \frac{e_{L0} - e_{L0}}{e_{L0}} \frac{e_{L0}}{1 - e_{L0}} \approx -\Delta \ln(e_{L1}) \frac{e_{L0}}{1 - e_{L0}} \tag{51}$$

We can use this to re-write the second part,

$$\theta_L \Delta \ln(e_{L1}) + \theta_H \Delta \ln(e_{H1}), \tag{52}$$

$$= \theta_L \Delta \ln(e_{L1}) - \theta_H \Delta \ln(e_{L1}) \frac{e_{L0}}{1 - e_{L0}}, \tag{53}$$

$$= \Delta \ln(e_{L1}) \Big(\theta_L - \theta_H \frac{e_{L0}}{1 - e_{L0}}\Big). \tag{54}$$

We note that,

$$\theta_L - \theta_H \frac{e_{L0}}{1 - e_{L0}} \tag{55}$$
$$= \theta_L - (1 - \theta_L)\frac{e_{L0}}{1 - e_{L0}} \tag{56}$$
$$= \theta_L - \frac{e_{L0}}{1 - e_{L0}} + \theta_L \frac{e_{L0}}{1 - e_{L0}} \tag{57}$$
$$= \theta_L(1 + \frac{e_{L0}}{1 - e_{L0}}) - \frac{e_{L0}}{1 - e_{L0}} \tag{58}$$
$$= \theta_L \frac{1}{1 - e_{L0}} - \frac{e_{L0}}{1 - e_{L0}} \tag{59}$$
$$= \frac{\theta_L - e_{L0}}{1 - e_{L0}} \tag{60}$$

Thus,

$$\Delta \ln(e_{L1})\Big(\theta_L - \theta_H \frac{e_{L0}}{1 - e_{L0}}\Big), \tag{61}$$
$$= \Delta \ln(e_{L1}) \frac{\theta_L - e_{L0}}{1 - e_{L0}}. \tag{62}$$

Solving for the log-change in the low-skilled employment share,

$$\Delta \ln(e_{L1}) \approx \Delta \ln(L) - \Delta \ln(N), \tag{63}$$
$$\Delta \ln(e_{L1}) \approx \frac{b}{\eta_L} - \frac{b}{\eta_L}\Big(e_L + e_H(\beta_H + \gamma_H)\Big), \tag{64}$$
$$\Delta \ln(e_{L1}) \approx \frac{b}{\eta_L}\Big(1 - e_L - e_H(\beta_H + \gamma_H)\Big), \tag{65}$$
$$\Delta \ln(e_{L1}) \approx \frac{b}{\eta_L}\Big(1 - \beta_H - \gamma_H\Big)(1 - e_{L0}). \tag{66}$$

Plugging this in,

$$\Delta \ln(e_{L1}) \frac{\theta_L - e_{L0}}{1 - e_{L0}}, \tag{67}$$
$$= \frac{b}{\eta_L}\Big(1 - \beta_H - \gamma_H\Big)(1 - e_{L0}) \frac{\theta_L - e_{L0}}{1 - e_{L0}}, \tag{68}$$
$$= \frac{b}{\eta_L}\Big(1 - \beta_H - \gamma_H\Big)(\theta_L - e_{L0}). \tag{69}$$

Finally, we combine the expressions for the first and second parts: Thus,

$$\Delta \ln(w_1) \approx \frac{b}{\eta_L}\Big((\beta_H+\gamma_H)\eta_H+\theta_L[1-(\beta_H+\gamma_H)\eta_H]\Big)+\frac{b}{\eta_L}\Big(1-\beta_H-\gamma_H\Big)(\theta_L-e_{L0}), \tag{70}$$

$$=\frac{b}{\eta_L}\Big((\beta_H+\gamma_H)\eta_H+\theta_L[1-(\beta_H+\gamma_H)\eta_H]+\Big(1-\beta_H-\gamma_H\Big)(\theta_L-e_{L0})\Big). \tag{71}$$

This expression is positive if (assuming $\theta_L < e_{L0}$):

$$\frac{b}{\eta_L}\Big((\beta_H+\gamma_H)\eta_H+\theta_L[1-(\beta_H+\gamma_H)\eta_H]+\Big(1-\beta_H-\gamma_H\Big)(\theta_L-e_{L0})\Big)>0, \tag{72}$$

$$(\beta_H+\gamma_H)\eta_H+\theta_L[1-(\beta_H+\gamma_H)\eta_H]-\Big(1-\beta_H-\gamma_H\Big)(e_{L0}-\theta_L)>0, \tag{73}$$

$$(\beta_H+\gamma_H)\eta_H+\theta_L[1-(\beta_H+\gamma_H)\eta_H]>\Big(1-\beta_H-\gamma_H\Big)(e_{L0}-\theta_L). \tag{74}$$

Notably, this holds if $\beta_H+\gamma_H>1$.

Wage Bill and Employment Skill Shares We now derive the wage bill and employment skill shares. From the first-order condition for each skill group, we have:

$$Y_i=(1+\eta_i)x_i^{\eta_i}, \tag{75}$$

$$Y\alpha_i=(1+\eta_i)x_i^{1+\eta_i}, \tag{76}$$

$$x_i^{1+\eta_i}=\frac{\alpha_i}{1+\eta_i}Y. \tag{77}$$

We then define the wage bill share as follows,

$$\theta_i=\frac{x_i^{1+\eta_i}}{L^{1+\eta_L}+H^{1+\eta_H}}, \tag{78}$$

$$\theta_i=\frac{\frac{\alpha_i}{1+\eta_i}}{\frac{\alpha_L}{1+\eta_L}+\frac{\alpha_H}{1+\eta_H}}. \tag{79}$$

Similarly, we define the employment share,

$$e_i = \frac{x_i}{L+H}, \tag{80}$$

$$e_i = \frac{(\frac{\alpha_i}{1+\eta_i}Y)^{\frac{1}{1+\eta_i}}}{(\frac{\alpha_L}{1+\eta_L}Y)^{\frac{1}{1+\eta_L}} + (\frac{\alpha_H}{1+\eta_H}Y)^{\frac{1}{1+\eta_H}}} \tag{81}$$

Since Y is homogenous of degree one, we have that

$$1 = \alpha_L + \alpha_H + \alpha_K. \tag{82}$$

Moreover,

$$Y(\alpha_L + \alpha_H + \alpha_K) = (1+\eta_L)L^{1+\eta_L} + (1+\eta_H)H^{1+\eta_H} + rK, \tag{83}$$

$$Y = (1+\eta_L)L^{1+\eta_L} + (1+\eta_H)H^{1+\eta_H} + rK, \tag{84}$$

$$\tag{85}$$