Payroll, Revenue, and Labor Demand Effects of the Minimum Wage*

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Abstract

We study the short-term impact of the 2015-2016 minimum wage increases in Seattle on wage bill, labor demand, and revenue of surviving firms using employer-employee matched data from the state of Washington. We show that employers were able to pass 30-50% of the minimum wage incidence to employees and consumers. They were able to achieve these profit gains through two channels. First, their revenues increased, suggesting that they raised prices. Second, they reallocated hours from low-wage to high-wage jobs. The observed pattern of adjustment is consistent with the competitive model of the labor market. However, the extent to which employers relied on each adjustment channel varied across industries, with stronger revenue increases in full-service restaurants and weaker to negligible disemployment effect in limited-service restaurants and retail.

JEL Classification: J38, J23, J63

Keywords: minimum wage, channels of adjustment

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1 Introduction

In this paper we revisit the question of how businesses respond to the minimum wage using the evidence from a large minimum wage hike in Seattle. In 2014 the City of Seattle passed the Minimum Wage Ordinance which raised the minimum wage to $15 over several years. We examine the minimum wage effect during the first two phase-in periods, when the minimum wage went from $9.47 to up to $11, and then to $13.[1] We focus on two questions. What is the incidence of the minimum wage on surviving businesses? What are the channels of within-firm adjustment to the minimum wage: do employers rely on product market adjustment, labor market adjustment, or both of these channels?

We show that employers which survived the minimum wage increase were able to pass 30-50% of the minimum wage incidence to consumers and/or employees. We demonstrate that employers adjusted to the minimum wage both through the product market and the labor market adjustment channels. First, they saw increases in revenue, most likely caused by higher prices.[2] We estimate that a 1% increase in average wages caused a 0.03% to 0.35% increase in revenue. Second, they reallocated hours from low-wage jobs to high-wage jobs. We estimate that a 1% increase in average wages led to a 0.3% to 0.6% decline in hours of jobs paying less than 150% of the minimum wage, and 0.3% to 1.2% increase in hours of jobs paying 150% of the minimum wage or more. In addition, we find that the minimum wage had a ripple effect on the jobs paying above the minimum wage, and led to wage raises to workers earning up to 150% of the minimum wage, which created additional pressure on the labor costs.

Our study draws on two linked confidential datasets on firms from the State of Washington: data on payroll records from the WA Unemployment Insurance (UI) program, and data on business revenue from the Washington Department of Revenue. These two datasets have several features which make them uniquely positioned to study the impact of minimum wage on businesses' adjustment strategies. First, Washington is one of the four states in the United States which collects not only quarterly earnings for each worker on payroll, but also requires employers to report quarterly hours worked. As a result, we can precisely measure the cost of compliance with the minimum wage for each business. We calculate the cost of compliance as the percentage increase in wage-bill required to meet the minimum wage if a business keeps the number of jobs and hours at the pre-policy level. Second, the UI records from the State of Washington cover the universe of private sector companies in the State of Washington, providing 6-digit NAICS code for each firm. This allows us to study employers' adjustment strategies across the entire market without restricting our analysis to low-paying industries such as restaurants and retail, as many previous studies had to

[1] Seattle Minimum Wage Ordinance adopted different minimum wage schedules depending on the number of employees in a firm and whether a firm contributes toward health benefits. We discuss the minimum wage schedules in Seattle in detail in section 2.

[2] Though we do not have the data on prices directly, Romich, Allard, Althauser, Buszkiewicz, and Obara (2017) conducted the Survey of Seattle's Employers and have shown that the majority of employers planned to or increased prices in response to the minimum wage.

do. Third, the Washington State collects a Business and Occupation tax on most businesses in the private sector, which is calculated as a share of gross quarterly revenue, allowing us to explore the product market and the labor market adjustment at the same time.

We estimate the impact of the minimum wage hike on business outcomes by comparing Seattle businesses with lower costs of compliance with the minimum wage to businesses with higher costs of compliance via a difference-in-differences approach. Our identification strategy relies on the assumption that the difference between employers with zero costs of compliance and employers with positive costs of compliance in 2015-2016 would have been similar to the prior years if the minimum wage ordinance was not implemented. We argue that this is a reasonable assumption by showing that the samples of exposed and non-exposed employers are balanced in size, age, and revenue relative to the prior years, and by demonstrating that the wage increases in exposed firms start exactly in the quarter when the minimum wage hikes were implemented. Lastly, we preform a falsification test by estimating the effect of a placebo ordinance passed in 2012, and find no effect of the placebo on wages or wagebill.

Although there is a vast literature on the employment effects of the minimum wage (see Neumark and Wascher, 2008; Flinn, 2011; Belman and Wolfson, 2014; Card and Krueger, 2015, for the comprehensive review), much less is known about the incidence of the minimum wage on businesses. Prior studies produced mixed evidence on whether employers' profits decrease or do not decrease as a result of the minimum wage hike (Draca, Machin, and Van Reenen, 2011), although several papers documented increases in revenue in response to the minimum wage (Giuliano, 2013; Hirsch, Kaufman, and Zelenska, 2015; Brummund, 2017; Harasztosi and Lindner, 2015), and there are robust findings of the minimum wage pass-through to prices (Allegretto and Reich, 2016; Aaronson, French, and MacDonald, 2008). The evidence on the employment effects of the minimum wage is inconclusive as well. On the one hand, several papers based on the payroll data found no reduction in low-wage labor (Giuliano, 2013; Hirsch, Kaufman, and Zelenska, 2015; Brummund, 2017). On the other hand, Aaronson and Phelan (2017) have demonstrated that businesses cut jobs in routine occupations which can be easier to automate, and Horton (2017) has shown that employers in an on-line marketplace responded to the minimum wage by cutting hours worked and hiring more productive workers. Finally, Gittings and Schmutte (2016) and Dube, Lester, and Reich (2016) have shown that minimum wage hikes lead to decreases in turnover rates, suggesting that lower turnover might be able to compensate employers for rising labor costs and help to avoid reductions in employment.

We contribute to this literature by providing evidence from a large minimum wage increase in the US. We find price increases and employment decreases in response to the minimum wage, consistent with the competitive model of the labor market. However, the extent to which employers relied on each adjustment channel varied across industries, with stronger revenue increases in full-service restaurants and weaker to negligible disemployment effect in limited-service restaurants and retail. These differences in adjustment strategies across industries can help reconcile the differences in prior studies, as many papers in the US focused on restaurants and retail.

2 Institutional Background and Data

2.1 Seattle's Minimum Wage Ordinance

In June of 2014, the City of Seattle passed a law which raised the minimum wage in Seattle to $15 over the following seven years. The law has several phase-in stages, allowing small firms more time to switch to $15 minimum wage compared to large firms, giving employers tip credit, and introducing lower minimum wager for those employers who contribute toward medical benefits. The complete minimum wage schedule is presented in table 1. The first phase-in began in April of 2015 and raised the minimum wage by 16.2%, from $9.47 to up to $11.[3] The second phase-in began in January of 2016 and raised the minimum wage to $12 through up to $13, or by 9.1% to 18.2% depending of the schedule.

In this paper, we focus on the first two phase-ins, from the period between the second quarter of 2014 when the Ordinance was passed, through the third quarter of 2016, which is the last period for which the data are currently available.[4] We investigate each phase-in period separately, and compare estimates of the impact of $11 minimum wage increase and $13 minimum wage increase.[5]

2.2 Data Sources

We use data on payroll from the Unemployment Insurance records (UI), collected by the Washington Employment Security Department (ESD) and data on revenue from the Business & Occupation tax records, collected by the Washington Department of Revenue.

Though every state collects quarterly data on payroll and total employment to administer unemployment insurance tax, Washington is one of four states in the US which also collects data on hours.[6] As a result, we can directly observe hourly compensation which each firm pays before and after the minimum wage hike. The dataset spans over 2005-2015, and allows us to track businesses

[3] Washington has a state minimum wage, which is indexed to inflation annually on January 1 of each year. Though the state minimum wage has been steadily growing during in 2005-2016, it has increased on average by 2.4% in nominal terms. Complete record of historical minimum wage in Washington State can be found at http://www.lni.wa.gov/WorkplaceRights/Wages/Minimum/History/default.asp.

[4] We cannot separate the effect of the minimum wage increase from the anticipatory effect of the following phase-in period. However, we do not observe any anticipatory effect before April 1, 2015, when the first minimum wage hike took place, which suggests that out results are indeed driven by response to the past minimum wage increase rather than anticipation effect of the upcoming one.

[5] Though firms were on different schedules during each phase-in, for simplicity we refer to the first phase-in period as implementing $11 minimum wage, and to the second phase-in period as implementing $13 minimum wage. $11 and $13 are the highest minimum wage levels imposed by the ordinance on large employers which do not contribute towards health benefits.

[6] Employment Security Department uses the data on hours to determine UI eligibility, and as a result the data on hours worked is considered to be very reliable.

Table 1. Minimum wage in Seattle under Seattle Minimum Wage Ordinance.

	Large employers[a]		Small employers	
	No benefits	With benefits[b]	No benefits or tips	Benefits or tips[c]
	Before Seattle MW Ordinance[d]			
January 1, 2015	$9.47	$9.47	$9.47	$9.47
	After Seattle MW Ordinance			
April 1, 2015	$11.00	$11.00	$11.00	$10.00
January 1, 2016	$13.00	$12.50	$12.00	$10.50
January 1, 2017	$15.00[e]	$13.50	$13.00	$11.00
January 1, 2018		$15.00[f]	$14.00	$11.50
January 1, 2019			$15.00[g]	$12.00
January 1, 2020				$13.50
January 1, 2021				$15.00[h]

[a] A large employer employs 501 or more employees worldwide, including all franchisees associated with a franchise or a network of franchises.
[b] Employers who pay towards medical benefits.
[c] Employers who pay towards medical benefits and/or employees who are paid tips. Total minimum hourly compensation (including tips and benefits) is the same as for the small employers who do not pay towards medical benefits and/or tips.
[d] Before April 1, 2015 Seattle was subject to the WA minimum wage, which is indexed to inflation using CPI-W.
[e] For large employers, after the minimum wage reaches $15.00 it is indexed to inflation using CPI-W for Seattle-Tacoma-Bremerton Area.
[f] Starting January 1, 2019, payment by the employer of medical benefits for employees no longer affects the hourly minimum wage paid by a large employer.
[g] After the minimum hourly compensation for small employers reaches $15 it goes up to $15.75 until January 1, 2021 when it converges with the minimum wage schedule for large employers.
[h] The minimum wage for small employers with benefits or tips is projected to converge with other employers by 2025.

longitudinally.[7] For each business, we observe industry code at NAICS 6 digit level, address of the firm, and wagebill and total hours worked for each worker who was on payroll in a given quarter. The wagebill includes all compensation received by an employee, including tips and bonuses.[8] However, we do not have information on non-pecuniary benefits or other forms of compensation, like stock etc.[9]

To determine if a business is covered by the Seattle's ordinance, we geocode business address and use the exact coordinates to determine if the business is located within the boundary of the City of Seattle. However, an important caveat of our data arises from the fact that non-franchise businesses operating multiple stores can file a joint report for all their locations. As a result, we

[7] Though payroll records are available for years before 2005, most of business addresses in the earlier years are P.O. boxes rather than physical addresses of businesses, which makes them unusable for the purposes of these study.

[8] Though IRS requires businesses to report tips received by their employees, and provides regular audits to enforce this regulation, the amount of tips is likely to be underreported.

[9] This limitation is most substantial insofar as we are unable to distinguish employers who pay health benefits as the ordinance specifies a lower minimum wage for employers which offer benefits.

do not observe which employees in these businesses work in Seattle and are covered by the Seattle Minimum Wage Ordinance. To overcome this problem, we focus our analysis on single-location businesses. This restriction excludes large companies which own their branches, but still allows us to study franchises – businesses with multiple locations which are owned independently. These single-location businesses constitute about 89% of all firms in Washington State and hire about 62% of all workers.[10] On average, these businesses tend to be younger and smaller than multi-location businesses. They also pay lower wages than multi-location businesses, and thus are more exposed to the minimum wage hike than an average business in Seattle. As such, we view our estimates as the effect on the most vulnerable firms.

We include only businesses which are located in Seattle into our sample, even though our dataset contains information on Washington businesses located outside of Seattle as well. We chose not to use the cross-border design popular in other minimum wage studies (Dube, Lester, and Reich, 2010), because the areas of Seattle-Bremerton-Tacoma Metro Area outside of the City of Seattle are a part of the common integrated labor market, and thus are likely to experience spillover effects of the Seattle minimum wage.[11]

We merge the payroll data with quarterly data on sales collected by the Department of Revenue (DOR). Washington has a Business & Occupation (B&O) tax on firms which is levied on receipts from all business activities, measured as the value of products, gross proceeds of sale, or gross income of the business. Every business in WA which is required to collect sales tax, has a gross income of $12,000 per year or more, is a buyer or processor of specialty wood products, or is otherwise required to pay taxes or fees to the DOR has to register with the DOR.[12] The DOR collects gross income quarterly, and tracks when the firm opened and if and when it closed, which allows us to control for age of business in the analysis.

Next, we restrict our analysis to businesses which had five or more employees on average through their lifetime, as is common practice in firm level studies.[13] Though most firms are very small (65% of all businesses in the data have fewer than five employees), these firms employed only 5% of the workforce in Seattle in 2014. Finally, we also exclude from our analysis firms which

[10] See Jardim, Long, Plotnick, van Inwegen, Vigdor, and Wething (2017a) for a more detailed discussion on the distribution of single-site and multi-site businesses in the Washington UI data.

[11] In particular, Jardim, Long, Plotnick, van Inwegen, Vigdor, and Wething (2017b) have shown that census tracts within 40 minute drive from Seattle have seen abnormal wage growth and employment loss in low-wage jobs following the enactment of Seattle minimum wage, though these effects are smaller in magnitude than the minimum wage effect inside Seattle city boundaries.

[12] Washington State uses a unique Uniform Business Identifier (UBI) for most of reporting purposes, though ESD creates its own identifier (employer account number). We define a business using UBI whenever available, even if one UBI corresponds to several account numbers in the payroll records. During the merge, we aggregate the income and payroll from all associated accounts, pick geographic identifiers from the largest account number within the UBI, and pick the earliest date of opening.

[13] Similar sample restriction is used, for example, in Harasztosi and Lindner (2015) and Kahn and McEntarfer (2014).

contain likely reporting errors for 10% or more of their employees.[14] Table 2 shows the summary statistics on the remaining sample. We are able to find revenue matches for almost 60% of single-location businesses which employ 80% of the workforce. Restricting our analysis to firms with 5 and more employees and excluding firms with a large share of reporting errors leads to dropping another 30% of firms and 10% of the workforce from our analysis. In the end, we are able to study firms which account for 61% of the workforce employed by single-location businesses in Seattle.

Table 2. Summary statistics on Seattle firms included and excluded from the analysis.

	Sample	Average No. firms	% of total no. firms	Average Employment	% of total employment
A.	All single-location businesses in Seattle	21,122	100.00	299,660	100.00
B.	Firms with available revenue data	12,535	59.34	243,677	81.32
C.	B and Firms with 5 and more employees	6,319	29.92	215,477	71.91
D.	C and Surviving firms	5,875	27.81	206,272	68.84
E.	D and Firms in the analysis sample	5,216	24.69	182,747	60.98

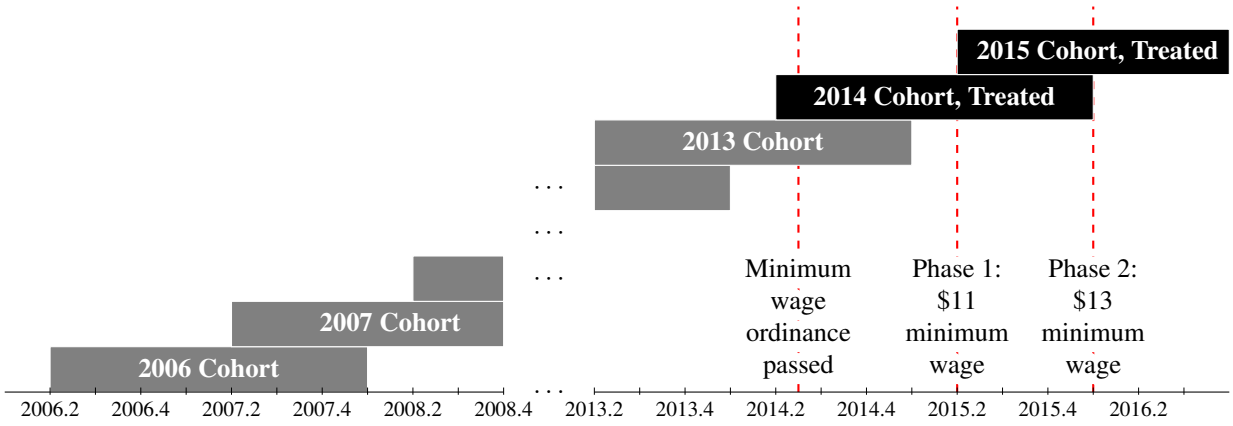
Source: UI records from WA state, 2005-2016. Sample: Single-location businesses in Seattle. Agriculture, Mining, Utilities, Management of Companies and Enterprises, Educational Services, and Public Administration were excluded from the sample due to small sample sizes. Average number of firms and employment across cohorts reported.

To study the impact of minimum wage on businesses, we split the data into cohorts as illustrated by the figure 1. We are interested in analyzing two treated cohorts: firms which were active before and after the first minimum wage step-up in April of 2015, and firms which were active before and after the second minimum wage step-up in January of 2016. To be able to analyze the impact of each step-up separately, we set the baseline period in the 2nd quarter of each calendar year and track firms for six subsequent quarters. As a result, the 2014 cohort starts in the 2nd quarter of 2014, when the Seattle minimum wage ordinance was passed, and ends in the 4th quarter of 2015, three quarters after the minimum wage increase to $11, and in the last quarter before the minimum wage hike to $13 per hour. Similarly, the 2015 cohort starts in the 2nd quarter of 2015, the first period after the implementation of the $11 minimum wage, and ends in the 3rd quarter of 2016, three periods after the implementation of the $13 minimum wage. We design control cohorts in a similar way, starting a new cohort in the 2nd quarter of each calendar year. This design allows us to take into account seasonal variation in business activity, as well as the annual increases in the state minimum wage.[15] Finally, because we track firms only for six quarters, we impose relatively weak requirements on firm age, and are able to keep most firms in the sample.

[14] We flag an observation as a likely reporting error if it is one with a wage rate lower than $9 per hour in 2015 prices, reports more than 1,000 hours worked in a quarter, or has a wage rate greater than $500 per hour and reports fewer than 10 hours in a quarter.

[15] The state minimum wage is indexed to inflation annually on January 1.

Figure 1. Definition of cohorts.



2.3 Businesses' Exposure to the Minimum Wage Hike

One of the key advantages of our data is that it allows us to observe the costs of compliance with the minimum wage for each firm. We measure the costs of compliance with the minimum wage hike, denoted by GAP, by calculating how much a business would need to increase its total wagebill to comply with the new minimum wage, if it kept the total number of hours worked the same as in the baseline period[16]:

$$GAP_{ic} = \frac{\sum_n h_{inc} \max\{MW - w_{inc}, 0\}}{\sum_n h_{inc} w_{inc}}, \tag{2.1}$$

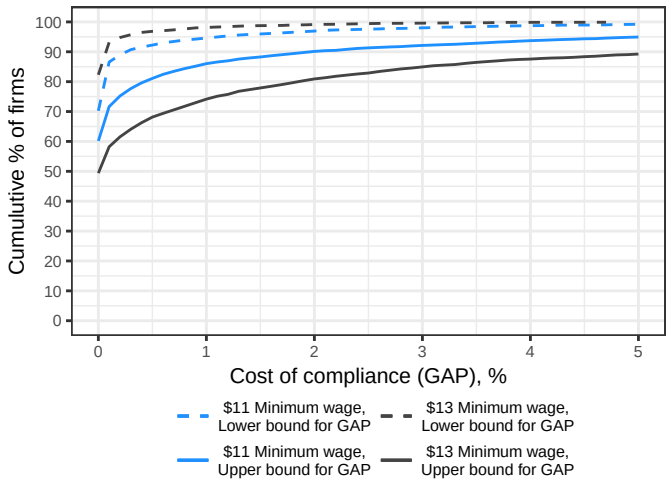
where i denotes firms, c denotes a cohort, n denotes employees of the firm i, h_{int} denotes hours worked by a worker n, w_{int} denotes hourly wage rate paid to an employee n, and MW is the minimum wage. A GAP of 1% means that a business needs to increase total labor costs by 1% to comply with the minimum wage. We calculate the costs of compliance at the baseline quarter for each cohort, and do not update costs of compliance as workforce composition changes. This allows us to interpret our estimates as an effect of one percentage point increase in the costs of compliance.

Seattle minimum wage ordinance establishes different minimum wage schedules for firms depending on their size and whether they contribute towards health benefits (see figure 1 on page 5 for details). Unfortunately, we cannot determine the exact schedule which applies to each firm in our data. This limitation arises because the City of Seattle counts firm size based on worldwide employees for all businesses in a chain or a network of franchises. Though we can compute the firm size in Washington, we have no data on business affiliation and thus are unable to identify businesses which belong to networks of franchises or national branches. The second limitation of our data is that we do not observe whether a job pays health benefits. To overcome these limitations, we first estimate the impact of the Seattle's minimum wage by assigning all firms to the highest

[16]This measure of the cost of compliance has been widely used in the literature (for example, Draca, Machin, and Van Reenen, 2011; Hirsch, Kaufman, and Zelenska, 2015; Brummund, 2017), and was first introduced by Card and Krueger (1994).

minimum wage schedule, which applies to businesses with 501 and more employees worldwide which do not provide health benefits.[17] Costs of compliance based on the highest minimum wage provide an upper bound estimate of the actual costs of compliance and will generally overestimate the true costs of compliance, but will never incorrectly assume that businesses are not affected by the minimum wage hike. We also calculate a lower bound estimate of the costs of compliance by assigning firms to the schedule based on their average size in the calendar year prior to the minimum wage implementation, and assuming that they contribute towards medical benefits.[18] We estimate the impact of the minimum wage using both measures to ensure that overestimating costs of compliance does not lead to attenuated results.

Figure 2. Distribution of the costs of compliance with the minimum wage across firms.



Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. GAP measures percentage increase in total wagebill required to meet the new minimum wage, assuming jobs and hours remain the same. Lower bound for GAP assumes all firms are subject to the lowest minimum wage in their size category imposed on employers which provide health benefits and/or employees which receive tips. Upper bound GAP assumes that all firms are subject to the highest minimum wage imposed on large employers which do not provide health benefits.

Figure 2 shows the cumulative density function of the costs of compliance in Seattle for both minimum wage phase-in periods. At the time of the passage of the minimum wage ordinance in June of 2014, only 39% of single-location businesses in Seattle had some workers who were paid less than $11 per hour. In the 2nd quarter of 2015, before the implementation of the $13 minimum wage, the share of exposed firms was larger – 49%, but we still see that as many as half of the

[17] During the first phase-in period the highest minimum wage was $11/hour, and during the second phase-in it was $13/hour.

[18] During the first phase-in period, we use $10 minimum wage for small employers and $11 for large employers to estimate the lower bound for costs of compliance, and during the second phase-in we use minimum wage of $12.50 per hour and $10.50 per hour for large and small employers respectively.

businesses were not affected by the minimum wage hike at all.[19]

Moreover, figure 2 shows that the costs of compliance were unequally distributed even among exposed firms. In particular, figure 2 demonstrates that among the exposed firms, most needed to increase their labor costs by less than 1%. At the same time, as many as 5% and 10% of businesses were required to raise their labor costs by more than 5% during the first and the second phase-in period respectively.

3 Empirical Strategy

In this section, we present our empirical strategy and discuss the assumptions required for identification. We study the effect of the minimum wage on the intensive margin, i.e. on the wagebill and hours worked in surviving businesses. We define surviving businesses as those which were active at the baseline quarter and remained open in the last quarter of each cohort.[20]

We start by studying the effect of the minimum wage hike on inflation-adjusted average hourly wage rate paid by each firm, as this is the intended effect of the minimum wage policy.[21] After that, we move to the main outcomes of interest: total wagebill, revenue, hours worked in all jobs, and hours worked in low-wage and high-wage jobs. We measure the growth rate in each outcome using a bounded measure of growth, which reduces the impact of outliers on the estimates[22]:

$$\Delta y_{ict} = \frac{y_{ict} - y_{ict_0}}{0.5\left(y_{ict_0} + y_{ict}\right)}, \tag{3.1}$$

where y is an outcome of interest, i denotes firm, c denotes cohort, t denotes the number of quarters after the baseline (we take the 2nd quarter of each calendar year as the baseline quarter), and t_0 denotes the baseline quarter.

To study the impact of the exposure to the minimum wage on business outcomes, we compare change in outcomes in each firm in the treated cohort to firms wich similar cost of compliance in the prior cohorts. We estimate the following difference-in-differences regression:

$$\Delta y_{ict} = \alpha_t \, GAP_{ic} + \beta_t \, GAP_{ic} \, T_{ic} + \gamma_t X_{ic} + \theta_{jct} + \mu_i + \varepsilon_{ict}, \tag{3.2}$$

[19] This fact holds even in heavily exposed industries, and cannot be explained by differences in pay between industries. Appendix table 13 breaks down exposure by industry. It demonstrates that in the most affected industries – food and accommodation services, and retail trade – there were 27-40% and 10-20% businesses respectively which already paid their workers more than the new minimum wage before it was implemented. However, limited-service restaurants were by far the most affected industry, with fewer than 10% of employers having zero costs of compliance, and the average cost of compliance of 6-8% of the wagebill.

[20] Cohorts used to study \$11 minimum wage span six quarters, and cohorts used to study \$13 minimum wage span five quarters.

[21] We express wage rates and earnings in constant prices of the 2nd quarter of 2015 using the national CPI-W.

[22] Bounded measure of growth is also convenient because it leads to a natural decomposition of the change in each outcome into contributions from separations, hires and changes in continuing jobs. We explore this decomposition in detail when we analyze the labor market adjustment to the minimum wage.

where j denotes industry (at NAICS 4-digit level), X_{ic} is a vector of controls, and T_{ic} is the indicator for the treated cohort, θ_{jct} is the industry-cohort-quarter fixed effect, and μ_i is the firm fixed effect. Since we are interested in the average effect of the minimum wage on businesses, we do not weight regression 3.2 by firm size, forcing one observation to be a firm rather than a job. Finally, we cluster standard errors in all regressions by cohort and by industry (at the NAICS 3 digit level) to allow for common shocks and autocorrelation (Bertrand, Duflo, and Mullainathan, 2004).

We deal with the staggered nature of minimum wage increase by estimating specification (3.2) separately for the minimum wage hike to \$11 and to \$13. To estimate the impact of the \$11 minimum wage, we compare firms which were active in the 2nd quarter of 2014 to firms in the prior cohorts, and calculate costs of compliance using \$11/hour as the new minimum wage for all cohorts. When we estimate the impact of the \$13 minimum wage, we exclude the 2014 cohort from the sample, and compare firms which were active in the 2nd quarter of 2015 to 2006-2013 cohorts. As before, the pseudo cost of compliance for the control cohorts is calculated using \$13/hour.

Because there are substantial differences in outcomes and in seasonal patterns across industries, we control for the cohort-quarter-industry fixed effect θ_{jtq}. Thus, we compare firms with different levels of exposure to the minimum wage within the same cohort, industry, and quarter since baseline. We also include firm fixed effects μ_i to capture unobserved heterogeneity across firms.[23] Next, we allow for different seasonal patterns across small and large firms, and young and mature firms. To capture the differential seasonal effects, we control for the number of employees in a firm at baseline (indicators for 1-4, 5-9, 10-49, 50-499 and $>$500 workers at baseline) and for the age of the firm (indicators for less than 1 year, 1-10, and older than 10 years at baseline following classification in Haltiwanger, Jarmin, and Miranda (2013)), and allow the coefficient γ_t to vary across quarters.

The costs of compliance with the minimum wage are measured at the baseline quarter (i.e at $t = t_0$) and are held constant for each firm for the subsequent six quarters, even if the workforce composition of the firm has changed. As a result, we can interpret the coefficient β as the impact of exposure to the minimum wage hike. A coefficient of 1 shows that a one percentage point increase in costs of compliance with the minimum wage, measured by GAP, leads to a 1 percentage point increase in outcome y.

Our difference-in-differences regression 3.2 estimates the difference between firms with positive costs of compliance and firms with zero costs of compliance in 2015-2016, when Seattle Minimum Wage Ordinance was enacted, using 2006-2013 cohorts as comparison. Firms with zero compliance cost, which have been paying their workers more than the minimum wage even before it was enacted, help us identify trends which are common for all firms, such as changes in consumer demand and seasonality. It is especially important to control for such trends because our period of observation stretches through the Great Recession and contains post-recession years when Seattle's economy was growing rapidly.[24]

[23] Fixed effect specification is estimated in Stata using a fast algorithm written and implemented by Correia (2016).

[24] Based on the data from the Quarterly Employment of Employment and Wages, between 2014 and 2016 employ-

The key identifying assumption for the specification 3.2 requires that the difference in outcomes between employers with zero cost of compliance and employers with positive costs of compliance would have been the same in 2014-2015 cohorts as in 2006-2013 cohorts after adjusting for the market-wide trends. Table 3 compares employers affected and unaffected minimum wage. As expected, firms exposed to the minimum wage had lower average hourly wage and lower revenue per hour. However, the treated low-paying firms were comparable in size, age, and average wage rate paid by the low-paying firms in the control cohorts, which suggests that our estimates should not be driven by different composition of firms in 2015–2016 compared to the earlier cohorts.[25]

To show that our estimates are unlikely to be driven by secular trends, we also estimate the effect of a placebo minimum wage ordinance passed in 2012, i.e. two years before the actual passage of the Seattle minimum wage ordinance. We see no effect of the pseudo ordinance on wagerate and wagebill of the firms with positive cost of compliance.

Finally, to trace the timing of the impact, we let the coefficient β vary across quarters. For each minimum wage step-up, we track firms for three quarters after the minimum wage hike was implemented, and for two to three quarters before the minimum wage hike. If we see an effect before the Minimum Wage Ordinance went into effect in the second quarter of 2015, it would suggest that firms started adjusting to the minimum wage hike ahead of the minimum wage implementation. However, the time periods before January of 2016, when the $13 minimum wage went in effect, correspond to the periods when the $11 minimum wage had been already enacted. As a result, even if firms did not have anticipatory reaction to $13 minimum wage, we would still expect to see a non-zero coefficient β for these quarters, and an increase in the magnitude of the effect in the quarters after the $13 minimum wage was implemented.

Though our preferred estimates are reported based on the specification 3.2, we also provide the estimates of the elasticity with respect to a 1% increase in wages rather than a 1 percentage point increase in the costs of compliance to show the magnitudes of the effects which are easier to interpret. To estimate the elasticity with respect to the wage change, we regress changes in outcomes on changes in wages, and use the costs of compliance as an instrument for changes in wages. To do so, we estimate the following IV regression specification:

$$\Delta y_{ict} = \alpha_t \, GAP_{ic} + \beta \, \Delta w_{ict} \, T_{ic} \, \mathbb{1}(t \geq 0) + \gamma_t X_{ic} + \theta_{jtq} + \mu_i + \varepsilon_{ict}, \tag{3.3}$$

and we instrument the term $\Delta w_{ict} \, T_{ic} \, \mathbb{1}(t \geq 0)$ with the term $GAP_{ict} \, T_{ic} \, \mathbb{1}(t \geq 0)$, where $t = 0$ denotes the quarter when the minimum wage step-up was implemented.[26]

ment in Seattle grew at the average annual rate of 3%, while nominal weekly earnings grew at the average annual rate of 4%.

[25] Appendix table 14 does the same exercise for growth rates in the main outcomes. The results show that employers with positive costs of compliance experienced higher growth rates in average wages and wagebill both in 2014 and in 2015 cohort.

[26] In addition, when we study the effect of the $13 minimum wage we allow the cost of compliance to have an effect on wages during the period when the $11 minimum wage was in effect, but before the implementation of

Table 3. Balance between control and treated cohorts.

	Control Cohorts		Treated Cohorts		Diff-in-Diff	P-val.
	GAP=0	GAP>0	GAP=0	GAP>0		
Panel A: 2014 Cohort, subject to $11 Minimum wage						
Cost of compliance (GAP), %	0	1.98	0	1.92	-0.06	0.53
Number of workers	26.44	47.42	26.77	50.16	2.41	0.25
Age, years	13.9	12.33	14.67	12.83	-0.26	0.33
Average wage rate, $ (2015 prices)	34.79	19.49	34.7	19.38	-0.02	0.96
Revenue per hour, $ (2015 prices)	232.53	94.08	212.35	90.69	16.78	0.12
Wagebill over revenue, %	31.27	30.96	31.87	31.88	0.32	0.49
Share of jobs paying <105% MW in hours, %	0.78	29.87	0.52	28.09	-1.52	0.01
Share of jobs paying <110% MW in hours, %	1.79	34.17	1.74	33.25	-0.86	0.23
Share of jobs paying <115% MW in hours, %	3.07	38.26	2.86	37.42	-0.63	0.35
Share of jobs paying <120% MW in hours, %	4.34	42.01	4.53	41.34	-0.85	0.24
Share of jobs paying <150% MW in hours, %	14.81	58.64	16.4	59.09	-1.14	0.25
No firms	26,544	15,915	3,818	2,427		
Panel B: 2015 Cohort, subject to $13 Minimum wage						
Cost of compliance (GAP), %	0	5.12	0	3.22	-1.9	0
Number of workers	23.8	43.29	27.34	48.02	1.18	0.64
Age, years	13.91	12.79	15.08	13.16	-0.8	0.01
Average wage rate, $ (2015 prices)	37.99	21.44	38.41	21.62	-0.23	0.76
Revenue per hour, $ (2015 prices)	268.66	105.86	237.84	98.62	23.58	0.2
Wagebill over revenue, %	31.46	30.9	31.56	31.79	0.79	0.18
Share of jobs paying <105% MW in hours, %	0.94	36.56	0.88	34.44	-2.06	0.15
Share of jobs paying <110% MW in hours, %	2.16	40.42	2.07	38.84	-1.5	0.31
Share of jobs paying <115% MW in hours, %	3.46	43.83	3.38	42.46	-1.28	0.4
Share of jobs paying <120% MW in hours, %	5.22	47.07	6.29	47.36	-0.79	0.62
Share of jobs paying <150% MW in hours, %	18.00	62.41	19.48	63.39	-0.5	0.78
No firms	19,671	22,788	3,180	3,142		

Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. GAP measures percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same. Diff-in-Diff and P-value shows the difference in differences between exposed and non-exposed firms in treated and control cohorts.

Regression of wages on the costs of compliance serves as a first stage for this instrumental variable specification. We show that the costs of compliance are a strong predictor of the wage growth in the exposed firms. Next, because the costs of compliance are measured at the baseline period, the validity of the instrument requires that $\mathbb{E}[\varepsilon_{ict}|GAP_{ic}] = 0$, or that growth in outcomes is not correlated with the magnitude of the costs of compliance. However, due to the measurement error in wages and hours worked, we would expect wages to revert to the mean. This auto-correlation in wages can produce mechanical correlation between the cost of compliance at baseline and wage growth, which we do indeed observe in the data. Because of this concern, be always report the results of both the OLS specification 3.2 and the IV specification 3.3, and rely on the OLS as our preferred estimates.[27]

4 Identification and Timing of the Minimum Wage Effect

In this section we examine the effect of the minimum wage on wages. Figure 3 shows the wage distribution in Seattle before and after the minimum wage hike for both phase-in periods, using 10-cent wage bins. The left panel compares the wage distribution in the 2nd quarter of 2014, when the Ordinance was passed, with the wage distribution in the 2nd quarter of 2015 (i.e. one year later), to demonstrate the effect of the $11 minimum wage, which went in effect on April 1, 2015; while the right panel compares the wage distribution in the 2nd quarter of 2015 to the 2nd quarter of 2016 to demonstrate the effect of the $13 minimum wage, which went in effect on January 1, 2016. Panel 3a plots the wage distribution among the exposed employers (i.e. those with the positive cost of compliance with the minimum wage). It clearly shows that hours worked in jobs paying below the new minimum wage declined dramatically, indicating employers' compliance with the minimum wage law. Furthermore, we can see large visible peaks in the wage distribution exactly at the level of the minimum wage schedules. We take this as the evidence of the quality of the data.[28] Panel 3b shows the wage distribution among the employers with the zero cost of compliance with the minimum wage. Just as expected, the wage distribution at those employers remains the same after the minimum wage hike, with some minor changes in wages most likely driven by inflation. This simple comparison reassures us that our identification strategy is relying on the changes in the wage distribution caused by the minimum wage increase.

Following the simple analysis of the wage distribution, we study the effect of the minimum wage on average hourly wage rates paid by a firm, estimated using the specification (3.2). We

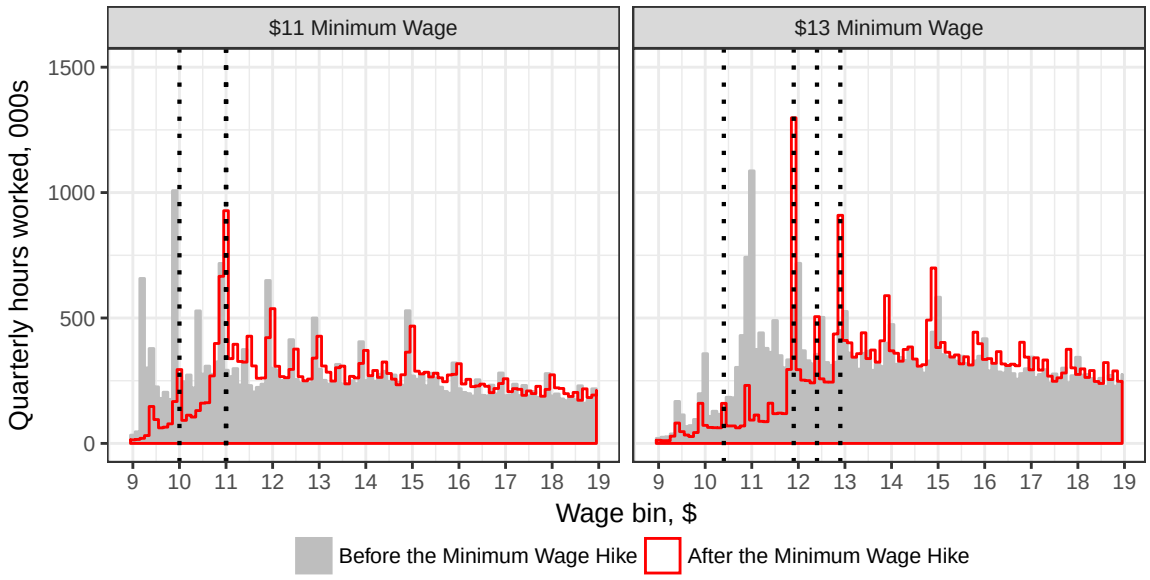
the $13 minimum wage. We change the regression specification to include an additional interaction term: $\Delta y_{ict} = \alpha_t\, GAP_{ic} + \beta_0\, \Delta w_{ict}\, T_{ic}\, \mathbb{1}(t<0) + \beta_1\, \Delta w_{ict}\, T_{ic}\, \mathbb{1}(t \geq 0) + \gamma_t X_{ic} + \theta_{jtq} + \mu_i + \varepsilon_{ict}$.

[27] In addition, we also provide the estimates of an IV specification in which we instrument GAP in the current cohort with the GAP in the previous cohort to ensure that our results are not driven by the mean reversion.

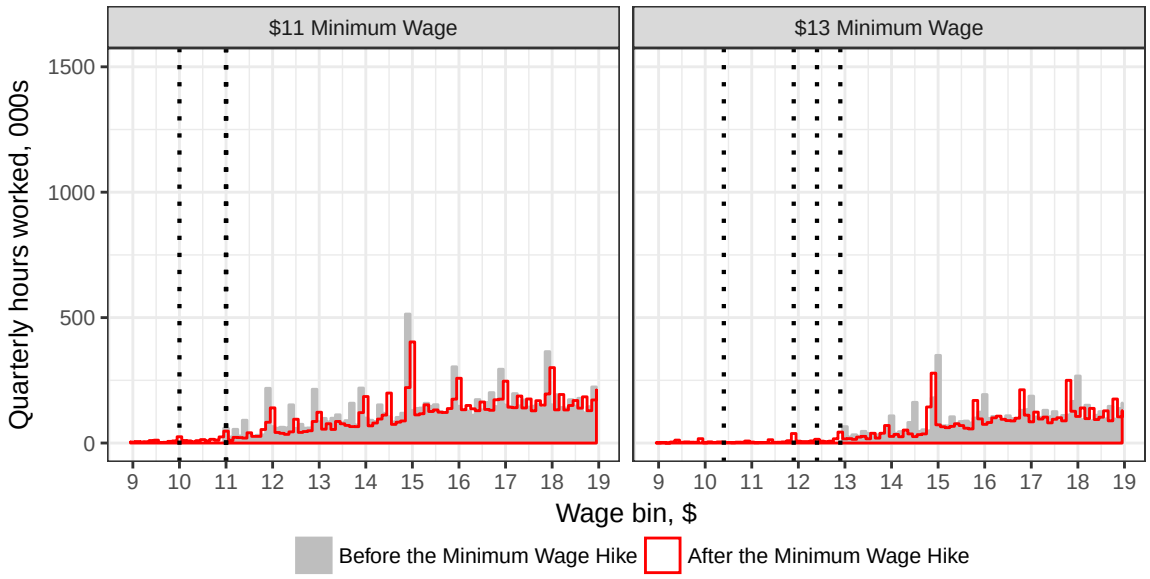
[28] The figure shows some jobs paying below the minimum wage. Some of this observations likely correspond to trainees, teenage workers, and workers with disability who are required to be paid at least 85% of the minimum wage. In addition, some of these observations occur due to the measurement error in hours worked.

Figure 3. Wage distribution in Seattle before and after the minimum wage hikes.

(a) Employers with positive cost of compliance with the minimum wage.



(b) Employers with zero cost of compliance with the minimum wage.



Source: UI records from WA, 2006-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. Left panel ($11 Minimum Wage) shows the change in the wage distribution between 2014.2 and 2015.2. Right panel ($13 Minimum Wage) shows the change in the wage distribution between 2015.2 and 2016.2. Wages have been adjusted for inflation using CPI-W. Dotted lines show the minimum wage schedules.

define an hourly wage rate as an average hourly compensation paid to an hour of work by the firm i, calculated as the quarterly wagebill divided by the quarterly hours worked. Table 4 shows our estimates. Over the six quarters surrounding the minimum wage increase to \$11 where the ordinance went into effect at $t = 0$, firms increased their average wage exactly when the policy was implemented. The coefficients before $t = 0$ are significantly different from zero, but are negative in sign. This implies no anticipatory effect of the minimum wage, but points out at the auto-correlation in wage changes. Moreover, the auto-correlation is stronger if we do not include the firm fixed effects in the regression, as shown by columns 2 and 4. This suggests that we should prefer the specification with the firm effects, and interpret the results of the IV specification with caution. Guided by these results, we will report the results of the OLS and IV specifications which include the firm fixed effects in the remainder of the paper.

During the phase-in of the \$13 minimum wage, we see the wage increases which begin before $t = 0$, but much larger coefficients in the quarters following the second wage hike. This is expected, because periods $t = -2$ and $t = -1$ correspond to the period when the \$11 minimum wage was already implemented. Finally, the coefficients in table 4 (columns 1 and 5, Panel B) are significantly different from zero, with F-statistics of 284 and 302 for the \$11 and the \$13 minimum wage respectively, which demonstrated that the cost of compliance is a strong predictor of the wage growth.

Next, we perform a falsification test to demonstrate that our results are unlikely to be driven by changes in Seattle's economy which occurred at the same time as the minimum wage hike. We run the falsification test by re-estimating the model using the 2012 cohort as a placebo experiment, and we see no effect of pseudo "minimum wage" on the average wage rate, as shown in the table 4 (columns 3-4 and 7-8). The estimates of the specification without the firm fixed effects demonstrate further auto-correlation in the falsification test, and suggest that we should focus on the regression specification which includes the firm fixed effects.

Appendix table 15 presents the effect of the minimum wage on total wagebill using the same specifications. The results show very similar patterns as the effect of the minimum wage on the average wage. The estimates demonstrate that there was no anticipatory effect before the minimum wage went in effect, and that our regression specifications pass the falsification test. However, just like in the case of the effect of the minimum wage on wages, we see auto-correlation in wagebill, which is stronger if we do not include firm fixed effects in our regressions.

Finally, we see that the magnitude of the effect on wagebill was commensurate with the magnitude of the effect on wages. In 2015, a one percentage point increase in the cost of compliance led to a 0.85 percentage point additional growth in average wages, and to a 0.79 percentage point additional growth in wagebill. In 2016, a one percentage point increase in the cost of compliance led to a 0.79 percentage point additional growth in average wages, and to a 0.86 percentage point additional growth in wage bill. These number suggest that employers generally saw the increase in the wage bill just as large as the increase in wages.

Table 4. Effect of the minimum wage on average wages.

Variable	Dependent variable: % Change in Mean wagerate							
	(1) $11 Min Wage Treatment	(2) $11 Min Wage Treatment	(3) $11 Min Wage Placebo	(4) $11 Min Wage Placebo	(5) $13 Min Wage Treatment	(6) $13 Min Wage Treatment	(7) $13 Min Wage Placebo	(8) $13 Min Wage Placebo
Panel A: Timing of the Effect								
GAP $\times$ $t = -3$	-0.35^{***}	-0.53^{***}	0.076	-0.12^{**}				
	(0.078)	(0.046)	(0.13)	(0.061)				
GAP $\times$ $t = -2$	-0.19^{**}	-0.37^{***}	0.081	-0.12^{***}	0.27^{***}	-0.095^{**}	0.03	-0.042
	(0.079)	(0.045)	(0.12)	(0.04)	(0.063)	(0.04)	(0.062)	(0.03)
GAP $\times$ $t = -1$	-0.062	-0.24^{***}	0.071	-0.13^{***}	0.17^{***}	-0.2^{***}	0.038	-0.034^{**}
	(0.071)	(0.026)	(0.11)	(0.036)	(0.063)	(0.049)	(0.056)	(0.015)
GAP $\times$ $t = 0$	0.66^{***}	0.48^{***}	0.098	-0.1^{***}	0.72^{***}	0.36^{***}	0.035	-0.036^{***}
	(0.084)	(0.019)	(0.1)	(0.019)	(0.051)	(0.02)	(0.051)	(0.013)
GAP $\times$ $t = 1$	0.83^{***}	0.65^{***}	0.14	-0.059^{**}	0.8^{***}	0.44^{***}	0.052	-0.02^{*}
	(0.07)	(0.015)	(0.11)	(0.026)	(0.043)	(0.018)	(0.044)	(0.011)
GAP $\times$ $t = 2$	0.91^{***}	0.73^{***}	0.23^{**}	0.027	0.86^{***}	0.49^{***}	0.082^{*}	0.011
	(0.057)	(0.029)	(0.094)	(0.038)	(0.046)	(0.015)	(0.048)	(0.01)
Obs	272,933	272,933	202,511	202,511	231,245	231,245	171,690	171,690
R^2	0.24	0.057	0.27	0.055	0.23	0.047	0.25	0.049
F-stat.	318	458	2.86	21.95	105	426	4.33	9.05
P-value	0	0	0.11	0	0	0	0.05	0.01
Panel B: Average Effect								
GAP $\times$ $t < 0$					0.22^{***}	-0.14^{***}	0.034	-0.038^{*}
					(0.054)	(0.03)	(0.058)	(0.019)
GAP $\times$ $t \geq 0$	0.85^{***}	0.68^{***}	0.13^{*}	-0.023	0.79^{***}	0.43^{***}	0.056	-0.015
	(0.051)	(0.012)	(0.068)	(0.023)	(0.046)	(0.016)	(0.048)	(0.011)
Obs	272,933	272,933	202,511	202,511	231,245	231,245	171,690	171,690
R^2	0.24	0.056	0.27	0.055	0.23	0.047	0.25	0.049
F-stat.	284	3,250	3.68	0.94	302	702	1.39	2.03
P-value	0	0	0.1	0.37	0	0	0.28	0.2
Year Quarter NAICS 4 FE	X	X	X	X	X	X	X	X
Firm FE	X		X		X		X	

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$. Standard errors clustered at the industry (NAICS 3 digit level) and cohort level in parentheses. Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and with average wagerate between $9 and $100 (in constant 2015 Q2 prices). All regressions include controls for firm size at baseline and firm age. Treatment corresponds to the treated cohort (2014 or 2015 depending on the phase), Placebo corresponds to the 2012 cohort used as placebo experiment. F-statistics and p-value shown for two-sided joint test of coefficients at GAP $\times$ Treatment equal to zero. GAP measures percentage increase in total wagebill required to meet the new minimum wage, assuming jobs and hours remain the same.

Though the cost of compliance of 1% was associated with a 0.79–0.85 percentage point increase in average wage rate after each minimum wage step-up, only a fraction of wage growth in exposed firms can be explained by the minimum wage hikes. In particular, from the 2nd quarter of 2014 to the 4th quarter of 2015 exposed firms saw a growth in average wage rates of 7.7%, out of which only 1.63 percentage points (= 0.85 $\times$ 1.92), or 21%, were driven by the minimum wage. This result suggests that Seattle's economy would have shown a significant wage growth even if the minimum wage was not implemented. The overall impact of Seattle's minimum wage on average wages paid by the exposed firms was larger in 2016. Between the 2nd quarter of 2015 and the 3rd quarter of 2016 average wage rates in the exposed firms have grown by 5.6%, out of which 2.6 percentage points (= 0.79 $\times$ 3.29), or 46%, can be explained by the minimum wage hike.

5 The Incidence of the Minimum Wage

Having established that our empirical strategy works as desired, we now turn to the estimation of the incidence of the minimum wage. The minimum wage increases labor costs for employers and lowers their profits if employers make no adjustment to reduce its incidence. Under the no adjustment scenario, a one percentage point increase in the average wages would lead to the reduction in profits proportional to the share of wagebill in total revenue:

$$\varepsilon_{\text{Profit}}(\text{No Adjustment}) = \frac{\%\Delta\Pi^{\text{No Adj}}}{\%\Delta w} = -\frac{s}{\pi}, \tag{5.1}$$

where Π denotes the firm's profit, π denotes the profit margin, or profit over revenue, s denotes the share of wagebill in revenue, and w denotes the average wage rate paid by a firm.

Since firms maximize profit, we would expect the observed reduction in profit to be lower in magnitude than the expression in the equation (5.1). the observed reduction in profit will be determined by the extent to which firms can pass the minimum wage increase to prices, and reallocate the factors of production to reduce labor costs. We can write the observed profit reduction as follows:

$$\varepsilon_{\text{Profit}}(\text{Observed}) = \frac{\%\Delta\Pi^{\text{Obs}}}{\%\Delta w} =$$
$$-\frac{1}{\pi}\Big(\varepsilon_{\text{Revenue}} - s\,\varepsilon_{\text{Wagebill}} - (1-s-\pi)\,\varepsilon_{\text{Non-labor costs}}\Big). \tag{5.2}$$

By comparing expressions (5.1) and (5.2), we can obtain the share of the incidence borne by employers, relative to the case of no adjustment, which we denote with ψ:

$$\psi = \frac{\varepsilon_{\text{Profit}}(\text{Observed})}{\varepsilon_{\text{Profit}}(\text{No Adjustment})} =$$
$$\frac{1}{s}\Big(\varepsilon_{\text{Revenue}} - s\,\varepsilon_{\text{Wagebill}} - (1-s-\pi)\,\varepsilon_{\text{Non-labor costs}}\Big). \tag{5.3}$$

We can estimate ψ using the data on revenue, payroll, and wages. The only component of the incidence which we do not observe in our data are the non-labor costs, as well as changes in these costs in response to the minimum wage. Therefore, we will report the estimates for the incidence borne by employers without taking non-labor costs into account, or $\hat{\psi} = \hat{\varepsilon}_{\text{Revenue}}/s - \hat{\varepsilon}_{\text{Wagebill}}$.[29] We can interpret our estimate as the lower bound of the incidence borne by employers.[30]

Table 5 provides the estimates of the effect of the minimum wage on wagebill and revenue. The estimates suggest that after both minimum wage phase-ins the wagebill increased by almost as much or slightly more than the average wages. The OLS estimates show that after the implementation of the $11 minimum wage the wagebill has increased by 0.79 and 0.69 percentage points per one percentage point increase in GAP, while the wage has increased by 0.85 and 0.68 percentage points respectively. Similarly, the OLS estimates show that after the implementation of the $13 minimum wage the wagebill increased by 0.85 and 0.38 percentage points depending on the specification, compared to 0.79 and 0.43 percentage point increases in wage respectively. The IV estimates of the effect of the $11 minimum wage suggest a somewhat smaller increase in wagebill of 0.57 and 0.51 percentage points per one percentage point increase in wages. The IV estimates of the effect of the $13 minimum wage vary significantly depending on whether we include or do not include firm fixed effects in our regressions, though both estimates are quite imprecise. The specification with the firm fixed effects shows a 2 percentage point increase in wagebill per one percentage point increase in wages, while the specification without the firm fixed effects shows a 0.55 percentage point increase in wagebill. Given that first estimate cannot reject an effect of 1.1, and the second estimate cannot reject an effect of 0.9 at the 95% confidence level, and taken together with the OLS estimates, we conclude that employers saw increases to the wagebill of about the same size or somewhat larger than the increases in wages.

Next, our estimates show that employers experienced small, if any, increases in revenue after the implementation of the $11 minimum wage, and large and significant increases in revenue following the implementation of the $13 minimum wage. Both the OLS and the IV estimates of the revenue change after the minimum wage hike to $11 are not statistically different from zero, and point estimates are in the range of 0.02-0.12 percentage point increase in revenue per one percentage point increase in wages. In contrast, both the OLS and the IV specifications which include firm fixed effects suggest that the $13 minimum wage led to a 0.3-0.4 percentage point increase in revenue per one percentage point increase in wage. The regressions specification without the firm

[29] Note that in the IV regression specification all coefficients have been already normalized by the increase in average wages, and thus the share of the incidence borne by employers can be estimates by plugging the elasticities into the expression. However, in the OLS regression we need to obtain elasticity with respect to change in wages first by dividing the effect of GAP on revenue by the effect of GAP on average wages, and similarly by dividing the effect of GAP on wagebill by the effect of GAP on wagebill.

[30] The few papers which provide the direct estimates of the changes in non-labor cost in response to the minimum wage find that there is no effect of the minimum wage on such expenditures as materials or capital (Giuliano, 2013; Brummund, 2017). On the other hand, the estimated effect of the minimum wage on automation suggests that expenditure on capital might increase in the long-run at least to some extent (Lordan and Neumark, 2017).

Table 5. Effect of the minimum wage on revenue and wagebill.

	(1) All industries OLS	(2) All industries OLS	(3) All industries IV	(4) All industries IV
Panel A: $11 Minimum Wage				
Dependent variable: $\%\Delta$Wagebill				
GAP$\times\ t \geq 0$	0.79^{***}	0.69^{***}		
	(0.19)	(0.26)		
$\%\Delta$Mean Wagerate$\times\ t \geq 0$			0.57^{***}	0.51^{***}
			(0.14)	(0.19)
Dependent variable: $\%\Delta$Revenue				
GAP$\times\ t \geq 0$	0.027	0.086		
	(0.082)	(0.07)		
$\%\Delta$Mean Wagerate$\times\ t \geq 0$			0.019	0.063
			(0.037)	(0.048)
Obs	272,933	272,933	272,933	272,933
Panel B: $13 Minimum Wage				
Depenedent variable: $\%\Delta$Wagebill				
GAP$\times\ t < 0$	0.33^{***}	-0.15^{***}		
	(0.09)	(0.049)		
GAP$\times\ t \geq 0$	0.86^{***}	0.38^{***}		
	(0.12)	(0.12)		
$\%\Delta$Mean Wagerate$\times\ t < 0$			3.3^{***}	-0.088
			(0.75)	(0.31)
$\%\Delta$Mean Wagerate$\times\ t \geq 0$			2.00^{***}	0.55^{**}
			(0.34)	(0.22)
Dependent variable: $\%\Delta$Revenue				
GAP$\times\ t < 0$	0.039	-0.16^{***}		
	(0.067)	(0.033)		
GAP$\times\ t \geq 0$	0.21^{**}	0.0082		
	(0.082)	(0.058)		
$\%\Delta$Mean Wagerate$\times\ t < 0$			0.6	-0.66
			(0.44)	
$\%\Delta$Mean Wagerate$\times\ t \geq 0$			0.44^{**}	-0.093^{**}
			(0.19)	(0.041)
Obs	231,245	231,245	231,245	231,245
Year Quarter NAICS 4 FE	X	X	X	X
Firm FE	X		X	

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$. Clustered standard errors in parentheses. Standard errors are clustered by the industry (NAICS 3 digit Sector) and cohort. Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. All regressions include controls for firm size at baseline and firm age. Change in wage rate in treated cohort is instrumented by GAP times an indicator for treated period. GAP measures percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

fixed effects, however, suggest a smaller effect of 0.02 to -0.1 per one percentage point increase in wage. Based on this evidence, we conclude that employers likely passed the minimum wage increase to consumers during the second minimum wage phase-in to $13/hour, but not during the first minimum wage phase-in to $11.

Appendix table 16 shows that our conclusions remain the same if we use alternative regressions specifications. First, we re-estimate the effect of the minimum wage on wagebill and revenue using the lower bound for GAP instead of the upper bound. In our baseline specifications, we have calculated the cost of compliance for all employers based on the $11/hour during the first phase-in period, and based on the $13/hour during the second phase-in period. As we discussed in the section 2, the ordinance allowed employers with 500 or fewer employees and employers who provided health benefits to pay less to their workers.[31] Columns 3 and 4, and 8 and 9 of the table 16 present our estimates based on the cost of compliance which use schedules for employers which provide health benefits. Consistent with our baseline results, these estimates show increases in wagebill comparable to increases in wages, no effect of the $11 minimum wage on revenue, and a strong positive effect of the $13 minimum wage effect on revenue.

The second sensitivity check which we perform concerns auto-correlation in the main outcomes. As we discussed in section 4 both wage rates and wagebill show signs of auto-correlation within cohort due to the mean reversion. Columns 5 and 10 of the table 16 present our estimates of the IV regression where the GAP in the current cohort has been instrumented with the GAP in the previous cohort. This specification shows that all of our main conclusions remain the same, albeit the magnitudes of the effects change somewhat. Therefore, our main results are unlikely to be driven by the mean reversion due to the measurement error.

What do these estimates imply about the incidence of the minimum wage on employers? Using the logic from the equation (5.3), we estimate the share of the incidence borne by employers. Table 6 presents the results of this exercise. The estimates demonstrate that employers were able to substantially reduce the incidence of the minimum wage during both minimum wage phase-in periods. However, employers in Seattle bore a large fraction of the minimum wage incidence of the minimum wage hike to $11/hour compared to the minimum wage hike to $13/hour. The OLS estimates suggest that employers bore 60-80% of the incidence of $11 minimum wage, while the IV estimates suggest that employers bore 30-50% of the incidence. The difference stems from the fact that the OLS estimates produce higher increases in wagebill than the IV estimates, while both specifications agree in small to negligible effects on revenue. The estimates of the incidence of the $13 minimum wage vary across specifications as well. The OLS specification with the firm fixed effects suggests that employer bore as little as 26% of the incidence, while the other regression specifications yield more conservative estimates in the range of 60-80%.

[31] The ordinance also introduced a tip credit for tipped workers, but mandated that the average hourly pay including tips is higher than the minimum wage imposed on small employers. Employers are required to report tips as part of the workers' earnings for the unemployment insurance purposes, so we should observe these workers being paid the minimum wage imposed on small employers whose employees do not receive tips.

Table 6. The incidence of the minimum wage.

	(1) All industries OLS	(2) All industries OLS	(3) All industries IV	(4) All industries IV
Panel A: $11 Minimum Wage				
$\hat{\varepsilon}_{\text{Wagebill}}$	0.93	1.01	0.57	0.51
$\hat{\varepsilon}_{\text{Revenue}}$	0.03	0.13	0.02	0.06
Observed incidence	−0.27	−0.20	−0.16	−0.10
Incidence under no adjustment	−0.32	−0.32	−0.32	−0.32
Share of incidence borne by employers	0.83	0.62	0.51	0.31
Panel B: $13 Minimum Wage				
$\varepsilon_{\text{Wagebill}}$	1.09	0.88	2.00	0.55
$\varepsilon_{\text{Revenue}}$	0.27	0.02	0.44	−0.09
Observed incidence	−0.08	−0.26	−0.20	−0.27
Incidence under no adjustment	−0.32	−0.32	−0.32	−0.32
Share of incidence borne by employers	0.26	0.82	0.63	0.84
Year Quarter NAICS 4 FE	X	X	X	X
Firm FE	X		X	

Notes: Observed incidence is calculated as $\hat{\varepsilon}_{\text{Revenue}} - s\,\hat{\varepsilon}_{\text{Wagebill}}$, where s is the average share of wagebill in revenue. Observed incidence does not take into account changes in non-labor costs, which are not available in the data. Incidence under no adjustment is taken to equal $-s$. Incidence reported per 1% increase in average wages. See text for details.

Taking the average of our estimates based on the models with the firm fixed effects, these results suggest that employers passed to consumers and.or employees 33% and 55% of the incidence of the \$11 and the \$13 minimum wage respectively. In the next two sections of the paper, we examine the channels of adjustment to the minimum wage in greater detail. First, we consider product market adjustment, which led to increases in revenue. Second, we turn to the labor market adjustment and examine if employers sought to optimize the workforce composition in response to the minimum wage increases.

6 Product Market Adjustment

In the previous section, we have shown that employers bore 67% of the minimum wage incidence after the hike to \$11/hour, and 45% of the minimum wage incidence after the hike to \$13/hour. Furthermore, we have demonstrated that the difference in magnitudes of this effects stems from the fact that employers experienced much larger increases in revenue in 2016, when the minimum wage went up to \$13/hour, compared to 2015, when the minimum wage went up to \$11/hour. In this section, we examine changes in the firm revenues in detail.

By definition revenue equals prices times quantity of the output produced, so the observed change in revenue has to be explained either by changes in prices or quantity of the good sold, or both. We can think of the single-location businesses in Seattle as small firms selling heterogeneous goods and operating on monopolistically competitive market, similarly to the set-up in Aaronson and French (2007) and Draca, Machin, and Van Reenen (2011). Without the loss of generality, the quantity of the good each firm can sell is determined by the consumer demand $q_i = g(p_i/P_j, P_j)$, where p_i is the price charged by firm i, P_j is the overall price level in industry j, q_i is the quantity of the good sold by the firm i, and $g(\cdot)$ is non-increasing in both arguments (i.e. $g_1 \leq 0$, $g_2 \leq 0$).[32] Then, the effect of the minimum wage on revenue can be written as follows:

$$\varepsilon_{\text{Revenue}} = \frac{\%\Delta R}{\%\Delta w} = (1-\eta)\varepsilon_p + (\eta - \rho)\varepsilon_P, \tag{6.1}$$

where $\eta > 0$ is the absolute value of the consumer demand elasticity with respect to own price, ρ is the absolute value of the consumer demand elasticity with respect to the market price, ε_p is the elasticity of own price with respect to average wage paid by the firm, and ε_P is the effect of the wage increase on the market price. We expect consumers to be more sensitive to the price of a particular firm rather than the price in the whole industry, so $\eta > \rho$.

Equation (6.1) shows that firm's revenue can both increase or decrease following the minimum wage hike. If the consumer demand is elastic, i.e. $\eta > 1$, we would expect to see moderate

[32]Note that in the general equilibrium firm revenues can also increase because the consumer demand is shifting upwards as a result of income and population growth, as well as because the earnings of the minimum wage workers are increasing. However, in this paper we do not have to consider these effects because we are comparing revenue of exposed employers to the revenue of non-exposed employers. As a result, our identification strategy should difference out any changes which are affecting all firms in the market.

decreases in revenue and large decreases in output if firms increase prices after the minimum wage hike. However, if the consumer demand is uni-elastic or inelastic, i.e. $\eta \leq 1$, raising prices will lead to increases in revenue. Moreover, if most firms in the industry are raising prices as well, the relative price of firm i will increase by less, and decline in consumer demand will be smaller.

Previous studies have documented that employers often pass the minimum wage increase to prices. For instance, Aaronson et al. (2008) and Allegretto and Reich (2016) have found that a 10% increase in the minimum wage leads to increases of restaurant prices in the range of 0.5–0.7%. In our data, we do not observe prices directly, but we examine three pieces of evidence which suggest thet the increases in revenue observed after the implementation of the $13 minimum wage have to be driven by the pass-through of the minimum wage to prices.

Table 7. Effect of the minimum wage on revenue, hours worked, and revenue labor productivity.

Dependent Variable	(1) All industries OLS	(2) All industries OLS	(3) All industries IV	(4) All industries IV
	Panel A: $11 Minimum Wage			
%ΔRevenue	0.027	0.086	0.019	0.063
	(0.082)	(0.07)	(0.037)	(0.048)
%ΔHours	−0.044	0.021	−0.031	0.015
	(0.2)	(0.26)	(0.13)	(0.18)
%ΔRevenue per hour	0.093	0.11	0.067	0.082
	(0.17)	(0.2)	(0.11)	(0.14)
Obs	272,933	272,933	272,933	272,933
	Panel B: $13 Minimum Wage			
%ΔRevenue	0.21**	0.0082	0.44**	−0.093**
	(0.082)	(0.058)	(0.19)	(0.041)
%ΔHours	0.11	−0.027	0.34	−0.048
	(0.089)	(0.11)	(0.22)	(0.21)
%ΔRevenue per hour	0.077	−0.011	0.046	−0.15
	(0.061)	(0.081)	(0.13)	(0.16)
Obs	231,245	231,245	231,245	231,245
Year Quarter NAICS 4 FE	X	X	X	X
Firm FE	X		X	

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$. Clustered standard errors in parentheses. Standard errors are clustered by the industry (NAICS 3 digit Sector) and cohort. Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. All regressions include controls for firm size at baseline and firm age. Coefficient at $GAP \times t \geq 0$ or $\%\Delta Wagerate \times t \geq 0$ reported. Change in wage rate in treated cohort is instrumented by GAP times an indicator for treated period. GAP measures percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

First, we decompose changes in revenue into changes in hours worked and changes in revenue

per hour. If employers are increasing prices, we would expect the effect of the minimum wage on revenue per hour to be positive. At the same time, the effect of the minimum wage on hours worked is theoretically ambiguous, because own price increase will have a negative effect on hours, but the overall price increase will make the relative price increase smaller and dampen the effect of the own price increase. Table 7 shows our estimates. All regression specifications show that the minimum wage hike to $11 had a positive effect on revenue per hour, though the coefficients are estimated imprecisely and are not statistically different from zero. The evidence on the effect of the $13 minimum wage on revenue per hour is more mixed. The regression specifications with the firm fixed effects suggest that the $13 minimum wage increased revenue per hour, while the regression specifications without the firm fixed effect yield negative, but statistically insignificant coefficients. Moreover, regression specifications with the firm fixed effects also yield positive, albeit statistically insignificant effect of the minimum wage on hour worked, suggesting that prices might have gone up overall as well. Taken together, these results do not not provide a clear indication of the price increases in response to the minimum wage, but suggest that price increases are consistent with the observed changes in revenue.

Second, we estimate the impact of the minimum wage on prices directly for a small subset of employers for whom prices were collected. We have collected primary data on prices for a small sample of restaurants, retailers, and service businesses in Seattle. The data were collected by foot and by scraping prices for restaurants from the delivery web-service GrubHub.com. For each business, one item was picked for on-foot price collection, and 10 items were scraped from the on-line menus. The data collection started in the 2nd quarter of 2015, when the minimum wage went up to $11/hour, and continued until the 2nd quarter of 2016. Because of the timing of the data collection, we have information on the price changes in response to the $13 minimum wage, but not to the $11 minimum wage. After merging the data on prices to our main analysis sample, we have 45 employers for whom we observe prices, wages, and revenue. Due to the set-up of the price data collection, we observe initial prices for these businesses in the 2nd quarter of 2015, and post-treatment prices in the 1st and 2nd quarter of 2016. Appendix table 17 presents the results of a simple OLS regression, where the dependent variables are changes in prices and wages, and the independent variable is the cost of compliance interacted with the time period. Due to the small number of observations we do not include any other controls in this regression. Because multiple item prices were collected from GrubHub.com, we have calculated a simple average of the price change across items for such businesses, and ran two regression specifications – column 1 of table 17 shows the results of an unweighted specification, while column 2 of table 17 shows the results of the specification weighted with the number of items. Despite the small number of observations, all specifications demonstrate strong correlation between the cost of compliance and the growth in average wage rate. Next, both regressions show that employers with higher cost of compliance saw higher price increases in the 2nd quarter of 2016, although the estimates are not statically significant. However, the effect of the cost of compliance on the price increase in the 1st quarter of 2016 was more mixed – while the unweighted regression specification found a positive

correlation, the weighted regression specification found a negative correlation, with both estimates not statistically different from zero.

Finally, using a different dataset than ours Romich, Allard, Althauser, Buszkiewicz, and Obara (2017) found that price increase was the most popular strategy of adjustment to the minimum wage hike in Seattle. Romich, Allard, Althauser, Buszkiewicz, and Obara (2017) conducted a survey of Seattle employers based on stratified random sample of businesses which hold a Seattle business license. The collected data contain information on more than 500 Seattle employers between 2015 and 2017. In the survey, employers were asked what measures they are taking to adjust to Seattle's minimum wage, including questions on price and headcount adjustments, health benefits provision, and relocation outside of the City of Seattle. Romich, Allard, Althauser, Buszkiewicz, and Obara (2017) found that more than half of employers (55.6%) increased prices or fees in 2016 to cope with the increases in labor costs. Price increase was by far the most often cited adjustment strategy, with reductions in hours or headcount being the second most popular strategy, used by 23.6% of the survey responders.

Overall, this indirect evidence suggests that the observed revenue increases in response to the minimum wage are consistent with the price pass-through, though our data does not allow us to estimate its prevalence or magnitude.

7 Labor Market Adjustment

We have shown previously that employers were able to avoid a large fraction of the minimum wage incidence through a combination of the product market and labor market adjustment. We first examined the product market adjustment in detail, and suggested that the observed revenue increases are likely driven by the pass-through of the minimum wage to prices. In this section we turn to the labor market adjustment to the minimum wage, and investigate how the minimum wage has affected hours worked, workforce composition, and within-firm wage distribution.

We start by examining the effect of the minimum wage on hours worked. The minimum wage makes an hour of work for low-wage jobs more expensive to employers, and thus we would expect the effects of the ordinance to be especially pronounced in the low-wage labor market segment. To understand the effects of the minimum wage on low-wage jobs, we decompose the growth in total hours worked into the growth due to changes in low-wage and high-wage jobs. To do so, we write down the expression for growth in total hours between periods t_0 and t, denoted by $NEG_{t_0,t}$, in terms of the contribution of low-paying jobs and high-paying jobs:

$$NEG_{t_0,t} = \frac{h_t - h_{t_0}}{0.5(h_t + h_{t_0})} = \underbrace{\frac{h_t(w_t < \bar{w}) - h_{t_0}(w_{t_0} < \bar{w})}{0.5(h_t + h_{t_0})}}_{\text{Contribution of jobs paying } < \bar{w}} + \underbrace{\frac{h_t(w_t \geq \bar{w}) - h_{t_0}(w_{t_0} \geq \bar{w})}{0.5(h_t + h_{t_0})}}_{\text{Contribution of jobs paying } \geq \bar{w}}, \quad (7.1)$$

where h_t denotes hours worked in all jobs in period t, and $h_t(w_t < \bar{w})$ denotes hours worked in period t in jobs paying less than $\bar{w}$ in period t.

Table 8. Labor market adjustment to the minimum wage:
changes in hours of low-wage vs. high-wage jobs.

Dependent Variable	(1)	(2)	(3)	(4)
	Hours		Hours	
	$11 Min Wage		$13 Min Wage	
	OLS	IV	OLS	IV
All jobs	-0.044	-0.031	0.11	0.34
	(0.2)	(0.13)	(0.089)	(0.22)
Growth in hours due to changes in hours of:				
Jobs paying <105% of MW	-2.00^{***}	-1.4^{***}	-1.00^{***}	-2.2^{***}
	(0.21)	(0.11)	(0.11)	(0.28)
Jobs paying <110% of MW	-1.4^{***}	-1.00^{***}	-0.69^{***}	-1.5^{***}
	(0.19)	(0.11)	(0.1)	(0.24)
Jobs paying <115% of MW	-1.1^{***}	-0.8^{***}	-0.46^{***}	-1.00^{***}
	(0.19)	(0.12)	(0.11)	(0.24)
Jobs paying <120% of MW	-0.74^{***}	-0.53^{***}	-0.36^{***}	-0.74^{***}
	(0.18)	(0.12)	(0.092)	(0.21)
Jobs paying <150% of MW	-0.26	-0.19	-0.19^{**}	-0.35^{*}
	(0.19)	(0.12)	(0.083)	(0.19)
Growth in hours due to changes in hours of:				
Jobs paying ≥105% of MW	1.9^{***}	1.4^{***}	1.1^{***}	2.6^{***}
	(0.1)	(0.019)	(0.087)	(0.29)
Jobs paying ≥110% of MW	1.4^{***}	0.97^{***}	0.8^{***}	1.8^{***}
	(0.076)	(0.04)	(0.074)	(0.23)
Jobs paying ≥115% of MW	1.1^{***}	0.77^{***}	0.56^{***}	1.4^{***}
	(0.068)	(0.039)	(0.077)	(0.21)
Jobs paying ≥120% of MW	0.7^{***}	0.5^{***}	0.47^{***}	1.1^{***}
	(0.049)	(0.023)	(0.067)	(0.18)
Jobs paying ≥150% of MW	0.22^{***}	0.15^{***}	0.29^{***}	0.69^{***}
	(0.055)	(0.036)	(0.049)	(0.14)
Obs	272,933	272,933	231,245	231,245
Year Quarter NAICS 4 FE	X	X	X	X
Firm FE	X	X	X	X

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$. Clustered standard errors in parentheses. Standard errors are clustered by the industry (NAICS 3 digit Sector) and cohort. Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. All regressions include controls for firm size at baseline and firm age. Coefficient at $GAP \times t \geq 0$ or $\%\Delta Wagerate \times t \geq 0$ reported. Change in wage rate in treated cohort is instrumented by GAP times an indicator for treated period. GAP measures percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

In our empirical application, we experiment with different levels of $\bar{w}$ to define the low-wage labor market segment. We report estimates for $\bar{w}$ equal to 105%, 110%, 115%, 120%, and 150% of the minimum wage.[33] Table 8 presents our results.[34] First, both minimum wage phase-in periods had no impact on total hours worked, as the coefficient for the effect of the wages on total hours worked is not statistically different from zero. As we discussed in the previous section, this result suggests that employers on average are facing inelastic or uni-elastic consumer demand, and thus price changes due to the minimum wage did not result in a detectable scale effect.

Second, we find large and significant reallocation of hours worked from low-wage jobs to high-wage jobs in response to both minimum wage hikes. We see the most pronounced declines in hours worked at wage rates close to the minimum wage level. After both of the minimum wage hikes, the largest decreases in hours worked occurred in jobs paying less than 105% of the minimum wage, and the magnitude of the effect went down as the wage threshold used to classify low-wage and high-wage jobs increased. However, there still was a negative effect on hours worked in jobs paying less than 150% of the minimum wage. The magnitudes of the effect were similar during the the first and the second phase-in period, though the effect of the $11 minimum wage was imprecisely estimated and not statistically different from zero. Appendix table 16 shows the results of the robustness exercises for the same outcomes. As before, we first used the lower bound for GAP as intensity of the treatment instead of the upper bound for GAP, and second we instrumented the GAP with the lagged GAP to ensure that mean-reversion is not driving our results. The robustness exercises largely yield the same results as the baseline specifications. First, we see declines in low-wage jobs and increases in high-wage jobs. Second, we see larger declines in the low-wage jobs which pay closer to the minimum wage as opposed to the low-wage jobs which pay much more than the minimum wage. For the $11 minimum wage, the magnitude of the effect in the robustness exercises is very close to the magnitude of the effect in the baseline specification as well. However, for the $13 minimum wage, both robustness exercises estimate a somewhat smaller and less precisely estimated effect than the baseline specification, though the qualitative conclusions remain the same.

As we increase the wage threshold, the declines in the low-wage jobs become smaller in magnitude. This phenomenon can arise for two reasons. First, if there are ripple effects of the minimum wage on higher-paying jobs, which have been previously documented in Neumark, Schweitzer, and Wascher (2004), the declines in low-wage jobs would occur because employers are raising wages of those workers, rather than due to declines in labor demand. Second, low-wage jobs are likely held by lower-skilled or less experienced workers. It mighte be easier for a business to substitute or

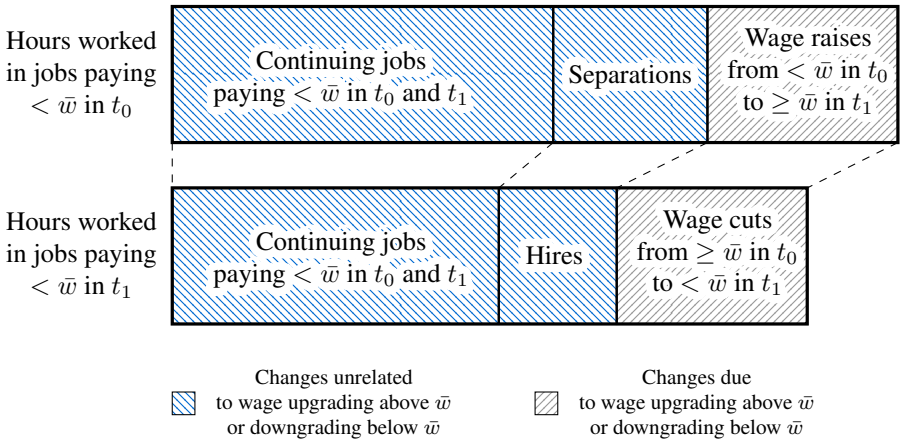
[33] For the first phase-in period, these thresholds correspond to the wage rates of $11.55, $12.10, $12.65, $13.20, and $16.50. For the second phase-in period, these thresholds correspond to the wage rates of $13.65, $14.30, $14.95, $15.60, and $19.50.

[34] For the clarity of exposition we show the results of our preferred regression specifications which include firm fixed effects. However, we have estimated the models without the firm fixed effects, and the signs and magnitudes of the coefficients are very similar. These results are available on request.

automate these jobs, and they are probably less productive than workers which are getting higher wages.

To understand if declines in low-wage jobs are driven by the ripple effects of the minimum wage or by differential reductions in labor demand, we further decompose the contribution of low-wage jobs to the overall growth into two components, as illustrated in the figure 4. First, we isolate the changes in low-wage jobs which arise because a job does not cease to exist, but crosses the threshold $\bar{w}$ and is no longer counted towards hours of jobs paying less than $\bar{w}$. This would happen if employers upgraded wages of jobs which used to pay less then $\bar{w}$ to wages above $\bar{w}$. Similarly, some jobs which used to pay above $\bar{w}$ could have received a wage cut and started to pay below $\bar{w}$. We would expect these changes to reflect the ripple effects of the minimum wage rather than the changes in the labor demand itself. Second, we isolate the changes in low-wage jobs which are unrelated to wage upgrades above $\bar{w}$ or downgrades below $\bar{w}$. Such changes can occur because of hires into low-wage jobs, separations from low-wage jobs, or because of the changes in hours worked in jobs which pay less than $\bar{w}$.[35]

Figure 4. Channels of adjustment in hours of low-wage jobs.



[35] Formally, we define the changes in hours worked due to wage upgrading or downgrading as $\Delta h(\text{Wage upgrade/downgrade})_{t_0,t} = -h_{t_0}(w_{t_0} < \bar{w}, w_t \geq \bar{w}) + h_t(w_{t_0} \geq \bar{w}, w_t < \bar{w})$, and changes in hours worked unrelated to wage upgrading or downgrading as $\Delta h(\text{Unrelated to wage upgrade/downgrade})_{t_0,t} = -Separations_{t_0,t} + Hires_{t_0,t} + \Delta h(w_{t_0} < \bar{w}, w_t < \bar{w})_{t_0,t}$. The contribution of separations is calculated as $Separations_{t_0,t} = h_{t_0}(w_{t_0} < \bar{w})$ for jobs which were active in t_0 but ended before t. The contribution of hires is calculated as $Hires_{t_0,t} = h_t(w_t < \bar{w})$ for jobs which started since t_0 and existed in t. Contribution of the changes in continuing jobs is calculated as $\Delta h(w_{t_0} < \bar{w}, w_t < \bar{w})_{t_0,t} = h_t(w_{t_0} < \bar{w}, w_t < \bar{w}) - h_{t_0}(w_{t_0} < \bar{w}, w_t < \bar{w})$ for jobs which existed both in t_0 and in t.

Table 9. Decomposition of changes in hours of low-wage and high-wage jobs.

Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
		$11 Min Wage			$13 Min Wage	
	Total change	Change due to wage upgrades $\geq \bar{w}$ or downgrades $< \bar{w}$	Change unrelated to wage upgrades $\geq \bar{w}$ or downgrades $< \bar{w}$	Total change	Change due to wage upgrades $\geq \bar{w}$ or downgrades $< \bar{w}$	Change unrelated to wage upgrades $\geq \bar{w}$ or downgrades $< \bar{w}$
	OLS	OLS	OLS	OLS	OLS	OLS
Jobs paying <105% of MW	-2.00^{***}	-0.7^{***}	-1.3^{***}	-1.00^{***}	-0.57^{***}	-0.46^{***}
	(0.21)	(0.11)	(0.1)	(0.11)	(0.052)	(0.081)
Jobs paying <110% of MW	-1.4^{***}	-0.44^{***}	-0.96^{***}	-0.69^{***}	-0.36^{***}	-0.33^{***}
	(0.19)	(0.096)	(0.1)	(0.1)	(0.044)	(0.081)
Jobs paying <115% of MW	-1.1^{***}	-0.38^{***}	-0.74^{***}	-0.46^{***}	-0.18^{***}	-0.28^{***}
	(0.19)	(0.11)	(0.11)	(0.11)	(0.058)	(0.077)
Jobs paying <120% of MW	-0.74^{***}	-0.22^{**}	-0.52^{***}	-0.36^{***}	-0.1^{*}	-0.26^{***}
	(0.18)	(0.094)	(0.11)	(0.092)	(0.054)	(0.08)
Jobs paying <150% of MW	-0.26	0.07	-0.33^{**}	-0.19^{**}	0.00071	-0.19^{**}
	(0.19)	(0.075)	(0.14)	(0.083)	(0.033)	(0.086)
Jobs paying ≥105% of MW	1.9^{***}	0.87^{***}	1.1^{***}	1.1^{***}	0.62^{***}	0.51^{***}
	(0.1)	(0.067)	(0.053)	(0.087)	(0.03)	(0.063)
Jobs paying ≥110% of MW	1.4^{***}	0.61^{***}	0.75^{***}	0.8^{***}	0.39^{***}	0.4^{***}
	(0.076)	(0.052)	(0.044)	(0.074)	(0.026)	(0.056)
Jobs paying ≥115% of MW	1.1^{***}	0.54^{***}	0.53^{***}	0.56^{***}	0.22^{***}	0.34^{***}
	(0.068)	(0.047)	(0.041)	(0.077)	(0.035)	(0.051)
Jobs paying ≥120% of MW	0.7^{***}	0.38^{***}	0.32^{***}	0.47^{***}	0.15^{***}	0.32^{***}
	(0.049)	(0.038)	(0.037)	(0.067)	(0.035)	(0.044)
Jobs paying ≥150% of MW	0.22^{***}	0.092^{***}	0.12^{***}	0.29^{***}	0.05^{***}	0.24^{***}
	(0.055)	(0.026)	(0.038)	(0.049)	(0.019)	(0.04)
Obs	272,933	272,933	272,933	231,245	231,245	231,245
Year Quarter NAICS 4 FE	X	X	X	X	X	X
Firm FE	X	X	X	X	X	X

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$. Clustered standard errors in parentheses. Standard errors are clustered by the industry (NAICS 3 digit Sector) and cohort. Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. All regressions include controls for firm size at baseline and firm age. Coefficient at $GAP \times t \geq 0$ reported. GAP measures percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

Table 9 shows the results of this decomposition.[36] We see strong evidence both of the ripple effect of the minimum wage and of the reductions in the labor demand for low-wage jobs. Columns 2 and 5 of the table show the contribution of wage upgrading and downgrading to the growth in low-wage jobs. Both after the implementation of the $11 and $13 minimum wage, a significant fraction of declines in low-wage jobs occurred because some low-wage jobs received wage upgrades. For jobs with the lowest wage, those paying less than 105% and less than 110% of the minimum wage, wage upgrading was responsible for up to 50% of the decline in hours. However, as we increase the wage threshold, the contribution of the wage upgrading diminishes, and the declines in jobs paying less than 150% of the minimum wage during both phase-in periods are driven entirely by changes in labor demand rather than by the wage upgrading. Based on these results, we conclude that Seattle's minimum wage had a ripple effects on higher paying jobs up to the level of 150% of the minimum wage. The extent of the ripple effect in Seattle was generally commensurate with the one found in the previous studies, but somewhat higher than the extent reported in Neumark, Schweitzer, and Wascher (2004). Moreover, the ripple effect was also consistent with self-reported channels of adjustment to the minimum wage documented in Romich, Allard, Althauser, Buszkiewicz, and Obara (2017). Among the respondents of the Survey of Seattle's Employers, 50% of businesses said that they raised employees' pay to decompress wages in the range in $13–$15/hour (i.e. 118%–136% of the $11 minimum wage, and 100%–115% of the $13 minimum wage), and 30% of businesses said that they raised pay of employees in the range of $15/hour and higher.

Having established that only a fraction of the declines in low-wage jobs are caused by the ripple effect of the minimum wage, we now turn to the analysis of the changes in labor demand. Columns 3 and 6 of the tables 9 show the contribution of low-wage jobs to the overall growth in hours worked net of the wage upgrading effect. Just as before, we see that the magnitude of the effect decreases as we increase the wage threshold, but there is still a negative and statistically significant effect on jobs paying less than 150% of the minimum wage during both phase-in periods. We also see a corresponding increase in high-wage jobs paying 150% of the minimum wage or higher.

Appendix table 18 presents further decomposition of changes in hours into hires, separations, and hours of continuing jobs using the framework of the figure 4. We see that during the first phase-in period, hires into low-wage jobs decreased and separations from low-wage jobs increased, thus decreasing turnover as well. At the same time, the hires into high-wage jobs increased, without significant changes to the separations. During the second phase-in period, both the hires into low-wage jobs and the separations from low-wage jobs increase, thus increasing turnover. However, the hires into high-wage jobs and the separations from high-wage jobs decrease, decreasing turnover. These findings suggest that the impact of the minimum wage on turnover might be heterogeneous across low-wage and high-wage jobs.

[36] We show the results of the OLS specification with the firm fixed effects for the clarity of exposition, but we have done ran the analysis using the IV specification with the firm fixed effects, as well as OLS and IV specification without firm fixed effects, and they yield the same results.

Table 10. Elasticity of labor demand for low-wage vs. high-wage jobs with respect to 1% increase in average wage rate paid by a firm.

Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Hours $11 Min Wage				Hours $13 Min Wage			
	Total change		Change unrelated to wage upgrades $\geq \bar{w}$ or downgrades $< \bar{w}$		Total change		Change unrelated to wage upgrades $\geq \bar{w}$ or downgrades $< \bar{w}$	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
All jobs	−0.05	−0.03			0.13	0.34		
Jobs paying <105% of MW	−8.38	−4.98	−5.44	−3.24	−3.42	−6.39	−1.57	−2.70
Jobs paying <110% of MW	−4.95	−3.01	−3.40	−2.08	−2.09	−3.86	−1.00	−1.70
Jobs paying <115% of MW	−3.46	−2.14	−2.33	−1.42	−1.27	−2.36	−0.78	−1.41
Jobs paying <120% of MW	−2.11	−1.28	−1.48	−0.90	−0.89	−1.56	−0.65	−1.14
Jobs paying <150% of MW	−0.52	−0.32	−0.66	−0.41	−0.35	−0.55	−0.35	−0.60
Jobs paying ≥105% of MW	3.11	1.95	1.80	1.06	1.97	3.97	0.92	1.83
Jobs paying ≥110% of MW	2.47	1.45	1.32	0.81	1.54	2.94	0.77	1.57
Jobs paying ≥115% of MW	2.07	1.23	1.00	0.61	1.14	2.43	0.70	1.51
Jobs paying ≥120% of MW	1.40	0.85	0.64	0.39	1.05	2.09	0.72	1.52
Jobs paying ≥150% of MW	0.63	0.37	0.35	0.22	0.93	1.89	0.77	1.70
Year Quarter NAICS 4 FE	X	X	X	X	X	X	X	X
Firm FE	X	X	X	X	X	X	X	X

Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. Elasticities for the IV specifications are calculated by dividing the effect on net employment growth by the average share of jobs in each wage group in total hours. Elasticities for the OLS specifications are calculated by dividing the effect on net employment growth by the effect on wages, and by the average share of jobs in each wage group in total hours.

Though our estimates clearly show that employers have reduced hours worked in low-wage jobs and increased hours worked in high-wage jobs, they do not show the magnitude of the labor demand elasticity. To obtain the labor demand elasticity, we convert the contribution of low-wage jobs to growth in total hours to the estimates of growth in low-wage jobs. We can do this by using the following relation between the average growth in low-wage jobs, denoted by $\overline{NEG}(w < \bar{w})_{t_0,t}$ and the average contribution of low-wage jobs to total growth:

$$\alpha_{w<\bar{w}}\, \overline{NEG}(w < \bar{w})_{t_0,t} = \underbrace{\frac{1}{N}\sum_{i=1}^{N} \frac{h_{it}(w_t < \bar{w}) - h_{it_0}(w_{t_0} < \bar{w})}{0.5(h_{it} + h_{it_0})}}_{\text{Contribution of jobs paying } < \bar{w}}, \tag{7.2}$$

where i indexes employers, and $\alpha_{w<\bar{w}}$ is the average share of jobs paying less than $\bar{w}$ in total hours.[37]

[37]Note that our sample has a sizable fraction of employers which do not have any jobs paying less than $\bar{w}$. Since

Table 10 reports our estimates of the labor demand elasticity based on expression (7.2). Columns 1, 2, 5, and 6 present the elasticity estimated based on the total effect, which combine the effect of the wage upgrading with the labor demand effect, while columns 3, 4, 7, and 8 present the elasticity estimates for changes net of the wage upgrading effect. The magnitude of the elasticity of labor demand for low-wage jobs is larger for lower-paying jobs. A one percentage point increase in average wages caused a more than one percentage point decline in the growth of jobs paying less than 120% of the minimum wage, even after the effects of the wage upgrading have been subtracted. In turn, jobs paying 120% of the minimum wage or more add almost a one percentage point in growth rates in response to a one percentage point growth in average wages. Using a conservative threshold of jobs paying less than 150% of the minimum wage, we find that a one percentage point increase in average wages leads to 0.3 to 0.6 percentage point declines in hours worked in those jobs. Using the fact that the average wage has increased by 1.63 percentage points in response to the $11 minimum wage increase, these elasticities suggest that hours worked in jobs paying less than 150% of the minimum wage, or $16.50/hour, declined by 0.5 to 1 percentage points during the first minimum wage phase-in period. A similar calculation for the impact of the $13 minimum wage suggests that hours worked in jobs paying less than 150% of the minimum wage, or $19.50/hour, declined by 0.8 to 1.5 percentage points during the second phase-in period.

8 Discussion

We have shown that businesses which survived the minimum wage increase in Seattle were able to pass 30-50% of the minimum wage incidence to customers and/or employees. They were able to achieve these profit gains through two channels. First, their revenues increased, suggesting that they passed the minimum wage to prices (i.e. product market adjustment). Second, they reallocated hours from low-wage to high-wage jobs (i.e. labor market adjustment). This adjustment pattern is consistent with the standard competitive model of the labor market, as discussed in detail in Aaronson, French, and MacDonald (2008). In this section, we provide the intuition behind the magnitude of each channel using the insights from the basic competitive model of the labor market.

As discussed in section 5, the share of the minimum wage incidence borne by employers, which we denoted by ψ, was determined by the magnitude of the product market and labor market adjustment to the minimum wage:

$$\begin{aligned}\psi &= \frac{1}{s}\Big(\varepsilon_{\text{Revenue}} - s\,\varepsilon_{\text{Wagebill}} - (1-s-\pi)\,\varepsilon_{\text{Non-labor costs}}\Big) \\ &= \frac{1}{s}\Big(\varepsilon_{\text{Revenue}} - s\,\big(1+\varepsilon_{\text{Hours}}\big) - (1-s-\pi)\,\varepsilon_{\text{Non-labor costs}}\Big). \qquad (8.1)\end{aligned}$$

Profit gains from the product market adjustment are determined by the degree of the minimum

these employers are included in the analysis sample when we calculate the contribution of low-wage jobs to the overall growth, we also include these employers when we calculate $\alpha_{w<\bar{w}}$.

wage pass-through to prices, and by the elasticity of consumer demand:

$$\varepsilon_{\text{Revenue}} = (1-\eta)\varepsilon_p + (\eta-\rho)\varepsilon_P. \tag{8.2}$$

As shown in Hamermesh (1996) and Aaronson and French (2007), the magnitude of the labor market adjustment is determined by the extent to which employers have to cut back on output because consumers are spending less on their products as a result of a price increase (scale effect), and by the degree to which low-wage jobs can be substituted by other inputs, such as high-wage jobs or non-labor inputs. As a result, the total number of hours worked as either decrease or increase. Denote by L the number of hours worked in low-wage jobs, and by H the number of hours worked in high wage jobs. Then, assuming that the production function has constant returns to scale and that the minimum wage does not affect wages of high-wage jobs, the elasticity of employment in each segment with respect to wages can be written as follows:

$$\varepsilon_L = -\eta\varepsilon_p + (\eta-\rho)\varepsilon_P - \frac{s_H}{1-\pi}\sigma_{HL} - \frac{1-\pi-s}{1-\pi}\sigma_{KL}, \tag{8.3}$$

$$\varepsilon_H = -\eta\varepsilon_p + (\eta-\rho)\varepsilon_P + \frac{s_H}{1-\pi}\sigma_{HL}, \tag{8.4}$$

where s_H is the share of wagebill to high-wage jobs in revenue, $-\sigma_{HL} < 0$ is the elasticity of substitution between low-wage and high-wage jobs, and $-\sigma_{KL} < 0$ is the elasticity of substitution between low-wage jobs and non-labor inputs.

Combining the expressions above, we can obtain the elasticity of total hours with respect to the change in wages:

$$\varepsilon_{\text{Hours}} = \underbrace{-\eta\varepsilon_p + (\eta-\rho)\varepsilon_P}_{\text{Scale effect}} \underbrace{- \alpha\frac{1-\pi-s}{1-\pi}\sigma_{KL} + (1-2\alpha)\frac{s_H}{1-\pi}\sigma_{HL}}_{\text{Substitution effect}}, \tag{8.5}$$

where α is the share of low-wage jobs in total hours.

Therefore, the simple model suggests that there can be four patterns of adjustment to the minimum wage, classified based on the dominating channel: 1) product market adjustment with inelastic consumer demand, 2) product market adjustment with elastic consumer demand, 3) labor market adjustment through labor-labor substitution, and 4) labor market adjustment through labor-capital substitution. The effects of these adjustment patterns on prices, hours worked, and reallocation of hours from low-wage to high-wage jobs are summarized in the table 11. If the consumer demand is inelastic, employers can pass the incidence of the minimum wage to consumers without cutting labor demand (pattern 1). On the other hand, if employers are facing an elastic consumer demand, employers will be able to pass some of the minimum wage increase to prices only at the cost of cutting on output and scaling down employment (pattern 2). Patterns 3 and 4 correspond to the stronger labor market adjustment through the substitution effect. If low-wage jobs can be automated, employers will invest in capital (pattern 4). If low-wage jobs can be substituted by high-wage jobs through a change of a business model, employers will reallocate labor from low-wage to high-wage jobs (pattern 3). In both cases, employment in low-wage jobs decreases.

Table 11. Patterns of adjustment to the minimum wage in a competitive labor market.

	(1)	(2)	(3)	(4)
Primary channel of adjustment	Product market	Product market	Labor market	Labor market
Required conditions	$\eta < 1$	$\eta > 1$	Large σ_{HL}	Large σ_{KL}
Effect on:				
Prices	$\uparrow$	$\uparrow$	0	0
Total hours	0	$\downarrow$	0 or $\uparrow$	$\downarrow$
Hours of low-wage jobs	0	$\downarrow$	$\downarrow$	$\downarrow$
Hours of high-wage jobs	0	$\downarrow$	$\uparrow$	0
Non-labor inputs	0	$\downarrow$	0	$\uparrow$

On average, our findings are consistent with the patterns of adjustment number one and three, in which employers are able to increase revenue, but reallocate labor from low-wage jobs to high-wage jobs.[38] However, because the technology of production varies widely across industries, and because some industries face more elastic demand consumer demand than others, we would expect that the primary channel of adjustment varies across industries as well. To test if this is the case, we estimate the effect of the minimum wage on employers by industry for the industries which have enough observations, and have been extensively studied by the minimum wage literature on the past. We report estimates for full-service restaurants, limited-service restaurants, retail trade, manufacturing, and other services.

Table 12 shows the estimates of the effect of the minimum wage on the main outcomes for the industries outlined above based on the OLS specification with the firm effects.[39] The results do indeed suggest that different industries relied on different channels to adjust to the minimum wage. In particular, full-service restaurants demonstrated similar adjustment pattern to all firms on average: they saw increases in revenue, and reallocation of hours worked from low-wage to high-wage jobs, but no change in total hours. In addition, full-service restaurants experienced revenue increases during both minimum wage phase-ins, and the magnitude of this effect was larger than the revenue increase observed in an average employer. On the other hand, limited-service restaurants showed no labor-labor substitution pattern, and experienced increases in revenue during the second phase-in period, but not during the first phase-in period. A weak labor-labor substitution effect was also observed among retail businesses, though they have experienced a decrease in revenue following the implementation of the $11 minimum wage. Finally, both businesses in manufacturing and businesses in other services responded to the $11 minimum wage by cutting hours of all jobs, both low-wage and high-wage, and businesses in services saw a corresponding decrease

[38] We are not able to distinguish between the case of labor-labor substitution and labor-capitol substitution, where high-wage jobs are complements to capital, as we do not observe changes in capital.

[39] We have estimated the model using the IV specification as well, and the results look similar.

Table 12. Differences in adjustment strategies across industries.

Dependent Variable	(1) All industries	(2) Full service restaurants	(3) Limited service restaurants	(4) Retail trade	(5) Manufacturing	(6) Other services
	OLS	OLS	OLS	OLS	OLS	OLS
Panel A: $11 Minimum Wage						
%ΔWagebill	0.79^{***}	1.4^{***}	0.7^{***}	0.99^{***}	-0.028	-0.38
	(0.19)	(0.49)	(0.25)	(0.35)	(0.45)	(0.47)
%ΔRevenue	0.027	0.51^{**}	-0.16	-0.61^{**}	0.36	-0.36
	(0.082)	(0.2)	(0.11)	(0.28)	(0.32)	(0.57)
%ΔHours	-0.044	0.32	-0.072	0.15	-0.94^{*}	-1.9^{***}
	(0.2)	(0.51)	(0.26)	(0.32)	(0.51)	(0.48)
Growth in hours due to changes in hours of:						
Jobs paying <150% of MW	-0.26	-0.38	-0.088	-0.084	-0.82	-2.4^{***}
	(0.19)	(0.5)	(0.28)	(0.32)	(0.57)	(0.47)
Jobs paying ≥150% of MW	0.22^{***}	0.7^{***}	0.016	0.24^{**}	-0.12	0.47^{***}
	(0.055)	(0.12)	(0.062)	(0.12)	(0.26)	(0.16)
Obs	272,933	26,562	12,816	27,774	17,412	15,504
Panel B: $13 Minimum Wage						
%ΔWagebill	0.86^{***}	1.1^{***}	0.68^{***}	0.56^{*}	1.2^{***}	0.29
	(0.12)	(0.26)	(0.19)	(0.29)	(0.26)	(0.4)
%ΔRevenue	0.21^{**}	0.51^{***}	0.24^{**}	0.012	0.64^{**}	-0.025
	(0.082)	(0.2)	(0.12)	(0.14)	(0.3)	(0.31)
%ΔHours	0.11	0.43	0.12	0.012	0.15	-0.23
	(0.089)	(0.28)	(0.17)	(0.28)	(0.33)	(0.35)
Growth in hours due to changes in hours of:						
Jobs paying <150% of MW	-0.19^{**}	-0.027	0.13	-0.13	-0.14	-0.54
	(0.083)	(0.29)	(0.17)	(0.25)	(0.32)	(0.36)
Jobs paying ≥150% of MW	0.29^{***}	0.46^{***}	-0.012	0.14	0.29^{**}	0.31^{***}
	(0.049)	(0.083)	(0.053)	(0.095)	(0.13)	(0.11)
Obs	231,245	22,820	11,005	23,600	14,640	13,155
Year Quarter NAICS 4 FE	X	X	X	X	X	X
Firm FE	X	X	X	X	X	X

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$. Clustered standard errors in parentheses. In regressions which combine several industries standard errors are clustered by the industry (NAICS 3 digit Sector) and cohort, in regressions for a single industry standard errors are clustered by firm identifier and cohort Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. All regressions include controls for firm size at baseline and firm age. Coefficient at $GAP \times t \geq 0$ reported. GAP measures percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

in revenue, suggesting that the scale effect dominated. However, both industries showed a labor-labor substitution pattern in response to the $13 minimum wage, and manufacturing employers experienced an increase in revenue as well.

It is not entirely surprising that industries rely on different channels to adjust to the minimum wage. However, these results have two profound implications. First, they demonstrate that conclusions of studies based on a particular industry do not necessarily reflect the experience of the entire low-wage market. In particular, several prior studies based on the payroll data similar to ours (Giuliano, 2013; Hirsch et al., 2015; Brummund, 2017) did not find the evidence of a substitution effect. These studies were based on restaurant and retail sectors, where we observe the weakest substitution effect as well.[40] Second, our analysis suggests that the aggregate effect of the minimum wage can depend on the composition of the affect firms, and likely varies across regions and over the business cycle.

9 Conclusion

In this paper we study the impact of the minimum wage hike in Seattle on business outcomes of surviving firms using the Unemployment Insurance records and the Business and Occupations Tax records from the State of Washington in 2005-2016. Due to Washington's unique policy of collecting hours for every employee in the state, we can measure the costs of compliance with the minimum wage for each employer. Our data also allow us to investigate the impacts of the minimum wage hike on firms in all industries, as we do not have to restrict our analysis to retail and restaurants like prior studies in the US.

We demonstrate that on average employers in Seattle faced low costs of compliance with the minimum wage, and many employers were not affected by the minimum wage increases. In particular, an average employer had to increase their labor costs by 2-3% to comply with the ordinance, and 40-50% of employers had no workers paid less than the new minimum wage even before the ordinance was implemented. However, the majority of restaurants and retail businesses had to pay more to their employees and faced by far the highest costs of compliance among all industries. Furthermore, we find that the minimum wage led to wage raises of workers earning up to 150% of the minimum wage in all industries, which created additional pressure on employers' labor costs.

We show that those businesses which survived the minimum wage increase were able to pass 30-50% of the minimum wage incidence to customers and/or employees. Employers adjusted to the minimum wage in two ways. First, they saw increases in revenue, most likely caused by higher prices. Second, they reallocated hours from low-wage jobs to high-wage jobs, leaving total hours worked unchanged. In addition, it is unclear if employers had any profit gains from changes to

[40] Our data does not permit the identification the the deeper parameters η, ρ, σ_{HL}, and $\sigma_K L$, but our results of the differential effect of the minimum wage across industries are consistent with the intuition that the magnitude of adjustment is driven by the price elasticity of demand and the elasticity of the factor substitution.

workers turnover. While turnover in high-wage jobs decreased, there was an increase in turnover for low-wage jobs.

The observed pattern of adjustment is consistent with the competitive model of the labor market, in which employers try to pass the minimum wage to consumers in the form of higher prices, and re-optimize their inputs to prevent total costs from increasing. This model suggests that the extent to which employers rely on the product market vs. the labor market mechanisms to cope with the higher labor costs is driven by conventional factors such as price elasticity of consumer demand and the elasticity of input substitution between low-wage labor and other factors of production. We show that the role of product market vs. labor market adjustment varies across industries, consistent with the fact that employers in different industries differ in technology of production and face different price elasticity of demand. In particular, we find stronger revenue increases in full-service restaurants and weaker to negligible disemployment effect in limited-service restaurants and retail compared with the effect on all businesses.

Finally, though we document strong evidence of labor-labor substitution, the overall disemployment effect of the minimum wage on low-wage jobs generated by surviving employers is relatively modest. We estimate employment elasticities in the range of -0.3 to -0.6% with respect to 1% increase in average wages. Using the same data and the same policy change in Seattle, Jardim, Long, Plotnick, van Inwegen, Vigdor, and Wething (2017a) find that a 1% increase in wages of low-wage jobs leads to a 1-3% decrease in hours worked in low-wage jobs. This discrepancy suggests that significant part of the disemployment effect had to come from the extensive margin, i.e. either through pushing low-paying firms off the market or by impeding entry of firms which employ low-wage workers. Understanding the relative contribution of extensive and intensive margin to the overall impact of the minimum wage hike in Seattle is a task for the future work.

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A Additional Tables

Table 13. Exposure to the minimum wage hike, by industry.

Industry	No. Firms		Employment, all jobs		Firms with GAP>0	
	All firms	Exposed firms, %	All firms	Exposed firms, %	Mean GAP, %	Median GAP,%
Panel A: 2014 Cohort, subject to $11 Minimum wage						
Construction	418	11.2	13,650	35.3	0.29	0.03
Manufacturing	348	38.2	13,630	56.8	1.55	0.43
Wholesale Trade	351	23.9	7,850	33.3	0.42	0.11
Retail Trade	567	61.6	11,362	63.1	1.97	0.86
Transportation and Warehousing	98	31.6	8,631	52.7	0.42	0.05
Information	219	19.6	13,948	22.7	0.90	0.20
Finance and Insurance	177	15.3	7,601	45.4	0.31	0.04
Real Estate and Rental and Leasing	171	38.6	6,064	60.9	0.64	0.16
Professional, Scientific, and Technical Services	1,066	12.5	36,259	26.0	0.32	0.08
Administrative and Support Services	286	34.3	13,369	68.8	1.15	0.19
Health Care and Social Assistance	571	27.8	29,620	68.5	0.67	0.15
Arts, Entertainment, and Recreation	111	67.6	8,423	91.7	1.37	0.28
Accommodation and Food Services	1,195	80.9	35,053	88.2	3.02	0.89
Full-Service Restaurants	640	83.6	18,676	88.8	1.77	0.54
Limited-Service Restaurants	332	84.9	8,062	88.7	5.85	4.39
Other Services (except Public Administration)	328	43.0	7,661	42.7	1.28	0.59
Total	5,906	39.8	213,121	55.4	1.92	0.43
Panel B: 2015 Cohort, subject to $13 Minimum wage						
Construction	413	22.0	15,983	39.2	0.60	0.08
Manufacturing	344	54.1	14,324	67.7	2.69	0.88
Wholesale Trade	351	38.2	8,300	52.1	1.26	0.45
Retail Trade	593	73.2	12,258	70.4	4.75	2.92
Transportation and Warehousing	95	43.2	7,339	72.0	1.31	0.56
Information	231	26.8	16,652	26.5	1.31	0.23
Finance and Insurance	175	20.0	7,085	48.1	0.40	0.10
Real Estate and Rental and Leasing	175	46.3	6,114	66.5	1.44	0.44
Professional, Scientific, and Technical Services	1,084	19.8	38,265	31.5	0.62	0.14
Administrative and Support Services	294	50.0	15,742	82.3	2.50	0.59
Health Care and Social Assistance	530	37.5	31,010	81.6	1.51	0.47
Arts, Entertainment, and Recreation	126	70.6	9,038	94.3	2.84	1.24
Accommodation and Food Services	1,249	89.6	36,808	94.8	4.61	1.99
Full-Service Restaurants	676	91.9	20,337	95.8	3.19	1.33
Limited-Service Restaurants	335	91.0	7,099	91.1	8.27	6.66
Other Services (except Public Administration)	337	59.9	7,789	76.2	2.56	0.91
Total	5,997	50.6	226,707	64.3	3.22	1.07

Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. Agriculture, Mining, Utilities, Management of Companies and Enterprises, Educational Services, and Public Administration were excluded from the sample due to small sample sizes. GAP measures percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

Table 14. Growth rates of the main outcomes in control and treated cohorts, %.

	Control Cohorts		Treated Cohorts		Diff-in-Diff	P-val.
	GAP=0	GAP>0	GAP=0	GAP>0		
Panel A: 2014 Cohort, subject to $11 Minimum wage						
Wage rate	3.45	2.65	6.09	7.72	2.42	0
Wage bill	6.33	3.17	11.04	8.35	0.47	0.54
Revenue	0.67	-0.36	7.36	4.94	-1.39	0
Revenue per hour	-2.35	-1.21	2.19	4	0.67	0.17
Hours	2.96	0.64	5.12	0.85	-1.95	0
Change in hours due to changes in:						
Jobs paying <105% MW	0.63	-2.19	0.15	-9.96	-7.29	0
Jobs paying <110% MW	0.45	-2.22	-0.48	-9.99	-6.85	0
Jobs paying <115% MW	0.35	-1.9	-0.76	-8.8	-5.79	0
Jobs paying <120% MW	0.29	-1.86	-1.32	-7.88	-4.42	0
Jobs paying <150% MW	0.1	-1.09	-2.49	-4.48	-0.8	0.04
Jobs paying ≥105% MW	2.33	2.83	4.97	10.81	5.35	0
Jobs paying ≥110% MW	2.52	2.85	5.6	10.85	4.91	0
Jobs paying ≥115% MW	2.61	2.53	5.88	9.65	3.85	0
Jobs paying ≥120% MW	2.67	2.49	6.44	8.73	2.47	0
Jobs paying ≥150% MW	2.86	1.73	7.61	5.33	-1.15	0.06
No firms	18,212	15,412	2,599	2,353		
Panel B: 2015 Cohort, subject to $13 Minimum wage						
Wage rate	3.52	2.91	2.75	5.64	3.51	0
Wage bill	6.77	3.6	8.12	8.44	3.49	0
Revenue	0.64	-0.32	4	4.53	1.49	0
Revenue per hour	-2.71	-1.29	-1.46	1.21	1.25	0.01
Hours	3.31	0.79	5.46	3.02	0.08	0.91
Change in hours due to changes in:						
Jobs paying <105% MW	1.09	-1.89	0.54	-8.26	-5.82	0
Jobs paying <110% MW	0.9	-1.84	0.21	-6.94	-4.42	0
Jobs paying <115% MW	0.79	-1.67	0.93	-4.46	-2.93	0
Jobs paying <120% MW	0.66	-1.43	-0.35	-4.78	-2.33	0
Jobs paying <150% MW	0.32	-0.94	-0.27	-1.51	0.02	0.95
Jobs paying ≥105% MW	2.22	2.68	4.92	11.28	5.89	0
Jobs paying ≥110% MW	2.42	2.63	5.25	9.96	4.49	0
Jobs paying ≥115% MW	2.53	2.46	4.53	7.48	3.01	0
Jobs paying ≥120% MW	2.65	2.23	5.82	7.8	2.41	0
Jobs paying ≥150% MW	2.99	1.74	5.73	4.53	0.06	0.92
No firms	18,212	22,040	2,962	3,035		

Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. Agriculture, Mining, Utilities, Management of Companies and Enterprises, Educational Services, and Public Administration were excluded from the sample due to small sample sizes. GAP measures percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same. Diff-in-Diff and P-value shows the difference in differences between exposed and non-exposed firms in treated and control cohorts.

Table 15. Effect of the minimum wage on wagebill.

Variable	Dependent variable: %Change in Wage bill							
	(1) $11 Min Wage Treatment	(2) $11 Min Wage Treatment	(3) $11 Min Wage Placebo	(4) $11 Min Wage Placebo	(5) $13 Min Wage Treatment	(6) $13 Min Wage Treatment	(7) $13 Min Wage Placebo	(8) $13 Min Wage Placebo
				Panel A: Timing of the Effect				
GAP $\times$ $t = -3$	-0.54^{***}	-0.61^{***}	-0.15	-0.26^{***}				
	(0.089)	(0.1)	(0.11)	(0.098)				
GAP $\times$ $t = -2$	-0.37^{***}	-0.44^{***}	0.033	-0.086	0.37^{***}	-0.11^{*}	-0.059	-0.073^{*}
	(0.099)	(0.11)	(0.12)	(0.073)	(0.094)	(0.062)	(0.042)	(0.041)
GAP $\times$ $t = -1$	-0.12	-0.18^{*}	0.00072	-0.12	0.28^{***}	-0.19^{***}	-0.0072	-0.022
	(0.081)	(0.1)	(0.066)	(0.13)	(0.11)	(0.069)	(0.057)	(0.027)
GAP $\times$ $t = 0$	0.81^{***}	0.75^{**}	0.89^{**}	0.78	0.66^{***}	0.18^{***}	0.024	0.01
	(0.28)	(0.35)	(0.42)	(0.49)	(0.11)	(0.06)	(0.051)	(0.052)
GAP $\times$ $t = 1$	0.86^{***}	0.79^{**}	0.84^{**}	0.72^{*}	0.85^{***}	0.37^{**}	0.28^{**}	0.27
	(0.24)	(0.31)	(0.38)	(0.43)	(0.15)	(0.17)	(0.13)	(0.17)
GAP $\times$ $t = 2$	0.43^{***}	0.35^{**}	0.2^{*}	0.079	1.1^{***}	0.6^{***}	0.28^{**}	0.26^{*}
	(0.12)	(0.17)	(0.12)	(0.25)	(0.13)	(0.13)	(0.13)	(0.15)
Obs	272,933	272,933	202,511	202,511	231,245	231,245	171,690	171,690
R^2	0.3	0.057	0.32	0.056	0.29	0.054	0.31	0.052
F-stat.	41.47	152	4.21	19.25	45.72	37.02	2.15	7.86
P-value	0	0	0.05	0	0	0	0.19	0.01
				Panel B: Average Effect				
GAP $\times$ $t < 0$					0.33^{***}	-0.15^{***}	-0.033	-0.048
					(0.09)	(0.049)	(0.051)	(0.033)
GAP $\times$ $t \geq 0$	0.79^{***}	0.69^{***}	0.66^{**}	0.55	0.86^{***}	0.38^{***}	0.19^{**}	0.18
	(0.19)	(0.26)	(0.3)	(0.36)	(0.12)	(0.12)	(0.081)	(0.11)
Obs	272,933	272,933	202,511	202,511	231,245	231,245	171,690	171,690
R^2	0.3	0.057	0.32	0.056	0.29	0.054	0.31	0.052
F-stat.	17.33	7.18	4.83	2.37	54.92	10.83	5.68	2.5
P-value	0	0.03	0.07	0.17	0	0.01	0.05	0.16
Year Quarter NAICS 4 FE	X	X	X	X	X	X	X	X
Firm FE	X		X		X		X	

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$. Standard errors clustered at the industry (NAICS 3 digit level) and cohort level in parentheses. Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and with average wagerate between $9 and $100 (in constant 2015 Q2 prices). All regressions include controls for firm size at baseline and firm age. Treatment corresponds to the treated cohort (2014 or 2015 depending on the phase), Placebo corresponds to the 2012 cohort used as placebo experiment. F-statistics and p-value shown for two-sided joint test of coefficients at GAP $\times$ Treatment equal to zero. GAP measures percentage increase in total wagebill required to meet the new minimum wage, assuming jobs and hours remain the same.

Table 16. Robustness of the main results to the alternative regression specifications.

Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	$11 Min Wage					$13 Min Wage				
	Baseline specification OLS	Baseline specification IV	Lower bound for GAP OLS	Lower bound for GAP IV	GAP instrumented with lagged GAP IV	Baseline specification OLS	Baseline specification IV	Lower bound for GAP OLS	Lower bound for GAP IV	GAP instrumented with lagged GAP IV
%ΔWagebill	0.79^{***}	0.57^{***}	2.00^{***}	0.57^{***}	0.93^{***}	0.86^{***}	2.00^{***}	3.5^{***}	1.6^{***}	0.35^{***}
	(0.19)	(0.14)	(0.53)	(0.15)	(0.17)	(0.12)	(0.34)	(0.54)	(0.43)	(0.11)
%ΔRevenue	0.027	0.019	−0.058	−0.017	0.012	0.21^{**}	0.44^{**}	1.6^{***}	0.81^{**}	0.11
	(0.082)	(0.037)	(0.22)	(0.047)	(0.078)	(0.082)	(0.19)	(0.6)	(0.36)	
%ΔRevenue per hour	0.093	0.067	0.22	0.063	−0.0024	0.077	0.046	0.46	0.092	0.056
	(0.17)	(0.11)	(0.62)	(0.17)	(0.13)	(0.061)	(0.13)	(0.47)	(0.24)	(0.099)
%ΔHours	−0.044	−0.031	−0.19	−0.056	0.013	0.11	0.34	0.72	0.48	0.026
	(0.2)	(0.13)	(0.6)	(0.16)	(0.17)	(0.089)	(0.22)	(0.64)	(0.37)	(0.088)
Growth in hours due to changes in hours of:										
Jobs paying <105% of MW	-2.00^{***}	-1.4^{***}	-4.3^{***}	-1.2^{***}	-1.9^{***}	-1.00^{***}	-2.2^{***}	-1.8^{**}	−0.45	-0.86^{***}
	(0.21)	(0.11)	(0.58)	(0.15)	(0.2)	(0.11)	(0.28)	(0.79)	(0.37)	(0.043)
Jobs paying <110% of MW	-1.4^{***}	-1.00^{***}	-3.00^{***}	-0.85^{***}	-1.4^{***}	-0.69^{***}	-1.5^{***}	-1.5^{*}	−0.35	-0.55^{***}
	(0.19)	(0.11)	(0.53)	(0.14)	(0.19)	(0.1)	(0.24)	(0.76)	(0.36)	(0.062)
Jobs paying <115% of MW	-1.1^{***}	-0.8^{***}	-2.4^{***}	-0.69^{***}	-1.1^{***}	-0.46^{***}	-1.00^{***}	−1.1	−0.26	-0.21^{***}
	(0.19)	(0.12)	(0.53)	(0.15)	(0.19)	(0.11)	(0.24)	(0.78)	(0.38)	(0.076)
Jobs paying <120% of MW	-0.74^{***}	-0.53^{***}	-1.5^{***}	-0.45^{***}	-0.74^{***}	-0.36^{***}	-0.74^{***}	−0.95	−0.21	−0.11
	(0.18)	(0.12)	(0.55)	(0.15)	(0.18)	(0.092)	(0.21)	(0.74)	(0.38)	(0.082)
Jobs paying <150% of MW	−0.26	−0.19	−0.62	−0.18	−0.2	-0.19^{**}	-0.35^{*}	−0.65	−0.098	0.039
	(0.19)	(0.12)	(0.6)	(0.16)	(0.16)	(0.083)	(0.19)	(0.66)	(0.33)	(0.089)
Jobs paying ≥105% of MW	1.9^{***}	1.4^{***}	4.1^{***}	1.2^{***}	1.9^{***}	1.1^{***}	2.6^{***}	2.6^{***}	0.94^{***}	0.89^{***}
	(0.1)	(0.019)	(0.23)	(0.058)	(0.13)	(0.087)	(0.29)	(0.36)	(0.16)	(0.047)
Jobs paying ≥110% of MW	1.4^{***}	0.97^{***}	2.8^{***}	0.8^{***}	1.4^{***}	0.8^{***}	1.8^{***}	2.2^{***}	0.84^{***}	0.57^{***}
	(0.076)	(0.04)	(0.16)	(0.046)	(0.11)	(0.074)	(0.23)	(0.32)	(0.14)	(0.051)
Jobs paying ≥115% of MW	1.1^{***}	0.77^{***}	2.2^{***}	0.63^{***}	1.1^{***}	0.56^{***}	1.4^{***}	1.8^{***}	0.75^{***}	0.24^{***}
	(0.068)	(0.039)	(0.13)	(0.038)	(0.096)	(0.077)	(0.21)	(0.31)	(0.12)	(0.06)
Jobs paying ≥120% of MW	0.7^{***}	0.5^{***}	1.4^{***}	0.39^{***}	0.76^{***}	0.47^{***}	1.1^{***}	1.7^{***}	0.69^{***}	0.14^{***}
	(0.049)	(0.023)	(0.11)	(0.025)	(0.098)	(0.067)	(0.18)	(0.29)	(0.12)	(0.049)
Jobs paying ≥150% of MW	0.22^{***}	0.15^{***}	0.43^{***}	0.12^{***}	0.22^{***}	0.29^{***}	0.69^{***}	1.4^{***}	0.58^{***}	−0.013
	(0.055)	(0.036)	(0.13)	(0.033)	(0.038)	(0.049)	(0.14)	(0.14)	(0.093)	(0.036)
Obs	272,933	272,933	272,933	272,933	256,559	231,245	231,245	231,245	231,245	217,125
Year Quarter NAICS 4 FE	X	X	X	X	X	X	X	X	X	X
Firm FE	X	X	X	X	X	X	X	X	X	X

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$. Clustered standard errors in parentheses. Standard errors are clustered by the industry (NAICS 3 digit Sector) and cohort. Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. All regressions include controls for firm size at baseline and firm age. Coefficient at $GAP \times t \geq 0$ or $\%\Delta Wagerate \times t \geq 0$ reported. Change in wage rate in treated cohort is instrumented by GAP times an indicator for treated period. GAP measures percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

Table 17. Effect of the $13 minimum wage on prices and mean wage rate for employers for which prices were collected.

	(1)	(2)
Dependent variable: %ΔMean price		
GAP × 2016.1	0.099	−0.13
	(0.12)	(0.15)
GAP × 2016.2	0.17	0.099
	(0.15)	(0.15)
Obs	89	89
R^2	0.036	0.043
Dependent variable: %ΔMean wagerate		
GAP × 2016.1	0.41***	0.43***
	(0.15)	(0.11)
GAP × 2016.2	0.32**	0.41***
	(0.13)	(0.11)
Obs	93	93
R^2	0.091	0.18

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$. Clustered standard errors in parentheses. Standard errors are clustered by firm identifier. Source: UI records from WA state and data on prices collected by the authors, 2015-2016. Sample: Surviving single-location firms which have data on revenue. GAP measures percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

Table 18. Decomposition of changes in hours worked into contributions from hires, separations, and changes in continuing jobs.

Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$11 Min Wage				$13 Min Wage			
	Change unrelated to wage upgrades $\geq \bar{w}$ or downgrades $< \bar{w}$	Change due to hires into	Change due to separations from	Change due to Δhours of continuing jobs	Change unrelated to wage upgrades $\geq \bar{w}$ or downgrades $< \bar{w}$	Change due to hires into	Change due to separations from	Change due to Δhours of continuing jobs
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Jobs paying <105% of MW	-1.3^{***}	-0.94^{***}	-0.2^{***}	-0.13^{***}	-0.46^{***}	0.46^{***}	-0.81^{***}	-0.11^{**}
	(0.1)	(0.078)	(0.05)	(0.041)	(0.081)	(0.07)	(0.046)	(0.051)
Jobs paying <110% of MW	-0.96^{***}	-0.64^{***}	-0.2^{***}	-0.13^{***}	-0.33^{***}	0.54^{***}	-0.78^{***}	-0.097^{*}
	(0.1)	(0.065)	(0.06)	(0.039)	(0.081)	(0.071)	(0.044)	(0.052)
Jobs paying <115% of MW	-0.74^{***}	-0.44^{***}	-0.19^{**}	-0.11^{***}	-0.28^{***}	0.56^{***}	-0.74^{***}	-0.093^{*}
	(0.11)	(0.067)	(0.074)	(0.038)	(0.077)	(0.066)	(0.041)	(0.051)
Jobs paying <120% of MW	-0.52^{***}	-0.26^{***}	-0.16^{**}	-0.096^{***}	-0.26^{***}	0.54^{***}	-0.7^{***}	-0.1^{*}
	(0.11)	(0.064)	(0.082)	(0.033)	(0.08)	(0.061)	(0.04)	(0.058)
Jobs paying <150% of MW	-0.33^{**}	-0.046	-0.19^{**}	-0.093^{***}	-0.19^{**}	0.49^{***}	-0.58^{***}	-0.091
	(0.14)	(0.08)	(0.096)	(0.034)	(0.086)	(0.047)	(0.05)	(0.063)
Jobs paying ≥105% of MW	1.1^{***}	1.00^{***}	-0.034^{***}	0.092^{***}	0.51^{***}	-0.087	0.53^{***}	0.069^{***}
	(0.053)	(0.041)	(0.0092)	(0.013)	(0.063)	(0.064)	(0.035)	(0.026)
Jobs paying ≥110% of MW	0.75^{***}	0.7^{***}	-0.031	0.079^{***}	0.4^{***}	-0.17^{**}	0.49^{***}	0.078^{***}
	(0.044)	(0.031)	(0.022)	(0.014)	(0.056)	(0.065)	(0.032)	(0.028)
Jobs paying ≥115% of MW	0.53^{***}	0.5^{***}	-0.043	0.074^{***}	0.34^{***}	-0.18^{***}	0.46^{***}	0.067^{**}
	(0.041)	(0.031)	(0.028)	(0.016)	(0.051)	(0.059)	(0.029)	(0.027)
Jobs paying ≥120% of MW	0.32^{***}	0.32^{***}	-0.068^{**}	0.061^{***}	0.32^{***}	-0.17^{***}	0.41^{***}	0.072^{***}
	(0.037)	(0.028)	(0.031)	(0.022)	(0.044)	(0.052)	(0.026)	(0.023)
Jobs paying ≥150% of MW	0.12^{***}	0.11^{***}	-0.038	0.055^{***}	0.24^{***}	-0.12^{***}	0.3^{***}	0.057^{***}
	(0.038)	(0.04)	(0.034)	(0.014)	(0.04)	(0.032)	(0.02)	(0.014)
Obs	272,933	272,933	272,933	272,933	231,245	231,245	231,245	231,245
Year Quarter NAICS 4 FE	X	X	X	X	X	X	X	X
Firm FE	X	X	X	X	X	X	X	X

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$. Clustered standard errors in parentheses. Standard errors are clustered by the industry (NAICS 3 digit Sector) and cohort. Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. All regressions include controls for firm size at baseline and firm age. Change in wage rate in treated cohort is instrumented by GAP times an indicator for treated period. GAP measures percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.