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**Working Paper**

## Payroll, revenue, and labor demand effects of the minimum wage

Upjohn Institute Working Paper, No. 19-298

**Provided in Cooperation with:**

W. E. Upjohn Institute for Employment Research, Kalamazoo, Mich.

*Suggested Citation:* Jardim, Ekaterina; Van Inwegen, Emma (2019) : Payroll, revenue, and labor demand effects of the minimum wage, Upjohn Institute Working Paper, No. 19-298, W.E. Upjohn Institute for Employment Research, Kalamazoo, MI, <https://doi.org/10.17848/wp19-298>

This Version is available at:

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2019

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

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Upjohn Institute working paper ; 19-298

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## Citation

Jardim, Ekaterina, and Emma van Inwegen. 2019. "Payroll, Revenue, and Labor Demand Effects of the Minimum Wage." Upjohn Institute Working Paper 19-298. Kalamazoo, MI: W.E. Upjohn Institute for Employment Research. <https://doi.org/10.17848/wp19-298>

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

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February 2019

### **ABSTRACT**

We study the impact of the minimum wage hike in Seattle from \$9.47 to \$13 on wagebill, labor demand, and firm revenue using administrative data from the state of Washington. We show that the minimum wage affected businesses both at the intensive and extensive margins. At the intensive margin, businesses increased their labor costs and adjusted to the minimum wage by mildly reducing demand for low-wage jobs, but they largely did not pass the increase in labor costs to prices. At the extensive margin, the minimum wage led to higher rates of business exit and shifted the composition of entering businesses towards less labor-intensive businesses. Finally, we find that the extensive margin and the intensive margin effects were of the same order of magnitude, and were equally important for understanding the impacts of the minimum wage.

**JEL Classification:** J38, J23, J63

**Keywords:** minimum wage, extensive and intensive margin, channels of adjustment

**Acknowledgments:** We thank the Washington State Employment Security Department and the Washington State Department of Revenue for giving us access to the data, and Scott Bailey, Jeff Robinson, and Anneleise Vance-Sherman for helping us navigate the administrative records. We thank Hilary Wething for geocoding the payroll data. We thank the Laura and John Arnold Foundation, the Russel Sage Foundation, and the City of Seattle for funding and supporting the Seattle Minimum Wage Study. Partial support for this paper came from the W.E. Upjohn Institute for Employment Research through the Early Career Research Grant No. 17-155-12 to Ekaterina Jardim who worked on this paper prior to joining Amazon. We are grateful to the members of the Minimum Wage Study team, seminar participants at the Federal Reserve Bank of New York, Portland State University, University of British Columbia, University of Notre Dame, University of Washington, 2017 Annual Conference of the Western Economic Association International, 2018 Annual Meeting of the American Economic Association, as well as Paul Beaudry, Peter Brummund, Jeff Clemens, Brian Dillon, Andrew Foster, Eduardo Jardim, Mark Long, Alexandre Mas, and Jacob Vigdor for comments and suggestions. All results have been reviewed by the Washington State Employment Security Department to ensure that no confidential information was disclosed. All remaining errors are our own.

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In this paper we revisit the question of how businesses respond to the minimum wage using 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 \$11, and then to \$13.<sup>1</sup> We focus on two questions: 1) Did employers use the labor market or the product market as the primary channel of adjustment to the minimum wage? and 2) What was the role of the intensive margin effect (within-firm adjustment of the surviving firms) versus the extensive margin effect (business entry and exit)?

Our study draws on two linked confidential datasets on firms from the State of Washington: data on payroll records from Washington's Unemployment Insurance (UI) program and data on business revenue from the Washington Department of Revenue. These two datasets have several features that make them uniquely positioned for study of the impact of minimum wage on businesses' adjustment strategies. First, Washington is one of the four states in the United States that 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 the wagebill required to meet the new 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, providing a 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

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<sup>1</sup> The 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 these minimum wage schedules in detail in the next section.

as restaurants and retail, as many previous studies have had to do. Third, 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 product and labor market adjustments 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 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 had not been implemented. We argue that this assumption is reasonable 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 perform a falsification test by estimating the effect of a placebo ordinance passed in 2012 and find no effect of the placebo ordinance on wages.

We find that Seattle’s firms adjusted to the minimum wage increase primarily through the labor market channel. Unlike many previous U.S.-based studies, we do not observe a pass-through effect of the minimum wage to prices. We also show that these labor market adjustments operated along both the intensive and extensive margins. First, the minimum wage hike caused a mild reduction in the hours of low-wage jobs in surviving firms. We estimate that a 1 percent increase in wages induced by the minimum wage led to a 0.3–0.8 percent reduction in hours of low-wage jobs, defined as those paying less than 130 percent of the minimum wage. Next, the minimum wage hike increased the rate of business exits by 13 percent, accelerated the exit of

firms with a higher share of low-wage jobs, and shifted the composition of the entering firms towards less labor-intensive businesses. Together, the impacts at the intensive and the extensive margins resulted in a 0.6 percent uptick in total labor costs and a 1.9 percent loss in hours of low-wage jobs. These findings imply that the aggregate low-wage employment elasticity in Seattle was of the order of  $-2$ .

Although there is a vast literature on the aggregate employment effects of the minimum wage (for a comprehensive review, see Card and Krueger, 1995; Neumark and Wascher, 2010; Flinn, 2011; Belman and Wolfson, 2014), much less is known about the impact of the minimum wage on businesses. Prior studies produced mixed evidence on whether or not employers' profits decrease as a result of a minimum wage hike (Draca, Machin, and Van Reenen, 2011), although several papers documented increases in revenue in response to a minimum wage (Giuliano, 2013; Hirsch, Kaufman, and Zelenska, 2015; Brummund, 2017; Harasztosi and Lindner, 2018), and there are robust findings of a minimum wage pass-through to prices (Aaronson, French, and MacDonald, 2008; Allegretto and Reich, 2018). 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, Aaronson and Phelan (2019) have demonstrated that businesses cut jobs in routine occupations that can be easier to automate, and Horton (2017) has shown that employers in an online marketplace responded to the minimum wage by cutting hours worked and hiring more productive workers. 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 offset the rising labor costs and help to avoid reductions in employment. Finally, Aaronson et al. (2018) found that a minimum wage hike is

followed by a spike in entry and exit, suggesting that the minimum wage affects the composition of firms as well.

We contribute to this literature by providing evidence from a large minimum wage increase in the United States. To our knowledge, this is the first study to quantify the role of within-firm adjustment versus effects to business exit and entry in the adjustment to a minimum wage using U.S. data. We find that the within-firm adjustment of the surviving firms accounted for only one-third of the minimum wage impact on low-wage jobs, whereas two-thirds came from effects along the extensive margin.

## **INSTITUTIONAL BACKGROUND AND DATA**

### **Seattle's Minimum Wage Ordinance**

In June 2014, the City of Seattle passed a law raising the minimum wage in Seattle to \$15 over the following seven years. The law had several phase-in stages, allowing small firms more time to switch to the \$15 minimum wage as compared to large firms, giving employers tip credit, and introducing a lower minimum wage for employers who contribute towards medical benefits. The complete minimum wage schedule is presented in Table 1. The first phase-in period began in April 2015 and raised the minimum wage by 16.2 percent, from \$9.47 to \$11.<sup>2</sup> The second phase-in period began in January 2016 and raised the minimum wage to \$12 to as much as \$13, or by 9.1 percent to 18.2 percent, depending on the schedule.

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<sup>2</sup> Washington has a state minimum wage, which is indexed to inflation annually on January 1 of each year. Although the state minimum wage steadily grew from 2005 to 2016, on average it increased only by 2.4% in nominal terms. A complete record of the historical minimum wage in Washington State can be found at <http://www.ini.wa.gov/WorkplaceRights/Wages/Minimum/History/default.asp>.

**Table 1 Minimum Wage Under Seattle’s Minimum Wage Ordinance**

	Large employers <sup>a</sup>		Small employers	
	No benefits	With benefits <sup>b</sup>	No benefits or tips	Benefits or tips <sup>c</sup>
<i>Before Seattle MW Ordinance</i>				
January 1, 2015	\$9.47 <sup>d</sup>	\$9.47	\$9.47	\$9.47
<i>After Seattle MW Ordinance</i>				
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 <sup>e</sup>	\$13.50	\$13.00	\$11.00
January 1, 2018		\$15.00 <sup>f</sup>	\$14.00	\$11.50
January 1, 2019			\$15.00 <sup>g</sup>	\$12.00
January 1, 2019				\$13.50
January 1, 2019				\$15.00 <sup>h</sup>

<sup>a</sup> A large employer employs 501 or more employees worldwide, including all franchisees associated with a franchise or a network of franchises.

<sup>b</sup> Employers who pay towards medical benefits.

<sup>c</sup> 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.

<sup>d</sup> Before April 1, 2015 Seattle was subject to the WA minimum wage, which is indexed to inflation using CPI-W.

<sup>e</sup> For large employers, after the minimum wage reaches \$15.00, it is indexed to inflation using CPI-W for the Seattle-Tacoma-Bremerton Area.

<sup>f</sup> 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.

<sup>g</sup> 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.

<sup>h</sup> The minimum wage for small employers with benefits or tips is projected to converge with other employers by 2025.

In this paper, we focus on the first two phase-ins and study the period from 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 were available.<sup>3</sup> We investigate each phase-in period separately and compare estimates of the impact of the \$11 minimum wage and the \$13 minimum wage.<sup>4</sup>

<sup>3</sup> 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 our results are indeed driven by a response to the past minimum wage increase rather than by an anticipation effect of the upcoming one.

<sup>4</sup> Even though firms were on different schedules during each phase-in, for simplicity, we refer to the first phase-in period as implementing the \$11 minimum wage and to the second phase-in period as implementing the \$13 minimum wage. At the time of implementation, each of those wage levels was the highest minimum wage imposed by the ordinance on large employers that did not contribute towards health benefits.



## Data Sources

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

Though every state collects quarterly data on payroll and total employment to administer the UI tax, Washington is one of four states that also collect data on hours worked.<sup>5</sup> As a result, we can directly observe the hourly compensation that each firm paid before and after the minimum wage hike. The dataset spans over from 2005 to 2015, which allows us to track businesses longitudinally.<sup>6</sup> For each business, we observe the industry code at the NAICS 6-digit level, address of the firm, and wagebill and total hours worked for each worker who was on the payroll in a given quarter. The wagebill includes all compensation received by an employee, including tips and bonuses.<sup>7</sup> However, we do not have information on non-pecuniary benefits or other forms of compensation, such as stock.<sup>8</sup>

To determine if a business is covered by the Seattle's ordinance, we geocode its 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 arises from the fact that non-franchise businesses operating multiple stores can file a joint report for all their locations. As a result, we cannot observe which employees in these businesses work in Seattle and are therefore covered

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<sup>5</sup> The Employment Security Department uses the data on hours worked to determine UI eligibility, and as a result, the data on hours worked are considered to be very reliable. See Lachowska, Mas, and Woodbury (2018) for more details on the quality of the Washington data.

<sup>6</sup> Although payroll records are available for years before 2005, most of the business addresses in the earlier years are P.O. boxes rather than the physical addresses of businesses, which makes precludes us from determining if these businesses are covered by the Seattle Minimum Wage Ordinance.

<sup>7</sup> Although the 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.

<sup>8</sup> This limitation is most substantial insofar as we are unable to distinguish employers who pay health benefits because the ordinance specifies a lower minimum wage for employers that offer benefits.

by the wage ordinance and which work outside of Seattle. Including businesses not covered by the ordinance would mix treated and non-treated businesses and attenuate effects of the policy. To overcome this problem, we focus our analysis on single-location businesses. This restriction excludes large companies that own their branches, but it still allows us to study franchises—businesses with multiple locations that are owned independently. These single-location businesses constitute about 89 percent of all firms in Washington State and hire about 62 percent of all workers.<sup>9</sup> 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.

Even though our dataset contains information on Washington businesses located outside of Seattle, we only include businesses located in Seattle in our sample. We chose not to use the cross-border design popular in other minimum wage studies (e.g., Dube, Lester, and Reich, 2010) because the areas of Seattle-Bremerton-Tacoma Metro Area outside of the City of Seattle are a part of a common integrated labor market, and thus are likely to experience spillover effects of the Seattle minimum wage.<sup>10</sup> Therefore, businesses outside of Seattle cannot provide a clean control group because they were affected by Seattle minimum wages as well.

We merge the payroll data with quarterly data on sales collected by the Department of Revenue (DOR). Washington has a Business and Occupation tax on firms levied on receipts

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<sup>9</sup> See Jardim et al. (2017a) for a more detailed discussion on the distribution of single-site and multi-site businesses in the Washington UI data.

<sup>10</sup> In particular, Jardim et al. (2017b) showed that census tracts within a 40-minute drive from Seattle have seen abnormal wage growth and employment loss in low-wage jobs following the enactment of the Seattle Minimum Wage Ordinance, although these effects are smaller in magnitude than the minimum wage effect inside the Seattle city boundary.

from all business activities, measured as the value of products, gross proceeds of sale, or gross income of the business. Every business in Washington that 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.<sup>11</sup> The DOR collects gross income data quarterly, and also 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 that had five or more employees on average through their lifetime, as is common practice in firm-level studies.<sup>12</sup> Though most firms are very small (65 percent of all businesses in the data have fewer than five employees), these small firms employed only 5 percent of the workforce in Seattle in 2014. Finally, we also exclude from our analysis firms that contain likely reporting errors for 10 percent or more of their employees.<sup>13</sup> Table 2 shows the summary statistics on the remaining sample. We are able to find revenue matches for 67 percent of single-location businesses employing 83 percent of the workforce. Restricting our analysis to firms with five or more employees and excluding firms with a large share of reporting errors leads to dropping another 30 percent of firms and 10 percent of the workforce from our analysis. In the end, we are able to study firms that account for 70 percent of the workforce employed by single-location businesses in Seattle.

To study the impact of minimum wage on businesses, we split the data into cohorts as illustrated in Figure 1. We are interested in analyzing two treated cohorts: firms that were active

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<sup>11</sup> Washington State uses a unique Uniform Business Identifier (UBI) for most of reporting purposes, though the Employment Security Department 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.

<sup>12</sup> A similar sample restriction is used, for example, in Harasztosi and Lindner (2018) and Kahn and McEntarfer (2014).

<sup>13</sup> 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.

before and after the first minimum wage step-up in April of 2015, and firms that 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 second quarter of each calendar year and track firms for six subsequent quarters. As a result, the 2014 cohort starts in the second quarter of 2014, when the Seattle Minimum Wage Ordinance was passed, and ends in the fourth 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 second quarter of 2015, the first period after the implementation of the \$11 minimum wage, and ends in the third 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 second 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.<sup>14</sup> 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.

**Table 2 Summary Statistics on Seattle Firms Included and Excluded from the Analysis**

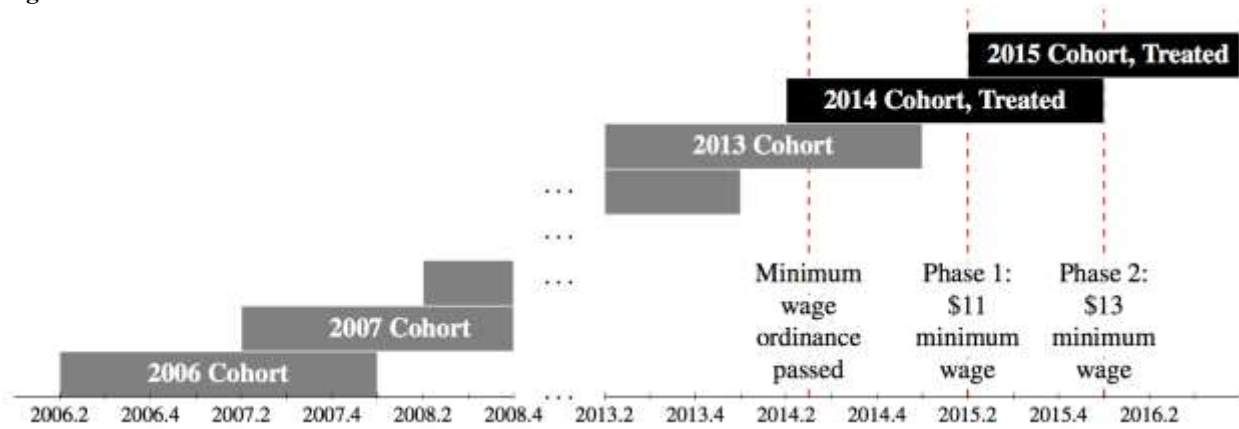
	Average number of firms per cohort	Average number of workers per cohort	Firm averages			
			Number of employees	Wage rate, \$	Hours per worker	Age, years
A. All single-location businesses in Seattle	21,162	279,094	16.88 (121.28)	32.77 (59.94)	336.99 (150.33)	
B. Firms with available revenue data	14,358	231,684	19.30 (105.07)	29.80 (45.91)	339.39 (140.64)	11.18 (9.63)
C. B and firms with 5 and more employees	6,347	204,159	33.85 (143.78)	28.92 (21.83)	356.19 (119.80)	12.57 (10.34)
D. C and firms in the analysis sample	5,888	195,979	33.34 (144.94)	28.93 (21.87)	354.47 (119.90)	12.71 (10.38)

NOTES: 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. Standard deviation reported in parentheses.

SOURCE: UI records from Washington State, 2005–2016.

<sup>14</sup> The state minimum wage is indexed to inflation annually on January 1.

Figure 1 Definition of Cohorts



## DESCRIPTIVE EVIDENCE

Before evaluating the causal impact of the minimum wage on businesses, we examine the distribution of the costs of compliance across firms and demonstrate how the wage distribution changed after the minimum wage hikes.

### 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:<sup>15</sup>

$$(1) \quad GAP_{ic} = \frac{\sum_n h_{inc} \max\{MW - w_{inc}, 0\}}{\sum_n h_{inc} w_{inc}}$$

<sup>15</sup> This measure of the cost of compliance has been widely used in the literature (e.g., Draca, Machin, and Van Reenen, 2011; Hirsch, Kaufman, and Zelenska, 2015; Brummund, 2017), and was first introduced by Card and Krueger (1994).

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

The Seattle Minimum Wage Ordinance establishes different minimum wage schedules for firms depending on their size and whether they contribute towards health benefits (see Table 1 for details). Unfortunately, we cannot determine the exact schedule that applies to each firm in our data because the City of Seattle counts firm size based on worldwide employees for all businesses in a chain or a network of franchises. We are able to compute the firm size in Washington, but we have no data on business affiliation and thus are unable to identify businesses belonging to networks of franchises or national branches. The second limitation of our data is that we cannot observe whether a job pays health benefits. We estimate the impact of the Seattle's minimum wage by assigning all firms to the highest minimum wage schedule, which applies to businesses with 501 or more employees worldwide that do not provide health benefits.<sup>16</sup> 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. By using this procedure, however, we will never incorrectly assume that businesses are not exposed to the minimum wage hike.

To establish that *GAP* is a credible measure of the costs of compliance, we first examine changes in *GAP* over time. To do so, we update *GAP* every period as wages and hours worked

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<sup>16</sup> During the first phase-in period, the highest minimum wage was \$11/hour; during the second phase-in, it was \$13/hour.

change at each firm, and compare it to GAP at the baseline. If GAP was closely related to the minimum wage, we would expect GAP to remain relatively stable in the years before Seattle Minimum Wage Ordinance. However, after it went into effect, we would expect companies to comply with the policy, in which case we would see GAP approach zero. This is, in fact, exactly what we see in our data (see Figure A.1). GAP exhibits small fluctuations over time in 2005–2013, but remains very stable. In 2015–2016 GAP declines sharply by 100–125 percent around the quarter when each minimum wage phase-in was implemented, which corresponds to paying all workers the minimum wage or more.

**Table 3. Costs of compliance with the minimum wage across firms.**

	\$11 Minimum wage 2014 cohort	\$13 Minimum wage 2015 cohort
Number of firms	6,327	6,577
Exposed firms (GAP>0), %	39.4	51.06
GAP among firms with GAP>0, %		
Mean	2.05	3.44
Standard deviation	3.49	5.09
25th percentile	0.08	0.24
Median	0.47	1.15
75th percentile	2.27	4.40

NOTE: Sample: Surviving single-location firms that had five or more workers on payroll on average during the firm’s lifetime and have revenue data. GAP measures percentage increase in total wagebill required to meet the new minimum wage, assuming jobs and hours remain the same.

SOURCE: UI records from WA state, 2005–2016.

Table 3 shows the average costs of compliance in Seattle for both phase-in periods. At the time of the passage of the minimum wage ordinance in the second quarter of 2014, only 39 percent of single-location businesses in Seattle had some workers who were paid less than \$11 per hour, and on average, exposed firms were required to increase labor costs by 2 percent. In the second quarter of 2015, before the implementation of the \$13 minimum wage, the share of exposed firms was larger, 51 percent, and the average required increase in labor costs was 3.4

percent, but about half of the businesses were still not exposed to the minimum wage hike.<sup>17</sup> However, the costs of compliance were unequally distributed even among exposed firms. In particular, half of the exposed firms needed to increase their labor costs by less than 1.5 percent to comply with both increases, while 25 percent of the exposed firms were required to raise their labor costs by 2.5 percent or more.

### **Changes in the Distribution of Hours Worked in Low-wage Jobs**

We examine changes to the wage distribution to verify that the Seattle Minimum Wage Ordinance led to substantial changes in the labor market. Figure 2 shows the histogram of hours worked in Seattle at jobs paying less than \$25 per hour 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 second quarter of 2012 to the second quarter of 2013 (i.e., one year before the passage of the minimum wage ordinance). The center panel compares the wage distribution in the second quarter of 2014, when the ordinance was passed, with the wage distribution in the second 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. Finally, the right panel compares the wage distribution in the second quarter of 2015 to the second quarter of 2016 to demonstrate the effect of the \$13 minimum wage, which went in effect on January 1, 2016. Both the center and the right panels of the Figure 2 show that hours worked in jobs paying below the new minimum wage declined dramatically, indicating employers' compliance with the minimum wage law. Furthermore, we see the large

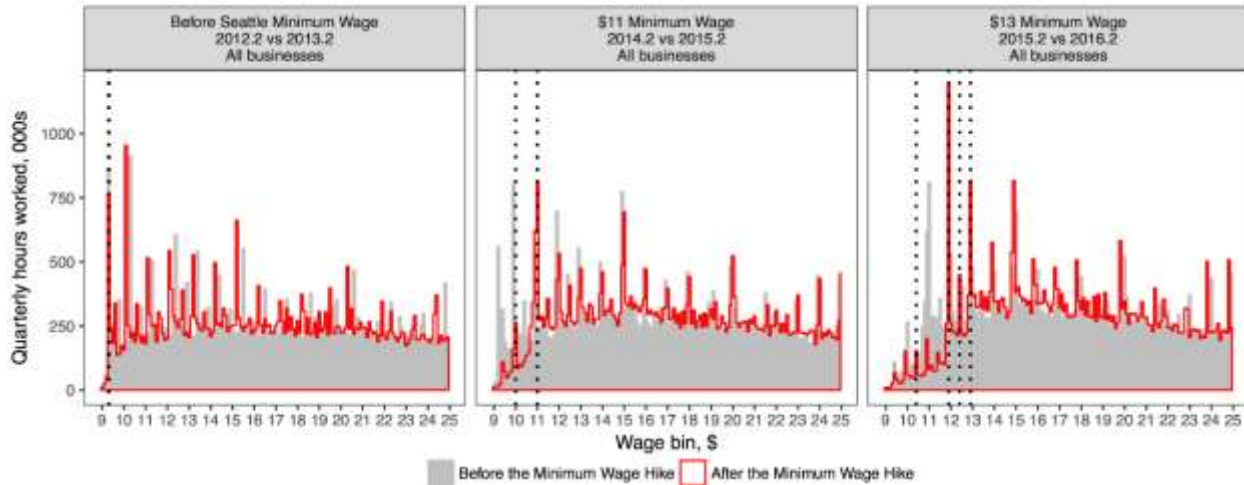
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<sup>17</sup> This fact holds even in heavily exposed industries and cannot be explained by differences in pay between industries. Table A.1 breaks down exposure by industry. It demonstrates that, in the most affected industries—food and accommodation services and retail trade—27–40 percent and 10–20 percent of businesses, respectively, already paid their workers more than the new minimum wage before it was implemented. Limited-service restaurants were by far the most affected industry, with less than 10 percent of employers having zero costs of compliance and the average cost of compliance being 5–8 percent of the wagebill.



visible spikes 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.<sup>18</sup>

**Figure 2 Histogram of Hours Worked in Low-wage Jobs in Seattle Before and After the Minimum Wage Hikes**



NOTE: Sample: Surviving single-location firms that had five or more workers on payroll on average during the firm’s lifetime and have revenue data. Wages have been adjusted for inflation using CPI-W. Dotted lines show the minimum wage schedules. The left panel (“Before Seattle Minimum Wage”) shows the placebo comparison where the gray area is the earlier date and the red is the later date.

SOURCE: UI records from WA state, 2005–2016.

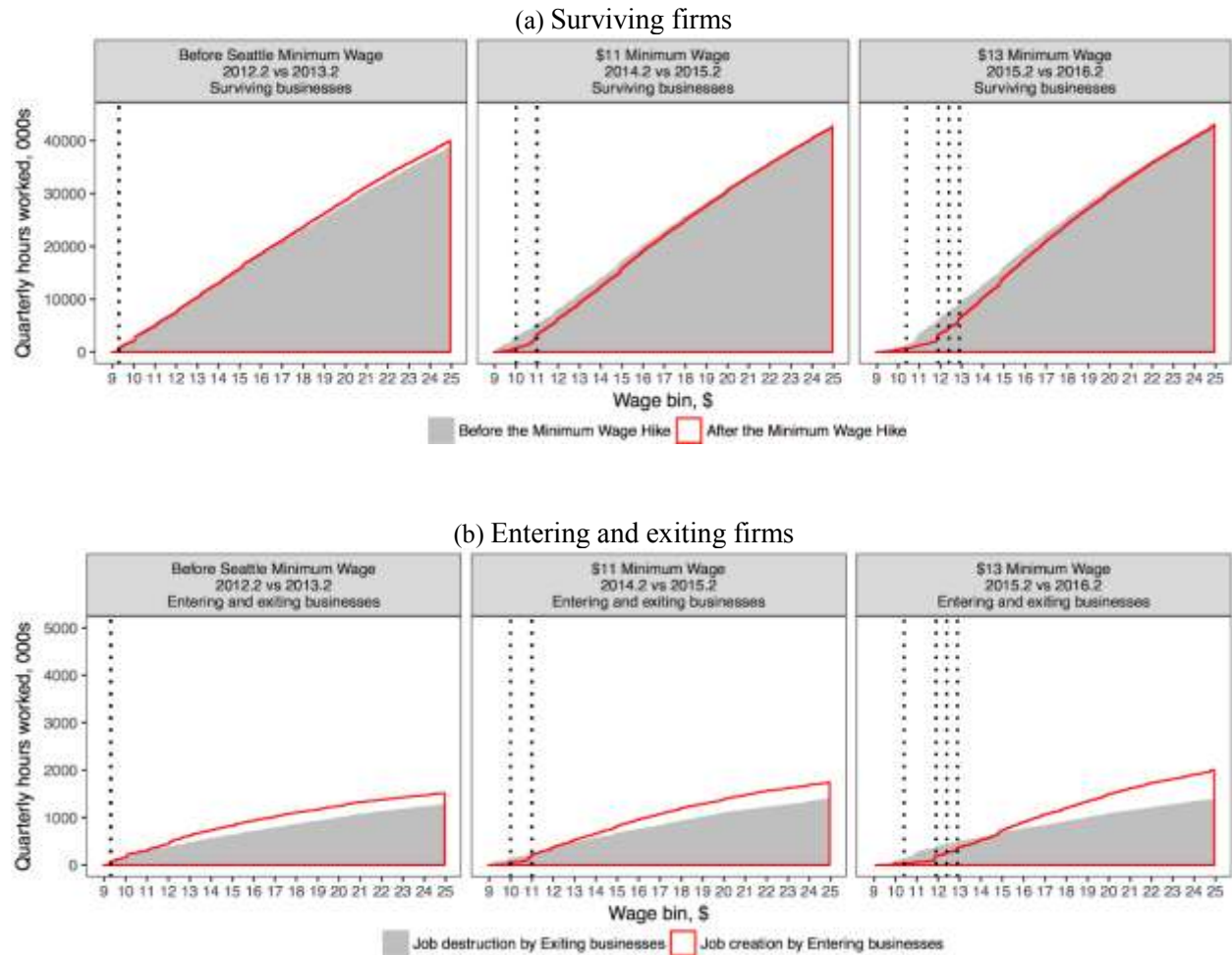
Our examination of the histogram of hours worked does not, however, permit us to gage whether the total number of hours worked in low-wage jobs declined, grew, or remained the same. To shed light on the changes to total number of hours worked in low-wage jobs, Figure 3 plots the cumulative distribution of hours worked at or below each wage level and shows the changes for the same time periods shown in Figure 2. Figure 3a shows hours worked in surviving businesses, defined as businesses that were listed as active in the DOR data both in the “pre” and “post” periods (e.g., the second quarter of 2012 and the second quarter of 2013 for the left panel). Figure 3b shows hours worked in exiting businesses (i.e., those that were active in the

<sup>18</sup> The figure shows some jobs paying below the minimum wage. Some of these observations likely correspond to trainees, teenage workers, and workers with disability who are required to be paid at least 85 percent of the minimum wage. In addition, some of these observations occur due to the measurement error in hours worked.

“pre” period but closed by the “post” period) and in entering businesses (i.e. those that were inactive in the “pre” period but became active by the “post” period). The figure clearly shows that though the total number of hours worked in jobs paying less than \$25 remained approximately the same in surviving businesses, but there were substantially fewer hours worked in jobs with lower wages. While we would expect the jobs paying less than the minimum wage (i.e., \$11 or \$13 per hour depending on the phase-in period) to become increasingly uncommon, the declines in hours worked propagate much farther than \$11 or \$13 per hour, respectively. These effects were absent in 2012–2013 and therefore were most likely associated with the minimum wage ordinance. This shift suggests that surviving businesses either upgraded wages of workers paid above the minimum wage as well to decompress the wage distribution, or they shifted away from less productive low-paid workers towards more productive workers that received higher wages. We will probe these two hypotheses in a later section, where we discuss the impact of the minimum wage on within-firm adjustments of surviving businesses.

Figure 3b shows that entering businesses created more jobs than exiting businesses destroyed, clearly indicating that Seattle’s economy was growing from 2012 to 2016. After both minimum wage hikes, entering businesses mostly stopped adding jobs paying less than the highest minimum wage, again showing compliance with the city’s laws. However, after the hike to \$13, entering businesses created fewer jobs paying up to \$15 per hour than those that were destroyed by exiting businesses. Since the net growth in jobs paying less than \$25 was still positive, this trend suggests that the minimum wage law did not slow down the rate of business entry, but it might have affected the type of business that was profitable despite higher labor

**Figure 3 Cumulative Hours Worked in Low-wage Jobs in Seattle Before and After the Minimum Wage Hike**



NOTE: Sample: Surviving single-location firms that had five or more workers on payroll on average during the firm’s lifetime and have revenue data. Wages have been adjusted for inflation using CPI-W. Dotted lines show the minimum wage schedules. The left panel (“Before Seattle Minimum Wage”) shows the placebo comparison where the gray area is the earlier date and the red is the later date.

SOURCE: UI records from WAstate, 2005–2016.

costs. We will probe this hypothesis further when we study the causal impact of the minimum wage on business entry and exit in a later section.

## CONCEPTUAL FRAMEWORK

Before we move to the empirical analysis, we outline the channels through which the minimum wage can impact firms’ revenue, wagebill, and labor demand. We can expect the

minimum wage to operate along the intensive and extensive margins. Intensive margin effects occur through within-firm adjustment in surviving firms, whereas extensive margin effects occur via business entry and exit, and via changes to the composition of surviving, entering, and existing businesses. To see how these effects propagate, consider the period-to-period growth rate in total hours worked, denoted by  $H$ . The percentage growth in hours worked, denoted by  $\Delta H/H_0$ , can be decomposed into the following components:

$$(2) \quad \frac{\Delta H_t}{H_0} = \underbrace{r_{Entry}}_{\substack{\checkmark \\ \text{Entry} \\ \text{rate}}} \underbrace{\theta_h^{Entry}}_{\substack{\checkmark \\ \text{Type of} \\ \text{entering} \\ \text{firm}}} + (1 - r_{exit}) \underbrace{\theta_h^{Surv}}_{\substack{\checkmark \\ \text{Survival} \\ \text{rate}}} \underbrace{\Delta H_t^{Surv}/H_0^{Surv}}_{\substack{\checkmark \\ \text{Type of} \\ \text{surviving} \\ \text{firm}}} - r_{Exit} \underbrace{\theta_h^{Exit}}_{\substack{\checkmark \\ \text{Exit} \\ \text{rate}}} \underbrace{\theta_h^{Exit}}_{\substack{\checkmark \\ \text{Type of} \\ \text{existing} \\ \text{firm}}}$$

where  $\Delta H_t = H_t - H_0$  shows the change in hours worked in all businesses between period 0 and period  $t$ ,  $H_0$  shows the number of hours worked in period 0,  $r_{entry} = N_{entry}/N_0$  is the entry rate relative to the number of businesses ( $N_0$ ) at the baseline,  $r_{exit} = N_{exit}/N_0$  is the exit rate, and parameters  $\theta_h^{Surv}$ ,  $\theta_h^{Entry}$ , and  $\theta_h^{Exit}$  capture the composition of surviving, entering, and existing businesses, respectively. Each of these parameters is defined as the ratio of average hours ( $\bar{h}_0^{Surv}$ ) at the baseline in the respective group (e.g., surviving businesses) to the average hours of all businesses ( $\bar{h}_0$ ) active at the baseline. For example, the type of surviving business, denoted by  $\theta_h^{Surv}$ , is defined as  $\theta_h^{Surv} = \bar{h}_0^{Surv}/\bar{h}_0$ , where  $\bar{h}_0$  is the average number of hours in all active firms at the baseline, and  $\bar{h}_0^{Surv}$  is the average number of hours at the baseline in businesses that survived through the last quarter in the cohort. The types of entering and existing firms, denoted by  $\theta_h^{Entry}$  and  $\theta_h^{Exit}$  respectively, are defined similarly. This decomposition shows that the total effect of the minimum wage is a combination of the effects of each component of Equation 2. In the empirical part of the paper, we will analyze the effect on each component separately. The rest

of this section outlines the market forces that determine the magnitude of the intensive margin and extensive margin adjustments.

At the intensive margin, the minimum wage raises the costs of employing low-paid labor to firms and increases firms' marginal costs, but it can reduce turnover and help firms save on vacancy-filling costs. If the reduction in turnover is large enough, it can offset the increase in costs of labor. However, if the reduction in turnover is not large enough to prevent firms' marginal costs from rising, a higher minimum wage will incentivize businesses to substitute away from low-paid labor to dampen the effect of the minimum wage on marginal costs, and to pass the remaining increase in marginal costs to consumers in the form of higher prices.

We can think of the single-location businesses in Seattle as small firms selling heterogeneous goods and operating in a monopolistically competitive market, similar to the set-up in Aaronson and French (2007) and Draca, Machin, and Van Reenen (2011). 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  $j$ , and  $q_i$  is the quantity of the good sold by firm  $i$ . Then, the effect of the minimum wage on revenue can be written as follows:

$$(3) \quad \varepsilon_{Revenue} = \frac{\% \Delta R}{\% \Delta w} = (1 - \eta) \varepsilon_p + (\eta - \rho) \varepsilon_P$$

where  $\eta > 0$  is the absolute value of the consumer demand elasticity with respect to own price,  $\rho$  is the absolute value of the consumer demand elasticity with respect to the market price,  $\varepsilon_p$  is the elasticity of own price with respect to average wage paid by the firm, and  $\varepsilon_P$  is the effect of the wage increase on the market price.<sup>19</sup>

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<sup>19</sup> 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 3 shows that a 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 decreases in revenue and large decreases in output if firms increase prices after a 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 the decline in consumer demand will be smaller.

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 shown in Hamermesh (1993) and Aaronson and French (2007). 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:

$$(4) \quad \varepsilon_L = \theta_L - \eta\varepsilon_p + (\eta - \rho)\varepsilon_P - \frac{s_H}{1-\pi}\sigma_{HL} - \frac{1-\pi-s}{1-\pi}\sigma_{KL}$$

$$(5) \quad \varepsilon_H = \theta_H - \eta\varepsilon_p + (\eta - \rho)\varepsilon_P + \frac{s_H}{1-\pi}\sigma_{HL}$$

where  $s_H$  is the share of wagebill to high-wage jobs in revenue,  $s$  is the share of wagebill in revenue,  $\pi$  is the profit margin,  $-\sigma_{HL} < 0$  is the elasticity of substitution between low-wage and high-wage jobs,  $-\sigma_{KL} < 0$  is the elasticity of substitution between low-wage jobs and non-labor inputs, and  $\theta_L$  and  $\theta_H$  are the benefits from decreased turnover of low-wage and high-wage labor.

Finally, at the extensive margin, the increase in the minimum wage can lead to a change in the composition of firms. First, it can push less productive firms out of the market if the increase in marginal costs makes them unprofitable. Second, a minimum wage increases the marginal costs of all firms, including the marginal costs of new businesses. As a result, some businesses will find that it is no longer profitable to enter the market. Because the minimum wage raises the costs of low-wage jobs, we would expect that the marginal costs of labor-intensive businesses would be particularly affected. Therefore, we can expect that the increases in the minimum wage might shift the composition of entering businesses towards less labor-intensive businesses.

## **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 both at the intensive margin (i.e., to the wagebill and hours worked in surviving businesses) and at the extensive margin (i.e., to the rates of entry and exit and the composition of entering and exiting firms). We define surviving businesses as those that were active in the baseline quarter and remained open in the last quarter of each cohort, entering businesses as those that opened between the baseline quarter and the last quarter of the cohort, and exiting businesses as those that closed between the baseline quarter and the last quarter.<sup>20</sup>

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<sup>20</sup> Cohorts used to study the \$11 minimum wage span six quarters, and cohorts used to study the \$13 minimum wage span five quarters.

We start by studying the effect of the minimum wage hike on surviving firms. We are interested in effects on inflation-adjusted average hourly wage rate paid by each firm<sup>21</sup>, 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:<sup>22</sup>

$$(6) \quad \Delta y_{ict} = \frac{y_{ict} - y_{ict_0}}{0.5(y_{ict} + y_{ict_0})}$$

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 second 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 with similar cost of compliance in the prior cohorts. We estimate the following difference-in-differences regression:

$$(7) \quad \Delta y_{ict} = \alpha_t GAP_{ic} + \beta_t GAP_{ic} T_{ic} + \gamma_t X_{ic} + \theta_{jct} + \mu_i + \varepsilon_{ict}$$

where  $i$  denotes the individual firm,  $c$  is cohort,  $t$  denotes quarter, and  $j$  denotes industry (at the NAICS 4-digit level).  $X_{ic}$  is a vector of controls,  $T_{ic}$  is the indicator for the treated cohort,  $\theta_{jct}$  is the industry-cohort-quarter fixed effect,  $\mu_i$  is the firm fixed effect, and  $\varepsilon_{ict}$  is the error term. For the treated cohort,  $GAP_{ic}$  shows the cost of compliance with the minimum wage. For control cohorts,  $GAP_{ic}$  shows the pseudo-costs of compliance, that is, the cost a business would have paid if the minimum wage was introduced in that cohort. Controlling for the pseudo-cost of compliance in the pre-policy period allows us to capture normal difference between high-paying

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<sup>21</sup> We express wage rates and earnings in constant prices of the second quarter of 2015 using the national CPI-W to match Washington's laws on inflation adjustment of the state minimum wage.

<sup>22</sup> A 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.



businesses, which would have had low costs of compliance, and low-paying businesses, which would have had high costs of compliance. Our coefficient of interest is  $\beta_t$ , which denotes the effect that a one percent increase in costs of compliance has on the outcomes of interest in the treated firms.  $\alpha_t$  shows the difference between low-paying and high-paying businesses in the pre-policy period, and  $\gamma_t$  shows the normal differential trends across small vs. large and young vs. old businesses. Since we are interested in the average effect of the minimum wage on businesses, we do not weight the regression in Equation 7 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 the minimum wage increase by estimating Equation 7 separately for the minimum wage hike to \$11 and to \$13. To estimate the impact of the \$11 minimum wage, we compare firms that were active in the second 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 second 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  $\theta_{jq}$ . Thus, we compare firms with different levels of exposure to the minimum wage within the same cohort, industry, and quarter since the baseline. We also include firm fixed effects  $\mu_i$  to capture unobserved

heterogeneity across firms.<sup>23</sup> 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 the 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 <1 year, 1–10, and >10 years at baseline following the classification in Haltiwanger, Jarmin, and Miranda [2013]), and allow the coefficient  $\gamma_i$  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  $\beta$  as the impact of exposure to the minimum wage hike, where  $\beta = 1$  indicates that a one percentage point increase in costs of compliance with the minimum wage, measured by *GAP*, leads to a one percentage point increase in outcome *y*.

Our difference-in-differences regression in Equation 7 estimates the difference between firms with positive costs of compliance and firms with zero costs of compliance in 2015–2016, when the Seattle Minimum Wage Ordinance was enacted, using the 2006–2013 cohorts as a 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 that 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. 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

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<sup>23</sup> Fixed effect specification is estimated in Stata using a fast algorithm written and implemented by Correia (2016).

Minimum Wage Ordinance). We see no effect of the pseudo-ordinance on the wage rate and wagebill of the firms with a positive cost of compliance. Finally, we demonstrate that regression specifications that do not include data prior to the passage of the minimum wage or data for unexposed firms fail to pass falsification tests.

**Table 4 Balance Between Control and Treated Cohorts**

	Control cohorts (2005–2013)		Treated cohort (2014 or 2015)		Difference-in- differences	P-value
	GAP=0	GAP>0	GAP=0	GAP>0		
<i>Panel A: 2014 Cohort, subject to \$11 Minimum wage (MW)</i>						
Cost of compliance (GAP), %	0.00	1.96	0.00	1.85	-0.107	0.059
Number of workers	25.83	46.93	26.24	50.14	2.798	0.237
Age, years	13.23	12.03	14.73	13.09	-0.442	0.070
Average wage rate, \$ (2015 prices)	34.7	19.5	34.9	19.5	-0.158	0.661
Revenue per hour, \$ (2015 prices)	238	96	215	92	18.642	0.120
Wagebill over revenue, %	30.9	30.5	31.8	31.8	0.293	0.518
Share of jobs paying <120% MW in hours, %	4.5	41.9	4.5	40.8	-1.056	0.077
Share of jobs paying <125% MW in hours, %	5.9	45.2	5.7	43.8	-1.237	0.043
Share of jobs paying <130% MW in hours, %	7.5	48.2	7.5	47.3	-0.904	0.152
Exit rate	3.31	4.94	3.23	4.73	-0.131	0.778
Entry rate	2.58		2.38		-0.199	0.481
Observations	26,677	16,790	3,603	2,372		
<i>Panel B: 2015 Cohort, subject to \$13 Minimum wage</i>						
Cost of compliance (GAP), %	0.00	5.07	0.00	3.19	-1.883	0.000
Number of workers	23.36	42.16	27.49	47.50	1.252	0.634
Age, years	13.19	12.36	15.09	13.25	-1.012	0.000
Average wage rate, \$ (2015 prices)	38.0	21.5	38.5	21.7	-0.397	0.472
Revenue per hour, \$ (2015 prices)	276	110	238	99	27.604	0.122
Wagebill over revenue, %	31.1	30.6	31.6	31.7	0.702	0.144
Share of jobs paying <120% MW in hours, %	5.2	46.8	6.1	47.2	-0.618	0.293
Share of jobs paying <125% MW in hours, %	6.9	49.6	8.7	50.6	-0.753	0.220
Share of jobs paying <130% MW in hours, %	9.0	52.5	10.5	53.3	-0.589	0.351
Exit rate	3.03	4.48	3.19	5.77	1.134	0.013
Entry rate	2.48		2.25		-0.225	0.504
Observations	19,335	24,286	3,005	3,106		

NOTE: Sample: Single-location firms that had five or more workers on payroll on average during the firms' lifetime and have revenue data. 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. Differences-in-differences and P-values show the difference in differences between exposed and non-exposed firms in treated and control cohorts.

SOURCE: UI records from WA state, 2005-2016.

The key identifying assumption for the regression in Equation 7 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 the 2014–2015 cohorts as in the 2006–2013 cohorts after adjusting for the market-wide trends. Table 4 compares employers that were exposed to the minimum wage to employers that had no workers paid below the new minimum. As expected, firms exposed to the minimum wage had lower average hourly wages and lower revenue per hour. However, the treated low-paying firms were comparable to the low-paying firms in the control cohorts in size, age, and average wage rate, which suggests that our estimates should not be driven by a different composition of firms in 2015–2016 as compared to the earlier cohorts.

After studying the effect of the minimum wage on surviving firms, we turn to the impact on business entry and exit. We estimate the effect of the minimum wage on the probability of exit in the same way as we estimate the impact of the minimum wage on surviving firms, except that we do not include firm fixed effects in these regressions. To trace the effects on business entry, we use the variation in exposure to the minimum wage across industries rather than across firms. For each NAICS 4-digit industry, we calculate the average costs of compliance  $GAP_{jc}$  the same way we calculated the costs of compliance for each firm. Then, we regress the entry rate in each industry on the industry’s exposure to the minimum wage using the following difference-in-differences specification:

$$(8) \quad Entry_{jct} = \alpha_t GAP_{jc} + \beta_t GAP_{jc} T_{jc} + \theta_{ct} + \varepsilon_{jct}$$

where  $Entry_{jct} = N_{jct}^{entry} / N_{jc0}$  is the ratio of the number of businesses in industry  $j$  that entered between period 0 and period  $t$  to the number of businesses in that industry in the baseline quarter.

Finally, we also investigate the minimum wage effects on the type of entering and exiting businesses by comparing mean outcomes in those firms to mean outcomes of all active businesses at the baseline. For example, the dependent variable for exiting firms in this regression is defined as  $y_i^{exit} / \bar{y}_0$ , where  $y^{exit}$  is the outcome at the baseline of business  $i$  that closed before the last quarter of the cohort, and  $\bar{y}_0$  is the mean outcome among all businesses that were active in the baseline quarter of the cohort. Then we estimate the effect of the minimum wage on the composition of existing firms using the baseline specification (Eq. 7). The outcome of this regression shows whether exiting firms had unusually high hours, wagebills, and revenue after the minimum hike as compared to the exiting firms in 2005–2013. We run a similar regression for entering firms using the regression specification in Equation 8.

## **WITHIN-FIRM ADJUSTMENT OF SURVIVING BUSINESSES**

### **Impact on Wages**

We start by examining the effect of the minimum wage on the average wage rates paid by a firm, estimated using Equation 7. The goal of this analysis is to establish that our data and our identification strategy capture the direct, intended effect of the minimum wage—the increase in wages.

We define an hourly wage rate as the average hourly compensation paid by the firm  $i$ , calculated as the quarterly wagebill divided by quarterly hours worked. Tables 5 and 6 show the estimated results for the \$11 and \$13 wage rates, respectively. We test four specifications. First, we estimate the effect on the sample of the treated businesses using only the treated cohorts, that is, businesses that were active in the baseline quarter and had positive costs of compliance with the minimum wage (column 1). Second, we estimate the effect on the sample of the treated

**Table 5 Effect of the \$11 Minimum Wage on Average Wages**

	Treatment				Placebo			
	(1)	(2)	(3)	(4) <sup>a</sup>	(5)	(6)	(7)	(8)
	Treated cohort GAP>0	Treated cohort All firms	All cohorts All firms	All cohorts All firms	Pseudo Treated cohort GAP>0	Pseudo Treated cohort All firms	All cohorts All firms	All cohorts All firms
<i>Panel A: Timing of the effect</i>								
$GAP \times t = -3$	0.00 (0.06)	0.12*** (0.05)	-0.59*** (0.05)	-0.39*** (0.06)	0.26*** (0.06)	0.34*** (0.06)	-0.18*** (0.06)	0.06 (0.07)
$GAP \times t = -2$	-0.13* (0.08)	-0.28*** (0.07)	-0.45*** (-0.08)	-0.25*** (0.08)	0.01 (0.08)	-0.15** (0.07)	-0.19*** (0.07)	0.04 (0.08)
$GAP \times t = -1$	0.18** (0.09)	0.11 (0.08)	-0.25*** (0.08)	-0.04 (0.08)	0.3*** (0.08)	0.38*** (0.07)	-0.17** (0.08)	0.07 (0.08)
$GAP \times t = 0$	0.97*** (0.10)	1.10*** (0.09)	0.49*** (0.09)	0.69*** (0.09)	0.42*** (0.10)	0.58*** (0.08)	-0.14 (0.09)	0.10 (0.08)
$GAP \times t = 1$	1.10*** (0.10)	1.20*** (0.09)	0.67*** (0.09)	0.87*** (0.09)	0.45*** (0.10)	0.60*** (0.09)	-0.13 (0.09)	0.11 (0.09)
$GAP \times t = 2$	0.81*** (0.11)	0.70*** (0.10)	0.73*** (0.09)	0.93*** (0.09)	0.24** (0.11)	0.10 (0.10)	-0.07 (0.10)	0.17* (0.10)
Obs	13,242	33,846	276,161	276,161	13,757	33,072	208,751	208,751
R <sup>2</sup>	0.09	0.06	0.06	0.24	0.06	0.05	0.06	0.20
<i>Panel B: Average effect</i>								
$GAP \times t \geq 0$	0.95*** (0.09)	1.00*** (0.08)	0.69*** (0.08)	0.89*** (0.07)	0.26*** (0.08)	0.41*** (0.08)	-0.08 (0.08)	0.11 (0.07)
Obs	13,242	33,846	276,161	276,161	13,487	33,072	208,751	208,751
R <sup>2</sup>	0.09	0.06	0.06	0.24	0.06	0.04	0.06	0.26
Year-quarter- industry FE			X	X			X	X
Firm FE				X				X

NOTE: \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ . Clustered standard errors in parentheses. Standard errors are clustered by the industry (NAICS 3-digit sector) and cohort (if more than one cohort). Sample: Surviving single-location firms that had five or more workers on payroll on average during the firm's lifetime and have revenue data. All regressions include controls for firm size at baseline and firm age. GAP measures the percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

<sup>a</sup> Columns 3, 4, 7, and 8 include cohort-quarter-industry fixed effects (FE) from 2005–2016; columns 4 and 8 also include firm FEs.

SOURCE: UI records from WAstate, 2005–2016.

cohorts on all of the cohorts; that is, we include businesses with both with zero and positive costs of compliance. Finally, we run the model on the sample of all businesses in the data from 2005 to 2016, and include cohort-industry-quarter fixed effects (column 3) and cohort-industry-quarter fixed effects and firm fixed effects (column 4). We also show the results of the falsification tests in columns (5) to (8) for the same respective categories to demonstrate that our results are unlikely to be driven by changes in Seattle's economy that occurred at the same time as the

**Table 6 Effect of the \$13 Minimum Wage on Average Wages**

	Treatment				Placebo			
	(1)	(2)	(3)	(4) <sup>a</sup>	(5)	(6)	(7)	(8)
	Treated cohort GAP>0	Treated cohort All firms	All cohorts All firms	All cohorts All firms	Pseudo-treated cohort GAP>0	Pseudo-treated cohort All firms	All cohorts All firms	All cohorts All firms
<i>Panel A: Timing of the effect</i>								
$GAP \times t = -2$	0.13*** (0.04)	0.18*** (0.04)	-0.09** (0.04)	0.26*** (0.05)	0.12*** (0.02)	0.15*** (0.02)	-0.06** (0.02)	0.02 (0.03)
$GAP \times t = -1$	0.01 (0.05)	-0.11** (0.05)	-0.21*** (0.04)	0.15*** (0.05)	-0.03 (0.03)	-0.062** (0.03)	-0.06** (0.03)	0.02 (0.03)
$GAP \times t = 0$	0.52*** (0.05)	0.50*** (0.05)	0.37*** (0.04)	0.72*** (0.06)	0.17*** (0.03)	0.18*** (0.03)	-0.05 (0.03)	0.03 (0.03)
$GAP \times t = 1$	0.56*** (0.05)	0.66*** (0.05)	0.45*** (0.05)	0.80*** (0.06)	0.20*** (0.03)	0.26*** (0.03)	-0.027 (0.03)	0.05* (0.03)
$GAP \times t = 2$	0.58*** (0.06)	0.66*** (0.05)	0.50*** (0.05)	0.85*** (0.06)	0.22*** (0.04)	0.28*** (0.03)	-0.01 (0.03)	0.07** (0.03)
Obs	14,685	29,235	235,325	235,325	16,255	28,150	177,690	177,690
R <sup>2</sup>	0.06	0.04	0.05	0.22	0.05	0.04	0.05	0.24
<i>Panel B: Average effect</i>								
$GAP \times t < 0$	0.07* (0.04)	0.04 (0.04)	-0.15*** (0.04)	0.20*** (0.05)	0.044* (0.02)	0.045** (0.02)	-0.062** (0.02)	0.02 (0.03)
$GAP \times t \geq 0$	0.55*** (0.05)	0.61*** (0.05)	0.44*** (0.04)	0.79*** (0.06)	0.19*** (0.03)	0.24*** (0.03)	-0.026 (0.03)	0.053* (0.03)
Obs	14,685	29,235	235,325	235,325	16,255	28,150	177,690	177,690
R <sup>2</sup>	0.06	0.04	0.05	0.22	0.05	0.04	0.05	0.24
Year-quarter- industry FE			X	X			X	X
Firm FE				X				X

NOTE: \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ . Clustered standard errors in parentheses. Standard errors are clustered by the industry (NAICS 3-digit sector) and cohort (if more than one cohort). Sample: Surviving single-location firms that had five or more workers on payroll on average during the firm's lifetime and have revenue data. All regressions include controls for firm size at baseline and firm age. GAP measures the percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

<sup>a</sup> Columns 3, 4, 7, and 8 include cohort-quarter-industry fixed effects (FE) from 2005–2016; columns 4 and 8 also include firm FEs.

SOURCE: UI records from WAstate, 2005–2016.

minimum wage hike. The falsification test re-estimates the model assuming that the minimum wage ordinance was passed in 2012 rather than in 2014.

All specifications show that the minimum wage had a strong positive effect on wages after  $t = 0$  during both the first and the second phase-in periods, where  $t = 0$  denotes the first period in which the minimum wage was raised. However, specifications that include only treated cohorts yield a larger effect as compared to the specifications that include all years of data.

Falsification tests reveal that the larger estimates can be explained by the fact that businesses

with high costs of compliance, which are also the low-paying businesses, saw faster wage growth in the pre-policy period. Both specifications based on the sample only from the treated cohorts yield estimates of the pseudo-minimum wage effect that are half as large as the effect observed in 2015–2016 when the ordinance was actually implemented. Because the specifications based on the treated cohort fail the falsification test, we will focus on the specifications that include all years of the data for the remainder of the paper. Our preferred specifications, which use the data from all cohorts and include cohort-quarter-industry fixed effects (at the NAICS 4-digit level), are presented in columns (3) and (4), perform reasonably well in the falsification test. However, specification without firm fixed effects shows a small negative and statistically significant effect of the pseudo-minimum wage in some periods, which warrants caution in interpretation. In the rest of the paper, we report both of these specifications along with the falsification test for each outcome in question.

Our preferred specifications show that the \$11 minimum wage had no anticipatory effect on wages in Seattle. In fact, the estimates suggest a slowdown in wage growth right before the minimum wage increase. Next, we see wage increases that begin before  $t = 0$  during the phase-in of the \$13 minimum wage and much larger coefficients in the quarters following the second wage hike. This is expected, because periods  $t = -2$  and  $t = -1$  for the second wage hike correspond to the period when the \$11 minimum wage was already implemented.

Overall, our results show that a 1 percent average cost of compliance led to an additional 0.80 percentage point increase in average wages after the phase-in of the \$11 minimum wage and to an additional 0.61 percentage point increase in average wages after the phase-in of the \$13 minimum wage. Overall, the \$11 minimum wage increased wages in all surviving firms by 0.64



percent (i.e., 0.80 multiplied by the average GAP of 2.05 percent and by the share of exposed firms, 0.39) and the \$13 minimum wage increased wages in all surviving firms by 1.07 percent.

Tables A.2 and A.3 present the effect of the minimum wage on total wagebill using the same regression 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 preferred 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 the wagebill, and it is stronger if we do not include firm fixed effects in our regressions.

Finally, we see that the magnitude of the effect on the wagebill was commensurate with the magnitude of the effect on wages. In 2015 a 1 percent cost of compliance led to a 0.94 percentage point increase in the wagebill. In 2016, a 1 percent cost of compliance led to a 0.73 increase. These numbers show that employers generally saw an increase in the wagebill that was just as large as the increase in wages, suggesting at most a mild disemployment effect in surviving firms. We turn to the detailed analysis of labor market and product market adjustments of surviving firms in the next two subsections.

### **Labor Market Adjustment**

In the previous section, we show that the wagebill of surviving firms increased by almost as much or slightly more than the average wages. 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. The minimum wage makes an hour of work in low-wage jobs more expensive to employers, and thus we would

expect the effects of the ordinance to be especially pronounced in this 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 express the growth in total hours between periods 0 and  $t$ , denoted by  $NEG_{0,t}$ , in terms of the contribution of low-paying jobs and high-paying jobs:

$$(9) \quad NEG_{0,t} = \frac{h_t - h_0}{0.5(h_0 + h_t)} = \underbrace{\frac{h_t(w_t < \bar{w}) - h_0(w_0 < \bar{w})}{0.5(h_0 + h_t)}}_{\text{Contribution of jobs paying } < \bar{w}} + \underbrace{\frac{h_t(w \geq \bar{w}) - h_0(w_0 \geq \bar{w})}{0.5(h_0 + h_t)}}_{\text{Contribution of jobs paying } \geq \bar{w}}$$

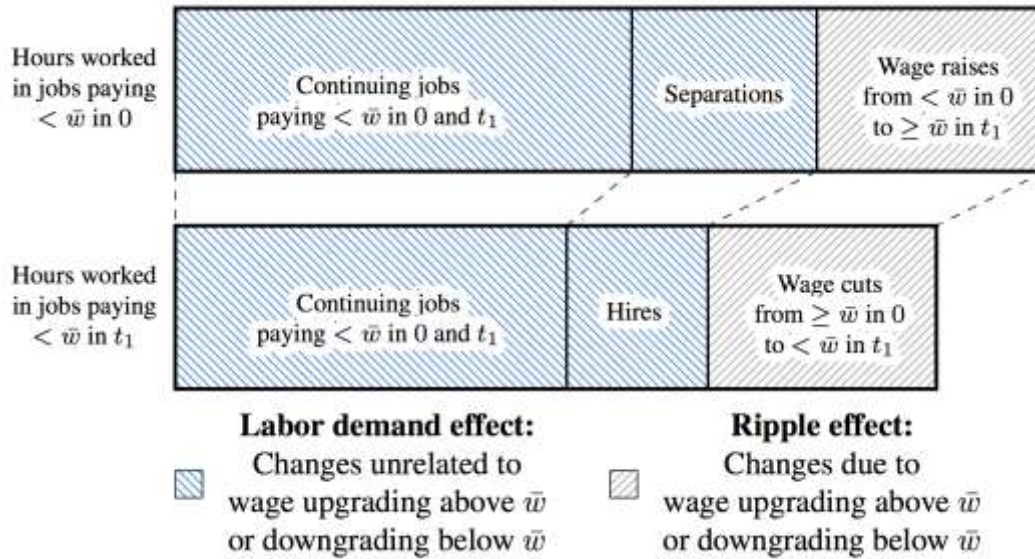
where  $h_t$  denotes hours worked in all jobs in period  $t$ , and  $h_t(w_t < \bar{w})$  denotes hours worked in period  $t$  in jobs paying less than  $\bar{w}$  in period  $t$ .  $\bar{w}$  is an arbitrary threshold wage rate, and any wage less than the threshold is considered low paying and any wage greater is considered high paying.

Generally, we expect that there are two conflating effects of the minimum wage on low-wage jobs. First, the ripple effect of the minimum wage on higher-paying jobs, which has been well documented in the past (Neumark, Schweitzer, and Wascher, 2004; Autor, Manning, and Smith, 2016; Phelan, 2019), can manifest itself as declines in low-wage jobs 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, so employers can substitute away from these workers through changes in the workforce composition or automation.

To separate the ripple effects of the minimum wage from the reduction in labor demand, we further decompose the growth in low-wage jobs into two components, as illustrated in Figure 4. First, we isolate the changes in low-wage jobs that arise because a job 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 that used to pay less than  $\bar{w}$  to wages above  $\bar{w}$ . Similarly, some jobs that used to pay wages 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 changes in labor demand. Second, we isolate the changes in low-wage jobs that 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 that pay less than  $\bar{w}$ .

**Figure 4 Channels of Adjustment in Hours of Low-wage Jobs in Periods 0 and  $t_1$**



Formally, we define the changes in hours due to wage upgrading or downgrading and changes in hours unrelated to wage upgrading or downgrading as follows:

$$(10) \quad \Delta h(\text{Ripple effect})_{0,t} = -h_0(w_0 < \bar{w}, w_t \geq \bar{w}) + h_t(w_0 \leq \bar{w}, w_t > \bar{w})$$

$$(11) \quad \Delta h(\text{Labor demand effect})_{0,t} = -\text{Separations}_{0,t} + \text{Hires}_{0,t} + \Delta h(w_0 < \bar{w}, w_t < \bar{w})$$

The contribution of separations is calculated as  $\text{Separations}_{0,t} = h_0(w_0 < \bar{w})$  for jobs that were active in period 0 but ended before period  $t$ . The contribution of hires is calculated as

$Hires_{0,t} = h_t(w_t < \bar{w})$  for jobs that started since period 0 and existed in period  $t$ . The contribution of the changes in continuing jobs is calculated as  $\Delta h(w_0 < \bar{w}, w_t < \bar{w})_{0,t} = h_t(w_0 < \bar{w}, w_t < \bar{w}) - h_0(w_0 < \bar{w}, w_t < \bar{w})$  for jobs that existed both in periods 0 and  $t$ .

We estimate the ripple effect of the minimum wage using the same regression specifications as before (i.e., Eq. 7). We experiment with different levels of  $\bar{w}$  to define the low-wage labor market segment, varying  $\bar{w}$  from 105 percent to 150 percent of the minimum wage.<sup>24</sup> The goal is to find a wage threshold  $\bar{w}$  at which the ripple effect of the minimum wage is no longer present.

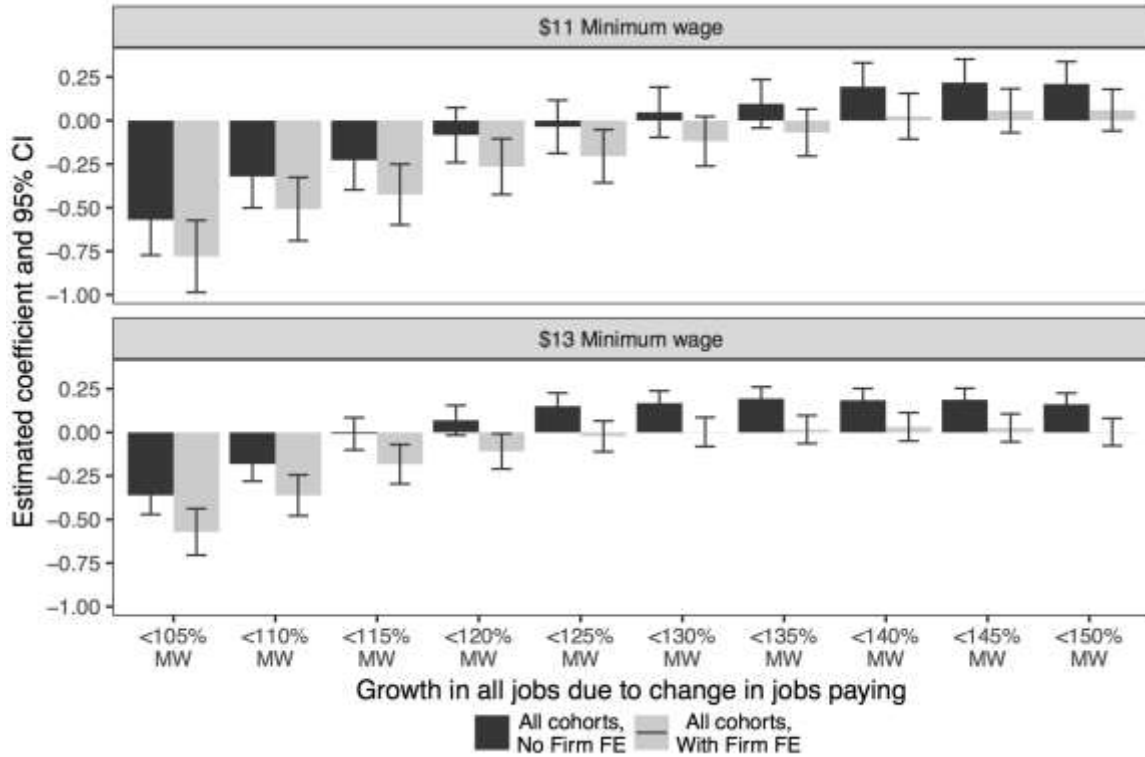
The results of this exercise are presented in Figure 5. We see strong evidence of the ripple effect during both phase-in periods; that is, a significant fraction of declines in low-wage jobs occurred because some low-wage jobs received wage upgrades. As we increase the wage threshold, the magnitude of reduction in hours due to wage upgrading diminishes, consistent with the intuition that the ripple effect tapers off. Our estimates show that Seattle’s minimum wage had ripple effects on higher paying jobs up to the level of 120–130 percent of the minimum wage, similar to the extent of the ripple effect found in previous studies (Neumark, Schweitzer, and Wascher, 2004; Autor, Manning, and Smith, 2016; Phelan, 2019). This threshold corresponds to \$13.20–\$14.50 per hour for the \$11 minimum wage and to \$15.60–\$16.25 per hour for the \$13 minimum wage. Moreover, our findings on the extent of the ripple effect are also consistent with employer-reported adjustments to the minimum wage in Seattle documented in Romich et al. (2019). Among the respondents in the Survey of Seattle’s Employers, 50 percent of businesses said that they raised employees’ pay to decompress wages in the range of \$13–

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<sup>24</sup> For the first phase-in period, these thresholds correspond to the wage rates from \$11.55 to \$16.50. For the second phase-in period, these thresholds correspond to the wage rates from \$13.65 to \$19.50.

\$15/hour, and 30 percent of businesses said that they raised pay of employees in the range of \$15/hour and higher.

**Figure 5 Ripple Effect of the Minimum Wage on Jobs Paying Above the Minimum Wage**



NOTE: Sample: Surviving single-location firms that had five or more workers on payroll on average during the firm’s lifetime and have revenue data. Ripple effect of the minimum wage is measured by changes in hours of low-wage jobs due to wage upgrading rather than due to hires, separations, or changes in hours without changes to wage rate. See text for details. SOURCE: UI records from WA state, 2005–2016.

Having established that the ripple effect of the minimum wage extended through 120–130 percent of the minimum wage, we now turn to the analysis of the changes in labor demand. We report the impact of the minimum wage on the growth in hours worked in all jobs, low-wage jobs, and high-wage jobs along the lines of the decomposition (Eq. 9). We define the low-wage labor market segment as jobs paying below 120–130 percent of the minimum wage to ensure that our estimates are not driven by the ripple effect of the minimum wage. Table 7 presents our results.

**Table 7 Effect of the Minimum Wage on Labor Costs and Hours Worked in Low-wage and High-wage Jobs in Surviving Firms**

	\$11 Minimum wage				\$13 Minimum wage			
	Treatment		Placebo		Treatment		Placebo	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	All	All	All	All	All	All	All
	cohorts	cohorts	cohorts	cohorts	cohorts	cohorts	cohorts	cohorts
	All firms	All firms	All firms	All firms	All firms	All firms	All firms	All firms
%ΔAverage wage rate	0.69*** (0.08)	0.89*** (0.07)	-0.08 (0.08)	0.11 (0.07)	0.44*** (0.04)	0.79*** (0.06)	-0.03 (0.03)	0.05* (0.03)
%ΔLabor costs	0.88*** (0.20)	1.00*** (0.17)	0.6*** (0.23)	0.6*** (0.18)	0.49*** (0.13)	0.96*** (0.13)	0.18** (0.09)	0.19** (0.09)
%ΔTotal hours	0.19 (0.19)	0.17 (0.16)	0.68*** (0.22)	0.5*** (0.18)	0.08 (0.13)	0.21 (0.14)	0.21** (0.09)	0.14 (0.09)
Contribution to %ΔTotal hours of:								
Jobs paying < 120% of MW	-0.14 (0.19)	-0.61*** (0.19)	0.77*** (0.20)	0.12 (0.18)	0.12 (0.12)	-0.29** (0.14)	0.24*** (0.08)	-0.039 (0.08)
Jobs paying < 125% of MW	-0.05 (0.19)	-0.49*** (0.18)	0.74*** (0.20)	0.11 (0.18)	0.22* (0.12)	-0.16 (0.14)	0.23*** (0.09)	-0.029 (0.08)
Jobs paying < 130% of MW	0.072 (0.19)	-0.34* (0.18)	0.73*** (0.20)	0.15 (0.18)	0.22* (0.12)	-0.13 (0.14)	0.22** (0.09)	-0.033 (0.08)
Obs	276,161	276,161	177,690	177,690	235,325	235,325	177,690	177,690
Year-quarter-industry FE	X	X	X	X	X	X	X	X
Firm FE		X		X		X		X

NOTE: \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ . Clustered standard errors in parentheses. Standard errors are clustered by industry (NAICS 3-digit sector) and cohort. Sample: Surviving single-location firms that had five or more workers on payroll on average during the firms' lifetime and have revenue data. All regressions include controls for firm size at the baseline and for firm age. GAP measures percentage increase in the total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

SOURCE: UI records from WA state, 2005-2016.

First, both minimum wage phase-in periods had no impact on total hours, because the coefficient for the effect of the cost of compliance on total hours is not statistically different from zero. This result is consistent with the fact that higher wages translated into one-to-one increases in labor costs in surviving firms, and suggests that the minimum wage in Seattle did not lead to a distinguishable scale effect among surviving firms. The scale effect would be generated if employers passed the increased in the minimum wage to prices. Therefore, the absence of the scale effect indicates that there was no substantial price increases in Seattle as a result of the minimum wage, which we will confirm in the analysis of the product market adjustment to the minimum wage.

Next, our estimates paint a mixed picture on the magnitude of the substitution effect. The specification that does not include firm fixed effects shows that the minimum wage did not lead to a disemployment effect in low-wage jobs either after the implementation of the \$11 or the \$13 minimum wage, because the estimated impact is not statistically different from zero. However, the specification that includes firm fixed effects shows that employment in low-wage jobs declined after both minimum wage phase-in periods. The negative impact of the \$11 minimum wage was observed for jobs paying less than 130 percent of the minimum wage, or \$13.20, and the negative impact of the \$13 minimum wage was observed for jobs paying less than 120 percent of the minimum wage, or \$15.60. To understand the magnitudes of these effects, we convert our estimates into employment elasticity using the following relationship:

$$\varepsilon_E = \frac{1}{\beta_{wages}} \frac{\beta_{Jobs\ paying < \bar{w}}}{\text{Share of jobs paying } < \bar{w} \text{ in total hours}}$$

The estimates of the employment elasticity are presented in Table 8. The elasticity estimate can be interpreted as a percentage change in hours of low-wage jobs in response to a 1

percent increase in average wages, induced by the minimum wage increase. We find that employment elasticity for jobs paying less than \$13.20 was at most  $-0.8$ , and for jobs paying less than \$15.50, it was at most  $-0.3$ . These estimates for employment elasticity imply that the \$11 minimum wage led to a 1.1 percent decrease in jobs paying less than \$13.20 and the \$13 minimum wage led to a 0.7 percent decline in jobs paying less than \$15.60 in surviving firms.

**Table 8 Employment Elasticity Implied by the Estimates**

	Employment elasticity	Wage increase in exposed firms, %	Employment effect on low-wage jobs in exposed firms, %	Share of low-wage jobs provided by exposed firms	Employment effect on all low-wage jobs, %
<i>Panel A. \$11 Minimum wage (MW)</i>					
Jobs paying <120% of MW	-1.68	1.82	-3.06	0.85	-2.62
Jobs paying <125% of MW	-1.26	1.82	-2.29	0.83	-1.91
Jobs paying <130% of MW	-0.81	1.82	-1.47	0.80	-1.18
<i>Panel B. \$13 Minimum wage</i>					
Jobs paying <120% of MW	-0.78	2.72	-2.11	0.89	-1.88
Jobs paying <125% of MW	-0.40	2.72	-1.09	0.86	-0.93
Jobs paying <130% of MW	-0.31	2.72	-0.84	0.84	-0.71

Our previous findings on the impacts of the Seattle minimum wage (Jardim et al., 2017a) suggest that aggregate employment elasticity in Seattle was of the order of  $-1$  to  $-2$ , which is about twice as large as the employment elasticity that we estimated for surviving firms. What can explain this difference? As we discussed in previously, employers would not need to substitute away from low-wage jobs if the increases in the wagebill were offset by lower turnover that results in savings on replacement costs. In another paper examining workers' employment trajectories after the minimum wage increase in Seattle, we find that the minimum wage reduced turnover by 8 percent (Jardim et al., 2018). This evidence indicates that the turnover channel most likely played a substantial role in mitigating the consequences of the minimum wage in Seattle for surviving firms. The second explanation for the differences in effects to surviving firms vs. effects to the aggregate labor market likely stems from the magnitudes of the effects on the intensive vs. extensive margins. In particular, if the technology of production is associated



with a fixed capital-to-labor ratio and technological changes are very costly, most of the adjustment would arise through business entry and exit (Aaronson et al., 2018). Moreover, new businesses cannot take advantage of reduced turnover, because they have to hire new workers. We will examine this hypothesis explicitly when we study the extensive margin effects of the minimum wage.

### **Product Market Adjustment**

In this section, we examine the product market adjustment to the minimum wage. In the conceptual framework section, we have shown that the impact of the minimum wage on revenue is driven by two parameters: the extent to which the minimum wage increases firm's marginal costs, which determines the increase in prices, and the elasticity of consumer demand, which determines the changes to output. In our data, we do not observe prices directly, but we examine changes to revenue and hours worked instead.

Table 9 presents our results. 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. However, all regression specifications show that the minimum wage had no impact on revenue per hour of surviving firms. The evidence on the impact of the minimum wage on revenue is more mixed. Consistent with no price effect, we see no effect of the minimum wage on revenue following the \$11 minimum wage hike. However, there is some evidence that surviving firms might have raised prices in response to the \$13 minimum wage. The specification with firm fixed effects suggests that a 1 percent cost of compliance led to a 0.2 percent increase in revenue of surviving firms, while the specification without firm fixed effects finds an effect of 0.05, which is not statistically

**Table 9 Effect of the Minimum Wage on Revenue, Hours Worked, and Revenue Labor Productivity of Surviving Firms**

	\$11 Minimum wage				\$13 Minimum wage			
	Treatment		Placebo		Treatment		Placebo	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All cohorts	All cohorts	All cohorts	All cohorts	All cohorts	All cohorts	All cohorts	All cohorts
	All firms	All firms	All firms	All firms	All firms	All firms	All firms	All firms
%ΔAverage wage rate	0.69*** (0.08)	0.89*** (0.07)	-0.08 (0.08)	0.11 (0.07)	0.44*** (0.04)	0.79*** (0.06)	-0.03 (0.03)	0.053* (0.03)
%ΔRevenue	0.11 (0.16)	0.11 (0.14)	0.081 (0.18)	0.12 (0.14)	0.047 (0.11)	0.23** (0.12)	0.034 (0.07)	0.057 (0.07)
%ΔRevenue per hour	-0.043 (0.18)	-0.047 (0.16)	-0.64*** (0.18)	-0.41** (0.17)	-0.074 (0.12)	-0.01 (0.13)	-0.19** (0.08)	-0.088 (0.08)
%ΔTotal hours	0.19 (0.19)	0.17 (0.16)	0.68*** (0.22)	0.50*** (0.18)	0.076 (0.13)	0.21 (0.14)	0.21** (0.09)	0.14 (0.09)
Obs	276,161	276,161	208,751	208,751	235,325	235,325	177,690	177,690
Year-quarter-industry FE	X	X	X	X	X	X	X	X
Firm FE		X		X		X		X

NOTE: \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ . Clustered standard errors in parentheses. Standard errors are clustered by industry (NAICS 3-digit sector) and cohort. Sample: Surviving single-location firms that had five or more workers on payroll on average during the firms' lifetime and have revenue data. All regressions include controls for firm size at the baseline and for firm age. GAP measures percentage increase in the total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

SOURCE: UI records from WA state, 2005-2016.

different from zero. Overall, our results show no effect or a minimal effect of the minimum wage to the product market in Seattle.

We also estimate the impact of the minimum wage on prices directly for a small subset of restaurants, retailers, and service businesses in Seattle for whom the data on prices were collected online and offline.<sup>25</sup> 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. Table A.4 presents the results of a simple linear 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 for some businesses, we have calculated a simple average of the price change across items for such businesses, and ran two regression specifications—column (1) of Table A.4 shows the results of an unweighted specification, while column (2) shows the results of the specification weighted with the number of items. Despite the small number of observations, all specifications demonstrate a strong correlation between the cost of compliance and the growth in average wage rate. However, prices are positively correlated with the costs of compliance only in the second quarter of 2016, but not in the first quarter of 2016, and the coefficient is not statistically significant in either period.

Taken together, our results do not provide a clear indication of price increases in surviving firms in response to the minimum wage. Aaronson, French, and MacDonald (2008)

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<sup>25</sup> The data was collected on 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 online menus. The data collection started in the second quarter of 2015, when the minimum wage went up to \$11/hour, and continued until the second quarter of 2016.

demonstrated that a strong price effect of the minimum wage is always accompanied by a disemployment effect, as both of these changes are associated with an increase in firms' marginal costs. The lack of a strong disemployment effect in surviving firms in Seattle and mixed evidence on the price adjustment suggests that the minimum wage in Seattle had only a mild impact on the marginal costs of surviving firms.

We also estimate the impact of the minimum wage on prices directly for a small subset of restaurants, retailers, and service businesses in Seattle for whom the data on prices were collected online and offline.<sup>26</sup> 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. Table A.4 presents the results of a simple linear 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 for some businesses, we have calculated a simple average of the price change across items for such businesses, and ran two regression specifications—column (1) of Table A.4 shows the results of an unweighted specification, while column (2) shows the results of the specification weighted with the number of items. Despite the small number of observations, all specifications demonstrate a strong correlation between the cost of compliance and the growth in average wage rate. However, prices are positively correlated with the costs of

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Taken together, our results do not provide a clear indication of price increases in surviving firms in response to the minimum wage. Aaronson, French, and MacDonald (2008) demonstrated that a strong price effect of the minimum wage is always accompanied by a disemployment effect, as both of these changes are associated with an increase in firms' marginal costs. The lack of a strong disemployment effect in surviving firms in Seattle and mixed evidence on the price adjustment suggests that the minimum wage in Seattle had only a mild impact on the marginal costs of surviving firms.

## **BUSINESS ENTRY AND EXIT**

In this section we turn to the extensive margin effects of the minimum wage. We start by examining the rates of business entry and exit. Table 10 shows our estimates. We see that the \$11 minimum wage did not affect the rates of business entry and exit, whereas the \$13 minimum wage increased the rate of business exit but had no effect on the rates of business entry. A 1 percent cost of compliance led to a 0.2 percentage point increase in the exit rate. Considering that 51 percent of firms faced a positive cost of compliance in 2016, and that average cost of compliance was 3.44 percent, our estimates show that the minimum wage raised the exit rate of exposed firms from 5.08 percent to 5.77 percent, or by 13 percent. Moreover, because exposed firms provide 84 percent of low-wage jobs, defined as those paying less than 130 percent of the minimum wage, an uptick in exit rates led to a 0.58 percent decline in hours worked in low-wage jobs.

**Table 10 Effect of the Minimum Wage on Rates of Entry and Exit**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	\$11 Minimum wage				13 Minimum wage			
	Exit Treatment	Exit Placebo	Entry Treatment	Entry Placebo	Exit Treatment	Exit Placebo	Entry Treatment	Entry Placebo
<i>Panel A: Timing of the effect</i>								
$GAP \times t = -3$	0.18** (0.08)	0.06 (0.05)	-0.40 (0.31)	-0.89 (0.69)				
$GAP \times t = -2$	0.18 (0.14)	0.06 (0.09)	-0.44 (0.35)	-0.61 (0.49)	0.15*** (0.03)	0.048* (0.03)	-0.26 (0.25)	-0.16 (0.18)
$GAP \times t = -1$	0.12 (0.14)	0.0091 (0.10)	-0.46 (0.37)	-0.43 (0.37)	0.30*** (0.06)	0.055 (0.04)	-0.22 (0.25)	-0.042 (0.14)
$GAP \times t = 0$	0.066 (0.17)	0.048 (0.12)	-0.41 (0.37)	-0.30 (0.31)	0.26*** (0.05)	0.045 (0.05)	-0.23 (0.26)	0.06 (0.13)
$GAP \times t = 1$	0.14 (0.17)	0.01 (0.13)	-0.37 (0.36)	-0.14 (0.24)	0.20*** (0.05)	0.062 (0.05)	-0.23 (0.27)	0.06 (0.14)
$GAP \times t = 2$	0.33* (0.20)	0.07 (0.12)	-0.39 (0.39)	0.02 (0.21)	0.15*** (0.05)	0.05 (0.05)	-0.23 (0.27)	0.06 (0.14)
Obs	313,367	237,965	50,806	41,128	262,345	198,305	28,383	22,413
$R^2$	0.03	0.03	0.43	0.44	0.03	0.03	0.58	0.75
<i>Panel B: Average effect</i>								
$GAP \times t < 0$					0.022*** (0.04)	0.05 (0.03)	-0.24 (0.25)	0.05 (0.14)
$GAP \times t \geq 0$	0.16 (0.21)	0.033 (0.11)	-0.14 (0.17)	-0.1 (0.13)	0.20*** (0.05)	0.052 (0.05)	-0.23 (0.26)	0.00 (0.13)
Obs	313,367	237,965	50,806	41,128	262,345	198,305	28,383	22,413
$R^2$	0.03	0.03	0.43	0.41	0.03	0.03	0.58	0.59
Year-quarter-industry FE	X	X			X	X		
Firm FE								

NOTE: \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ . Clustered standard errors in parentheses. Standard errors are clustered by the industry (NAICS 3-digit sector) and cohort (if more than one cohort). Sample: Surviving single-location firms that had five or more workers on payroll on average during the firms' lifetime and have revenue data. All regressions include controls for firm size at the baseline and for firm age. GAP measures percentage increase in the total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

SOURCE: UI records from WA state, 2005–2016.

This result is consistent with the previous findings on the minimum wage effects to entry and exit in Aaronson et al. (2018) and Luca and Luca (2018), who also find a spike in exit rates of restaurants following the minimum wage increase. An uptick in exit rates also shows that the minimum wage increased the marginal costs of some firms, which made them no longer profitable. Next, we study the impact of the minimum wage on the composition of entering and exiting businesses. For exits, we estimate whether the average hours worked, revenue, and wagebill in firms that exited following the minimum wage hike were higher or lower than the same outcomes in firms that exited in the years before the minimum wage hike. Formally, we

compare the ratio of average hours worked, revenue, and wagebill in exiting firms to the average hours worked, revenue, and wagebill of a typical firm at the baseline, and we evaluate if this ratio changed after the minimum wage hike. We repeat this exercise for the entering firms using the ratio of average hours worked, revenue, and wagebill in entering firms to the average hours worked, revenue, and wagebill of a typical firm at the baseline.

Our results on the composition of entering and existing firms are presented in the Table 11. We find after the implementation of the \$11 minimum wage, revenue per hour of existing firms increased, but there were no other changes to entering or existing firms. However, the \$13 minimum wage had a pronounced effect both on the composition of entering and exiting firms. Businesses that exited in 2016 paid lower average wages, had lower revenue productivity, and provided substantially more low-wage jobs than a typical business in their cohort, compared to existing firms in 2005–2013. The impact on hours in low-wage jobs was especially large. A 1 percent cost of compliance increased the ratio of hours in low-wage jobs in exiting firms to hours in low-wage jobs in all active firms by 2.3 times. This increase translated into an additional 0.23 percent loss in employment in hours of jobs paying less than 130 percent of the minimum wage, or \$15.60. Just as in the case with the increased exit rate, this finding suggests that businesses that employed low-wage workers were unable either to pass the increases in marginal costs to consumers or to change their technology of production, and were forced to exit instead.

Finally, the \$13 minimum wage also resulted in substantial changes to the composition of entering businesses. Following the minimum wage hike to \$13, entering businesses became less labor intensive. We see that the labor costs of the average entering firm were reduced by 6.2 times relative to the labor costs of all active firms at the baseline, and average hours of entering firms were reduced by 7.6 times relative to hours of all active firms at baseline. These findings

**Table 11 Effect of the Minimum Wage on the Composition of Entering and Exiting Businesses**

	\$11 Minimum wage (MW)				\$13 Minimum wage			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Treatment Exiting firms	Treatment Entering firms	Placebo Exiting firms	Placebo Entering firms	Treatment Exiting firms	Treatment Entering firms	Placebo Exiting firms	Placebo Entering firms
Average wage rate	0.22*** (0.09)	-1.30 (1.10)	0.05 (0.25)	-0.32 (0.55)	-1.70*** (0.18)	0.16 (1.40)	-0.18** (0.08)	-0.55 (0.37)
Average labor costs	0.43 (0.44)	-1.10 (6.60)	-0.37 (0.54)	-1.80** (0.85)	-0.23 (0.15)	-6.20* (3.40)	-0.60*** (0.20)	-0.72 (1.20)
Average revenue	0.55 (0.44)	1.20 (4.90)	1.60 (1.80)	1.30 (3.40)	0.30 (0.32)	-4.70 (3.70)	0.34 (0.32)	-0.71 (1.00)
Average revenue per hour	4.60** (1.10)	0.23 (1.40)	1.70 (2.10)	-1.00 (1.00)	-0.75*** (0.26)	-1.30 (2.80)	-0.59* (0.31)	0.95 (1.00)
Average total hours	-0.42 (0.44)	0.52 (6.60)	-0.69* (0.40)	-1.7*** (0.57)	0.18 (0.29)	-7.60*** (2.40)	-0.43** (0.20)	-0.68 (1.00)
Average hours in:								
Jobs paying <120% of MW	-2.60 (2.00)	9.50 (6.90)	-2.30 (1.70)	-0.28 (1.70)	3.10*** (0.69)	-9.60*** (3.50)	0.09 (0.79)	1.20 (1.80)
Jobs paying <125% of MW	-2.20 (1.60)	8.80 (7.10)	-2.00 (1.40)	0.43 (1.80)	2.70*** (0.66)	-11.00*** (3.40)	0.00 (0.73)	0.77 (1.40)
Jobs paying <130% of MW	-2.00 (1.50)	8.20 (7.50)	-1.90 (1.40)	0.62 (2.20)	2.30*** (0.58)	-11.00*** (3.30)	-0.08 (0.66)	0.70 (1.20)
Obs	276,161	276,161	208,751	208,751	235,325	235,325	177,690	177,690
Cohort-quarter-industry FE	X	X	X	X	X	X	X	X
Firm FE		X		X		X		X

NOTE: \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ . Clustered standard errors in parentheses. Standard errors in regressions for exit are clustered by industry (NAICS 3-digit sector) and cohort.

SOURCE: UI records from WA state, 2005–2016.

imply that the minimum wage increased the marginal costs of labor-intensive businesses and made a labor-intensive business model unsustainable. As a result, only less labor-intensive businesses chose to open for business. The change in the composition of the entering businesses also translated into further employment losses in low-wage jobs. On average, hours in jobs paying less than 130 percent of the minimum wage decreased by 0.43 percent due to the shift to less labor-intensive businesses.

## MINIMUM WAGE ACCOUNTING

We have estimated the impacts of the minimum wage to surviving businesses, as well as to the rates of entry and exit and to the composition of entering and exiting businesses. In this



section, we provide a bird's eye view of our findings and discuss the contribution of each adjustment channel to the total impact of the minimum wage.

Table 12 shows the total impact of the minimum wage on each outcome of interest. Overall, we find that the \$11 minimum wage was largely absorbed by Seattle's labor market and had a negligible impact on employers. However, the \$13 minimum wage put enough cost pressure on employers to induce adjustment along several margins. Though the minimum wage caused a one-to-one increase in labor costs per one percentage point increase in the wage rate in surviving firms, the total wagebill of all employers increased only by half as much as did the wage rate. Moreover, the extensive margin effect was equally split between the effects on exit and on the composition of the entering businesses. Our results clearly show that surviving firms were able to sustain higher labor costs as compared to the new businesses. Surviving employers likely were able to benefit from reduced turnover, which offset some of the increases in direct labor costs (see Jardim et al., 2018, for the evidence on turnover reductions after the minimum wage hike in Seattle). However, entering businesses could not take advantage of this channel because they had no pre-minimum wage employees and therefore higher retention rates could not generate savings for them. As a result, entering businesses had to bear the burden of the increase in labor costs. Since higher labor costs generally increase marginal costs as well, making some business model unprofitable, entering businesses shifted towards less labor-intensive technology and substantially reduced labor costs and hours worked at all wage levels as compared to entering businesses in the pre-policy time period. Finally, the minimum wage increased the exit rate because some businesses were not able to offset the increases in labor costs either by passing them to consumers in the form of higher prices or by benefiting from reduced turnover.

**Table 12 Total Impact of the Minimum Wage and Contribution of Extensive and Intensive Margin**

	Surviving firms	Exit rate	Composition of exiting firms	Entry rate	Composition of entering firms	Total impact, %
<i>Panel A. \$11 Minimum wage (MW)</i>						
Average wage rate	0.45					0.45
Labor costs	0.51	-	-	-	-	0.51
Revenue	-	-	-	-	-	0.00
Hours in all jobs	-	-	-	-	-	0.00
Hours in jobs paying <130% of MW	-1.13	-	-	-	-	1.13
<i>Panel B. \$13 Minimum wage</i>						
Average wage rate	0.95					0.95
Labor costs	1.07	-0.25	-	-	-0.24	0.57
Revenue	0.22	-0.21	-	-	-	0.02
Hours in all jobs	-	-0.44	-	-	-0.30	-0.74
Hours in jobs paying <130% of MW	-0.66	-0.58	-0.23	-	-0.43	-1.91

NOTE: “-” indicates that the minimum wage had zero impact through this channel.

The extensive margin adjustment played an essential role in the employment effect of the minimum wage. Overall, the \$13 minimum wage reduced hours worked in all jobs in Seattle by 0.7 percent and hours worked in jobs paying less than \$15.60 by 1.9 percent. The entirety of the minimum wage effect on hours in all jobs came from the extensive margin effect. The minimum wage impact on low-wage jobs was roughly split 2:1 between the extensive margin and the intensive margin effects. Within-firm adjustment of surviving firms generated 36 percent of the disemployment effect, higher rates of business exit generated another 42 percent of the effect, and the shift of the entering businesses towards less labor-intensive technology produced the remaining 22 percent of the total effect. As a result, any analysis that focuses only on one of these margins will grossly underestimate the impact of the minimum wage in Seattle.

Finally, while we estimate the employment elasticity of surviving firms to be  $-0.3$  to  $-0.8$ , our estimates of the aggregate employment effect imply a much larger employment elasticity of  $-2$ , which takes into account both intensive and extensive margin effects.

## CONCLUSION

In this paper, we study the impact of the minimum wage hike in Seattle on business outcomes using the UI 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 calculate hourly compensation for each employee and 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 because we do not have to restrict our analysis to retail and restaurants as was the case in many prior studies in the United States. Finally, we are able to study the effects both to the intensive and the extensive margins and quantify their roles in the total minimum wage impact.

We demonstrate that on average employers in Seattle faced low costs of compliance with the minimum wage, and many employers were not exposed to the minimum wage increase at all. In particular, an average employer had to increase their labor costs by 2–3 percent to comply with the ordinance, and 40–50 percent of employers had no workers paid less than the new minimum wage even before the ordinance was implemented.

Despite the relatively low costs of compliance with the minimum wage, we find that the minimum wage had a pronounced effect on the labor market. First, the minimum wage had a ripple effect on wages of workers paid above the minimum. We estimate that employers raised wages of workers paid up to 130 percent of the minimum wage to decompress the wage distribution. This result is echoed by self-reported responses on adjustment channels collected through the Survey of Seattle’s Employers (Romich et al., 2019). Second, the minimum wage increased the labor costs of surviving firms by 1.2 percent and labor costs of all businesses by 0.57 percent. Surviving firms adjusted to this increase by mildly reducing demand for low-wage

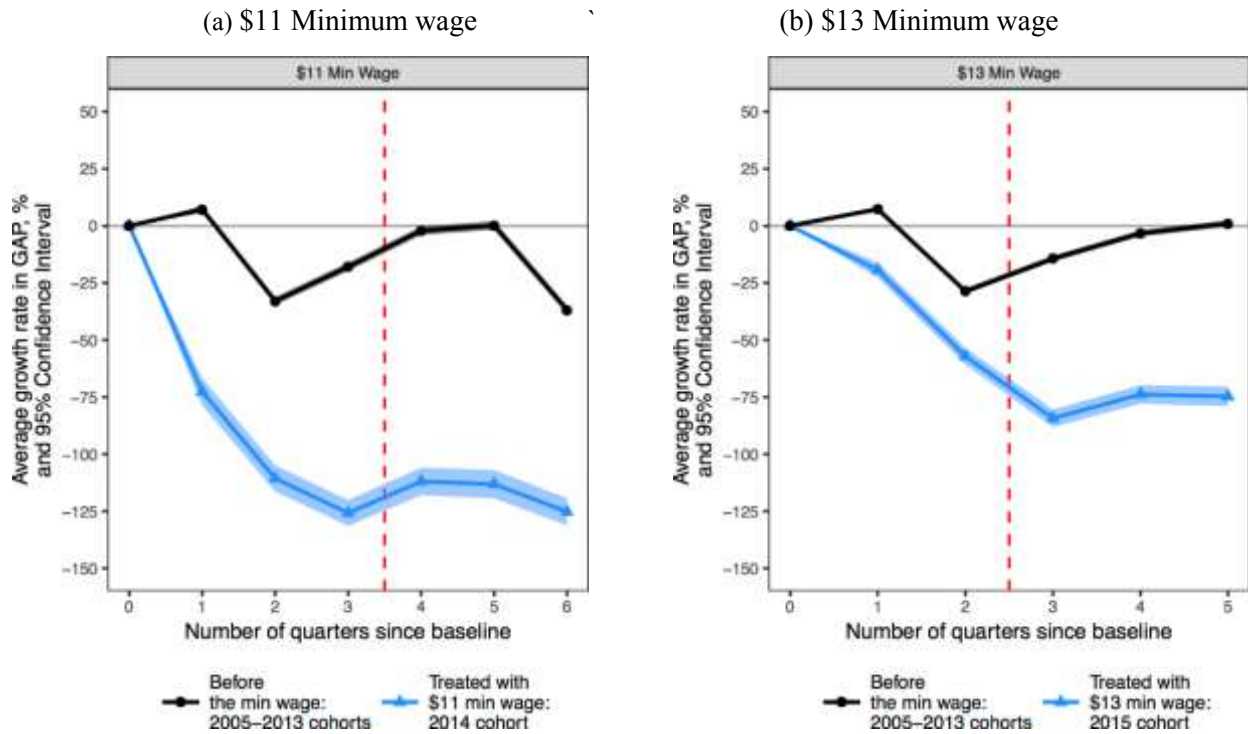
jobs, but largely did not pass the increases to prices. Findings in Jardim et al. (2018) suggest that reductions in turnover might have helped surviving firms sustain higher direct labor costs. Finally, we find that the minimum wage led to a 1.9 percent reduction in employment of low-wage jobs, defined as those paying \$15.60 and less. Over one-third of this effect was generated by surviving firms, while the remaining two-thirds of the effect was produced by an increased rate of business exit and by the shift in the composition of entering businesses towards less labor-intensive technology.

Our finding that more than half of the overall impact of the minimum wage low-wage jobs comes from the extensive margin is relatively novel. Aaronson et al. (2018) discuss the minimum wage effects in the context of a putty-clay model that can generate substantial extensive margin adjustment, and provide evidence of accelerated entry and exit following the minimum wage hike in the United States. However, because they use the aggregate data from the Quarterly Census of Employment and Wages, they are unable to attribute employment effects to entry or exit.

Finally, an unusual feature of the business adjustment to the minimum wage in Seattle is the lack of the effect to prices. Multiple studies in the past found that passing the increases in labor costs to prices is a primary channel of adjustment to the minimum wage (Aaronson, French, and MacDonald, 2008; Allegretto and Reich, 2018; Harasztosi and Lindner, 2018). Understanding under what conditions employers adjust to the minimum wage via the product market versus labor market adjustment is a task for future work.

## APPENDIX: ADDITIONAL TABLES AND FIGURES

**Figure A.1.** Growth rate in cost of compliance and pseudo-cost (before the Minimum Wage Ordinance) of compliance over time.



NOTE: Sample: Surviving single-location firms that had five or more workers on payroll on average during the firm’s lifetime and have revenue data. GAP measures percentage increase in total wagebill required to meet the new minimum wage, assuming jobs and hours remain the same. Vertical red dashed line shows the quarter when the minimum wage went up for the treated cohort and a comparable period for the control cohorts before the Minimum Wage Ordinance.

SOURCE: UI records from WA state, 2005–2016

**Table A.1.** Exposure to the minimum wage hike, by industry.

Industry	Number of firms		Employment, number of jobs		Firms with GAP>0	
	All firms	Exposed firms, %	All firms	Exposed firms, %	Mean GAP, %	Median GAP, %
<i>Panel A: 2014 Cohort, subject to \$11 minimum wage</i>						
Construction	446	9.9	13,765	31.3	0.35	0.03
Manufacturing	358	37.7	14,065	55.4	1.64	0.42
Wholesale Trade	374	23.0	8,103	32.7	0.55	0.17
Retail Trade	618	62.5	11,737	63.6	2.23	0.98
Transportation and Warehousing	103	29.1	7,136	65.8	0.45	0.05
Information	249	18.1	13,952	22.1	0.95	0.21
Finance and Insurance	189	14.8	7,576	42.1	0.64	0.04
Real Estate and Rental and Leasing	175	38.9	5,931	59.5	1.11	0.18
Professional, Scientific, and Technical Services	1,172	12.4	38,887	25.5	0.34	0.08
Administrative and Support Services	313	34.8	13,779	69.6	1.10	0.20
Health Care and Social Assistance	560	26.8	26,882	67.0	0.71	0.16
Arts, Entertainment, and Recreation	124	65.3	8,247	90.4	1.68	0.33
Accommodation and Food Services	1,282	80.2	36,514	87.7	3.07	0.96
Full-Service Restaurants	713	83.0	20,156	88.3	2.01	0.62
Limited-Service Restaurants	339	83.5	7,662	87.1	5.73	4.31
Other Services (except Public Administration)	364	44.0	8,341	43.9	1.54	0.62
Total	6,327	39.4	214,915	54.6	2.05	0.47
<i>Panel B: 2015 Cohort, subject to \$13 minimum wage</i>						
Construction	470	22.3	16,718	37.6	0.57	0.08
Manufacturing	367	55.9	14,743	67.6	2.67	0.89
Wholesale Trade	376	38.0	8,546	51.7	1.26	0.45
Retail Trade	666	74.6	13,199	71.9	5.06	3.25
Transportation and Warehousing	99	43.4	7,746	73.3	1.16	0.56
Information	259	26.3	17,273	25.4	1.46	0.16
Finance and Insurance	189	20.6	7,743	47.4	0.68	0.11
Real Estate and Rental and Leasing	181	47.5	6,188	66.9	1.68	0.44
Professional, Scientific, and Technical Services	1,178	20.5	40,192	32.6	0.63	0.15
Administrative and Support Services	325	49.5	16,958	81.0	2.62	0.64
Health Care and Social Assistance	551	37.0	29,127	79.0	1.71	0.51
Arts, Entertainment, and Recreation	141	70.9	9,196	94.2	2.91	1.25
Accommodation and Food Services	1,395	89.2	40,588	94.8	4.86	2.08
Full-Service Restaurants	755	92.1	21,796	95.9	3.43	1.44
Limited-Service Restaurants	388	89.9	9,184	92.3	8.54	6.72
Other Services (except Public Administration)	380	58.4	8,577	74.3	2.91	1.03
Total	6,577	51.1	236,794	63.9	3.44	1.15

NOTE: Sample: Single-location firms which had five or more workers on payroll on average during their lifetime and have revenue data. 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.

SOURCE: UI records from WA state, 2005–2016.

**Table A.2.** Effect of the \$11 minimum wage on the wagebill.

	(1)	(2)	(3)	(4) <sup>a</sup>	(5)	(6)	(7)	(8)
	Treatment	Treatment	Treatment	Treatment	Placebo	Placebo	Placebo	Placebo
	Treated cohort	Treated cohort	All cohorts	All cohorts	Pseudo Treated cohort	Pseudo Treated cohort	All cohorts	All cohorts
	GAP>0	All firms	All firms	All firms	GAP>0	All firms	All firms	All firms
<i>Panel A: Timing of the effect</i>								
$GAP \times t = -3$	-0.02 (0.17)	0.17 (0.16)	-0.43** (0.17)	-0.25 (0.17)	0.37* (0.19)	0.62*** (0.18)	-0.17 (0.19)	0.19 (0.22)
$GAP \times t = -2$	-0.37* (0.21)	-0.66*** (0.19)	-0.34* (0.20)	-0.17 (0.19)	-0.01 (0.20)	-0.30 (0.18)	0.18 (0.21)	0.20 (0.22)
$GAP \times t = -1$	0.06 (0.23)	-0.26 (0.21)	-0.13 (0.20)	-0.04 (0.19)	0.13 (0.22)	-0.14 (0.21)	-0.13 (0.24)	-0.10 (0.23)
$GAP \times t = 0$	0.08*** (0.21)	0.71*** (0.19)	0.94*** (0.22)	1.10*** (0.21)	0.61** (0.25)	0.44* (0.23)	0.93*** (0.26)	0.95*** (0.24)
$GAP \times t = 1$	0.98*** (0.23)	0.89*** (0.21)	1.00*** (0.23)	1.20*** (0.21)	0.57** (0.27)	0.47* (0.25)	0.085*** (0.26)	0.87*** (0.24)
$GAP \times t = 2$	0.40 (0.29)	-0.10 (0.26)	0.53*** (0.25)	0.70*** (0.23)	0.23 (0.29)	-0.52* (0.27)	0.05 (0.28)	0.07 (0.23)
Obs	13,242	33,846	276,161	276,161	13,757	33,072	208,751	208,751
$R^2$	0.07	0.06	0.06	0.30	0.06	0.05	0.06	0.32
<i>Panel B: Average effect</i>								
$GAP \times t \geq 0$	0.75*** (0.21)	0.53*** (0.19)	0.88*** (0.20)	1.00*** (0.17)	0.18 (0.21)	0.12 (0.22)	0.60*** (0.23)	0.60*** (0.18)
Obs	13,242	33,846	276,161	276,161	13,487	33,072	208,751	208,751
$R^2$	0.07	0.06	0.06	0.30	0.07	0.05	0.06	0.32
Cohort-quarter-industry FE			X	X			X	X
Firm FE				X				X

NOTE: \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ . Clustered standard errors in parentheses. Standard errors are clustered by the industry (NAICS 3-digit sector) and cohort (if more than one cohort). Sample: Surviving single-location firms that had five or more workers on payroll on average during the firm's lifetime and have revenue data. All regressions include controls for firm size at baseline and firm age. GAP measures the percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

<sup>a</sup> Columns 3, 4, 7, and 8 include cohort-quarter-industry fixed effects (FE) from 2005–2016; columns 4 and 8 also include firm FEs.

SOURCE: UI records from WAstate, 2005–2016.

**Table A.3.** Effect of the \$13 minimum wage on wagebill.

	(1)	(2)	(3)	(4) <sup>a</sup>	(5)	(6)	(7)	(8)
	Treatment	Treatment	Treatment	Treatment	Placebo Pseudo	Placebo Pseudo	Placebo	Placebo
	Treated cohort	Treated cohort	All cohorts	All cohorts	Treated cohort	Treated cohort	All cohorts	All cohorts
	GAP>0	All firms	All firms	All firms	GAP>0	All firms	All firms	All firms
<i>Panel A: Timing of the effect</i>								
$GAP \times t = -2$	0.25** (0.11)	0.30*** (0.10)	0.03 (0.10)	0.50*** (0.12)	0.25*** (0.07)	0.30*** (0.07)	0.03 (0.07)	0.04 (0.08)
$GAP \times t = -1$	0.089 (0.14)	-0.25* (0.13)	-0.087 (0.13)	0.39*** (0.13)	-0.048 (0.08)	-0.15* (0.08)	0.025 (0.08)	0.034 (0.08)
$GAP \times t = 0$	0.62*** (0.16)	0.25* (0.14)	0.24* (0.14)	0.71*** (0.14)	0.067 (0.09)	-0.05 (0.08)	-0.03 (0.09)	-0.021 (0.09)
$GAP \times t = 1$	0.58*** (0.15)	0.42*** (0.14)	0.50*** (0.14)	0.10*** (0.14)	0.24*** (0.09)	0.18** (0.09)	0.29*** (0.09)	0.30*** (0.09)
$GAP \times t = 2$	0.73*** (0.16)	0.53*** (0.15)	0.74*** (0.15)	1.20*** (0.15)	0.26** (0.10)	0.24** (0.10)	0.29*** (0.10)	0.30*** (0.09)
Obs	14,685	29,235	235,325	235,325	16,255	28,150	177,690	177,690
$R^2$	0.08	0.07	0.06	0.29	0.05	0.05	0.05	0.30
<i>Panel B: Average effect</i>								
$GAP \times t < 0$	0.02 (0.11)	0.02 (0.11)	-0.03 (0.11)	0.44*** (0.11)	0.10 (0.07)	0.08 (0.07)	0.03 (0.07)	0.04 (0.08)
$GAP \times t \geq 0$	0.63*** (0.14)	0.40*** (0.13)	0.49*** (0.13)	0.96*** (0.13)	0.19** (0.09)	0.12 (0.08)	0.18** (0.09)	0.19** (0.09)
Obs	14,685	29,235	235,325	235,325	16,255	28,150	177,690	177,690
$R^2$	0.08	0.07	0.06	0.29	0.05	0.04	0.05	0.30
Cohort-quarter-industry FE			X	X			X	X
Firm FE				X				X

NOTE: \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ . Clustered standard errors in parentheses. Standard errors are clustered by the industry (NAICS 3-digit sector) and cohort (if more than one cohort). Sample: Surviving single-location firms that had five or more workers on payroll on average during the firm's lifetime and have revenue data. All regressions include controls for firm size at baseline and firm age. GAP measures the percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

<sup>a</sup> Columns 3, 4, 7, and 8 include cohort-quarter-industry fixed effects (FE) from 2005–2016; columns 4 and 8 also include firm FEs.

SOURCE: UI records from WA state, 2005–2016.



**Table A.4.** Effect of the \$13 minimum wage on prices and mean wage rate for employers for which prices were collected.

	(1)	(2)
	Unweighted	Weighted
<i>Dependent variable: %ΔMean price</i>		
<i>GAP</i> × 2016.1	0.10	-0.13
	(0.12)	(0.15)
<i>GAP</i> × 2016.2	0.17	0.10
	(0.15)	(0.15)
Obs	89	89
<i>R</i> <sup>2</sup>	0.04	0.04
<i>Dependent variable: %ΔMean wage rate</i>		
<i>GAP</i> × 2016.1	0.41***	0.43***
	(0.15)	(0.11)
<i>GAP</i> × 2016.2	0.32**	0.41***
	(0.13)	(0.11)
Obs	93	93
<i>R</i> <sup>2</sup>	0.09	0.18

NOTE: \*\*\**p* < 0.001, \*\**p* < 0.01, \**p* < 0.05. Clustered standard errors in parentheses. Standard errors are clustered by firm identifier. Sample: Surviving single-location firms that have revenue data. *GAP* measures percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

SOURCE: UI records from WA state and data on prices collected by the authors, 2015–2016.

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