Business Churn, Labor Intensity, and the Minimum Wage: Appendix

Ekaterina Jardim
Amazon.com*

Emma van Inwegen
MIT

1 Policy Change and Data

1.1 Policy Details

The City of Seattle passed an ordinance in June 2014 raising the minimum wage in steps over seven years to $15, 58% higher than that of the state. Washington has a state minimum wage, indexed to inflation annually on January 1 of each year, which has on average increased by 2.4% in nominal terms between 2005 and 2016. [1] The Seattle law had several phase-in stages, and different firms operated on different schedules. Firms which were small, gave employees tip credit, or contributed towards employee medical benefits were given longer to reach $15. The complete minimum wage schedule is presented in Appendix Table 1. The first phase-in period began in April 2015 and raised the minimum wage by 16.2 percent, from $9.47 to up to $11. The second phase-in period began in January 2016 and raised the minimum wage to $12 through up to $13, or by 9.1 percent to 18.2 percent depending on the schedule.

Unfortunately, we cannot determine the exact schedule that applies to each firm in our data because firm size is based on counts of 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 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.[2]

1.2 Data

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

*Ekaterina Jardim worked on this paper prior to joining Amazon.

[1] Complete record of historical minimum wage in Washington State can be found at http://www.lni.wa.gov/WorkplaceRights/Wages/Minimum/History/default.asp.

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

Table 1. Seattle Minimum Wage Schedule

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

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

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. 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 et al. (2018) for more details on the quality of the Washington data. 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. 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 minimum wage law. For each business, we observe the industry code at the NAICS 6-digit level, address of the firm, opening and closing date, quarterly wagebill and total hours worked for each worker, and quarterly revenue.

We use the DOR data to study the effects of the minimum wage to firm revenue. 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. Washington businesses report to the Department of Revenue receipts from all business activities, measured as the value of products, gross proceeds of sale, or gross income of the business. The wagebill includes

all compensation received by an employee, including tips and bonuses. Though IRS requires businesses to report tips received by their employees, and provides regular audits to enforce this regulation, the amount of tips is likely to be underreported. However, we do not have information on non-pecuniary benefits, healthcare benefits, or stock options. 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.

To build the analysis sample we start with all single-location firms in Washington state. Due to the way firms file their payroll taxes we cannot separate Seattle employees from non-Seattle employees at a subset of business with multiple locations across the state. [3] Including non-Seattle employees, who are not covered by the ordinance, in our analysis would mix treated and non-treated businesses and attenuate effects of the policy. To avoid this violation of the Stable Unit Treatment Value Assumption, we focus 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.

We also exclude firms where 10 percent or more of their observations are likely reporting error-if it is one with a real wage rate lower than $9 per hour, reports more than 1,000 hours worked in a quarter, or has a real wage rate greater than $500 per hour and reports fewer than 10 hours in a quarter.

Finally, 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[4] and which exclude only firms which employed 5% of the Seattle workforce in 2014. 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. The firms that make up the final sample account for 70 percent of the workforce employed by single-location businesses in Seattle. See Appendix Table 2 for details.

2 Instrument: Cost of Compliance

2.1 Construction of GAP

Our independent variable, GAP measures a firm's cost of compliance with the new minimum wage. We define this as the percentage increase in total payroll required to meet the new minimum wage if a business keeps the number of jobs and hours at the pre-policy leve.

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

[3] Non-franchise businesses operating multiple stores are given the option to file a joint report for all their locations under one address. As a result, we cannot observe which employees in these businesses work in Seattle and are therefore covered by the wage ordinance and which work outside of Seattle. See (Jardim et al., 2017) for more details on ESD's coverage of firms.

[4] Similar sample restriction is used, for example, in Harasztosi and Lindner (2019) and Kahn and McEntarfer (2014).

Table 2. Summary Statistics on Analysis Sample

		Avg number of firms per cohort	Avg number of workers per cohort	Firm averages			
				Number of employees	Wagerate, $	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)

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

where i denotes firms, c denotes a cohort, n denotes employees of firm i, h_{int} denotes hours worked by a worker n, w_{int} denotes hourly wage rate paid to worker n, and MW is the minimum wage.

The GAP measure depends on the level of the minimum wage, for which we use $11 for the first phase in and $13 for the second. However, the ordinance establishes different minimum wage schedules for firms depending on their number employees globally and whether they contribute towards health benefits (see Appendix Figure 1 for details). Because we cannot determine firm size globally or employee benefits, we cannot identify which minimum wage a firm must follow. Costs of compliance based on the highest minimum wage provide an upper bound estimate of the actual costs of compliance, however, we will never incorrectly assume that businesses are not exposed to the minimum wage hike. We have also run this analysis using the second highest minimum wage ($10.50 and $12.50) and the results are robust.

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 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 the ordinance. However, after it went into effect, we would expect companies to comply with the policy, in which case we would see GAP fall until it approached zero. This is, in fact, exactly what we see in our data. In Appendix Figure 1 we show the growth rate of the cost of compliance for the placebo and treated years. Before the implementation of the minimum wage law, GAP remains stable, and then in 2015 and 2016 timed with the hikes to the minimum wage, GAP declines sharply by more than 100%, which corresponds to firms raising all workers wages to the minimum wage or higher.

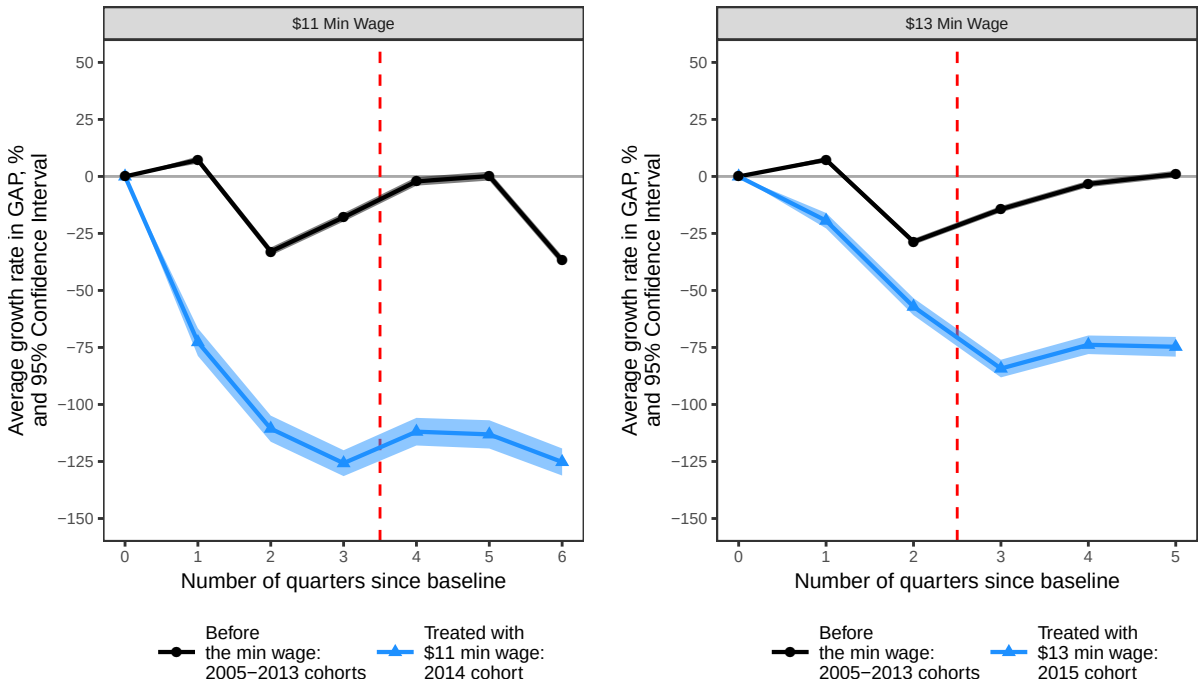
Table 3. Costs of compliance with the minimum wage across firms.

	$11 Min Wage 2014 cohort	$13 Min 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

Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. GAP measures percentage increase in total wagebill required to meet the new minimum wage, assuming jobs and hours remain the same.

Figure 1. Growth rate in cost of compliance and pseudo-cost of compliance over time.

(a) $11 Minimum Wage. (b) $13 Minimum Wage.



Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. GAP measures percentage increase in total wagebill required to meet the new minimum wage, assuming jobs and hours remain the same.

Table 4. Exposure to the minimum wage hike, by industry.

Industry	No. Firms		Employment, all jobs		Firms with GAP>0	
	All firms	Exposed firms, %	All firms	Exposed firms, %	Mean GAP, %	Median GAP,%
Panel A: 2014 Cohort, subject to $11 Minimum wage						
Construction	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
Panel B: 2015 Cohort, subject to $13 Minimum wage						
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

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

3 Empirical strategy

We run the analysis by comparing a treated cohort of firms with control cohorts from prior years within Seattle. We deal with the staggered nature of the minimum wage increase by

estimating Equation (4.1) 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 (which were affected by the \$11 minimum wage), 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.

Table 5. Balance between control and treated cohorts, 2014 cohort subject to $11 Minimum Wage

	Control cohorts		Treated cohorts			
	GAP=0	GAP>0	GAP=0	GAP>0	Diff-in-Diff	P-value.
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	0.07
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	0.12
Wagebill over revenue, %	30.9	30.5	31.8	31.8	0.293	0.518
Share of jobs paying <120% Min wage in hours, %	4.5	41.9	4.5	40.8	-1.056	0.077
Share of jobs paying <125% Min wage in hours, %	5.9	45.2	5.7	43.8	-1.237	0.043
Share of jobs paying <130% Min wage in hours, %	7.5	48.2	7.5	47.3	-0.904	0.152
Exit rate	3.31	4.94	3.23	4.73	-0.1307	0.7777
Entry rate	2.58		2.38		-0.1985	0.4814
Observations	26,677	16,790	3,603	2,372		

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

Table 6. Balance between control and treated cohorts, 2015 cohort subject to $13 Minimum Wage

	Control cohorts		Treated cohorts			
	GAP=0	GAP>0	GAP=0	GAP>0	Diff-in-Diff	P-value.
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	0.00
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% Min wage in hours, %	5.2	46.8	6.1	47.2	-0.618	0.293
Share of jobs paying <125% Min wage in hours, %	6.9	49.6	8.7	50.6	-0.753	0.22
Share of jobs paying <130% Min wage 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	0.0126
Entry rate	2.48		2.25		-0.225	0.5042
Observations	19,335	24,286	3,005	3,106		

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

3.1 Determining Cut-Off Point for Low Wage Jobs

We now 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. 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:

$$NEG_{0,t} = \frac{h_t - h_0}{0.5(h_0 + h_t)} = \underbrace{\frac{h_t(w_t < \bar{w}) - h_0(w_0 < \bar{w})}{0.5(h_0 + h_t)}}_{\text{Contribution of jobs paying} < \bar{w}} + \underbrace{\frac{h_t(w_t \geq \bar{w}) - h_0(w_t \geq \bar{w})}{0.5(h_0 + h_t)}}_{\text{Contribution of jobs paying} \geq \bar{w}}, \quad (3.1)$$

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

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 which used to pay less then $\bar{w}$ to wages above $\bar{w}$. Similarly, some jobs which used to pay above $\bar{w}$ could have received a wage cut and started to pay below $\bar{w}$. We would expect these changes to reflect the ripple effects of the minimum wage rather than changes in labor demand. Formally, we define the changes in hours due such threshold crossing and changes in hours unrelated to wage upgrading or downgrading as follows:

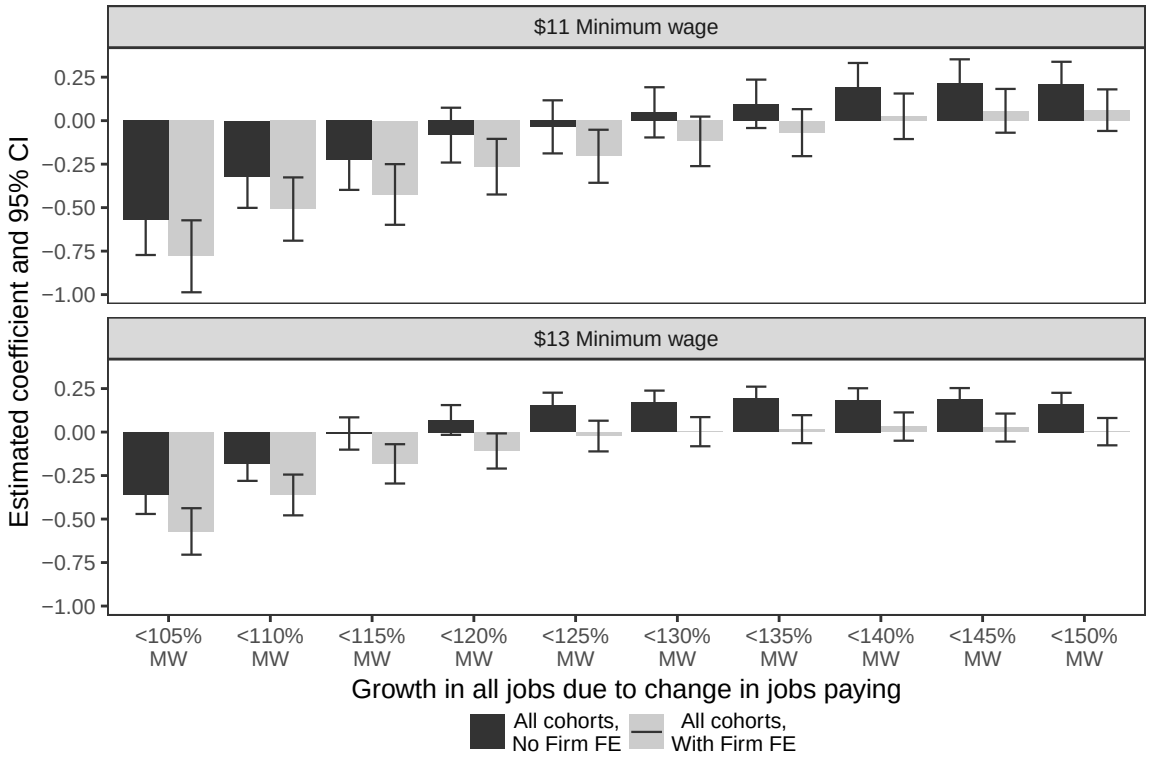
$$\Delta h(\text{Ripple effect})_{0,t} = -h_0(w_0 < \bar{w}, w_t \geq \bar{w}) + h_t(w_0 \geq \bar{w}, w_t < \bar{w}) \quad (3.2)$$

We estimate the ripple effect of the minimum wage using Equation (4.1)). We experiment with the different levels of $\bar{w}$ to define the low-wage labor market segment, with $\bar{w}$ varying from 105 percent to 150 percent of the minimum wage.[5] 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 Appendix Figure 2.

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 \$11 minimum wage and to \$15.60-\$16.25 per hour for \$13 minimum wage. Moreover, our

[5] 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.

Figure 2. Ripple effect of the minimum wage on jobs paying above the minimum wage.



Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. 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 is hours without changes to wage rate. See text for details.

findings on the extent of the ripple effect are also consistent with employer-reported adjustments to the minimum wage in Seattle documented in Romich, Allard, Obara, Althauser and Buszkiewicz (2019). Among the respondents of the Survey of Seattle's Employers, 50% of businesses said that they raised employees' pay to decompress wages in the range in $13–$15/hour, and 30% of businesses said that they raised pay of employees in the range of $15/hour and higher.

4 Sensitivity Checks

In this section we provide additional results on the the effects of the minimum wage on wages, total wagebill, and business entry and exit. We test a variety of specifications, with our preferred one including YearQuarter-Industry fixed effects and Firm fixed effects (Specification 4.)

Table 7. Sensitivity Analysis for effect of the $11 minimum wage on average wages

	(1) Treatment Treated cohort GAP>0	(2) Treatment Treated cohort All firms	(3) Treatment All cohorts All firms	(4) Treatment All cohorts All firms	(5) Placebo Pseudo Treated cohort GAP>0	(6) Placebo Pseudo Treated cohort All firms	(7) Placebo All cohorts All firms	(8) Placebo All cohorts All firms
				Panel A: Timing of the Effect				
$GAP \times t = -3$	−0.0019	0.12	−0.59	−0.39	0.26	0.34	−0.18	0.055
	(0.055)	(0.045)	(0.051)	(0.057)	(0.06)	(0.056)	(0.062)	(0.069)
$GAP \times t = -2$	−0.13	−0.28	−0.45	−0.25	0.0058	−0.15	−0.19	0.044
	(0.08)	(0.073)	(0.077)	(0.077)	(0.077)	(0.069)	(0.07)	(0.077)
$GAP \times t = -1$	0.18	0.11	−0.25	−0.043	0.3	0.38	−0.17	0.067
	(0.087)	(0.079)	(0.08)	(0.077)	(0.08)	(0.074)	(0.077)	(0.079)
$GAP \times t = 0$	0.97	1.1	0.49	0.69	0.42	0.58	−0.14	0.099
	(0.1)	(0.093)	(0.093)	(0.094)	(0.096)	(0.084)	(0.087)	(0.083)
$GAP \times t = 1$	1.1	1.2	0.67	0.87	0.45	0.6	−0.13	0.11
	(0.097)	(0.09)	(0.09)	(0.088)	(0.096)	(0.087)	(0.091)	(0.087)
$GAP \times t = 2$	0.81	0.7	0.73	0.93	0.24	0.1	−0.072	0.17
	(0.11)	(0.099)	(0.094)	(0.09)	(0.11)	(0.1)	(0.1)	(0.095)
Obs	13,242	33,846	276,161	276,161	13,757	33,072	208,751	208,751
R^2	0.093	0.06	0.056	0.24	0.057	0.045	0.055	0.26
				Panel B: Average Effect				
$GAP \times t \geq 0$	0.95	1.00	0.69	0.89	0.26	0.41	−0.081	0.11
	(0.091)	(0.083)	(0.08)	(0.074)	(0.08)	(0.08)	(0.079)	(0.069)
Obs	13,242	33,846	276,161	276,161	13,487	33,072	208,751	208,751
R^2	0.093	0.059	0.056	0.24	0.056	0.044	0.055	0.26
Year Quarter Industry FE	X	X	X	X	X	X	X	X
Firm FE				X				X

No stars are used to designate bucketed p-values in accordance with the American Statistical Association's recommendations. Clustered standard errors in parentheses. Standard errors are clustered by the industry (NAICS 3 digit Sector) and cohort (if more than 1 cohort). Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. All regressions include controls for firm size at baseline and firm age. GAP measures percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

Table 8. Sensitivity Analysis for effect of the $13 minimum wage on average wages

	(1) Treatment Treated cohort GAP>0	(2) Treatment Treated cohort All firms	(3) Treatment All cohorts All firms	(4) Treatment All cohorts All firms	(5) Placebo Pseudo Treated cohort GAP>0	(6) Placebo Pseudo Treated cohort All firms	(7) Placebo All cohorts All firms	(8) Placebo All cohorts All firms
				Panel A: Timing of the Effect				
$GAP \times t = -2$	0.13	0.18	−0.092	0.26	0.12	0.15	−0.06	0.019
	(0.037)	(0.036)	(0.036)	(0.047)	(0.023)	(0.022)	(0.024)	(0.026)
$GAP \times t = -1$	0.01	−0.11	−0.21	0.15	−0.03	−0.062	−0.063	0.016
	(0.05)	(0.047)	(0.043)	(0.05)	(0.029)	(0.028)	(0.027)	(0.028)
$GAP \times t = 0$	0.52	0.5	0.37	0.72	0.17	0.18	−0.045	0.034
	(0.051)	(0.047)	(0.044)	(0.056)	(0.031)	(0.03)	(0.03)	(0.03)
$GAP \times t = 1$	0.56	0.66	0.45	0.8	0.2	0.26	−0.027	0.052*
	(0.053)	(0.049)	(0.047)	(0.06)	(0.033)	(0.031)	(0.032)	(0.03)
$GAP \times t = 2$	0.58	0.66	0.5	0.85	0.22	0.28	−0.0063	0.073
	(0.056)	(0.051)	(0.048)	(0.06)	(0.035)	(0.034)	(0.033)	(0.032)
Obs	14,685	29,235	235,325	235,325	16,255	28,150	177,690	177,690
R^2	0.063	0.036	0.047	0.22	0.047	0.039	0.049	0.24
				Panel B: Average Effect				
$GAP \times \ t < 0$	0.07	0.038	−0.15	0.2	0.044*	0.045	−0.062	0.017
	(0.038)	(0.037)	(0.036)	(0.046)	(0.023)	(0.022)	(0.024)	(0.026)
$GAP \times \ t \geq 0$	0.55	0.61	0.44	0.79	0.19	0.24***	−0.026	0.053*
	(0.049)	(0.045)	(0.043)	(0.057)	(0.03)	(0.029)	(0.03)	(0.028)
Obs	14,685	29,235	235,325	235,325	16,255	28,150	177,690	177,690
R^2	0.063	0.036	0.047	0.22	0.047	0.038	0.049	0.24
Year Quarter Industry FE	X	X	X	X	X	X	X	X
Firm FE				X				X

No stars are used to designate bucketed p-values in accordance with the American Statistical Association's recommendations. Clustered standard errors in parentheses. Standard errors are clustered by the industry (NAICS 3 digit Sector) and cohort (if more than 1 cohort). Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. All regressions include controls for firm size at baseline and firm age. GAP measures percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

Table 9. Sensitivity Analysis for effect of the $11 minimum wage on wagebill

	(1) Treatment Treated cohort GAP>0	(2) Treatment Treated cohort All firms	(3) Treatment All cohorts All firms	(4) Treatment All cohorts All firms	(5) Placebo Pseudo Treated cohort GAP>0	(6) Placebo Pseudo Treated cohort All firms	(7) Placebo All cohorts All firms	(8) Placebo All cohorts All firms
				Panel A: Timing of the Effect				
$GAP \times t = -3$	−0.021	0.17	−0.43	−0.25	0.37	0.62	0.17	0.19
	(0.17)	(0.16)	(0.17)	(0.17)	(0.19)	(0.18)	(0.19)	(0.22)
$GAP \times t = -2$	−0.37	−0.66	−0.34	−0.17	−0.0066	−0.3	0.18	0.2
	(0.21)	(0.19)	(0.2)	(0.19)	(0.2)	(0.18)	(0.21)	(0.22)
$GAP \times t = -1$	0.059	−0.26	−0.13	0.042	0.13	−0.14	−0.13	−0.1
	(0.23)	(0.21)	(0.2)	(0.19)	(0.22)	(0.21)	(0.24)	(0.23)
$GAP \times t = 0$	0.84	0.71	0.94	1.1	0.61	0.44	0.93	0.95
	(0.21)	(0.19)	(0.22)	(0.21)	(0.25)	(0.23)	(0.26)	(0.24)
$GAP \times t = 1$	0.98	0.89	1.00	1.2	0.57	0.47	0.85	0.87
	(0.23)	(0.21)	(0.23)	(0.21)	(0.27)	(0.25)	(0.26)	(0.24)
$GAP \times t = 2$	0.4	−0.096	0.53	0.7	0.23	−0.52	0.049	0.073
	(0.29)	(0.26)	(0.25)	(0.23)	(0.29)	(0.27)	(0.28)	(0.23)
Obs	13,242	33,846	276,161	276,161	13,757	33,072	208,751	208,751
R^2	0.069	0.063	0.059	0.3	0.064	0.054	0.058	0.32
				Panel B: Average Effect				
$GAP \times t \geq 0$	0.75	0.53	0.88	1.00	0.18	0.12	0.6	0.6
	(0.21)	(0.19)	(0.2)	(0.17)	(0.21)	(0.22)	(0.23)	(0.18)
Obs	13,242	33,846	276,161	276,161	13,487	33,072	208,751	208,751
R^2	0.069	0.062	0.059	0.3	0.073	0.053	0.058	0.32
Year Quarter Industry FE	X	X	X	X	X	X	X	X
Firm FE				X				X

No stars are used to designate bucketed p-values in accordance with the American Statistical Association's recommendations. Clustered standard errors in parentheses. Standard errors are clustered by the industry (NAICS 3 digit Sector) and cohort (if more than 1 cohort). Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. All regressions include controls for firm size at baseline and firm age. GAP measures percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

Table 10. Sensitivity Analysis for effect of the $13 minimum wage on wagebill

	(1) Treatment Treated cohort GAP>0	(2) Treatment Treated cohort All firms	(3) Treatment All cohorts All firms	(4) Treatment All cohorts All firms	(5) Placebo Pseudo Treated cohort GAP>0	(6) Placebo Pseudo Treated cohort All firms	(7) Placebo All cohorts All firms	(8) Placebo All cohorts All firms
				Panel A: Timing of the Effect				
$GAP \times t = -2$	0.25	0.3	0.027	0.5	0.25	0.3	0.034	0.043
	(0.11)	(0.1)	(0.1)	(0.12)	(0.07)	(0.069)	(0.074)	(0.081)
$GAP \times t = -1$	0.089	−0.25	−0.087	0.39	−0.048	−0.15	0.025	0.034
	(0.14)	(0.13)	(0.13)	(0.13)	(0.078)	(0.076)	(0.082)	(0.083)
$GAP \times t = 0$	0.62	0.25	0.24	0.71	0.067	−0.05	−0.03	−0.021
	(0.16)	(0.14)	(0.14)	(0.14)	(0.085)	(0.083)	(0.089)	(0.087)
$GAP \times t = 1$	0.58	0.42	0.5	0.97	0.24	0.18	0.29	0.3
	(0.15)	(0.14)	(0.14)	(0.14)	(0.091)	(0.087)	(0.094)	(0.091)
$GAP \times t = 2$	0.73	0.53	0.74	1.2	0.26	0.24	0.29	0.3
	(0.16)	(0.15)	(0.15)	(0.15)	(0.1)	(0.097)	(0.1)	(0.094)
Obs	14,685	29,235	235,325	235,325	16,255	28,150	177,690	177,690
R^2	0.08	0.069	0.055	0.29	0.049	0.045	0.053	0.3
				Panel B: Average Effect				
$GAP \times \ t < 0$	0.17	0.022	−0.03	0.44	0.1	0.075	0.03	0.039
	(0.11)	(0.11)	(0.11)	(0.11)	(0.067)	(0.065)	(0.073)	(0.077)
$GAP \times \ t \geq 0$	0.64	0.4	0.49	0.96	0.19	0.12	0.18	0.19
	(0.14)	(0.13)	(0.13)	(0.13)	(0.086)	(0.082)	(0.089)	(0.085)
Obs	14,685	29,235	235,325	235,325	16,255	28,150	177,690	177,690
R^2	0.08	0.069	0.055	0.29	0.048	0.044	0.052	0.3
Year Quarter Industry FE	X	X	X	X	X	X	X	X
Firm FE				X				X

No stars are used to designate bucketed p-values in accordance with the American Statistical Association's recommendations. Clustered standard errors in parentheses. Standard errors are clustered by the industry (NAICS 3 digit Sector) and cohort (if more than 1 cohort). Source: UI records from WA state, 2005-2016. Sample: Surviving single-location firms which had 5 and more workers on payroll on average during their lifetime and have data on revenue. All regressions include controls for firm size at baseline and firm age. Change in wage rate in treated cohort is instrumented by GAP times an indicator for treated period. GAP measures percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

Table 11. Effect of the minimum wage on rates of entry and exit.

	$11 Minimum Wage				*$13 Minimum Wage*			
	(1) Exit Treatment	(2) Exit Placebo	(3) Entry Treatment	(4) Entry Placebo	(5) Exit Treatment	(6) Exit Placebo	(7) Entry Treatment	(8) Entry Placebo
				Panel A: Timing of the Effect				
$GAP \times t = -3$	0.18	0.056	−0.4	−0.89				
	(0.075)	(0.046)	(0.31)	(0.69)				
$GAP \times t = -2$	0.18	0.061	−0.44	−0.61	0.15	0.048	−0.26	−0.16
	(0.14)	(0.085)	(0.35)	(0.49)	(0.025)	(0.025)	(0.25)	(0.18)
$GAP \times t = -1$	0.12	0.0091	−0.46	−0.43	0.30	0.055	−0.22	−0.042
	(0.14)	(0.10)	(0.37)	(0.37)	(0.062)	(0.041)	(0.25)	(0.14)
$GAP \times t = 0$	0.066	0.048	−0.41	−0.3	0.26	0.045	−0.23	0.00
	(0.17)	(0.12)	(0.37)	(0.31)	(0.053)	(0.046)	(0.26)	(0.13)
$GAP \times t = 1$	0.14	0.0084	−0.37	−0.14	0.20	0.062	−0.23	0.06
	(0.17)	(0.13)	(0.36)	(0.24)	(0.051)	(0.047)	(0.27)	(0.14)
$GAP \times t = 2$	0.33	0.065	−0.39	0.018	0.15	0.05	−0.23	0.06
	(0.2)	(0.12)	(0.39)	(0.21)	(0.051)	(0.048)	(0.27)	(0.14)
Obs	313,367	237,965	50,806	41,128	262,345	198,305	28,383	22,413
R^2	0.029	0.029	0.43	0.44	0.026	0.026	0.58	0.75
				Panel B: Average Effect				
$GAP \times t < 0$					0.22	0.052	−0.24	0.046
					(0.037)	(0.032)	(0.25)	(0.14)
$GAP \times t \geq 0$	0.16	0.033	−0.14	−0.1	0.20	0.052	−0.23	−0.00
	(0.21)	(0.11)	(0.17)	(0.13)	(0.051)	(0.046)	(0.26)	(0.13)
Obs	313,367	237,965	50,806	41,128	262,345	198,305	28,383	22,413
R^2	0.029	0.029	0.43	0.41	0.026	0.026	0.58	0.59
Year Quarter Industry FE	X	X			X	X		
Firm FE								

Clustered standard errors in parentheses. Standard errors are clustered by the industry (NAICS 3 digit Sector) and cohort. Source: UI records from WA state, 2005-2016. GAP measures percentage increase in total wagebill required to comply with the new minimum wage, assuming jobs and hours remain the same.

References

Autor, David H., Alan Manning, and Christopher L. Smith, "The Contribution of the Minimum Wage to US Wage Inequality over Three Decades: A Reassessment," *American Economic Journal: Applied Economics*, January 2016, *8* (1), 58–99.

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

Jardim, Ekaterina, Mark C Long, Robert Plotnick, Emma van Inwegen, Jacob Vigdor, and Hilary Wething, "Minimum Wage Increases, Wages, and Low-Wage Employment: Evidence from Seattle," Working Paper 23532, National Bureau of Economic Research June 2017.

Kahn, Lisa B and Erika McEntarfer, "Employment Cyclicality and Firm Quality," Working Paper 20698, National Bureau of Economic Research November 2014.

Lachowska, Marta, Alexandre Mas, and Stephen A. Woodbury, "How Reliable Are Administrative Reports of Paid Work Hours?," 2018. Unpublished manuscript, Upjohn Institute for Employment Research.

Neumark, David, Mark Schweitzer, and William Wascher, "Minimum wage effects throughout the wage distribution," *Journal of Human Resources*, 2004, *39* (2), 425–450.

Phelan, Brian J, "Hedonic-based labor supply substitution and the ripple effect of minimum wages," *Journal of Labor Economics*, 2019, *37* (3), 905–947.

Romich, Jennifer, Scott W. Allard, Emmi E. Obara, Anne K. Althauser, and James H. Buszkiewicz, "Employer Responses to a City-level Minimum Wage Mandate: Early Evidence from Seattle.," *Urban Affairs Review*, 2019. Forthcoming.