Who's Afraid of the Minimum Wage? Measuring the Impacts on Independent Businesses Using Matched U.S. Tax Returns*

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Abstract

A common concern surrounding minimum wage policies is their impact on independent businesses, which are feared to be less able to either bear or pass-on cost increases. We examine how independent firms accommodate minimum wage increases along product and labor market margins using a new matched owner-firm-worker panel dataset drawn from the universe of U.S. tax records over a 10-year period. We find that, on average, firms in highly exposed industries do not substantially reduce employment, but instead fully finance the added labor costs with new revenues. Among surviving firms, we even observe small average increases in owner profits. We show, however, that these average gains belie significant heterogeneity by industry and productivity. Among restaurants, the most acutely impacted industry, the minimum wage causes firm exits. Exits are concentrated among the least productive small firms, while the observed profit gains stem from the more productive surviving small restaurants. These findings are consistent with a model of Cournot competition with heterogeneous productivity and fixed production costs. The cost shock and resulting exits winnow the productivity distribution of surviving and entrant firms with demand and workers reallocated to more productive survivors. Following low-earning and young workers, we find that their earnings increase on average, they are no less likely to be employed, and their turnover rates decline when minimum wages rise.

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1. Introduction

Proposals to raise the minimum wage are often met with arguments that independent businesses may be particularly vulnerable to wage floor increases.[1] Though recent research has found that minimum wage increases have had few deleterious aggregate employment impacts in the short-run,[2] fears that independent businesses operate on margins too slim to accommodate cost increases or face demand too elastic to pass costs through to consumers motivate small businesses exemptions and even wholesale opposition to raising wage floors. At the same time, surveys repeatedly find independent businesses owners divided on minimum wage policy, with large shares actually in support of higher wage floors.[3]

This study presents the first comprehensive examination of how independent firms accommodate minimum wage increases in the United States. To track independent firms, we construct a novel linked firm-worker-owner panel dataset created from the universe of U.S. tax returns. To measure responses in both product and labor markets, we match the tax returns of pass-through firms — the predominant organizational form of independent businesses — to the individual income tax returns of each of their workers and owners over a 10-year period. While we primarily take a firm-level view, we complement this analysis by creating an individual panel to follow outcomes of the owners of exiting firms and the workers most likely to be impacted by wage policies across employers and over time.

To estimate the causal effects of minimum wage increases, we exploit sub-national policy changes allowing us to compare treated firms to similar, but wholly untreated firms in states that did not adjust their wage regulations, controlling flexibly for firm size, industry and market characteristics. Our long panel helps to validate the causal interpretation of the findings and to measure impacts over time for a consistent set of firms, while the breadth of the data lets us capture market-level impacts and measure how responses vary by firm and

[1] For example, see reporting in the Wall Street Journal and Forbes.

[2] See Cengiz et al. (2019), Dustmann et al. (2021), Dube et al. (2010); Allegretto and Reich (2018), and Harasztosi and Lindner (2019) plus Belman and Wolfson (2014) for a review of recent research

[3] For example, see polls from Gallop, CNBC, the American Sustainable Business Council, the Society for Human Resource Management, and reporting in the Washington Post.

worker characteristics.

Using these data, we empirically examine the various margins by which independent firms accommodate the cost shock associated with the minimum wage increases. First, saliently, firms may adjust employment levels when wage floors rise. We find that employment effects manifest through a combination of moderately lower hiring rates and higher retention rates among existing workers, resulting in little effective change in employment among exposed independent businesses on average. Further, we show that reduced hiring is almost entirely concentrated among teenagers in part time jobs paying less than $4,000 per year.

While minimum wages only modestly impact net employment from a firm perspective, reduced part-time hiring could potentially deny young workers a foothold into the labor market. Examining individual panels of low-earning workers in highly exposed industries and young people more generally, we find that on average, these groups have higher earnings in the years following the minimum wage increase and are no less likely to be employed, relative to similar workers in untreated states. Overall, we find that, on average, minimum wage increases have little effect on employment among potentially vulnerable firms and workers, which complements estimates from Card and Kreuger (1995) as well as recent studies finding small short-to-medium-run employment effects of the minimum wages.

Next, we examine how independent firms accommodate higher minimum wages since they do not substantially reduce employment. Higher minimum wages drive the wage bills of exposed firms up by 7% on average, with income gains concentrated among low-earning workers. We document that exposed firms finance the wage increases through higher revenues. In fact, on average, the revenues of surviving firms increase enough to fully offset the increased labor costs, resulting in a small net profit increase. Yet, we also document an increased probability of firm exit as a result of the labor cost shock. These exits and profit increases arise in the same industry, restaurants, where the minimum wage raises variable costs most acutely. Exits are concentrated among the least productive small restaurants while profits rise only among productive small restaurants that survive while their less productive counterparts exit.

We present a simple conceptual framework — a model of Cournot competition with heterogeneous productivity and a fixed production cost — that rationalizes the disparate impacts of minimum wages when they bite sharply as in the restaurant industry. While the market price rises as firms pass through the added costs of complying with the higher wage floor, margins narrow for firms whose cost increases outpace the market price increase, leading some to exit. In this framework, exiting firms could be those with the lowest productivity, the largest cost shock (i.e. the highest share of low wage labor per unit of output), or a combination of the two. Empirically, we find that low *ex ante* productivity drives exits, while productive firms, even those with high shares of low-earning workers, are able to survive and even benefit from the minimum wage increases. These exits have two implications for surviving firms. First, there is selection — the distribution of remaining firms in the market is more productive than the pre-shock distribution. Second, some of the remaining demand is reallocated from the exiting firms to (more productive) surviving firms. This combination can result in increased profits among surviving firms, at least in the short-to-medium run. In effect, rather than shuttering otherwise healthy businesses, raising the minimum wage winnows the productivity distribution of restaurants, rendering the industry more efficient. We estimate a relatively precise zero exit response for firms in exposed industries outside of restaurants and, as the model would predict, find no evidence of higher profits.

Finally, we leverage the individual dimension of the panel to measure how minimum wages affect the transition patterns of workers and owners of exposed firms. We find that the reallocation of output and profits towards more productive restaurants through firm exit and entry is paralleled by greater worker retention at larger, higher value-added firms and reallocation of workers from from smaller, lower-value added firms toward larger firms. Turning to a panel of owners of independent firms, we estimate the effects of policy-induced exits on owner outcomes. Compared to owners whose exits are not attributable to minimum wage policy, owners that exit due to the minimum wage are less likely to be business owners five years later, but earn no less in wages plus business income or net ordinary business income. Average incomes remain steady in part because these former business owners are significantly less likely to report negative incomes; policy-induced exiters appear more likely to substitute away from potentially risky or less profitable business ownership.

Our paper makes four key contributions. First, we comprehensively document how higher wage floors affect independent businesses whose ostensible vulnerability is often cited in debates around minimum wage policies. While a number of studies have shown that higher minimum wages have little impact on aggregate employment, ours is the first study to examine how the small and medium-sized firms that typify independent businesses cope with higher wage floors. We show that even independent firms make only modest employment adjustments and are largely able to pass the added costs of higher wage floors on to customers. In short, minimum wage policies mainly redistribute from customers to workers rather than within small firms from owners to workers.

Second, because the merged tax data describe the operations of firms so fully, we are also able to contribute a uniquely complete assessment of how a consistent set of firms responds to minimum wage policies. While prior work has assessed responses across specific margins such as revenue and profits (Draca et al., 2011), pass-through (Leung, 2021; Renkin et al., 2020), employment, worker reallocation (Dustmann et al., 2021), and exit (Luca and Luca, 2019), we measure the joint responses across these margins among a single set of firms spanning many affected industries.[4] This allows us to tie the higher worker retention and small net employment changes of productive firms to their revenue and profits gains, and understand that these effects manifest among the same firms.

Third, by taking a firm perspective we capture how firm exit leads to a combination of

[4] One notable exception is (Harasztosi and Lindner, 2019) who examine the impacts of Hungary's introduction of a minimum wage on revenues, variable costs and employment. They find that on average firms can finance three-quarters of the added costs of the minimum wage, and though exporting firms make small employment reductions, they find no evidence of higher exit rates. We build on these findings and examine how in a large economy like the U.S., where minimum wage policies reach less far into the wage distribution, these responses are mediated by extensive margin responses among competing firms. Other work has incorporated multiple response margins but for establishments of a single firm (Coviello et al., 2022; Ashenfelter and Jurajda, 2021; Brummund, 2018) or industry (Ruffini, 2022).

selection on pre-reform characteristics and reallocation through the product market that ultimately shapes the post-reform trajectories of workers, firms and markets. Through the lens of a framework with heterogeneously productive firms, we document a fresh dimension of reallocation as more productive surviving firms, even those that heavily rely on low-earning labor, generate enough new revenue following the exits of their less productive competitors to post higher profits following the cost shock. This "creative destruction" where exposed industries become more efficient as the best firms gain while the weakest close, helps rationalize persistent findings, including ours here, of limited employment impacts when minimum wages rise.[5]

Fourth, we contribute estimates of how firms accommodate minimum wages with greater applicability to proposed policies in large economies where the impacts of wage floors are focused in the service sector rather than extending to tradables as they might in smaller, export-focused economies. Further, because our identification strategy relies on subnational policy variation, affording us an untreated control group, we side-step recently raised concerns (Haanwinckel, 2023) about identification drawing on national variation and using "fraction affected" and "effective minimum wage designs."

Taken together, our findings show that independent, potentially vulnerable firms are broadly able to accommodate minimum wage increases through higher revenues. Minimum wage policies have deeper impacts in the restaurant industry where they harm the viability of the least productive firms while benefiting surviving firms through a combination of higher worker retention and new revenues. While in the end the industry is more efficient, with even entering firms mirroring the productivity of survivors, these gains come at the cost of exiting firms and their owners. This divergence in outcomes helps explain why surveys repeatedly show that independent business owners are divided when it comes to minimum wage policy.

[5]This perspective also facilitates interpretations of estimates derived from different subsets of firms or differentially exposed markets. For example, providing context for how i) studies of surviving firms may offer different conclusions from cross-sectional studies, ii) studies that combine more or less exposed industries may provide averages of qualitatively different responses, or iii) studies of a specific industry or sample of firms (particularly if selecting on productivity) may reach different conclusions than studies that focus on different subset of industries or firms types.

Uncertainty about cost pass-through, and about possibilities of demand reallocation and worker retention likely broaden opposition. Ultimately, higher wage floors raise the earnings of low income workers with the costs borne in part by the small share of owners whose firms shutter, and largely by consumers who finance the revenue increases that offset added wage costs and leave most business owners no worse off.

2. Analyzing Firm Responses with Administrative Data

The central question of our analysis is how minimum wage increases are financed by firms and their workers. To understand how compensation changes among workers within a firm and between workers and owners we need a dataset that combines worker-level measures of earnings and employment with firm-level measures of profit and owner earnings. We assemble such data by linking the annual tax returns of the universe of U.S. pass-through businesses — the primary business form for small and medium-sized firms in the U.S — to the yearly individual returns and information reports of all workers and owners associated with a firm each year.

2.1. Independent Firms

For our empirical analysis, we focus on pass-through businesses. Pass-throughs, or independent businesses, are privately owned businesses with legal forms including S-corporations, Partnerships and Limited Liability Companies (LLCs).[6] In 2015, pass-throughs comprised 78% of non-sole-proprietorship businesses and accounted for 46% of employment and 52% of business income. Pass-throughs are smaller than publicly traded firms on average, but they represent the majority business forms in all two-digit NAICS industry groups except utilities and management of companies and enterprises. They represent 79% of firms with fewer than 20 employees, 72% with 20-99 employees, 61% with 100-500 employees, and 77%

[6]These private business forms are called pass-throughs because of their tax treatment. Business income is not taxed at the entity level, but is "passed through" to the individual tax returns of the firm owners. This is in contrast to publicly traded C-corporations where the business income is subject to the corporate income tax, and shareholders are taxed at the individual level on any distributions of dividends.

of all firms with fewer than 500 employees. They only represent 18% of firms with more than 500 workers, of which publicly traded C-corporations are the predominant business form.[7]

We focus on pass-throughs for a few key reasons. First, the effect of minimum wage increases on the viability, employment and financial health of independent businesses is a top flight concern when it comes to wage floor policy and the vast majority of independent business in the U.S. are organized as pass-throughs. Minimum wage studies that use worker-level surveys will implicitly subsume responses among large businesses because they employee half the population, though representing a small subset of firms. Further, we find that minimum wage increases have the most substantial effects on restaurants, an industry in which pass-throughs account for the large majority of firms, employment, revenue, and business income. Additionally, we are able to link all owners of pass-throughs to the firm allowing us to separately identify responses of employees from firm owners that also provide labor to the firm. Going forward, we refer to these pass-through businesses as independent businesses for simplicity.

2.2. Minimum Wage Exposure at the Firm Level

In the U.S., only 4.3% of workers paid hourly rates are paid at or below the minimum wage (≈2.5% of all workers, or 3.25 million workers), but these workers are highly concentrated in a few industries. Appendix Figure A.1 shows the share of workers at or below the minimum wage by industries in 2013 according to the U.S. Bureau of Labor Statistics (BLS). The vast majority of the minimum wage workforce can be found in the Leisure and Hospitality and Retail Trade industries. For our analyses, we focus on the firms in "highly exposed" industries. To do so, we use the tax data to generate a rank of 4-digit NAICS industries by the share of low-earning workers in that industry in 2013. We use low-earning workers as a proxy for likely minimum wage workers and define low-earning workers in 2013 as those

[7] Statistics are from SOI Integrated Business Data (https://www.irs.gov/statistics/soi-tax-stats-integrated-business-data) and Census's SUSM Annual Data Tables by Establishment Industry (https://www.census.gov/data/tables/2015/econ/susb/2015-susb-annual.html). See Smith et al. (2019), Yagan (2015), Cooper et al. (2016) and Risch (2023) for further descriptions of pass-throughs and their owners relative to other business forms in the United States.

earning less than \$15,080 (= 40 hrs/week x 52 weeks/year x \$7.25/hour federal minimum wage) across all jobs in each year from 2012-2014.[8] The resulting rankings correspond very well with the Census industry rankings (Figure A.1). Our definition of "highly exposed" industries use these internally generated measures and are defined as those with at least 15% low-earning workers.[9]

2.3. Administrative Data: Firm-Worker Panel

Firm and worker information is drawn from the universe of de-identified administrative tax data. We use a 100% sample of pass-through firms in highly exposed industries in treatment states (states with legislated minimum wage increases in 2014) and control states in each year from 2010 to 2019.[10] For each firm, we collect information from the firm's annual income tax return, which we then link with the individual income tax returns and information reports of all owners and workers to create a combined firm-worker-owner dataset. The resulting dataset includes individual income variables for all employees and owners in each year, as well as firm-level income, tax, productivity and characteristic variables from the business income tax return.[11] We use a balanced sample to track how active firms exposed to minimum wage increases finance the increased labor costs. Additionally, we use the full unbalanced panel of firms to estimate effects of the minimum wage on firm exit and on characteristics of firms that exit and enter following the policy change. The analysis sample consists of approximately 235,000 firms per year.

The linked employer-employee data we assemble provides several advantages. Principally, it allows us to estimate various margins of response among affected firms and their workers to provide a comprehensive picture of how independent businesses respond to minimum wage increases. Firm tax returns disclose many key details of firm operations while the worker-

[8] This definition will include persistent part-time workers in addition to minimum wage workers, so is over-inclusive. Details of this procedure are further described in Appendix C.

[9] The qualitative results are not sensitive to the exact cut-off industry, but as we discuss in detail in Sections 4.4 and 5, the effect of minimum wage policies on firms and industries depend on the industry level of exposure to the policy.

[10] Treatment and control states are defined in Section 3.2.1.

[11] Details of the data creation are in Appendix C.

firm-owner link allows us to measure heterogeneous effects across workers within firms. Using the universe of administrative data allow us to i) identify differential responses across *ex ante* firm characteristics with sufficient power to detect small effects even for subsets of firms, and ii) estimate extensive margin responses among firms, including differential characteristics of firms that exit as a result of the policy or of firms that enter following the policy change.

The principal weakness of the tax data for our purposes is that we do not directly observe hourly wages. Tax returns report aggregate earned income and W-2 forms report earnings from different employers, but do not separately report hours and wages. As a result we screen likely minimum wage workers using criteria based on earned income across jobs and over time as described above, and focus on low-earning workers more broadly to understand the impact of wage floor policies on individuals. Our data are uniquely well suited to understanding how minimum wage policies affect the business operations of firms and incomes of low income individuals years down the line, but are less well-suited for measuring the direct effect on minimum wage workers, since they cannot be directly observed in the tax data. We focus on firms in highly exposed industries, which allows us to estimate average effects within these industries and heterogeneous effects across firm characteristics within these industries.

To complement our firm-level analyses, we also construct two individual-level panels to estimate outcomes on potentially vulnerable workers. The first panel is a random sample of all workers in highly exposed independent firms prior to the reform (2013).[12] Second, we draw a random sample of young individuals (ages 16 to 26), regardless of whether they are working prior to the reform or not. The first sample allows us to test for worker-level effects of the minimum wage for those working in the potentially most vulnerable firms. The second sample allows us to test outcomes among young workers, whom previous work has found particularly vulnerable to minimum wage policies, using the administrative tax data.[13]

[12] We take a 40% sample of workers (≈1 million workers) in treatment states and a 20% (≈1 million) sample from control states. See Appendix C.3 for further details.

[13] These samples are detailed further in Appendix C.

3. State Minimum Wage Changes and Empirical Strategy

3.1. Policy Details

Our analysis centers on the six state minimum wage changes that took effect in 2014. We focus on these legislative changes because they are the most recent policy events that also allow for a multi-year post period to assess the consequences of raising wage floors. Figure 1 plots the minimum wage over time for each of these six states (California, Connecticut, Delaware, Michigan, Minnesota and New Jersey) with with X marks denoting the passage of new legislation

In five of these six states the 2014 minimum wage increase was the first part of a larger, phased-in minimum wage hike. These phase-ins mirror federal proposals to raise the minimum wage over several years. Connecticut and California legislated further minimum wage increases in 2014 and 2016, respectively, which also phased in over time and supplanted minimum wage increases dictated by the 2013 legislation.[14] Delaware and Michigan adopted further increases in the minimum wage in 2018, and though these took effect after our analysis period, we may observe some anticipatory reaction to these policy changes in the last year of our sample. The details of each state's minimum wage schedule can be found in Appendix Table B.1. For the average firm in these six states the total impact of the minimum wage legislation was to increase the minimum wage by 30.6% by 2018. In comparison, recently proposed federal legislation aims roughly double the minimum wage from $7.25 to $15 over four and a half years, an increase of about $1.72 per year.

Our event study analysis traces the collective impact of these wage floor changes over time with the estimates from 2018 providing our most complete measure of the cumulative effect. Because firms may anticipate scheduled or potential future minimum wage increases,

[14] Connecticut's 2014 law replaced the $9.00 minimum wage that was scheduled to take effect in 2015 with a new $9.15 minimum wage followed by further increases in each of the next two years. California's 2016 legislation built on the minimum wage increases of it 2013 law, and for the first time distinguished between larger and smaller employers. Employers of 26 or more workers face minimum wage increases each year until the minimum wage reaches $15.00 in 2022 when become inflation indexed. Smaller California firms ultimately face the same minimum wage but with a one-year delay in the scheduled increases.

our estimates may attribute too strong a response to the actual change in minimum wages in any given year. Changes in employment, wages, and revenues may also be disproportionate if firms face adjustment frictions.

3.2. Identification

Using the policy variation described above, we define a treatment and control group of states based on whether they raised their minimum wages in 2014. The treated states are those shown in Figure 1, which are all states that experienced a minimum wage increase in 2014 and had not had an increase in the previous two years (i.e. the increase in 2014 was not part of a phase-in of a previously legislated increase). The control group consists of all states that did not experience a minimum wage increase anytime between 2012-2018.[15]

To estimate the effect of the 2014 minimum wage increases we use an event-study style approach to compare outcomes of firms and workers in treated and untreated states over time. Our workhorse model is a panel difference-in-differences (DD) specification of the form:

$$f(y_{jt}) = \alpha + \sum_{s \neq 2013} (\beta_s treated_j + \Gamma_s X_j) \times year_{s=t} + \delta_t + \psi_j + \nu_{jt} \tag{1}$$

where y_{jt} is a firm-level outcome and β_s is the DD estimator of the differential in the average outcome between firms in treated and untreated states relative to the pre-reform base-year, 2013. The primary definition of treatment, $treated_j$, is an indicator for the firm operating in a state with a minimum wage increase. The event-study style design helps to assess the validity of comparing firms in treated and untreated states by estimating whether trends moved in parallel prior to the reforms. Firm (ψ_j) and year (δ_t) fixed effects are included, and X_j is a vector of baseline firm and local area characteristics, such as firm industry and size and local unemployment rate and density, to facilitate comparisons across similar firms in similar markets.

[15] Control states are Alabama, Georgia, Iowa, Idaho, Illinois, Indiana, Kansas, Kentucky, Louisiana, Mississippi, North Carolina, North Dakota, New Hampshire, New Mexico, Nevada, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Virginia, Wisconsin, and Wyoming.

To enhance the comparability of treatment and control firms, we use the re-weighting methodology of DiNardo et al. (1996) (DFL) to construct a distribution of firms from states that did not change their minimum wage that is observationally similar to the set firms subject to minimum wage increases in 2014.[16] For our regression analyses that examine dollar-valued outcomes, such as the total wage bill or owner's income, we weight by the product of the DFL weight and firm size, so that each observation contributes to all graphs and estimates according to its economic scale and all estimates are representative of U.S. economic activity. We winsorize all raw reported firm values from above and below at the 1% level.[17]

Table 1 shows key characteristics of the sampled firms. Means are presented in the left panel and medians in the right. The first two columns show the raw means for treatment and control firms in the base year 2013 while the third column shows the adjusted measures for control firms using the DFL weights. The summary statistics show that the firms in treatment and control states are quite similar in terms of observable characteristics prior to re-weighting. Comparing raw means, the firms in the treatment and control states are very similar in the number of employees but the firms in the treatment states are somewhat larger on average in terms of revenues, total wage bill, gross profit and owner income. Applying the DFL weights pulls the means and medians of the control group closer into alignment with the treatment group.

Our primary empirical strategy is a state-level panel design, but in Appendix D (also discussed in Section 5) we present results from a design using border counties as in Card and Krueger (2000), Dube et al. (2010, 2016) and Allegretto et al. (2013, 2017). We use the state-level design in the main analysis for two complementary reasons, each facilitated by the breadth of the administrative data. First, border counties may be different than interior counties on several dimensions. In states where larger cities are not near borders, or

[16]Our DFL procedure is similar to Yagan (2015), which re-weights S corporations to make their within-industry size distributions comparable to C corporations. Details are discussed in Appendix C.

[17]Winsorization is standard when working with the population business tax returns. For example, Yagan (2015), DeBacker et al. (2019) and Kline et al. (2019) winsorize all values at the 5% level.

generally where the local economies around borders differ from the average county in a state, there could be heterogeneous effects among firms in border counties relative the average firm in the state. Second, our broad panel of administrative data allows us to include a range of firm and local labor market controls to mitigate concerns about confounding variation across states, and to observe conditional pre-trends in the outcomes of interest to help assess the plausibility of the identifying assumption of our research design. Since we would like to leverage the comprehensive nature of our administrative data to provide a holistic picture of how independent firms in the U.S. accommodate minimum wage increases, we utilize the state panel design in our primary analysis.[18]

3.2.1. Implications of Research Design for Understanding Minimum Wage Responses

Our identification strategy compares similar firms in states that increase their minimum wages to similar firms in states that left their wage floors unchanged. By focusing on firms in highly exposed industries, we estimate the effect of minimum wage increases on the average firm in the affected market, and effects within any subgroups of interest. Since our estimation strategy does not rely on exploiting variation by baseline firm-level exposure, we are able to conduct high-powered heterogeneity analysis across subgroups that may be, on average, more or less exposed to the minimum wage change. By comparing firms in treated and untreated markets, we can estimate responses among firms that are more and less directly affected by the policy due to their workforce composition, but are simultaneously exposed through the market-level shock. That is, we can estimate effects on firms that may be less exposed to minimum wage changes, but operate in the same product and labor markets as firms that are more exposed, thus providing information about the market-level effect of the policy in addition to the firm-level effect.

The principle threat to identification is policy endogeneity.[19] One form of endogeneity

[18] As discussed in Section 4.4 and Appendix D, the main findings are supported by the border design, which bolsters our use of the full sample for the main analysis.

[19] Other research centered on minimum wage increases during recessionary periods has somewhat larger employment (Clemens and Wither, 2019) impacts and effects on firm finances and exit rates (Chava et al., 2019)

is if states that choose to implement minimum wages at a given time are on different paths than those that do not, for example, if minimum wages are increased in states with faster growing economies. This would be a violation of the standard parallel trends assumption for DD designs. This is a legitimate concern, and we use pre-trend analyses for all of the primary outcomes to assess the plausibility of this assumption in our setting. The second identifying assumption is that there are no other changes, concurrent with the minimum wage change, that would differentially affect the outcomes in treated and control states. This is a general challenge for designs with state-level variation. We provide evidence that our estimates are consistent with responses to minimum wage policies, for example, by investigating the distribution of wage changes and by using within-state, across firm variation in exposure. That said, we cannot rule out unobservable, factors that coincide with the timing of treatment and differentially affect treated and untreated firms.

4. Impacts on Firms and Workers

4.1. The employment and earnings impacts of minimum wages for independent businesses and low-earning workers

The employment effects of minimum wage laws have been widely studied with many, but not all, recent studies finding small impacts in the near term (Dube et al., 2010; Cengiz et al., 2019; Harasztosi and Lindner, 2019), and others pointing to the potential for larger long-run impacts (Meer and West, 2016; Aaronson and French, 2007).[20] We focus on the impacts of minimum wages on ostensibly vulnerable independent businesses and find that the average exposed firm does not meaningfully reduce employment in response to higher minimum wages. We estimate an own-wage elasticity of -0.209 (0.0112), which is small in magnitude and in line with previous studies that do not focus on the small and medium-sized firms that typify independent businesses (see Appendix Figure A.3). Our measure of

[20]Belman and Wolfson (2014) provide a detailed review and Clemens (2021) provides an excellent overview of recent findings on firm responses on non-employment margins.

employment relationships reports the total numbers of workers who receive a W2 from a firm in a calendar year, including any partial year workers. As such, decreases (increases) in turnover may appear as decreases (increases) in employment. Therefore, our modest employment response estimates may still overstate the degree of true reductions in labor inputs if higher minimum wages boost worker retention.[21]

To better understand how firms adjust employment, Figure 2, Panel A traces the average change in overall firm employment as well as the change in new hires (entrants) and existing workers (separations). The average firm subject to a higher wage floor does not layoff workers employed by the firm prior to the minimum wage increase as shown by the flat retention line. Firms in treated states, do however, reduce hiring. By 2018, firms in highly exposed industries in states that raised the minimum wage on average hire and thus have employment relationships with roughly one fewer worker than similar firms in control states.

Reduced hiring is wholly concentrated among low-earning jobs and largely teenagers. The lower two panels of Figure 2 decompose the change in employment by employee age and earnings. Firms subject to higher minimum wages primarily hire fewer teenagers. The missing hires consist entirely of workers who would have been paid less than $3,900 annually — with the majority (67%) earning less than $1,000 per year. In short, higher minimum wages lead firms to turn away from very part-time, less-experienced labor inputs.

One reason independent businesses may hire fewer part-time teenage workers is that raising the minimum wage makes it substantially more likely that workers remain with the same employer.[22] As shown in Figure 3, Panel D, low-earning workers of all ages and teenage employees generally, are 2 to 4 percentage points more likely still be working for their 2013 employer in 2016 with prime-age low-earning workers exhibiting the most pronounced retention rates. The workforces of highly exposed independent businesses thus feature more experienced and likely more effective workers after the minimum wage increase.

[21] This is typically the case with administrative data that describes only employment and compensation rather than hours worked by employees over the reporting period (here one year).

[22] Turnover reductions have been previously demonstrated for specific employers (Michael Reich and Jacobs, 2004; Coviello et al., 2022) or by worker rather than firm characteristics (Dube et al., 2016).

The lack of meaningful employment impacts and lower turnover at independently owned businesses raise the possibility that higher wages can lead to higher incomes for the lowest paid workers as they avoid job losses and gain firm-specific experience. However, Figure 2 suggests that some teenage workers may lose their first foothold in the workforce as independent firms hire fewer young workers. To learn how minimum wage policies affect the earnings of the types of workers they are aimed to help, we construct two individual-level panels describing the earnings trajectories of 1) low-earning workers employed by independent businesses, where low-earners are those earning less than $25K in total individual wages each year between 2012 and 2014,[23] and 2) young individuals not attached to any employer in 2013.[24]

Figure 3, Panels A and B plot the evolution of average earnings in treated states relative to control states for our low-earner panel and panel of young individuals not working in 2013, respectively. The earnings trajectories of low income or young individuals in control states effectively stand-in for how earnings may have evolved in treatment states had they not raised their minimum wages, thereby helping to account for any mean reversion or macroeconomic trends affecting the earnings of low income or young workers similarly in control and treatment states. In both panels the earnings of workers in control and treatments states track each other closely between 2010 and 2013, bolstering the idea that they would have continued similarly absent the minimum wage increases.

Panel A shows the earnings trajectories for all low-earners and separately for teenage low-earners (16 to 19 years old). For both groups, earnings significantly rise following the minimum wage hike with an average increase of about $2,000 per year by 2018.[25] We might worry that the reduction in hiring of young, part-time workers documented in Figure 2

[23]Members of the low income panel need not work in 2012 or 2014.

[24]This is a subset of a random sample of all young people (15-26 years old) in treatment and control states. We take a stratified random sample of 12% (6%) of those 20-26 years old in treatment (control) states and 24% (12%) random sample of those 15-19 years old in treatment (control) states. See Appendix C.3 for further details.

[25]These estimates do not condition on being employed in any year other than 2013 and earnings are recorded as zeros for non-employed individuals.

might make it difficult for young labor market entrants to gain a hold in the workforce, leading minimum wage increases to actually dampen their earnings trajectories. Panel B of Figure 3 plots the earnings of young (20-26 years old) and teen individuals without jobs in 2013. Young workers benefit quite quickly and dramatically with a relative increase of almost $4,000 per year by 2018). Teenagers have a smaller, but still significant increase of about $1,000 in income gains over teens living in states that did not increase their minimum wages by 2018.

Figure 3 Panel C plots the effect of the minimum wage hike on the probability of non-employment for these low-earning and young individuals. Specifically, the estimates measure the change in non-employment rates over the five-year period between 2013 and 2018. The estimated employment responses are all either flat or show small increases in the probability of employment relative to similar workers in untreated states, demonstrating that extensive margin responses may contribute to the earnings gains shown in Panels A and B. The earnings trajectories and employment gains depicted in Figure 3 show that despite fears that employment losses could ultimately undermine the redistribution goals of minimum wage increases, five years after these wage floor increases were legislated, ostensibly vulnerable workers enjoy substantial income gains on average.

4.2. The Magnitude of the Cost Shock for Highly Exposed Independent Firms

Raising the minimum wage improves the earnings trajectories of low-earning workers, but it also raises the cost of low-skill labor inputs for firms. We can see the impact of this cost shock in the evolution of firm wage bills over time. Panel A of Figure 4 plots coefficients from a firm-level event study regression of equation (1) where log annual total wages is the dependent variable. The annual estimates measure the percent increase in wage bills relative to 2013 among firms in highly exposed industries operating in states that raised their minimum wages compared to similar firms in control states.

The estimates from 2010 through 2012 show that firms in treated and untreated states had similar trends in the years prior to the 2014 minimum wage increases. Average wage bills then rose sharply among treated firms. Wage bills grew each year as minimum wage increases phased-in; by 2018 the average firm was paying 7.03% (0.0153) more in wages as a result.[26,27] Minimum wage policies meaningfully increased labor costs for firms in industries that most rely on low-income labor.[28]

Raising the minimum wage directly increases the hourly pay of workers for whom the floor binds, but may also indirectly affect the incomes of other workers. Firms may partly offset the added costs of higher minimum wages by reducing the compensation of higher-earning workers. Alternatively, increased pay to the lowest earners may boost pay higher up the distribution as firms maintain wage differentials by occupation or seniority. The changes in total wage bills subsume all of these direct and potential indirect impacts. Panel B of Figure 4 examines how higher minimum wages affect the distribution of compensation across workers within a firm. Annual compensation rises substantially for workers earning between $15,600 and $35,000 a year. There is no evidence of reduced earnings for those higher up in the earnings distribution, ruling out redistribution from middle- or high-income employees. Instead, the increases are concentrated among those earning around or slightly above full-time at the new minimum wage, suggesting potential spillovers to low-earning workers above the statutory wage floor.[29]

[26]This estimate aligns with the 6.4% increase we would expect from a simple calculation — low-earning workers account for 21% of wage bills at these firms on average and states raised minimum wages by 30.6% in 2014 ($0.21x0.306 = 0.064$). The closeness of our estimate and the predicted wage bill effect is comforting since our data do not reveal actual wages.

[27]Using partially populated measures of compensation outside of wages and salary, we find that higher minimum wages have no discernible impact on pension contribution but slightly reduce firm deductions for other worker benefits, which include health insurance and other in-kind benefits. These estimates, reported in Table B.5 are consistent with Clemens et al. (2018) who show that higher state minimum wages reduce the likelihood individuals report having employer-sponsored health insurance, though the magnitude of the dollar change we estimate is very small.

[28]The observed wage bill change subsumes any changes to their input mix that firms make in response to the higher wage floor. As we do not observe large employment changes, these behavioral responses may be less substantial. They will, however, include any other changes firms make in the hours employees work and the type and effort of work they do.

[29]This pattern also serves as a validity test for the results, showing that the wage bill increases are driven by the low-earning workers most likely to be affected by minimum wage policies, and not by high-earning workers where changes may be more likely to be driven by other policies or market shocks.

4.3. Financing Higher Pay to Low-Wage Workers with Added Revenue

Since independent businesses do not reduce the compensation to higher income workers or substantively shed workers in response to minimum wage increases, they must find other ways to accommodate the roughly 7% average increase in labor costs caused by higher wage floors. Prior work suggests that firms are often able to pass the cost of minimum wage increases on to consumers through higher prices (Harasztosi and Lindner, 2019; Ashenfelter and Jurajda, 2021; Leung, 2021; Renkin et al., 2020; Link, 2019; Sorkin, 2015) though there is also evidence of reduced profits as well (Draca et al., 2011; Harasztosi and Lindner, 2019; Ganapati and Weaver, 2017).[30] Tax data do not allow us to separate quantities and prices, but we can examine how revenues evolve to offset higher labor costs following the 2014 minimum wage increases.

The upper panel of Figure 5 plots the average yearly change in revenue relative to 2013, among firms subject to higher minimum wages compared to firms in control states. After following a pre-trend similar to that of untreated firms, revenue among treated firms rises starting in 2015. By 2018, the revenue of the the average firm subject to a higher wage floor grew roughly 2.1% more than the revenue of firms in states that did not raise their minimum wages. In other words, these firms on average face demand inelastic enough to bear at least part of the added wage costs.

We next directly examine the effect of minimum wages on owners' profits. Panel B of Figure 5 plots the evolution of owner income in dollars among firms subject to higher minimum wages relative to firms that were not. For the average independent business in states that raised their minimum wage, the increase in revenues outpaced higher wage bills leading to an increase in owner income.[31] Owner's gains are moderate, amounting to roughly

[30] Studies using scanner data such as Leung (2021) and Renkin et al. (2020) naturally focus on products made and retailed by the large firms that typically report their data to Nielsen, Kantar or other scanner data aggregators. As such, these estimates may be less applicable to small and medium-size firms or the service firms that account for the majority of minimum wage workers.

[31] Owner income is estimated in levels because of the substantial share of negative values corresponding to firm losses.

$3,360 (1,123) on average by 2018, or about 2.7% of average owner income in 2013, but are robustly positive, indicating that the average owner is able to fully finance the added wage costs higher minimum wages with new revenue and escape the economic burden.

One factor that may ease cost pass-through when it comes to the minimum wage is the common nature of the cost shock. All firms using low-wage labor face higher production costs following the minimum wage increase, making the elasticity of *market* demand, rather than the higher elasticity of firm demand, the relevant parameter determining pass-through. Firm owners may be more familiar with the elasticity of demand their individual firms face from prior price changes. Uncertainty regarding the elasticity of market demand and the commonness of the cost shock may make the net impact of minimum wage increases on owner profits harder to forecast and may contribute to opposition to policy changes.

The minor magnitude of the cost shock relative to revenues may also make it easier to pass-through. Despite the controversy surrounding the minimum wage, the 7% average wage bill increase among surviving firms amounts to just 1.4% of firm revenues in 2013. Covering these added costs requires only minor price increases, which in turn may have only a marginal impact on quantity demanded. In fact, firms may find it difficult to raise prices by such a small increment due to pricing conventions like price points (ending prices in whole or half dollars, or $0.99 etc.) documented by Conlon and Rao (2020) and Strulov-Shlain (2022). Stale prices and relatively large discrete price changes induced by pricing conventions open the door to revenue increases that are large compared to the actual cost shock.

4.4. Minimum Wages and Firm Viability

Concerns regarding the cost of higher minimum wages often center on the viability of smaller firms. If some independent businesses are less able to substitute away from higher cost labor, or pass the cost shock on to consumers, the fear is that slimmer margins and unchanged fixed costs may lead them to shutter. Figure 6 examines the impact of higher minimum wages on firm exit rates where a firm is considered to have exited if it filed a tax return in 2013 but then did not file a return in other years.[32] The plotted coefficients from linear probability models similar to Equation 1 with exit as the dependent variable convey the difference in exit rates between firms in treatment and control states accounting for firm and market characteristics.[33] Figure 6 reports exit rates for the full set of all highly exposed independent businesses as well as separately for restaurants and firms in other, non-restaurant, highly exposed industries, which are largely retail firms.

The estimates show that, on average, there is a small significant increase in firm exits following the minimum wages increase among all firms in exposed industries. The breadth of our data allow for quite precise estimates and suggest that by 2018, exposed firms in treatment states are 0.9 percentage points (s.e.=0.0029) less likely to be alive as a result of the minimum wage increase. Compared to a mean raw exit rate of approximately 29% between 2013 and 2018 in treated and control states, these estimates imply that higher minimum wages have at most a very small impact on the viability of the small and medium firms that typify independently owned businesses.[34]

This average, however, belies important heterogeneity by industry. While there is no effect on firm viability for retailers and firms in other highly exposed industries, higher minimum wages raise exit rates among restaurants. By 2018 restaurants in treated states are 1.85 percentage points (s.e.=0.0039) more likely to exit than similar restaurants not forced to comply with a higher minimum wage. This disparity in exit effects stems from the more central role low-earning labor plays in production at restaurants relative to retailers. While low-earning labor comprises a similarly large share of labor costs at restaurants and retailers — roughly 41.8% at restaurants and 38.5% at retailers — labor costs overall are more than twice as large at restaurants relative to retailers. At restaurants, wage bills account for 39% of variable costs and 27% of revenues, but are just 16% of variable costs

[32] "Exit" is an indicator for the firm not filing a tax return in year t. Therefore, prior to 2013 this is an indicator for the firm not yet existing and differential trends represent differential entrance rates; post-2013 it is an indicator for the firm having exited and the coefficients represent differential exit rates.

[33] Specifically, we control for interactions of industry, value-added decile, categories for number of employees, and quintile of county job density.

[34] The average one-year exit rate is 5.2% for firms in these highly exposed industries.

and 13% of revenues at retailers and other independent businesses where intermediate inputs naturally account for a large share of variable costs.

These disparate cost shocks manifest very differently among independent businesses in the restaurant industry and outside of it. As shown in Appendix Table B.2, non-restaurant independent businesses are able to fully pass-through the smaller cost shocks they face when states raise the minimum wage, resulting in flat profits and neither employment nor exit impacts. Among restaurants, however, higher wage floors precipitate more substantial cost increases and have divergent impacts, driving out some firms while raising the profits of surviving firms. As shown in Appendix Figure A.6, profits among surviving restaurants rise following the minimum wage increase, peak in 2017, and are \$5,941 (s.e.=1,546) higher in 2018 than in 2013 relative to similar restaurants in control states. Perhaps unexpectedly, we see these profit increases only in the restaurant industry alongside higher exit rates while other exposed independent firms experience neither heightened exit nor higher profits.

When using the border design (Appendix D, Table D.7), the results are broadly consistent with the those from the full sample of firms. On average wage bills increase for firms in treated states, as do revenues such that surviving businesses do not lose profits on average. There are small reductions in employment and the minimum wage increase causes some firms to exit, with exits concentrated among the least productive businesses. As a robustness check, the similarity of results supports that confounding variation across firms in treatment and control states is not driving our main findings. More details regarding this analysis can be found in Appendix D.

The cost impacts of higher wage floors clearly reverberate differently across industries and even within the restaurant industry as some restaurants are forced out while others see higher profits. Our analysis will focus primarily on the restaurant industry going forward to understand the dynamic impacts of minimum wages, and how these disparate impacts arise in the industry in which they truly bite.[35]

[35] All of the firm-level analyses discussed previously are reported for restaurants and other independent businesses separately in the appendix.

5. Dynamic Impacts: Selection, Survival and Reallocation

Higher state minimum wages have little effect on the way most independent firms do business. Among restaurants, however, cost increases are more substantial, raising variable costs by 5.76% and leading to both higher exit and, somewhat surprisingly, higher profits among surviving firms.

Here we present a simple framework to highlight how extensive margin responses (firm exits) to minimum wage increases can mediate observed outcomes for surviving firms. This exercise is in the style of Besley (1989) and Bhaskar and To (1999). For example, Besley (1989) shows that when firms can exit under Cournot competition, the introduction of a specific (per unit) tax on output can increase output per firm and total welfare, depending on the shape of market demand.[36] Like a specific tax, the minimum wage is a cost shock to the firm, but rather than a cost increase per unit of output, the minimum wage raises the cost of a specific input. This means that the cost shock associated with a minimum wage increase will depend directly on the firm's production technology. Firms that hire different amounts of minimum wage labor, that use minimum wage labor more or less efficiently to produce a unit of output conditional on the number of workers, or that have different relative mixes of capital and labor in producing a unit of output will all experience different costs shocks even if producing the same product. For this reason, we augment our framework to account for heterogeneous technologies across firms, as is conceptually and empirically relevant in our setting.

We analyze a framework of Cournot competition with fixed costs of entry to highlight the role of extensive margin responses and embed asymmetric production technologies to highlight how selection on productivity can further mediate observed effects of the minimum wage. Consider a market for restaurant meals characterized by Cournot competition among

[36] Besley (1989) shows that the introduction of a specific tax can cause exits and when market demand is concave or not too convex output per firm and total welfare will increase; when demand is convex the reverse is true. Bhaskar and To (1999) show that free entry and monoposonistic competition in labor markets imply that increases in the minimum wage raise employment per firm, cause firm exits and may increase or decrease industry employment and welfare.

N firms facing market demand $Q_D(P)$ with asymmetric (but constant) marginal costs, c_i, which yields a familiar expression for the price-marginal cost margin

$$\frac{P - c_i}{P} = \frac{s_i}{\varepsilon_D(Q_D)}$$

where P is the common output price, ε_D is the absolute value of the elasticity of consumer demand and varies with market quantity, and s_i denotes the market share of firm i selling quantity q_i:

$$s_i = \frac{q_i}{Q_D} = \frac{q_i}{\sum_i q_i}$$

Market shares are proportional to margins with the most efficient firms enjoying both the largest margins and market shares. If costs are symmetric, the N firms simply split the market equally.

Minimum wages will increase marginal costs to the extent firms employ workers at wages below the new floor. As such, the marginal cost increase, Δ_i^c, can vary by firm. The resulting market share for firm i will be:

$$\frac{P^{\bar{w}} - (c_i + \Delta_i^c)}{P^{\bar{w}}} = \frac{(s_i + \Delta_i^s)}{\varepsilon_D(Q_D^{\bar{w}})} \tag{2}$$

where the super-script $\bar{w}$ denotes post minimum wage hike prices and quantities and Δ_i^s is the resulting change in market share.

Heterogeneous technology implies reallocation in response to the cost shock. When firms have heterogeneous ex-ante productivity, c_i, even when the marginal cost shock is the same for all firms, $\Delta_i^c = \Delta^c$, there will be reallocation of market shares toward the more productive firms because their margins will shrink relatively less. Asymmetric cost shocks also lead to reallocation from high shock to low shock firms.[37] In any case, without firm exit, average profits, average quantities per firm and total quantity in the market will decrease.

[37] Depending on the differentials between the shocks, asymmetric shocks can cause profits and quantities to increase among some firms.

We find that minimum wage increases lead some restaurants to exit; that is, for some firms the added marginal cost of complying with higher wage floors will exceed market price increases and these narrower margins will leave them unable to cover their fixed costs, f, or

$$\pi_i^{\bar{w}} = \left(P^{\bar{w}} - (c_i + \Delta_i^c)\right) q_i^{\bar{w}} - f < 0.$$

Exiting firms could be those with the lowest *ex ante* productivity (high c_i), the largest cost shock due to a high share of low wage labor (high Δ_i^c) per unit of output, or a combination of the two.

Under Cournot competition, a reduction in the number of players with unchanged costs will lead to higher markups and higher market shares for surviving firms, with the most cost-efficient firms gaining the most. Average profits and quantities among surviving firms increase, though market quantity decreases. When exit is induced by the cost shock, market price will rise due to both the increase in market power arising from exit and cost pass-through. Even with homogeneous firms that experience symmetric cost increases, average profits and quantities among surviving firms can increase if some firms exit, depending on the relative cost shock and degree of exit.

Heterogeneous productivity makes this more likely as selection on ex-ante productivity and/or the exposure (the least productive and/or the firms with the largest cost shocks exit) facilitates increases in average profits and quantities among survivors and result in lower reductions in market quantity as production is reallocated to the *ex post* most efficient firms. Larger markups for some firms will be matched by higher market shares ($\Delta_i^s > 0$ on the right-hand side of equation (2)) offsetting potentially more elastic demand as prices rise. For other firms, the added marginal cost of complying with the minimum wage may narrow margins and reduce market shares.[38] When there is selection on ex-ante productivity, the market quantity is distorted the least conditional on the cost shock because these firms had

[38] Because the elasticity of market demand rises, narrowing margins do not necessitate a decline in market shares if margins are only slightly shaved; for firms with larger margin declines, market shares will decline as well.

the smallest market shares to begin with.[39]

When cost increases cull less productive firms, more efficient firms can thus benefit from minimum wage increases through the combination of higher margins and larger market shares as demand is reallocated from the exiting firms to the surviving firms. If market demand is not too elastic and market quantity does not decline too much, the average output and profits of more efficient surviving firms can even rise following the cost shock in the short-to-medium run. We find that surviving firms not only have higher average profits following the minimum wage increase, but they also spend 2.53% (s.e.=0.0101) more on non-labor inputs, suggesting that, consistent with the model, surviving restaurants actually increase their output after the cost shock that led their competitors to exit.[40]

The empirical entrance and exit dynamics correspond with the implications of this framework, clarifying the nature of selection and the relationship with the profit increases we observe among surviving restaurants. First, we find that exit is wholly concentrated among the firms that were least productive before the policy change. As Table 2 reports, exit rises only among restaurants in the bottom productivity quartile with no evidence of higher exit following the minimum wage increase among firms in the upper three quartiles of the *ex ante* productivity distribution. While the model suggests that exits could be associated with low productivity or high exposure (i.e. a large share of low wage labor), our findings suggest that productivity is the main factor determining exit. Restaurants across the *ex ante* productivity distribution use similar shares of low-earning labor with low-earning workers accounting for 40%, 42%, 44% and 40% of wage bills for the bottom through top productivity quartiles, respectively. The third panel of Table 2 shows that exits are fully attributable to the lowest productivity quartile, with no significant effects among highly exposed, but more productive

[39] The key comparative statics discussed here are presented in Appendix E for the case of a linear inverse demand function. Though a special case, the closed-form solutions allow for simple illustration of the key implications of the model.

[40] Rising non-labor COGS spending could also be consistent with upstream suppliers raising prices to pass through the costs of complying with higher minimum wages. If the input spending increase were driven purely by prices, however, we would expect the increase in non-labor COGS expenditures to be similar across firms rather than increasing with firm productivity.

firms. Among low productivity firms, it is those most dependent on low-earning labor that see the largest exit rates.[41]

This selection into survival is mirrored in entry. Restaurants entering after the minimum wage increase resemble survivors — they have higher wage bills, earn more revenue and are more productive than entrants in control markets as reported in Table 3. By raising production costs, higher minimum wages cull the least productive restaurants and force entrants to be leaner, yielding a more productive distribution of firms after the policy change. This pattern is consistent with Sorkin (2015)'s insight that minimum wage policies shape the capital choices of entrants, and may hint at larger longer run employment impacts of higher minimum wages. Through exit and entry, the minimum wage thus shapes the productivity distribution of restaurants in a manner akin to how the emergence of new technologies (Collard-Wexler and De Loecker, 2015), exposure to international trade (Melitz, 2003), and recessions (Osotimehin and Pappadà, 2017) can shift the productivity distribution in an industry.

Second, the Cournot framework has the added implication that profit should rise only where some firms exit. This is exactly what we see. In industries outside of restaurants like retail, firms do not exit and profits are flat following the minimum wage increase (Appendix Table B.2). Further, as predicted by the model, among surviving small restaurants, which we expect to be the closest substitutes to the primarily small restaurants that exit, profits increase more among higher productivity restaurants (see the lower panel of Table 4). These gains to the most efficient firms, of course, come at the cost of firms that are forced to exit, as well as less efficient surviving firms whose profits and market shares decline due to the cost shock. This pattern can help explain why some firms support minimum wage increases despite the higher labor costs they will face.[42] Yet, we underscore that there may be other welfare relevant margins not captured by this model. For example, Kroft et al.

[41] This pattern comports with the findings of Luca and Luca (2019) who show that restaurant exits following city minimum wage increases in California are concentrated among poorly rated restaurants based on Yelp reviews.

[42] See Amazon in addition to the polls cited in the Introduction.

(2024) develop a model of imperfect competition with consumers who have love-of-variety preferences to analyze the welfare effects of commodity taxes. They show that both the externality associated with firm entry and exit, as highlighted here, and the loss of variety associated with exit are welfare relevant and the loss of variety may dominate in many cases.

Overall, the extensive margin effects of the minimum wage among highly exposed restaurants resulted in selection on productivity for surviving and entrant firms (the average firm in the market is more productive) and reallocation toward more productive firms (*ex ante* productive firms see increased profits). These impacts are reflected in the market-level estimates for changes in average revenues, costs and profits among restaurants in treated states using an unbalanced sample of all firms operating in each year t (Figures A.11 and A.12).[43]

5.1. Reallocation and Worker Transitions

This reallocation of output and profits towards higher value-added restaurants through firm exit and entry is paralleled by greater worker retention at larger, higher value-added firms and the reallocation of workers from from smaller, lower-value added firms toward larger firms. To understand the impact of minimum wage increases on how workers move between firms, and thus the retention and allocation of workers across employers, Table 5 details transition patterns of workers employed by highly exposed independent firms in 2013. The rows consider different baseline samples of workers by the revenue quartile of the highly exposed business that employed them in 2013, and compare worker transitions in states that raised their minimum wages to transitions in control states. The upper panel describes

[43] Our border county analysis provides additional support for the importance of product market competition in mediating how firms are able to accommodate minimum wage increases. While the average retailer in a treated state experiences no deleterious effects when minimum wages are raised, retailers near state borders appear to experience reduced profits and higher exit rates, though estimates are imprecise (Appendix D, Table D.7). Along state borders the cost shock arising from minimum wage legislation is less commonly felt. Because consumers can shop across the border, treated retailers near the border face more elastic demand and are less able to finance the wage cost shock with new revenues (as in studies from the tax literature on cross border shopping and tax pass-through (Harding et al., 2012; Cawley and Frisvold, 2017)). Further from the border, where the cost shock is more common to potential substitutes, the effects on all subsets of industries are very similar to the aggregate results from the full sample. In this way product market competition and the associated elasticity of demand are key to understanding the impacts of minimum wage legislation.

transitions of all workers, while the middle panel focuses on low-earning workers. Five-year transition rates are reported, describing whether in 2018 a worker lacks a Form W-2 and is non-employed (column 1), remains employed by the same firm (column 2) or has transitioned to a firm, whether independently owned or corporate, in different quartiles of the revenue distribution (columns 3 through 6).[44]

The higher average retention we document in Figure 3 accrues to the largest independent businesses. Higher minimum wages mean that that workers remain with large independent businesses for longer, staving off switches to other large independent firms or corporations. Compared to similar workers in states that did not increase their minimum wages, the average worker employed by an independent business in the top revenue quartile is 3.52 percentage points more likely to still work for that employer in 2018, and 2.36 percentage points less likely to have switched to another large firm.

Retention declines at the smallest independent businesses which is not surprising since firm exits are concentrated among the smallest businesses and a firm that has exited is unable to retain workers. Rather than remaining with their 2013 employers, workers employed by firms outside the top quartile of size at baseline are more likely to work for larger firms five years down the line. Nevertheless, average retention rates increase in these industries by 2.44 percentage points because there are many more workers at the large firms. Even outside of their own employer, on average, workers in each quartile are at least as likely to remain working in highly exposed industries in treatment states following the minimum wage increase.[45]

The expansion of stronger firms in part explains the lack of aggregate employment losses. These transition patterns we document among U.S. independently owned businesses are consistent with Dustmann et al. (2021), which examines worker reallocation following the

[44] Specifically, in this table, the outcome of the regression specification is the number of workers in each column as a share of workers defined by each row at baseline.

[45] Average differential rates of remaining in a highly exposed industry (at any firm) can be obtained by summing across columns (2) through (6), i.e., the sum of those remaining with their firm and those transitioning to other firms in these industries of each size.

introduction of a minimum wage in Germany. However, we find that the largest effect of minimum wages on the allocation of workers is not from transitions but the lack of transitions away from the largest of independent firms.

Further, we find that it is the large firms who benefit from lower turnover that reduce their hiring of very part time teenagers, lowering average hiring as documented in Figure 2. As detailed in Appendix Table B.6, while firms outside the top revenue quartile, make only modest employment adjustments, firms in the top quartile of size, shed roughly 4.5 employment relationships on average following the minimum wage increase. But this net employment impact at large firms combines their higher retention of roughly 4.15 workers and their reduced hiring of 8.67 very part time teenage workers (Appendix Figure A.9). In short, as these large firms retain more of their existing workforce, the need to hire part-time, stop-gap, less experienced, teen labor is diminished. As a result, the workforces of larger firms feature more experienced workers, raising their effective labor input and potentially improving their productivity.

Beyond a simple framework of Cournot competition over homogenous goods, alternative frameworks are also consistent with the higher profits we document among surviving restaurants. Anderson et al. (2001) show that cost increases can be over-shifted into prices and increase short-run profits in an oligopoly industry with Bertrand competition over differentiated products when the slope of demand is sufficiently elastic. Weyl and Fabinger (2013) codify these and other findings by Katz and Rosen (1983); Seade (1985); Stern (1987) and show that sufficiently log convex demand can generate over-shifting over a range of conduct parameters.

Higher profits following minimum wage increases are also consistent with initially sub-optimal pricing. If firms set prices at particular price points due to left-digit bias or whole number pricing norms as has been documented extensively (Conlon and Rao, 2020; Strulov-Shlain, 2022; Knotek, 2019), these sticky prices,[46] may be less than profit-maximizing at the

[46] Bils and Klenow (2004) find that restaurant prices are particularly sticky in the U.S. while Fougère et al. (2010) document that price stickiness led to lumpy and protracted restaurant price adjustments in French

time of the policy change. If the cost shock associated with higher wage floors is sufficiently large that firms reset prices,[47] profits will rise following the cost shock as firms come back in alignment with profit-maximizing prices. These price increases will of course be made easier by the common nature of the cost shock; costs and prices are not changing for a single firm but for *all* firms making firm demand less responsive to price changes and encouraging all firms to adjust prices following the policy change. Any reduction in customer antagonization from price increases if they can be attributed to policy rather than firm choices, will only make price increases easier by reducing the elasticity of demand.

5.2. Implications for Teenagers

In Section 4.1, we saw that employment responses largely manifest as lower entrance rates for teenagers at part-time jobs. Using the individual data, we can further investigate the implication of this finding for workers and firms.

First, we conduct transition analyses, as described above, focusing on two groups of teenagers: 1) those with no job prior to the minimum wage increase (i.e. potential future minimum wage workers at these service firms), and 2) teenagers working for exposed independent firms prior to the minimum wage increase. Figure 3 showed that these groups of workers earn more and are no less likely to be employed on average following the minimum wage increase. Panel B of Table 5 shows where these teenagers end-up in 2018. Row 1 shows that teenagers that had no job at baseline are less likely to work at firms in exposed industries in 2018, particularly at large restaurants where the largest decreases in entrance rates were observed. On average, this group finds employment at the same rate as in unexposed states but they tend to work in industries less exposed to the minimum wage. In contrast, the second row shows that teenagers with some experience in the exposed industries at the time of the minimum wage change are significantly more likely to be working in exposed industries five years after the minimum wage increase, particularly at large restaurants. This

restaurants following the adoption of the Euro.

[47] Prior work has found that pass-through of minimum wage increases is higher during high-inflation periods Aaronson (2001), when prices were further from optimal MacDonald and Aaronson (2006)

is consistent with the employment effects being driven by lower entrance rates among teens, not separations, and with increased retention of teenagers at surviving firms.

Next, we can learn about what types of teenagers are not entering the part-time jobs in highly exposed industries. To do so, we link teen workers at exposed firms to their income tax returns to obtain household income information, including teens claimed as dependents. We estimate Eq. (1) with lagged household income of teen workers in firm j at time t as the outcome to measure how the composition of teen workers at small firms changes following the minimum wage increase.[48] Table Table 5, Panel C shows that on average, there were relatively fewer low income teenagers working at independent firms in highly exposed industries following the minimum wage increase. It is not possible to directly observe which teen workers would be the potential entrants to these firms, but this suggests that it was teens from relatively low-earning households that did not receive the temporary positions after the minimum wage increase. Together, the results show that the minimum wage increases did not substantially harm teenagers, but did have differential impacts on the types of firms teenagers work at, depending on their prior experience, and that it could be teens from the lowest income households that are most affected by these dynamics.

5.3. Firm Survival and Owner Outcomes

Finally, we leverage our data link between firms and their owners to study what happens to owners of firms that exit as a result of the minimum wage increase. To do so, we create a panel of the owners of independent firms in highly exposed industries in base year 2013.[49] We estimate the differential outcomes of owners of exiting firms in treatment states relative to control states. We note that this analysis does not identify the effect of firm closure as a result of the minimum wage relative to the potential outcome had the minimum wage increase not occurred. Instead, it describes the outcomes of owners who exited as a result of

[48] The outcome is household adjusted gross income (AGI) in year t-5. We lag the household income measure to obtain pre-reform characteristics of teen workers in the post-reform period so that potential effects of the minimum wage increase on household incomes does not affect the estimates.

[49] See Appendix C.3 of further information on the creation of the owner panel.

the minimum wage relative to those of the average owner of firms that exit for other reasons in untreated states.

Table 6 and Figure A.13 display results of this analysis. Focusing on small restaurants, the group of highly exposed firms that experienced policy induced exit, we see that owners of firms that close as a result of the minimum wage increase are significantly less likely to own an independent business and less likely to receive all of their earnings (wage income plus ordinary business income) from business ownership. While policy induced exiters are less likely to continue as businesses owners than other exiters, their average earnings are no lower on average five years later. One explanation for this is that that policy-induced exiters are significantly less likely to be earning negative incomes five years out. Policy induced exiters appear more likely to substitute away from potentially risky or less profitable business ownership. While average incomes are no lower for these owners, this does not imply that utility is also the same, as policy induced exiters may have preferred to remain business owners even if it does not lead to higher income.

Table 6 also shows that for large restaurants and for other, non-restaurant, highly exposed industries, the outcomes for owners of exiting firms in treatment and control states are essentially the same. That is, in industries where we do not observe higher exit rates following the minimum wage increase, we also do not see differential impacts of exits for owners.

6. Conclusion

The controversy surrounding minimum wage policies often seems out of proportion with their role in the U.S. economy. BLS estimates peg the number of workers affected by federal minimum wage changes at 1.1 million or 1.5% of all hourly paid workers and about 0.6% of all employed U.S. residents. Even with spillover effects to higher-paid workers, which our estimates confirm, the number of individuals whose pay would rise with the minimum wage is fairly modest.

One reason these policies generate such strong debate is out of concern for potentially vulnerable independent businesses. We find that the average independent business in a highly exposed industry like leisure and hospitality or retail is broadly able to accommodate minimum wage increases through higher revenues. Yet, among restaurants, where low-earning workers account for approximately 16% of variable costs as opposed to just 6% of production costs among retailers, higher minimum wages cause some less productive small restaurants to close. The strong adverse impacts on some small firms help explain the opposition among some business owners. More broadly, uncertainty about the ease of passing through what is a common cost shock when owners may be more familiar with the elasticity of firm demand from prior attempts at unilateral price changes, and ultimately how much of the costs consumers and firms will bear, may expand opposition to include even those firms who in equilibrium are able to pass the costs through.

Simultaneously, surviving restaurants benefit on average through a combination of higher worker retention and new revenues. In fact, surviving owners see modestly higher average profits following the minimum wage increase as closures increase both margins and market shares among the most productive survivors, particularly highly productive smaller restaurants that may be the closest substitutes to the exiting establishments. That many firms see higher profits following minimum wage increases helps to explain the solid support proposals to raise wage floors receive among small business owners. Ultimately, our findings show that higher wage floors raise the earnings of low-income workers with the costs borne in part by the small share of owners whose firms shutter, and largely by consumers who finance the revenue increases that offset added wage costs and leave most business owners no worse off.

It is important to note that our findings center the short-to-medium-run impact of phased-in minimum wage increases. The longer-run impacts could be quite different if entrants utilize production methods that rely less on low-wage labor and incumbents reconfigure their inputs away from the workers most affected by these policies. In addition, it is possible that firms respond on to the increased labor costs along margins not estimated here, such as paring back workplace amenities, or reducing equipment maintenance.

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Tables and Figures

Table 1: Summary Statistics

	Means			Medians		
	Treatment	Control Unweighted	Control DFL Weighted	Treatment	Control Unweighted	Control DFL Weighted
Employees	57	62	65	21	22	24
Revenue ($)	1,925,350	1,826,718	1,868,747	918,900	848,400	875,500
Wage Bill ($)	383,203	345,882	367,486	166,400	160,500	180,500
Value-added ($)	1,430,235	1,129,913	1,198,940	501,500	444,200	482,400
Owner Income ($)	125,932	115,107	121,624	65,820	59,060	63,070
Net profits ($)	99,813	94,668	101,819	39,330	38,020	41,630
COGS ($)	934,467	921,019	921,317	351,100	325,200	328,000
# young workers	19	21	22	6	6	7
Productivity	0.41	0.39	0.40	0.41	0.40	0.40
Labor share	0.23	0.25	0.25	0.21	0.22	0.23

Note: The table above reports means and medians from our estimation sample for key firm variables in the pre-reform year 2013. The first and fourth columns report raw means and medians for firms in treatment states. The second and fifth columns report raw means and medians for firms in control states. The third and sixth columns report DFL re-weighted means and medians where the DFL weights are based on the distribution of two-year lagged value-added within three-digit NAICS industries. For confidentiality, dollar values of medians are rounded to $100 or $10 and statistics on number of workers include more than 10 firms with the reported value workers.

Table 2: Firm Exit Effects by Productivity and Size (Restaurants)

	Panel A: Productivity			
	Q1 (lowest)	Q2	Q3	Q4 (highest)
Exit	0.0254***	-0.0017	0.0021	0.010
	(0.0079)	(0.0081)	(0.0081)	(0.0075)

	Panel B: Size (employees)			
	<25	25-50	50-100	>100
Exit	0.0297***	0.0214***	0.0040	-0.0017
	(0.0054)	(0.0079)	(0.0089)	(0.0110)

Panel C: Exposure by Productivity

Exposure	Productivity quartile			
quartile	Q1 (lowest)	Q2	Q3	Q4 (highest)
Q1 (least)	0.0142	0.0206	0.0292	-0.0085
	(0.0162)	(0.0164)	(0.0166)	(0.0152)
Q2	0.0250	0.0102	0.0020	0.010
	(0.0148)	(0.0153)	(0.0159)	(0.0153)
Q3	0.0435***	-0.0065	-0.0013	0.0176
	(0.0159)	(0.0158)	(0.0150)	(0.0146)
Q4 (most)	0.0385***	-0.0097	-0.0115	0.0066
	(0.0079)	(0.0171)	(0.0159)	(0.0145)

Note: This table reports the estimated effect of the minimum wage increases on firm exit by baseline firm characteristics for restaurants. The coefficients represent the differential probability of a firm exiting between 2013 to 2018 in treatment relative to control states (positive coefficients represent and increased probability of exit). The top panel shows estimates by baseline (2013) firm productivity, measured as quartiles of the firm distribution of net profits/revenues. The second panel shows estimates by firm size measured as the number of baseline firm employees. Estimates are from linear probability models where firm exit is the dependent variable and an interaction of a treated state indicator and year fixed effects are the regressors of interest (estimates for 2018 (β_{2018} from Eq. 1) are shown. Standard errors are clustered at the firm level.

Table 3: Entrant Firms in Exposed States (Restaurants)

	Wage bill	Revenue	Value-added	Productivity (income/rev)	Owner income	Employees
Levels	46549.0***	23087.0*	47746.6***	0.0077***	1304.2	-1.443
	(2128.9)	(9155.9)	(4723.1)	(0.0013)	(1295.9)	(0.895)
Logs	0.138***	0.0402***	0.0837***	0.0224***	0.0527***	-0.0005
	(0.0085)	(0.0067)	(0.0074)	(0.0045)	(0.0134)	(0.0067)

Note: This table presents estimates of the differential characteristics of new restaurants following minimum wage increases in treatment states relative to control states. The estimates represent the average difference in each outcome (column) in 2018 among restaurants that did not exist in 2013, between restaurants in treatment and control states. The top row shows the differences in level and the bottom row in logs.

Table 4: Heterogeneity in Effects of MW on Firm Net Income

	Restaurants	Other exposed	Small restaurants	Big restaurants
$\beta_{2013-2018}$	5,941.1***	1,072.9	5,369.3***	2,505.1
	(1,546.2)	(1,920.4)	(1,405.8)	(2,860.5)
Mean (2013)	$122,421	$150,628	$71,644	$171,053

	Productivity (Small restaurants)			
	Q1 (lowest)	Q2	Q3	Q4 (highest)
$\beta_{2013-2018}$	4,250.2	1,603.4	7,915.4**	9,160.7***
	(3,024.0)	(2,912.4)	(3,325.6)	(2,126.9)
Mean (2013)	$26,525	$62,555	$89,113	$88,486

Note: This table shows the estimates of the effect of the minimum wage on owner profits across various types of firms defined by baseline firm characteristics. Each set of estimates is from a regression of owner income on firm fixed effects, year fixed effects and the interaction of a treated state indicator and year fixed effects. The coefficients are for 2018 relative to 2013 (β_{2018} from Eq. 1) and standard errors are clustered at the firm level. The first two columns of the top panel shows the effect on profits for restaurants and for firms in other, non-restaurant, highly exposed industries. The third and fourth columns split restaurants by baseline firm size, where small (big) firms are those with ≤ 25 (>25) workers. The second panel divides small restaurants by baseline productivity, defined as quartiles of the distribution of net profits/revenues.

Table 5: Worker Transitions From Highly Exposed Pass-Through Firms in 2013

Panel A: Transitions for All Workers

	(1) Non-employment	(2) Remain	(3) Q1	(4) Q2	(5) Q3	(6) Q4
Exposed	-0.0022**	0.0244***	–	–	–	–
	(0.0007)	(0.0009)				
Exposed Q1	0.0096**	-0.0212***	-0.0003	0.0072***	0.0055**	0.0071*
	(0.0034)	(0.0038)	(0.0015)	(0.0022)	(0.0018)	(0.0029)
Exposed Q2	0.0076**	-0.0011	-0.0059**	0.0030**	0.0047**	-0.0012
	(0.0025)	(0.0030)	(0.0019)	(0.0011)	(0.0017)	(0.0023)
Exposed Q3	0.0019	0.0016	-0.0017*	-0.0064***	0.0017	0.0087***
	(0.0019)	(0.0023)	(0.0008)	(0.0014)	(0.0010)	(0.0020)
Exposed Q4	-0.0040***	0.0352***	-0.0019***	-0.0022***	-0.0011*	-0.0236***
	(0.0009)	(0.0011)	(0.0003)	(0.0003)	(0.0005)	(0.0009)

Panel B: Transitions for Teenagers

	Exposed industry	Restaurant	Q1	Q2	Q3	Q4
Not employed	-0.0057***	-0.0139***	0.0002	-0.0001	0.0012	-0.0072***
	(0.0016)	(0.0012)	(0.0005)	(0.0005)	(0.0006)	(0.0014)
Workers	0.0154***	0.0394***	-0.0074***	-0.0036***	-0.0031**	0.0267***
	(0.0026)	(0.0026)	(0.0011)	(0.0012)	(0.0014)	(0.0270)

Panel C: Composition of Teenage Workforce at Exposed Firms

	AGI	Single parent	AGI $< \$25K$	AGI \$25K-50K	AGI \$50K-100K	AGI $> \$100K$
All exposed	1,271	-0.0008	-1.058***	-0.420***	-0.237	-0.056
	(834)	(0.0011)	(0.200)	(0.122)	(0.122)	(0.094)
Restaurants	2,927***	-0.0020	-1.827***	-0.624***	-0.170	-0.003
	(880)	(0.0014)	(0.350)	(0.210)	(0.170)	(0.133)

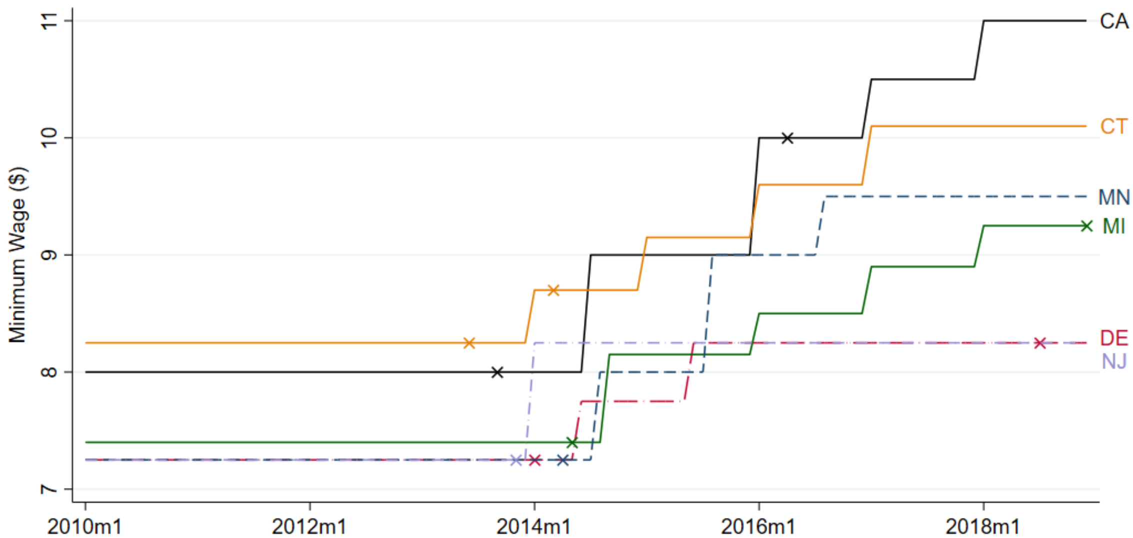
Note: Panels A and B report the impact of minimum wage increases on five-year transition rates from regressions comparing outcomes of individuals in treatment relative to control states. Panel A compares workers at highly exposed independent firms. Each row represents where the individual worked at baseline (2013) and each column represents where they were in 2018 (eg. the row "Exposed Q2" are for workers at highly exposed industries in the second quartile of the 2013 revenue distribution). The columns represent the differential shares of such workers that are (1) not employed in 2018, (2) still working with their baseline employer, and (3) through (6) working at a firm in a highly exposed industry in the first quartile (smallest) to the fourth quartile (largest) of the 2018 revenue distribution. Panel B shows differential transitions for teenagers that at baseline did not have a job at baseline (row 1) or were working at an independent firm in a highly exposed industry (row 2). Column (1) shows transition rates into firms in highly exposed industries, column (2) for restaurants specifically, and columns (3) through (6) are the same as in Panel A. Panel C shows estimates of changes in the characteristics of teenagers working in the balanced panel of firms, using Eq. (1). The outcome in col (1) is average AGI, col (2) number of dependent teenagers with single parents, and cols (3) through (6) the number of teenage workers with household income (including family income for dependent teenagers) in different ranges of AGI.

Table 6: Outcomes of Owners of Exiting Firms

	Small Restaurants	Big Restaurants	Other Exposed
Pr(own business)	-0.0425***	-0.0143	-0.0059
	(0.0096)	(0.0109)	(0.0046)
Pr(only business owner)	-0.0324***	-0.0028	-0.0243***
	(0.0098)	(0.0145)	(0.0116)
Pr(negative income)	-0.0315***	0.0120	-0.0024
	(0.0091)	(0.0118)	(0.047)
Income (wages+business)	8,040	11,657	2,513
	(5,641)	(10,859)	(2,880)
Business income	2,308	6,865	-301
	(1,603)	(3,938)	(816)

Note: This table reports estimates of the effects of minimum wage induced exits on independent business owners. The regressions compare the outcomes for owners of firms that exit between 2013 and 2018 in treatment states to those of exiting firms in control states. Since exit is an endogenous outcome, the estimates do not represent the effect of policy-induced exits relative to a counterfactual world where the firm did not exit. Instead it provides a comparison of the outcomes of owners of firms that may have exited due to the minimum wage increase relative to those of owners whose firms exit for non-policy reasons. The first column shows estimates for owners of exiting small restaurants (less than 25 workers), col. 2 for large restaurants (>25 workers) and col. 3 for firms in other, non-restaurant, highly exposed industries (any size). In row 1, the outcome is an indicator for owning any business, row 2 an indicator for having business income but no wage income, row 3 an indicator for the owner having negative wage+business income, row 4 the outcomes is average wage+business income and row 5 is average ordinary business income. Each estimate is from a DiD regression as in Eq. (1), estimating the differential outcome between owners in treatment and control states in 2018 relative to 2013 (i.e., β_{2018}).

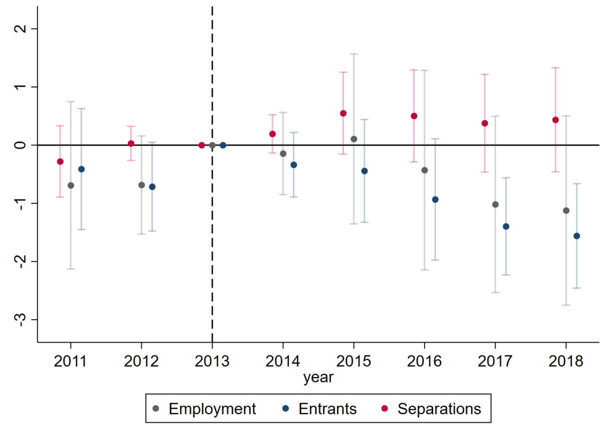
Figure 1: State Minimum Wage Changes



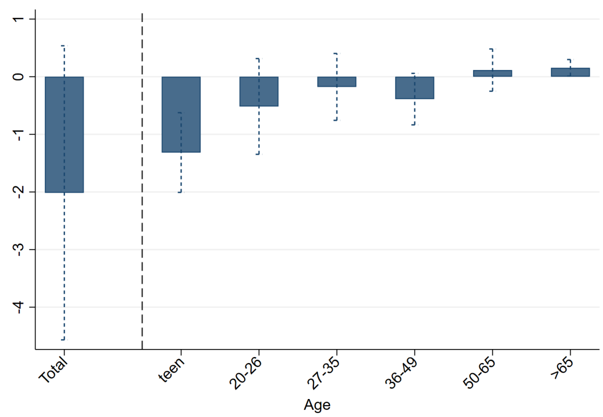
Note: The figure above tracks the statutory minimum wage in California, Connecticut, Delaware, Michigan, Minnesota and New Jersey from 2010 through 2018. The date of enactment for minimum wage legislation is denoted with an X. In fix of six states legislated increases were phased in over time, leading to multiple increases following enactment. Connecticut and California legislated further minimum wage increases in 2014 and 2016, respectively, which supplanted 2013 minimum wage legislation and were phased-in over time. Delaware and Michigan passed new minimum wage legislation in 2018 that took effect after our analysis period, though we may observe some anticipatory impacts.

Figure 2: Change in Employment Relationships Due to Minimum Wage Increases

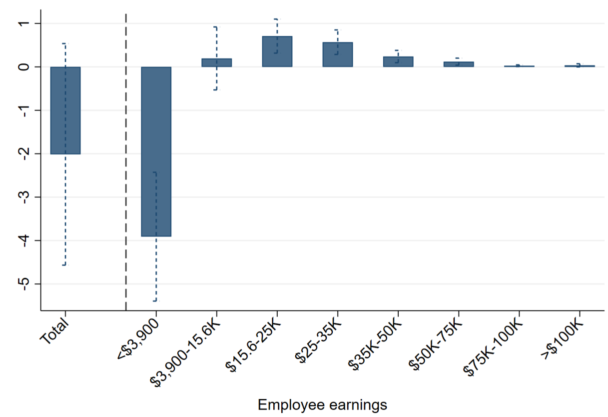
Panel A: Change in Number of Employment Relationships



Panel B: Employment Impact by Age

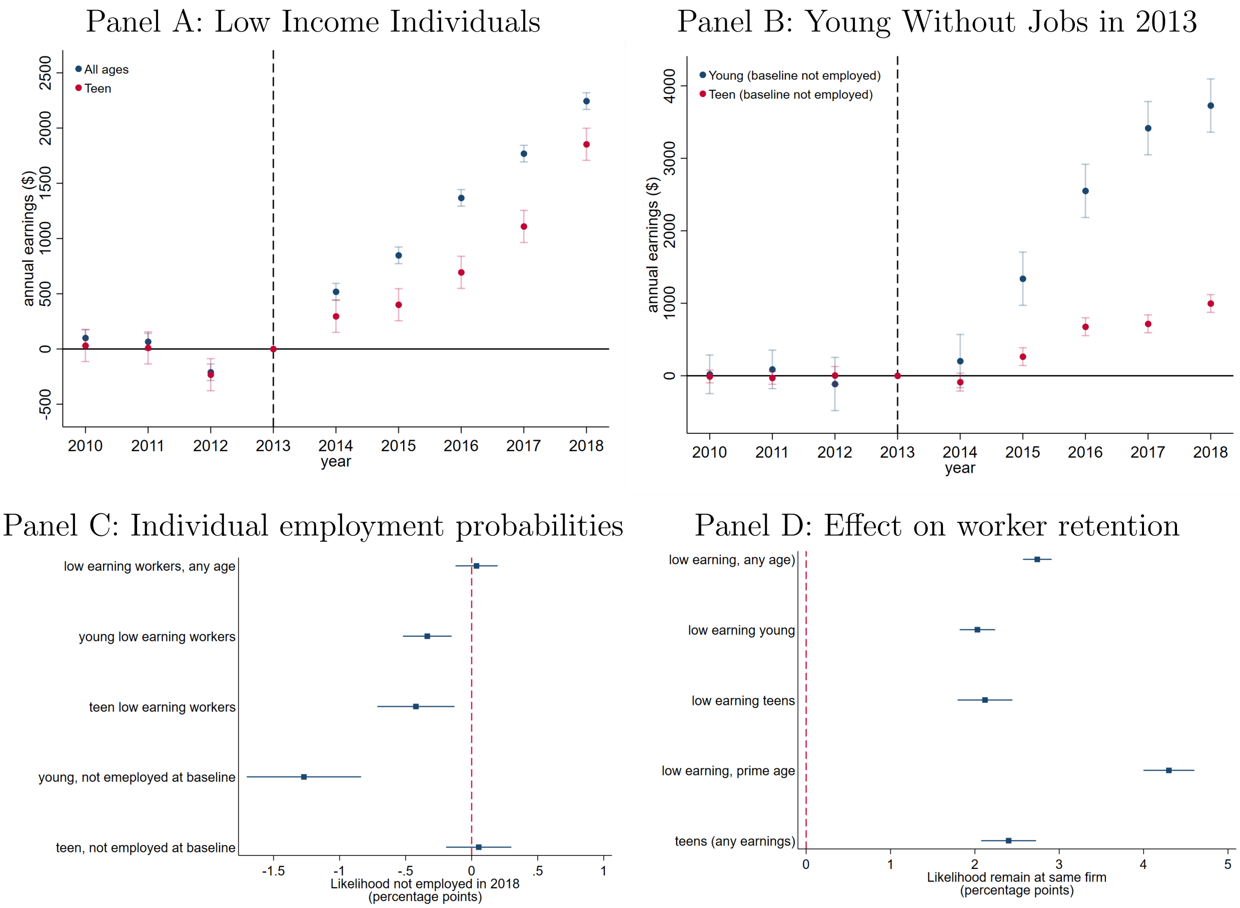


Panel C: Employment Impact by Earnings



Note: The figure above describes the change in the number and composition of employment relationships due to the minimum wage. Our employment measure counts the number of W-2s attached to a firm each year and may change due to true changes in employment or changes in worker churn. Panel (a) traces how minimum wage increases affect the number of employment relationships of the average firm as well as the number of new (entrance) and incumbent (retention) workers. Entrance rates are estimated using Equation 1 where the outcome is the number of new hires, defined as employees of the firm in year t that were not with the firm in year *t-1*. Separation rates are estimated using the outcome of the number of separating workers, those at the firm in year *t-1* that were not with the firm in year t. This decomposition is such that the coefficients from the entrants and separations specifications sum to the net employment response. Panels (b) and (c) decompose the 2013 to 2018 change in employment relationships by worker age and earnings in 2013, respectively. All regressions control for baseline deciles of revenue and firm size (# employees) categories both interacted with year. Dashed lines represent 95% confidence intervals.

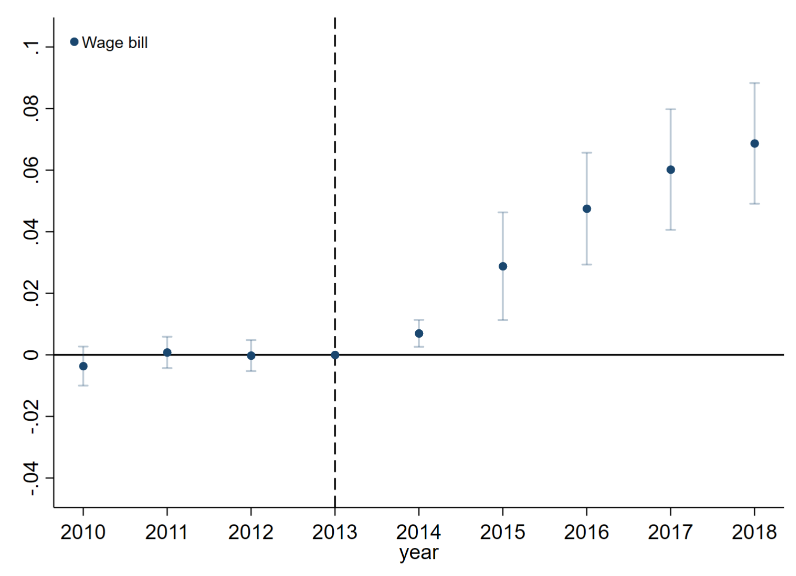
Figure 3: Impact of Minimum Wage Increases on Earnings Trajectories and Employment of Low Income Individuals



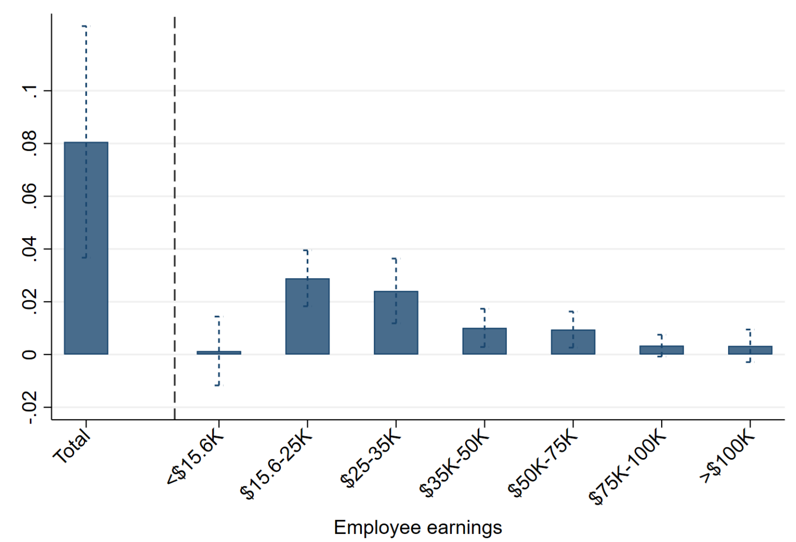
Note: The figure above demonstrates the impact of minimum wage increases on the evolution of average earnings and employment impact for low-income and young workers. Panel (a) plots the earnings trajectories of low earning workers (<25,000 in 2012 and 2013) in treatment relative to control states. The blue series shows trajectories for all low earning workers in highly exposed industries; the red series for low earning teen (16-19 years old) workers in these industries. Panel (b) focuses on young and teen individuals without W-2 income in 2013. Panel (c) shows the relative probability of being not employed as a result of the minimum wage for various groups. The top three estimates are for low earning workers working in exposed industries at baseline (young workers are 16-26 years old). The bottom two estimates are for young workers not working at baseline. Positive (negative) coefficients represent increased (decreased) likelihood of being not employed. Panel (d) shows the effect of the minimum wage on the probability of staying at your employer for low earning workers in highly exposed industries. Positive coefficients represent the percentage point increase in the likelihood a worker remains at the firm that they were employed with in 2013 at least two years after the minimum wage increase (2016). All estimates are generated by regressions the control for age and age squared interacted with year and quintiles of baseline (2013) county unemployment rates where the individuals lived also interacted with year.

Figure 4: Impact of Minimum Wage Increases of Firm Wage Bills

(a) Changes in Average Wage bill



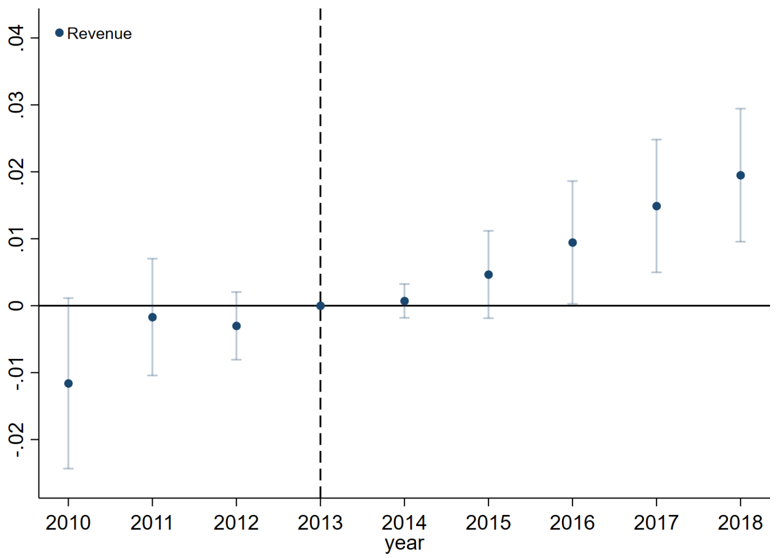
(b) Wage Bill Increases by Employee Income, 2013 to 2018



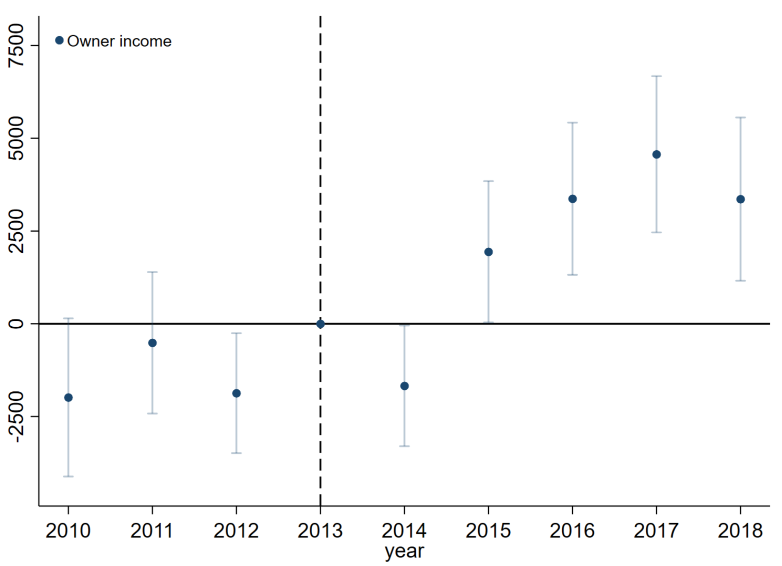
Note: The figure above plots the estimated effects of the 2014 increases in state minimum wages on firm wage bills overall and by worker income for independent businesses in highly exposed industries. Panel (a) tracks the evolution mean wage bills over time where each estimate is from a regression of log total wages paid on firm fixed effects, year fixed effects and the interaction of a treated state indicator and year fixed effects. The coefficients on these interaction terms trace out the difference over time in average total wages paid relative to the 2013 base year between firms in treated and untreated states. Panel (b) shows the decomposition of the total earnings response across the earnings distribution. The total wage bill effect is shown on the left, and the gains by 2013 earnings range are on the right. Each bar is the DD coefficient estimate from 2013 to 2018, where the outcome is the change in the total wage bill in each earnings bin over the total 2013 wage bill for firm j. Standard errors are clustered by firm. The solid line is the best unweighted linear fit through the coefficients. All regressions control for baseline deciles of revenue and firm size (# employees) categories both interacted with year. Dashed lines represent 95% confidence intervals.

Figure 5: Impact of Minimum Wage Increases on Average Revenues and Profits

(a) Average Change in Revenue Relative to 2013

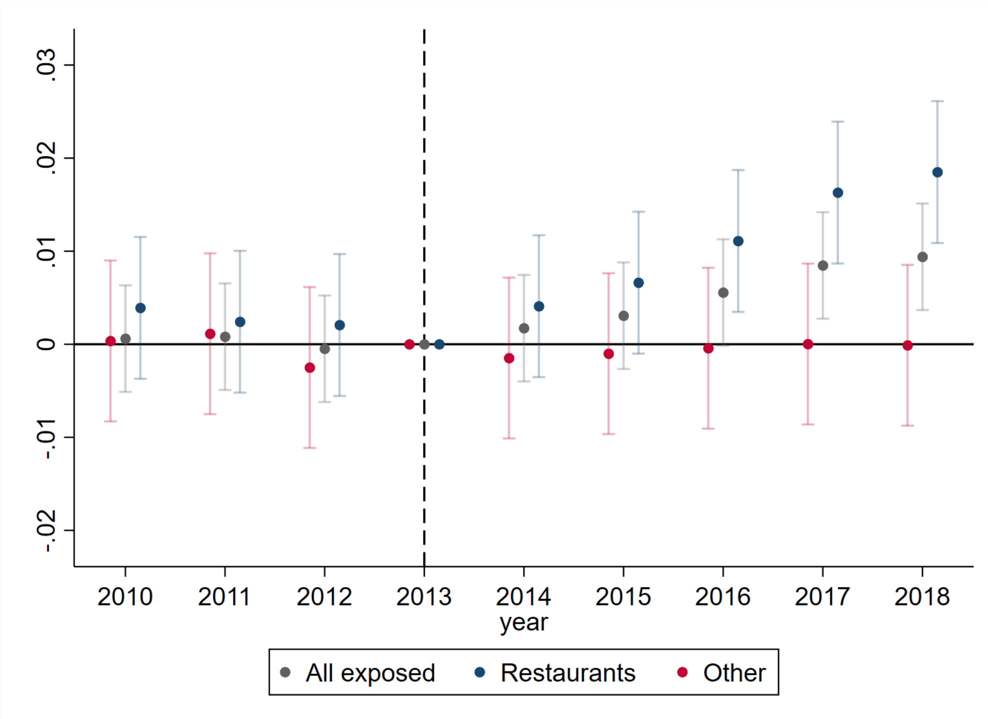


(b) Average Change in Owner Profit Relative to 2013



Note: The figure above plots the estimated effects of the 2014 increases in state minimum wages on firm revenue in panel (a) and owner income in panel (b). Each set of estimates is from a regression of log revenue or owner income on firm fixed effects, year fixed effects and the interaction of a treated state indicator and year fixed effects. The coefficients on these interaction terms trace out the difference over time in average revenue or owner income relative to the 2013 base year between firms in treated and untreated states. Standard errors are clustered by firm. The solid line is the best unweighted linear fit through the coefficients. All regressions control for baseline deciles of revenue and firm size (# employees) categories both interacted with year. Dashed lines represent 95% confidence intervals.

Figure 6: Impact of Minimum Wage Increases on Firm Exit



Note: The figure above plots estimates from linear probability models where firm exit is the dependent variable and an interaction of a treated state indicator and year fixed effects are the regressors of interest. The coefficients on these interaction terms trace out the difference over time in the average change in exit rates relative to the 2013 base year between firms in treated and untreated states. Positive coefficients represent an increased probability of exit. The grey (middle) series shows the differential exit probabilities for independent firms in all highly exposed industries; the blue (right) series for restaurants; the red (left) series for all other, non-restaurant, highly exposed industries. Standard errors are clustered by firm. The solid line is the best unweighted linear fit through the coefficients. All regressions control for baseline deciles of revenue and firm size (# employees) categories both interacted with year. Dashed lines represent 95% confidence intervals.

A. Appendix Figures

Figure A.1: Highly Exposed Industries in Tax Data and Census Statistics

Merged IRS Tax Data

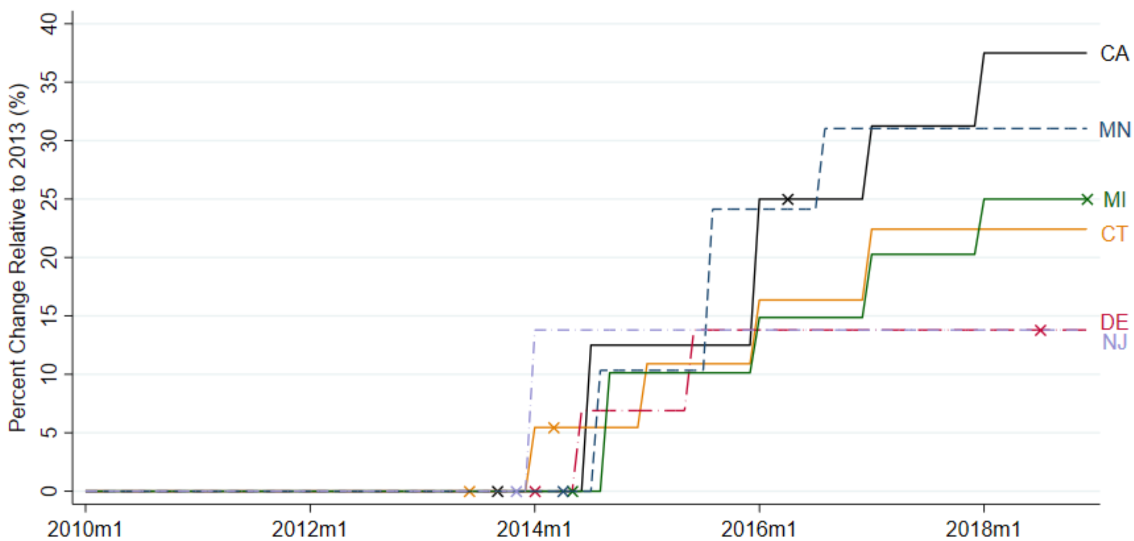
	Share Likely MW Workers	Firms
Amusement Parks	21.6%	1,385
Specialty Food Store	20.8%	19,286
Restaurants	20.2%	115,173
Special Food Services	18.4%	10,163
Day Care	17.7%	8,906
Clothing Stores	17.6%	8,996
Shoe Stores	17.3%	1,426
Other Amusement	16.5%	16,478
Grocery Stores	16.2%	21,913
Used Merchandise Stores	15.7%	1,695
RV Parks and Camps	15.1%	962

BLS

	Workers at or below MW	
	Number	Percent
Leisure and hospitality	1,814	55.0%
Retail trade	468	14.2%
Education and health	278	8.4%
Other services	172	5.2%
Professional services	129	3.9%
Manufacturing	94	2.8%
Construction	37	1.1%
Transportation and utilities	36	1.1%
Information	32	1.0%
Agriculture	31	0.9%
Finance	29	0.9%
Wholesale trade	19	0.6%
Mining	5	0.2%
Total MW workers	3,300	

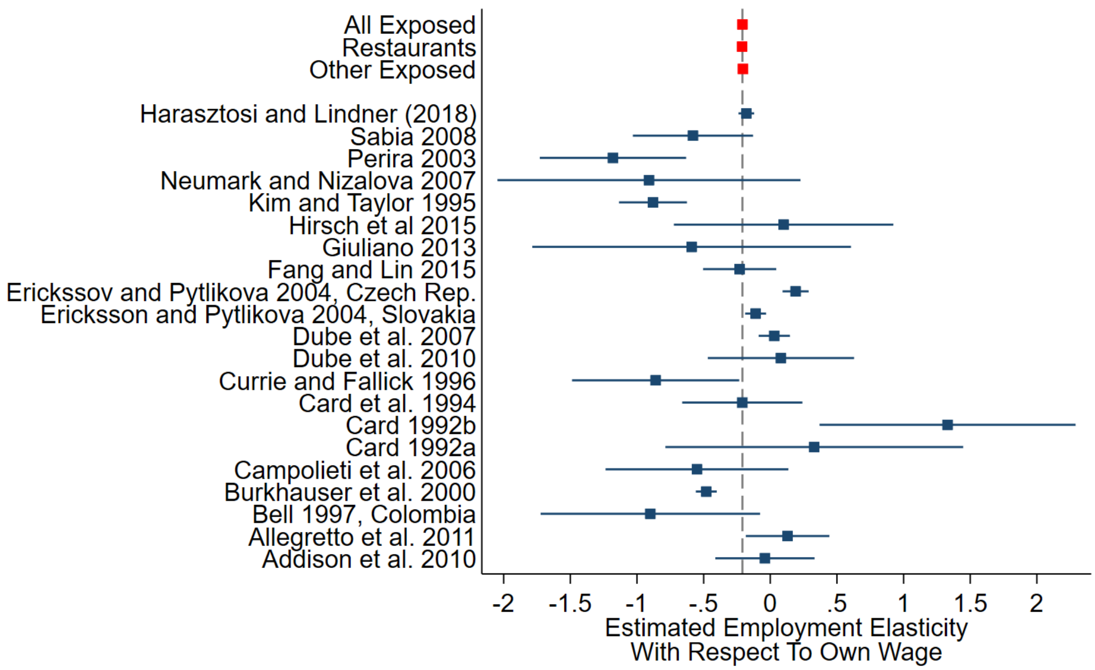
Note: This figure presents measure of exposure to the minimum wage by industry in 2013. The right panel presents statistics from the U.S. Bureau of Labor Statistics (BLS) on the number and share of workers at or below the minimum wage by broad industry groups. Numbers of workers are in thousands and percents show the share of all minimum wage workers that work in that industry ($MW_{industry}/MW_{total}$). The left panel shows our measure of the share of low earning workers by 4 digit NAICS industry using the administrative tax data. Shares are the share of all workers in independent (pass-through) firms in that industry that are low earning in 2013, where low-earning workers are those earning less than \$15,080 per year from all jobs in each year from 2012-2014. The listed industries are those with above 15% shares of low-earning workers by our measure, which represent our definition of "highly exposed" industries. We drop gas stations due to regional gas price volatility. The 4 digit industries that match this definition in the administrative data map very well with the BLS broad industry categories.

Figure A.2: State Minimum Wage Changes (percent changes)



Note: This is an alternate version of Figure 1, but showing the percent changes in statutory minimum wages. It tracks the statutory minimum wage in California, Connecticut, Delaware, Michigan, Minnesota and New Jersey from 2010 through 2018. The date of enactment for minimum wage legislation is denoted with an X. In fix of six states legislated increases were phased in over time, leading to multiple increases following enactment. Connecticut and California legislated further minimum wage increases in 2014 and 2016, respectively, which supplanted 2013 minimum wage legislation and were phased-in over time. Delaware and Michigan passed new minimum wage legislation in 2018 that took effect after our analysis period, though we may observe some anticipatory impacts. The average weighted change in the minimum wage among these states is 30.6% by 2018.

Figure A.3: Employment Elasticity Comparison



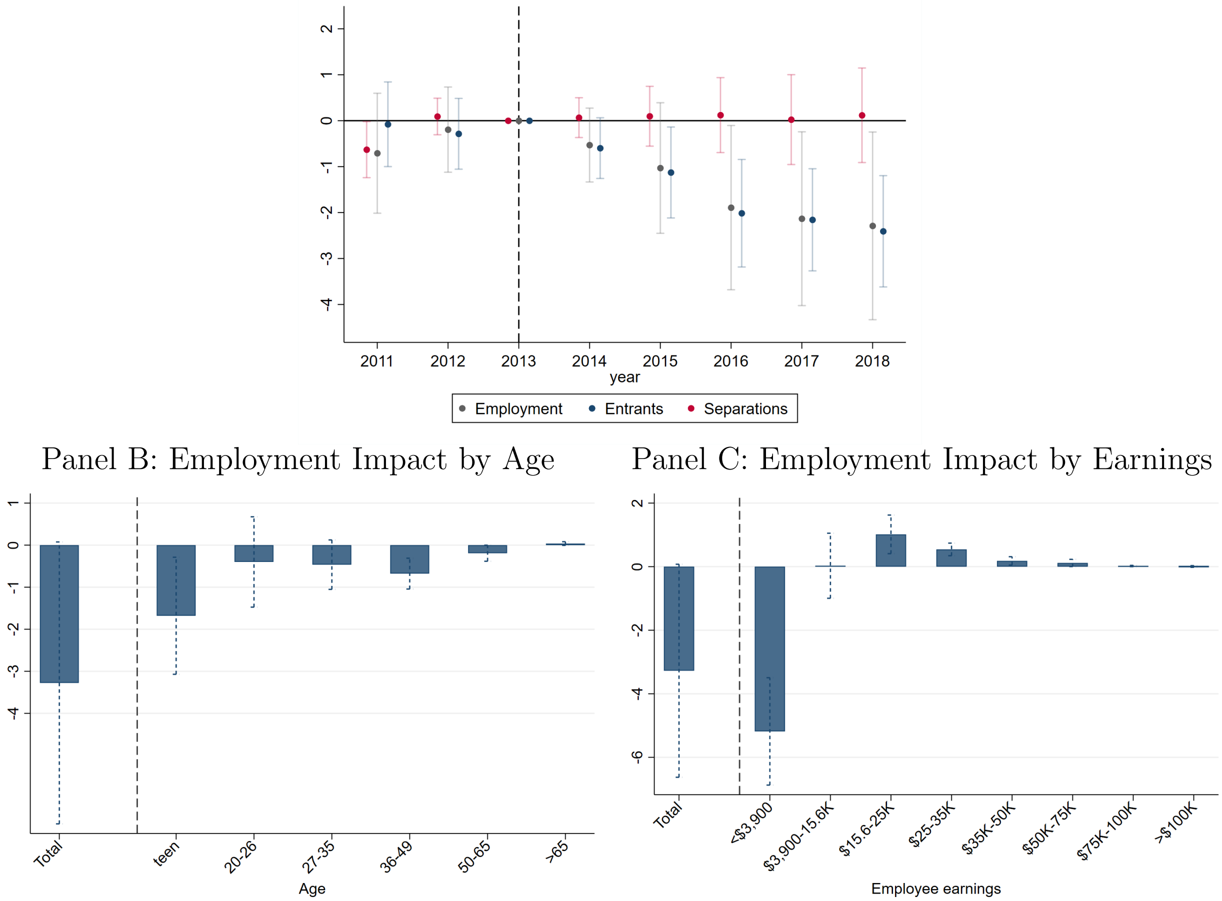
Note: This figure compares the own wage employment elasticities estimated in this study to those from previous studies. The point estimates and 95% confidence intervals from this study are at the top in red, one each for all independent firms in highly exposed industries, for restaurants and for other, non-restaurant, highly exposed industries (largely retail). The own wage elasticities are estimated using equation (1) where the outcome variable is log employment and the exposure variable is average earnings of workers in firm j interacted with an indicator for the firm being located in a treatment state. The coefficients represent the differential change in employment from 2013 to 2018 (i.e. β_{2018}). The comparisons to previous literature are taken directly from Harasztosi and Lindner (2019). This figure is a replica of their Appendix Figure A.6, but with the addition of their estimate and the estimates from this study.

Figure A.4: Change in Employment Relationships Due to Minimum Wage Increases (Restaurants)

Panel A: Change in Number of Employment Relationships

Panel B: Employment Impact by Age

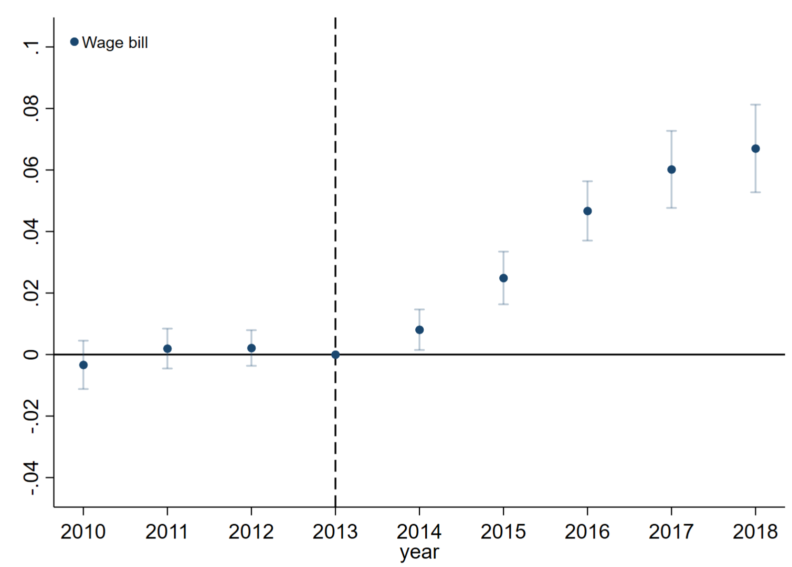
Panel C: Employment Impact by Earnings



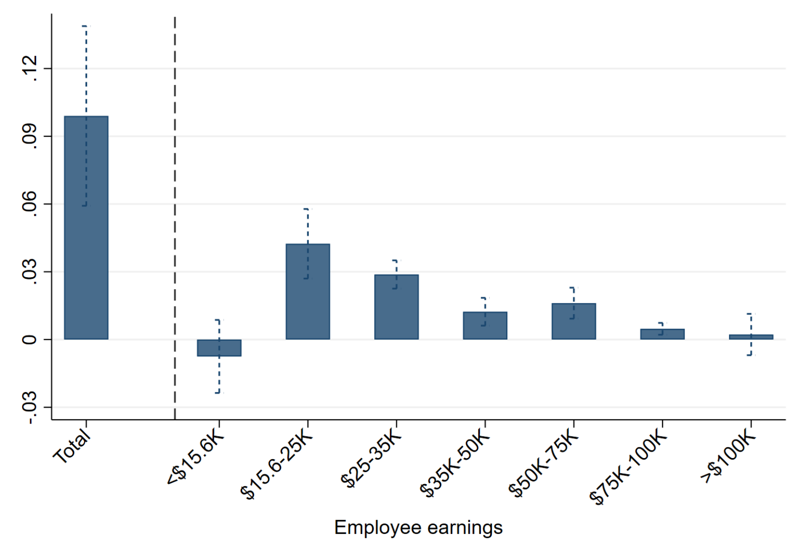
Note: This figure is a version of Figure 2 from the main text, but for independent restaurants only. The figure describes the change in the number and composition of employment relationships due to the minimum wage. Our employment measure counts the number of W-2s attached to a firm each year and may change due to true changes in employment or changes in worker churn. Panel (a) traces how minimum wage increases affect the number of employment relationships of the average firm as well as the number of new (entrance) and incumbent (retention) workers. Entrance rates are estimated using Equation 1 where the outcome is the number of new hires, defined as employees of the firm in year t that were not with the firm in year *t-1*. Separation rates are estimated using the outcome of the number of separating workers, those at the firm in year *t-1* that were not with the firm in year t. This decomposition is such that the coefficients from the entrants and separations specifications sum to the net employment response. Panels (b) and (c) decompose the 2013 to 2018 change in employment relationships by worker age and earnings in 2013, respectively. All regressions control for baseline deciles of revenue and firm size (# employees) categories both interacted with year. Dashed lines represent 95% confidence intervals.

Figure A.5: Impact of Minimum Wage Increases of Firm Wage Bills (Restaurants)

(a) Changes in Average Wage bill



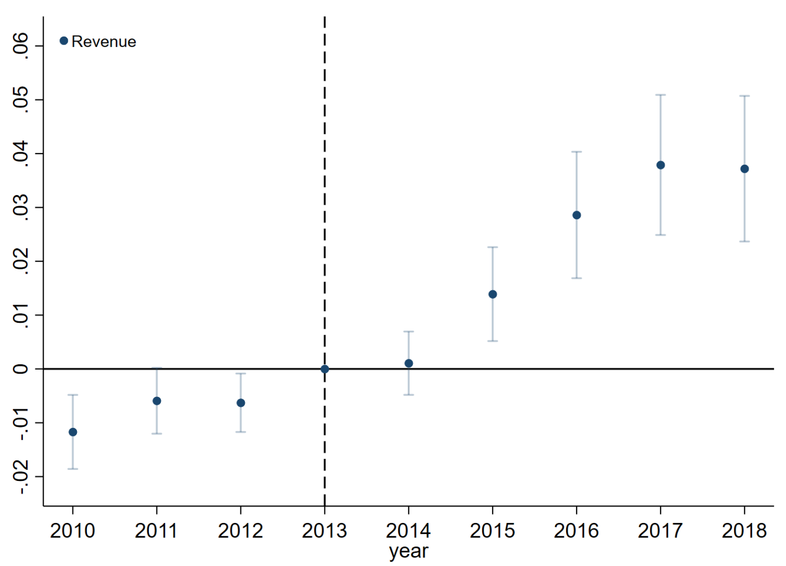
(b) Wage Bill Increases by Employee Income, 2013 to 2018



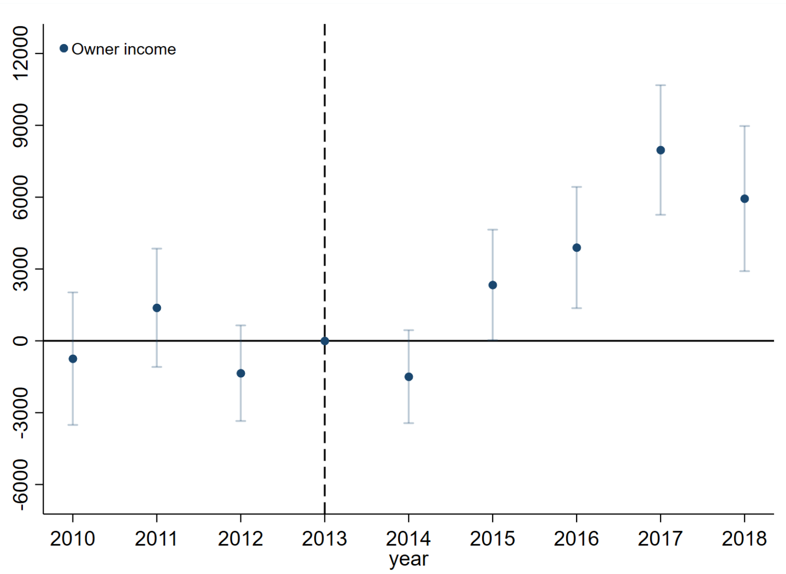
Note: This figure is a version of Figure 4 from the main text, but for independent restaurants only. The figure plots the estimated effects of the 2014 increases in state minimum wages on firm wage bills overall and by worker income for independent businesses in highly exposed industries. Panel (a) tracks the evolution mean wage bills over time where each estimate is from a regression of log total wages paid on firm fixed effects, year fixed effects and the interaction of a treated state indicator and year fixed effects. The coefficients on these interaction terms trace out the difference over time in average total wages paid relative to the 2013 base year between firms in treated and untreated states. Panel (b) shows the decomposition of the total earnings response across the earnings distribution. The total wage bill effect is shown on the left, and the gains by 2013 earnings range are on the right. Each bar is the DD coefficient estimate from 2013 to 2018, where the outcome is the change in the total wage bill in each earnings bin over the total 2013 wage bill for firm j. Standard errors are clustered by firm. The solid line is the best unweighted linear fit through the coefficients. All regressions control for baseline deciles of revenue and firm size (# employees) categories both interacted with year. Dashed lines represent 95% confidence intervals.

Figure A.6: Impact of Minimum Wage Increases on Revenues and Profits (Restaurants)

(a) Average Change in Revenue Relative to 2013



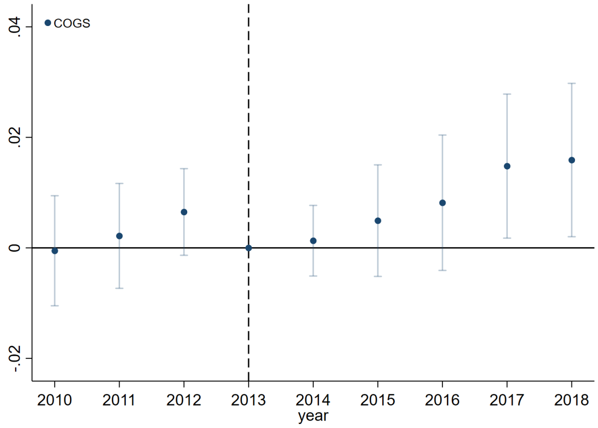
(b) Average Change in Owner Profit Relative to 2013



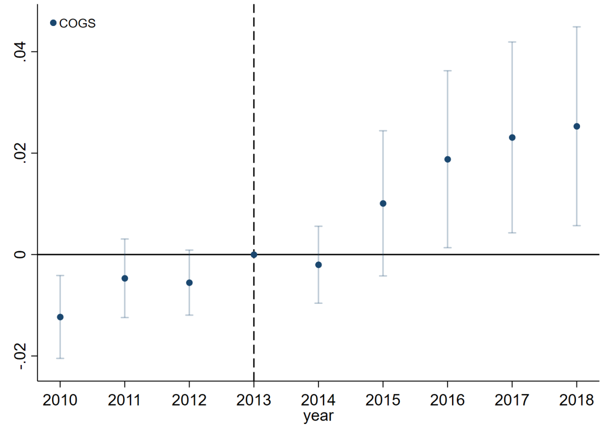
Note: This figure is a version of Figure 5 from the main text, but for independent restaurants only. The figure plots the estimated effects of the 2014 increases in state minimum wages on firm revenue in panel (a) and owner income in panel (b). Each set of estimates is from a regression of log revenue or owner income on firm fixed effects, year fixed effects and the interaction of a treated state indicator and year fixed effects. The coefficients on these interaction terms trace out the difference over time in average revenue or owner income relative to the 2013 base year between firms in treated and untreated states. Standard errors are clustered by firm. The solid line is the best unweighted linear fit through the coefficients. All regressions control for baseline deciles of revenue and firm size (# employees) categories both interacted with year. Dashed lines represent 95% confidence intervals.

Figure A.7: Impact of Minimum Wage Increases: Additional Outcomes

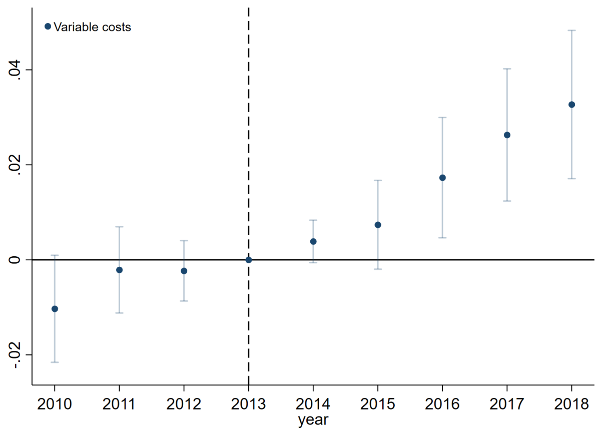
Panel A: Cost of Goods Sold (all exposed)



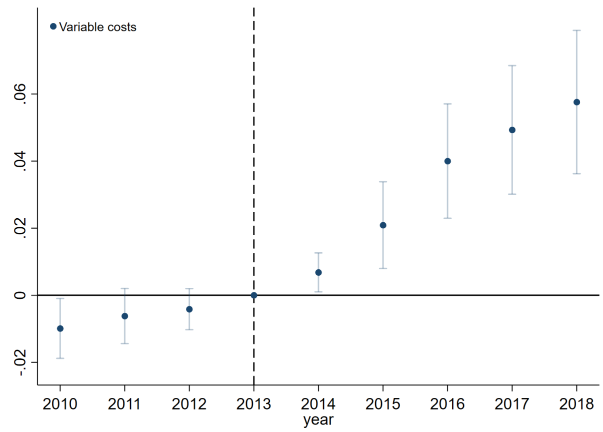
Panel B: Cost of Goods Sold (restaurants)



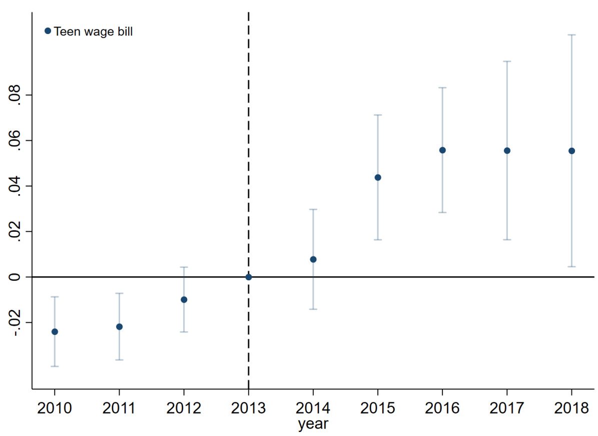
Panel C: Variable Costs (all exposed)



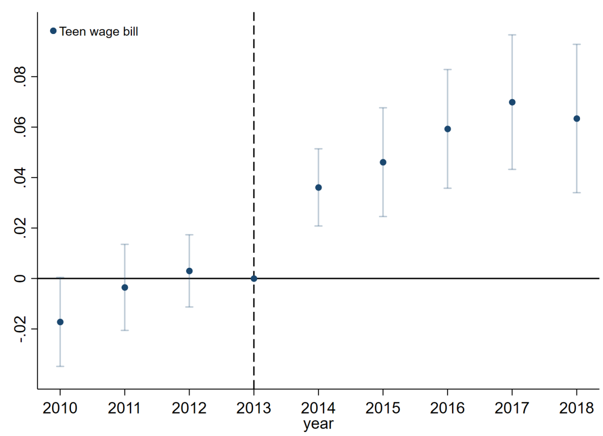
Panel D: Variable Costs (restaurants)



Panel E: Teen Wage Bill (all exposed)

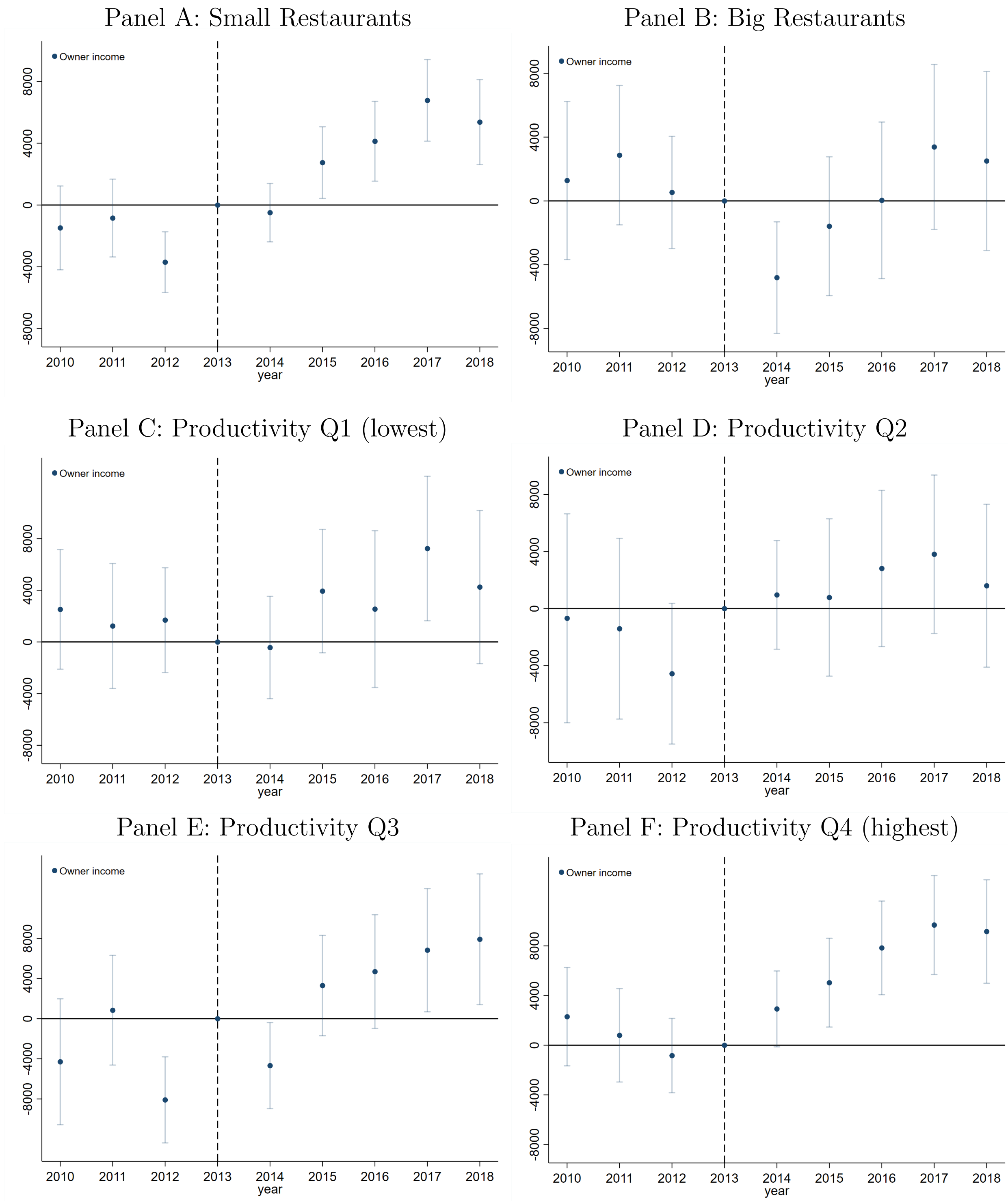


Panel F: Teen Wage Bill (restaurants)



Note: This figures shows the panel DiD results using specification (1) for the outcomes cost of goods sold (COGS), variable costs (COGS+wage bill) and teen wage bill for all highly exposed industries and restaurants.

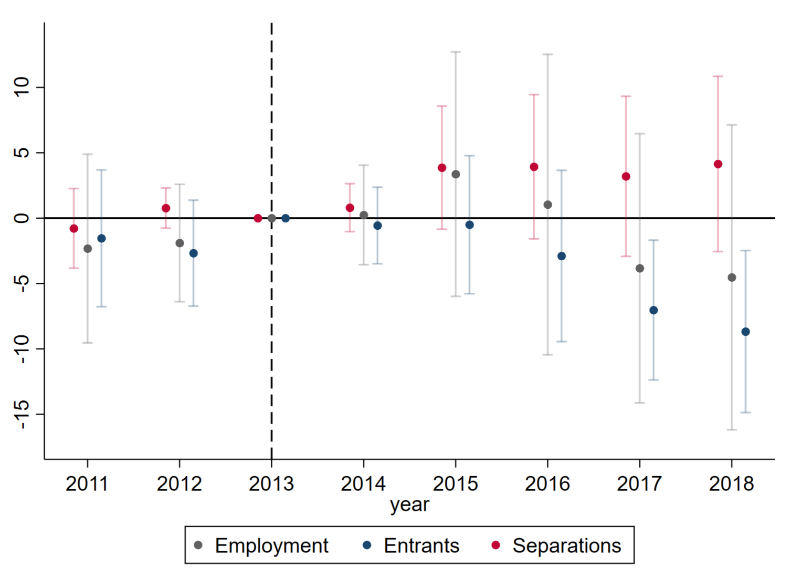
Figure A.8: Heterogeneity - Owner Income (Restaurants)



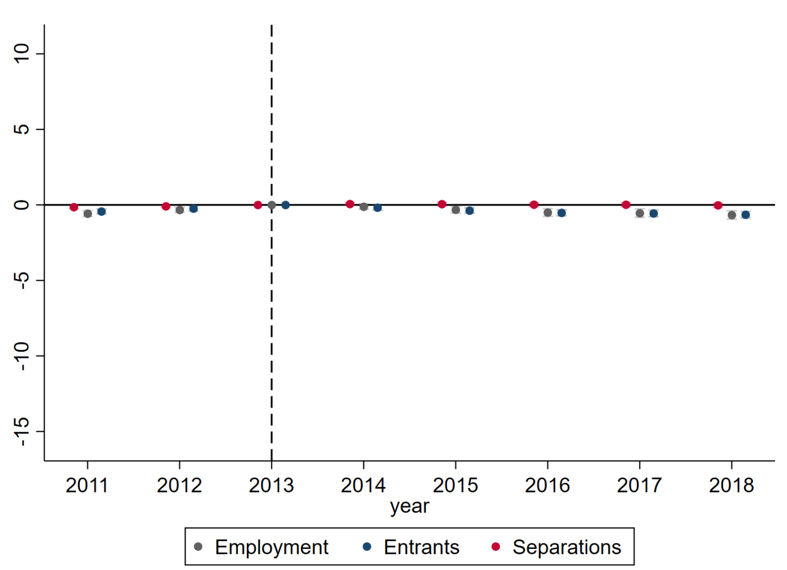
Note: This figures shows the panel DiD results using specification (1) for the outcomes presented in Table 4.

Figure A.9: Employment Effects by Size (Quartiles of baseline revenue)

(a) Top revenue (top 25%)

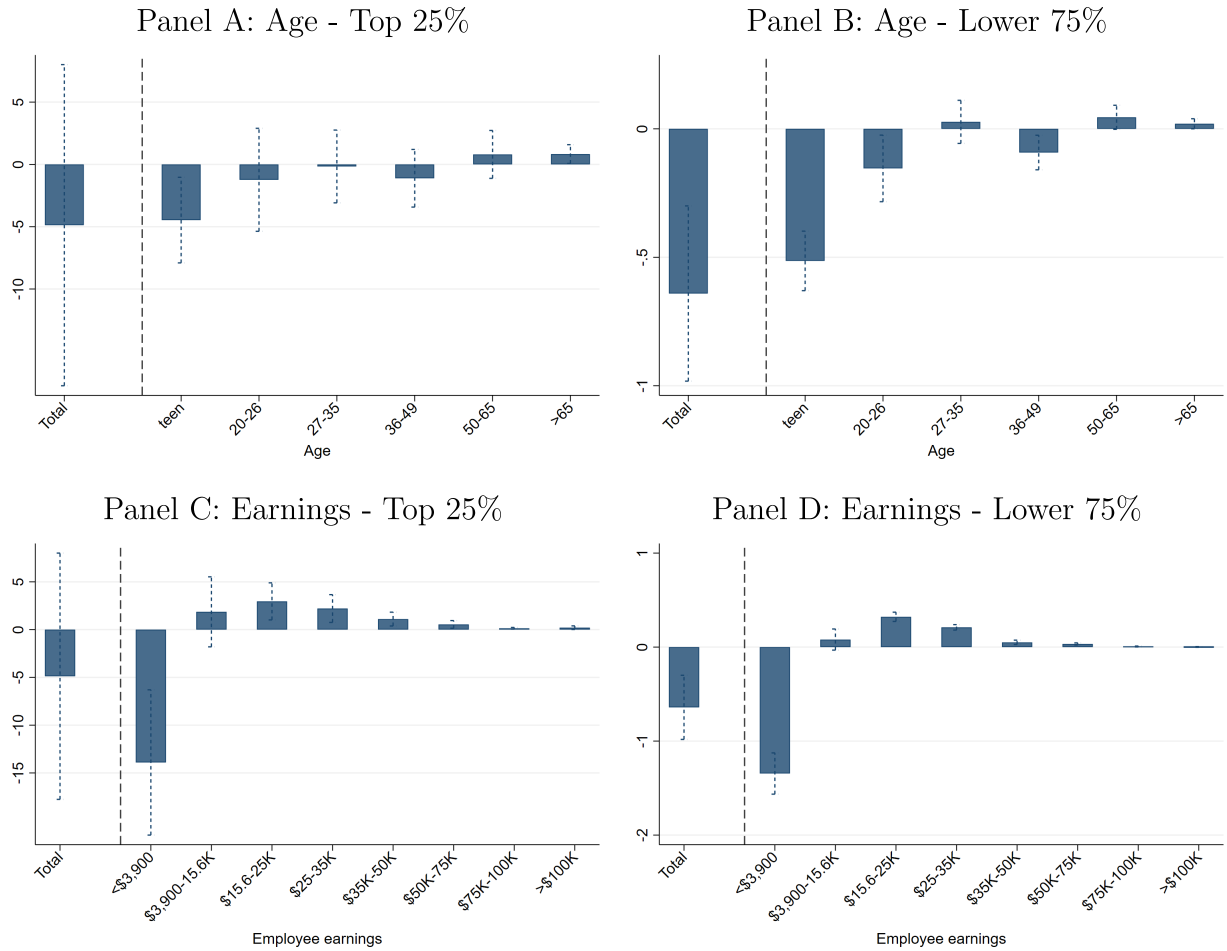


(b) Not top revenue (Lower 75%)



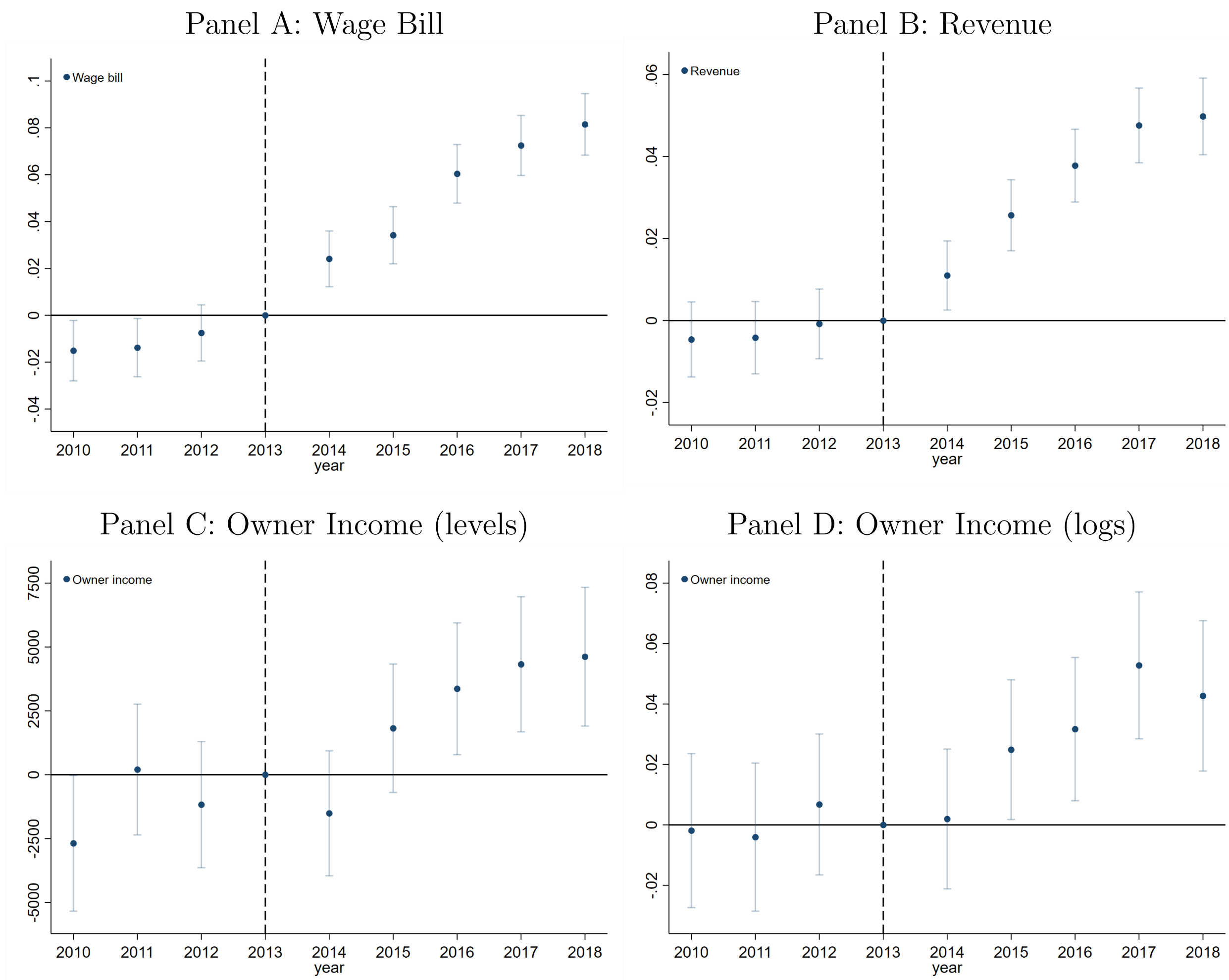
Note: This figure presents estimates of the effects of the minimum wage increase on firm employment as in Figure 2 Panel A, but splitting firms by baseline size. Panel A shows estimates for the biggest firms, those in the top quartile of the revenue distribution at baseline (2013), and Panel B shows estimates for the remaining firms (those in the lower 3/4 of the revenue distribution). The revenue distribution is taken over independent firms in highly exposed industries. Our employment measure counts the number of W-2s attached to a firm each year and may change due to true changes in employment or changes in worker churn. The figure traces how minimum wage increases affect the number of employment relationships of the average firm as well as the number of new (entrance) and incumbent (retention) workers. Entrance rates are estimated using Equation 1 where the outcome is the number of new hires, defined as employees of the firm in year t that were not with the firm in year *t-1*. Separation rates are estimated using the outcome of the number of separating workers, those at the firm in year *t-1* that were not with the firm in year t.

Figure A.10: Employment Effect Decompositions by Size (Quartiles of baseline revenue)



Note: This figure shows decompositions of the 2013 to 2018 change in employment by worker age and earnings as in Figure 2 Panels B and C, but splitting firms by baseline size. Panels A and C show estimates for the biggest firms, those in the top quartile of the revenue distribution at baseline (2013), and Panels B and D show estimates for the remaining firms (those in the lower 3/4 of the revenue distribution). The revenue distribution is taken over independent firms in highly exposed industries. Panels A and B show decompositions by worker age and Panels C and D by annual earnings. All regressions control for baseline deciles of revenue and firm size (# employees) categories both interacted with year. Dashed lines represent 95% confidence intervals.

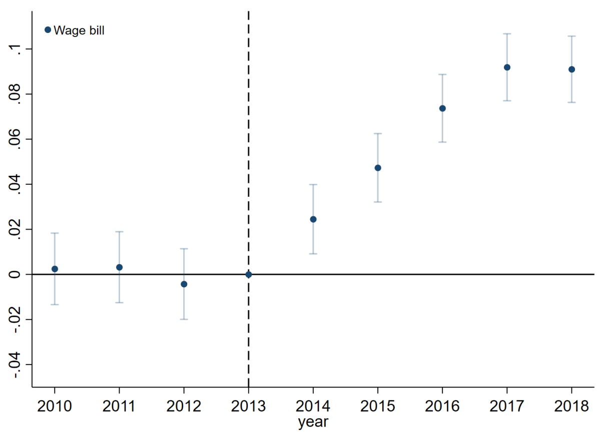
Figure A.11: Effects of Minimum Wage - Unbalanced Panel



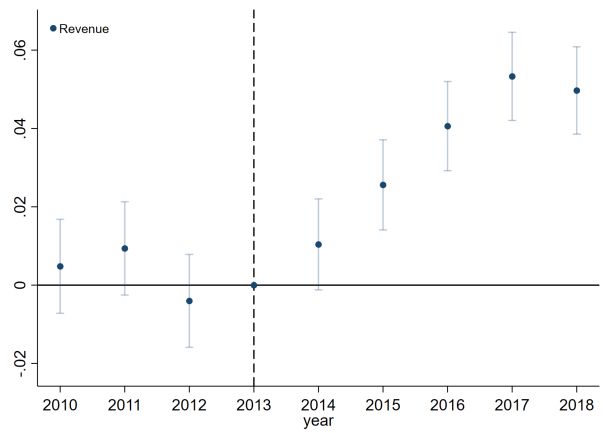
Note: This figure shows estimates of the effect of the minimum wage on independent businesses in highly exposed industries across various outcomes using estimation Eq. 1. The sample of firms is an unbalanced panel and includes all firms active in any year (i.e. not conditioning on being active at baseline and including entrant and exiting firms in this period). The coefficients trace the average differential characteristics of active firms in treatment and control states over time, relative to 2013. In Panel A the outcome is log firm wage bill; Panel B is log revenue; Panel C is owner profits in levels and Panel D is owner profits in logs.

Figure A.12: Effects of Minimum Wage - Unbalanced Panel (Restaurants)

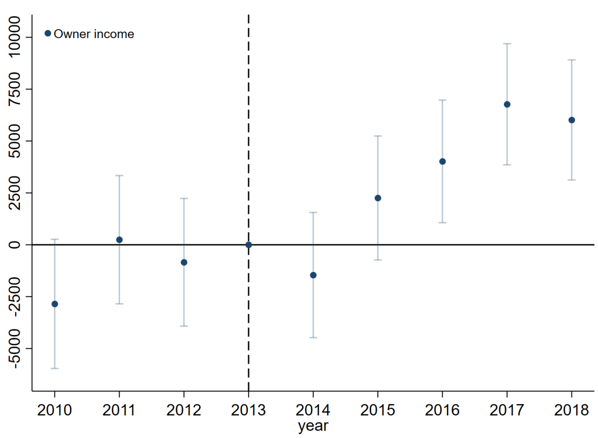
Panel A: Wage Bill



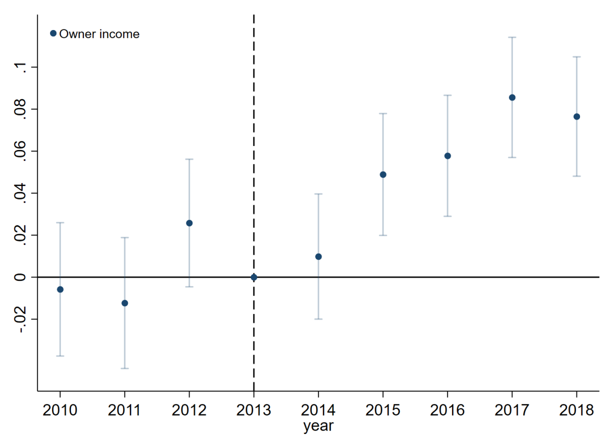
Panel B: Revenue



Panel C: Owner Income (levels)



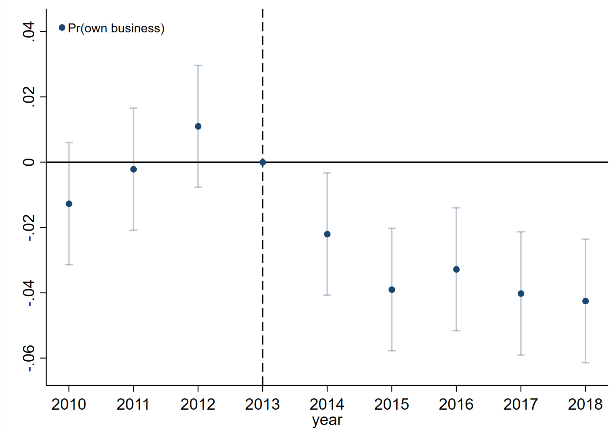
Panel D: Owner Income (logs)



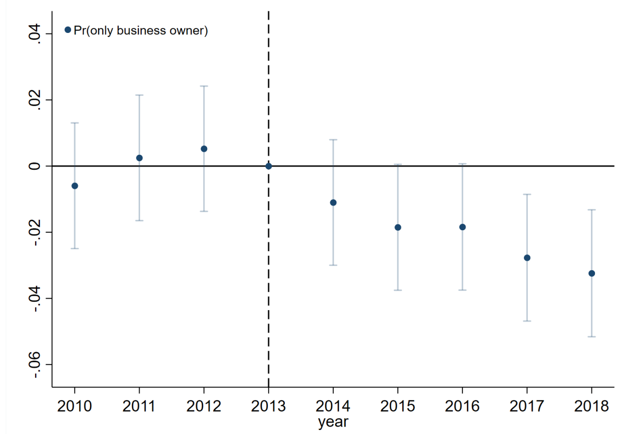
Note: This figure shows estimates of the effect of the minimum wage on restaurants across various outcomes using estimation Eq. 1. The sample of firms is an unbalanced panel and includes all firms active in any year (i.e. not conditioning on being active at baseline and including entrant and exiting firms in this period). The coefficients trace the average differential characteristics of active firms in treatment and control states over time, relative to 2013. In Panel A the outcome is log firm wage bill; Panel B is log revenue; Panel C is owner profits in levels and Panel D is owner profits in logs.

Figure A.13: Outcomes for Owners of Exiting Firms (small restaurants)

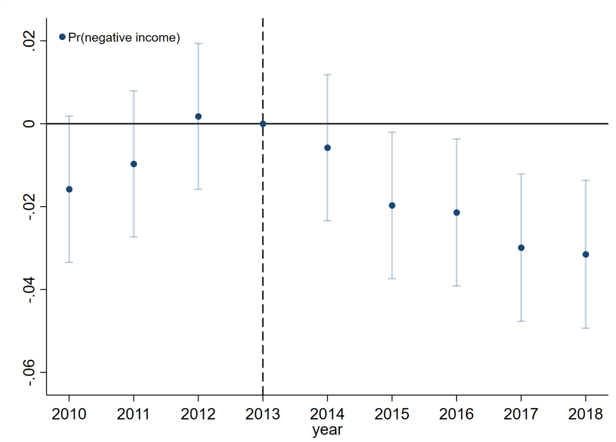
Panel A: Own a Business



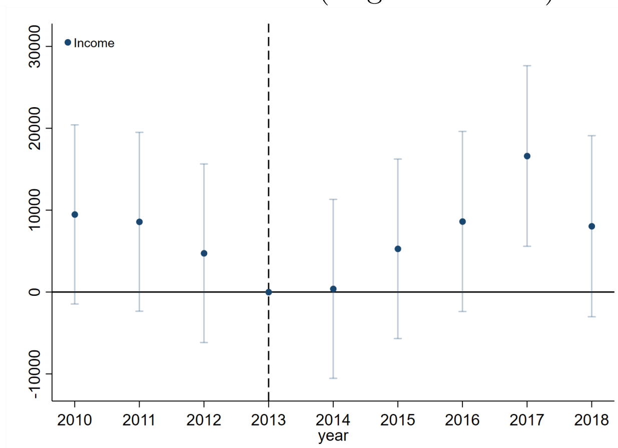
Panel B: Only Business Owner



Panel C: Negative Income



Panel D: Income (wages+business)



Note: This table reports estimates of the effects of minimum wage induced exits on owners of small restaurants. The regressions compare the outcomes for owners of firms that exit between 2013 and 2018 in treatment states to those of exiting firms in control states. Since exit is an endogenous outcome, the estimates do not represent the effect of policy-induced exits relative to a counterfactual world where the firm did not exit. Instead it provides a comparison of the outcomes of owners of firms that may have exited due to the minimum wage increase relative to those of owners whose firms exit for non-policy reasons. In Panel A, the outcome is an indicator for owning any business; in Panel B the outcome is an indicator for having business income but no wage income; in Panel C the outcome is an indicator for the owner having negative wage+business income; in Panel D the outcomes is average wage + ordinary business income. Each estimate is from a DiD regression as in Eq. (1), estimating the differential outcome between owners in treatment and control states relative to 2013.

B. Appendix Tables

Table B.1: 2014 Minimum Wage Increases

State	Enactment	Effective	2014 MW	Prior MW	Phase-In	Exclusions	Next MW Change	
							Date	Details
CA	09/25/2013	07/01/2014	$9.00	$8.00	$10.00 on 01/01/16	–	04/04/2016	MW increases to $10.50 on 01/01/17 and $11 on 01/01/18 for employers with 26+ employees, then increases by $1.00 a year through 2022 when it reaches $15 and is then inflation indexed; employers with 25 or fewer employees have a 1 year delay for all increases.
CT	06/06/2013	01/01/2014	$8.70	$8.25	$9.00 on 01/01/15	–	03/27/2014	MW increases to $9.15 on 01/01/15, then to $9.60 on 01/01/16, and finally to $10.10 on 01/01/17.
DE	01/30/2014	06/01/2014	$7.75	*$7.25*	$8.25 on 06/01/15	–	07/01/2018	MW increases to $8.25 on 10/01/18, to $9.25 on 10/01/19, to $9.75 on 10/01/20 and then to $10.25 on 10/01/21.
MI	05/27/2014	09/01/2014	$8.15	$7.40	$8.50 on 01/01/16, $8.90 on 01/01/17 and $9.25 on 01/01/18	Firms with only a single employee	12/04/2018	MW increases to $9.45 on 03/29/19, then potentially rises to $12 in 2030.
MN	04/14/2014	08/01/2014	$8.00	*$7.25*	$8.00 on 08/01/14, $9.00 on 08/01/15 and $9.50 on 8/01/16	Firms with gross revenues less than $500K required to pay roughly 80% of standard minimum wage	–	–
NJ	11/05/2013	01/01/2014	$8.25	*$7.25*	–	–	02/04/2019	MW increases to $10.00 on 07/01/19, $11.00 on 01/01/20, with $1.00 increases until 01/01/24 when MW will be 2024. Indexed to inflation with annual increases either $1.00 or inflation.

Note: This table describes the state minimum wage increases in 2014, which represent the treatment in our empirical analysis. The first column lists the enactment date and the second column the policy went into effect. The third and fourth columns show the new 2014 minimum wage and the prevailing prior minimum wage. The next column describes whether the initial 2014 increase was part of a longer planned phase-in. The next column describes any exclusions and the final columns detail any further minimum wage policies enacted subsequent to the 2014 policy.

Table B.2: Effects of Minimum Wage - Main Firm-level Outcomes

	All Exposed	Restaurants	Other Exposed
Wage bill	0.0703***	0.0670***	0.0734***
	(0.0153)	(0.00727)	(0.0223)
Revenue	0.0217***	0.0372***	0.0177**
	(0.0053)	(0.0069)	(0.00738)
COGS	0.0010	0.0253**	0.00887
	(0.0082)	(0.0101)	(0.00985)
Variable costs	0.0327***	0.0576***	0.00762
	(0.00796)	(0.0109)	(0.0116)
Wage bill (teen)	0.0555**	0.0634***	0.0589
	(0.0267)	(0.0150)	(0.0621)
Wage bill (young)	0.0485***	0.0399***	0.0567
	(0.0122)	(0.0091)	(0.0336)
Profits	3,360.4***	5,941.1***	1,072.9
	(1122.5)	(1546.2)	(1920.4)
Employment	-0.947	-2.580**	-0.0367
	(0.910)	(1.170)	(1.548)
Empl. Elasticity	-0.209***	-0.211***	-0.184***
	(0.0112)	(0.0158)	(0.0376)
Exit	0.0094***	0.0185***	0.0001
	(0.0029)	(0.0039)	(0.0044)

Note: This table presents estimates of the effect of the minimum wage increases on various outcomes separately by industry subsamples. Each coefficient represents the differential effect in treatment states relative to control states from 2013 to 2018 (i.e., β_{2018} from Eq. 1). The first column shows estimates for independent businesses in all highly exposed industries, column 2 for restaurants only, and column 3 for other, non-restaurant, highly exposed industries (largely retail). Note, Cost of goods sold (COGS) is a measure of non-labor variable costs; "variable costs" is the sum of firm wage bills and COGS; Wage bill (teen) is the total wages paid to teen workers (ages 15-19); Wageb bill (young) is the total wages paid to other young workers (ages 20-26); employment elasticities are estimates of the effect of a percent increase in firm wage bills on employment. See Figure A.7 for panel DiD results for the additional outcomes.

Table B.3: Exit Effects by Productivity and Share of Low Earning Workers (Restaurants)

Exposure quartile	Productivity Q1 (lowest)	Q2	Q3	Q4 (highest)
Q1 (least)	0.0142	0.0206	0.0292	-0.0085
	(0.0162)	(0.0164)	(0.0166)	(0.0152)
Q2	0.0250	0.0102	0.0020	0.010
	(0.0148)	(0.0153)	(0.0159)	(0.0153)
Q3	0.0435***	-0.0065	-0.0013	0.0176
	(0.0159)	(0.0158)	(0.0150)	(0.0146)
Q4 (most)	0.0385***	-0.0097	-0.0115	0.0066
	(0.0079)	(0.0171)	(0.0159)	(0.0145)

Note: This table reports the estimated effect of the minimum wage increases on firm exit by baseline firm characteristics for restaurants. The coefficients represent the differential probability of a firm exiting between 2013 to 2018 in treatment relative to control states (positive coefficients represent and increased probability of exit). Each estimate is for a subsample of firms differentiated by baseline productivity and "exposure" to the minimum wage change. Firm exposure is defined as the share of low-earning workers at the firm, where low earning workers are those that earn no more than $25,000 in wage and salary earnings from all jobs in 2012-2014. The columns represent the position in the baseline (2013) distribution (quartiles) of firm productivity, defined as net profits/revenues, and the rows reflect the position in the distribution of firm exposure (# low-earning workers / workers). Estimates are from linear probability models where firm exit is the dependent variable and an interaction of a treated state indicator and year fixed effects are the regressors of interest (estimates for 2018 (β_{2018} from Eq. 1) are shown. Standard errors are clustered at the firm level.

Table B.4: Effects of Minimum Wage Increases by Density

	All exposed		Restaurants	
	Low Density	High Density	Low Density	High Density
Wage bill	0.0370***	0.0855***	0.0571***	0.0710***
	(0.0088)	(0.0219)	(0.0123)	(0.0084)
Revenue	-0.0013	0.0250***	0.0278**	0.0401***
	(0.0083)	(0.0060)	(0.0124)	(0.0077)
Employment	-0.824	-0.783	-1.767*	-2.703*
	(1.280)	(1.227)	(0.981)	(1.560)
Profits	-770.2	5,564.0***	1,791.3	6,407.1***
	(1781.9)	(1422.9)	(2206.9)	(1753.3)
Exit	0.0051	0.0124***	0.0165**	0.0202***
	(0.0053)	(0.0035)	(0.0078)	(0.0045)

	Exits by Productivity (Restaurants)			
	Q1 (lowest)	Q2	Q3	Q4 (highest)
Low density	0.0342**	0.0074	-0.0177	0.0025
	(0.0142)	(0.0161)	(0.0166)	(0.0171)
N firms	4,973	3,770	3,299	2,830
High density	0.0227***	-0.0048	0.0071	0.0146
	(0.0095)	(0.0094)	(0.0093)	(0.0084)
N firms	8,196	9,250	9,721	10,191

Note: This table presents estimates of the effect of the minimum wage increases on various outcomes separately by industry and by whether the firm operates in a high density or low density area. Zip codes are ranked by the number of highly exposed independent firms in that zip. Dense zip codes are those with more firms, so high density firms are those that operate in zips in the top quintile of the density distribution and low density firms are those in the lower three quintiles. Each coefficient represents the differential effect in treatment states relative to control states from 2013 to 2018 (i.e., β_{2018} from Eq. 1). The first two columns of the top panel are for all independent business in highly exposed industries, and the next two columns for restaurants only. The bottom panel digs into the estimated effects on firm exit, further dividing restaurants by baseline productivity (quartiles of net profits/revenues). The top row shows estimated effects on firm exit for firms in low density areas across the distribution of baseline productivity, and the bottom row for firms in high density areas. The coefficients represent the differential probability of a firm exiting between 2013 to 2018 in treatment relative to control states (positive coefficients represent and increased probability of exit).

Table B.5: Effects of Minimum Wage - Additional Firm-level Outcomes

	All exposed		Restaurants	
	level	percent	level	percent
Firm Income Items				
Total Income	20,068***	0.0220***	29,967***	0.0345***
	(4279)	(0.0036)	(9489)	(0.0043)
Value Added	19,455***	0.0255***	28,806***	0.0359***
	(4199)	(0.0039)	(9193)	(0.0045)
Net Business Inc.	4,307***	-0.0234	6,876***	-0.119*
	(1137)	(0.0690)	(1932)	(0.0490)
Deductions/Expenditures				
Total deductions	17,586	0.0240***	23,732***	0.0325***
	(3915)	(0.0033)	(8883)	(0.0041)
Officer comp	-860.3**	0.0120**	-1,308	0.0009
	(341)	(0.0053)	(710)	(0.0087)
Wage deductions	15,491***	0.0340***	18,952***	-0.0462***
	(1712)	(0.0063)	(4043)	(0.0079)
Repairs	184	-0.0069	546	0.0100
	(175)	(0.0107)	(340)	(0.0111)
Rent deductions	-1,575***	-0.0042	-1,371	0.0059
	(579)	(0.0098)	(1341)	(0.0053)
Interest deductions	-8	-0.0050	-180	-0.0046
	(146)	(0.0433)	(263)	(0.0257)
Depreciation	33	-0.0300	88	-0.0237
	(342)	(0.0190)	(625)	(0.0225)
Advertising	-106	-0.0124	-364	-0.0125
	(184)	(0.0086)	(463)	(0.0090)
Pensions	24	0.0002	7	-0.0013
	(18)	(0.0020)	(29)	(0.0015)
Worker benefits	-333***	0.0209	-435**	-0.0042
	(100)	(0.0127)	(194)	(0.0113)
Other deductions	1,501	0.0150***	4,411	0.0181***
	(1358)	(0.0041)	(2964)	(0.0047)

Note: Note: This table presents estimates of the effect of the minimum wage increases on various firm outcomes, both income and expenses, as reported on the firms' income tax returns. Each coefficient represents the differential effect in treatment states relative to control states from 2013 to 2018 (i.e., β_{2018} from Eq. 1). Each coefficient represents the differential effect in treatment states relative to control states from 2013 to 2018 (i.e., β_{2018} from Eq. 1).

Table B.6: Effects of MW by Baseline Firm Revenue

	Wage bill	Revenue	Owner income	Employment	Exit
Lower 75%					
$\beta_{2013-2018}$	0.0772***	0.0274***	1,909**	-0.671***	-0.0138***
	(0.0056)	(0.0042)	(776)	(0.141)	(0.0032)
mean	168,989	729,909	61,614	24	·
Top 25%					
$\beta_{2013-2018}$	0.0628***	0.0110	13,429**	-4.529	0.0089
	(0.0231)	(0.0071)	(5494)	(5.952)	(0.0065)
mean	989,334	5,748,295	305,427	183	·

Note: This table presents estimates of the effect of the minimum wage increases on various outcomes separately by baseline firm size. The top panel shows estimates for the biggest firms, those in the top quartile of the revenue distribution at baseline (2013), and Panel B shows estimates for the remaining firms (those in the lower 3/4 of the revenue distribution). The revenue distribution is taken over independent firms in highly exposed industries.

C. Administrative Data

C.1. High Exposure Industries

For our analyses, we focus on the firms in "highly exposed" industries. To do so, we use the tax data to generate a rank of 4 digit NAICS industries by the share of low-earning workers in that industry in 2013. We use low-earning workers as a proxy for likely minimum wage workers and define low-earning workers in 2013 as those earning less than $15,080 (= 40 hrs/week x 52 weeks/year x 7.25 $/hour federal minimum wage) across all jobs in each year from 2012-2014. To generate our industry ranks, we start by pulling a 20% sample of all pass-through firms in treatment and control states in 2013. For each firm, we link all employees through their Form W-2. For each worker, we then link all W-2s from all jobs in each year from 2012-2014. We define a low earning worker as a worker earning less than $15,080 across all jobs in each of these years. Then, among sampled pass-through firms, within each 4 digit NAICS industry we calculate the share of employees that are low-earning by this measure. Finally, we rank industries by these shares. The results are shown in Appendix Figure A.1.

C.2. Linked Firm-Worker Data

Firm and worker information is drawn from the universe of de-identified administrative tax data. We use a 100 percent sample of pass-through firms in highly exposed industries in treatment states (states with legislated minimum wage increases in 2014) and control states in each year from 2010 to 2019.[50] For each firm, we collect information from the firm's annual income tax return, which we then link the individual income tax returns and information reports of all owners and workers to create a combined firm-worker dataset.The resulting dataset includes individual income variables for all employees in each year, as well as firm-

[50] Treated states, as described further in Section 3.2.1, are those shown in Figure 1 and the control states are Alabama, Georgia, Iowa, Idaho, Illinois, Indiana, Kansas, Kentucky, Louisiana, Mississippi, North Carolina, North Dakota, New Hampshire, New Mexico, Nevada, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Virginia, Wisconsin, and Wyoming.

level income, tax, productivity and characteristic variables from the business income tax return.

From the firm tax returns, we use information on production and productivity including, i) net ordinary business income, ii) revenues: gross sales, iii) Revenues: equivalent to gross profits or sales, iv) total deductions and non-wage deductions, defined as total deductions less deductions for officer and employee compensation. Other firm-level variables collected from the tax return include the NAICS industry code and the state and zip code of operation.

The firms' income tax returns are linked to every employee who was issued a W-2 with positive wage and salary income. The firm's wage bill is the sum of wage and salary earnings of all non-owner employees, and the number of employees is the number of non-owners receiving W-2s. Further, we use earnings information to define a subset of workers that are more likely "exposed" to minimum wage changes. We define more "exposed" workers in the base year, 2013, based on their 2011-2015 earnings history to isolate true low earning workers as opposed to those with idiosyncratically low earnings in a given year. We define these low earning workers as those with total earnings (from all jobs) that are less than 40 hours per week for 52 weeks at the minimum wage in each year from 2011-2015. For each firm, we calculate the share of workers and the share of the firm's wage bill in 2013 associated that are potentially exposed by this measure. We note that while this group should contain essentially all minimum wage workers, there may be consistently part time workers that earn wages well above the minimum wage that are included as well.[51]

Pass-throughs are required to file a Schedule K-1 on behalf of each owner, which reports the owner's share of firm income in each year. To identify owners, we match each firm with all filed Schedule K-1 reports. Owners can be active, shareholder-employees, or passive owners. Firm owners earn annual profits or losses from their businesses and active owners may pay themselves wage and salary income as well. We define owner income/profits as net business income plus wage and salary income paid to active owners. This definition provides

[51] We also include information on the age of each employee and define shares of young workers, those under 26 years old, at each firm.

a measure of the owners' total residual business income from owning the firm, paid as either wages or profits.[52] We further use the K-1 owner link to exclude active owner-employees from our worker estimates and to separately estimate the effect of policies on firm owners.

C.3. Individual Panels of Workers and Owners

Worker Panel. We construct a worker-level panel to study the effects on the minimum wage changes on workers in exposed firms. To do so, we start by pulling a spine of all workers at independent firms in highly exposed industries in the treatment and control states in 2013 (pre-reform). From this sample frame, we take a 40% random sample of workers from firms in treatment states (≈1 million workers) and a 20% random sample of the workers in control states control states (≈1 million workers). For each worker sampled, we create a panel of tax records from year 2010-2019. To each worker in each year we link information on all jobs through all W-2s received. For each job, we collect information about that job by linking the W-2 to the payer (firm) tax return to collect information on the industry of the firm and the corporate form (partnership, S-corp, C-corp, sole proprietorship or not-for-profit). These data allow us to follow the industries each worker works in over time and total wages from all jobs and from jobs in a given industry. Also, for each worker we collect information on the year of birth and sex as reported in social security records.

Young and Teen Panel. We create a second individual panel focusing on young individuals - those with or without a job in the pre-reform period (2013). A spine of all individuals ages 15-26 in 2013 is selected. These are individuals who file tax returns on their own or are listed as dependents on a household return. From this spine, we take a stratified random sample, oversampling teenagers. From treatment states, we take a sample of 12% of individuals 20-26 years old in, and a 6% sample of individuals this age from control states.

[52] Guidance on the IRS website states, "S-corporations must pay reasonable compensation to a shareholder-employee in return for services that the employee provides to the corporation before non-wage distributions may be made to the shareholder-employee." Active owners have some discretion over how much "reasonable compensation" to pay themselves and how much they receive as profits. Tax policy affects the relative incentives for owners to compensate themselves through profits or wages. For this reason, a comprehensive measure that includes both is more consistent across time and location.

For teenagers (15-19 years old), we take a 24% sample from treatment states and a 12% sample from control states.

For each sampled individual we link all of the same information as with the worker panel. This we perform separate analyses with this panel for those working at baseline (2013) and for those not employed (receiving no W-2s) at baseline.

Owner Panel. To follow outcomes of owners, including those that may leave their firms or whose firms may exit the market, we create a separate owner panel. We create a 100% panel of individual owners of independent firms in highly exposed industries in treatment or control states in 2013. Concretely, for each S-corporation or Partnership in these industries and states, we link all individual owners through Schedule K-1, which reports the owners' shares of business income and losses in each year. For each owner in 2013, we create an individual panel. We link all information as with the worker panels. Additionally, we link all received Schedule K-1s in each year to compile information on business ownership. We define business ownership in year t as receiving a Schedule K-1 with non-zero ordinary business income in that year.[53] A business owner is considered a primary business owner in year t if they receive more than half of their total wage (the sum of W-2 wage and salary income) plus ordinary business income (sum across all Schedule K-1s) in that year. Finally, we link the Schedule K-1s to the payer (firm) income tax return to incorporate information on the industry the owned firm operates in.

C.4. DFL Weighting

To implement DFL re-weighting, we bin firms by three-digit NAICS industry code, tax year, and within-industry size decile, where size is the two-year average of lagged value-added[54] and the deciles are based on the within-industry distribution of firms in treated states in 2013.

[53] That is, if an individual receives a Schedule K-1 with only investment income such as rental income, capital gains, dividends or interest, but no ordinary business income, they are not classified as a business owner in that year even though they received a Schedule K-1. We mean to differentiate owners of pass-throughs for investment purposes from those that are business owners in the typical economic sense of being shareholders in an active, operating firm.

[54] Value-added is total gross receipts less total wage bill and cost of goods sold.

Then, for each year and set of firms we adjust each bin's weight such that each bin carries the same relative weight as in the 2013 distribution of firms in treated states. Re-weighting the sample this way allows us to flexibly control for time-varying size- or industry-based shocks preventing, for example, time-varying shocks to large retail firms from influencing the results because large retail firms in treated and untreated states in each year will contribute equally to the estimates.

D. Border Design

We provide additional analyses using a border county design similar to that advanced in Card and Krueger (2000), Dube et al. (2010, 2016) and Allegretto et al. (2013, 2017). To implement this design within our context, we use treatment states (T) and the control states (C) in our sample that border these states. The state pairs that contain the counties in this analysis are: Delaware (T) with Pennsylvania (C), New Jersey (T) with Pennsylvania (C), Michigan (T) with Wisconsin (C), Minnesota (T) with Wisconsin (C) and North Dakota (C), California (T) and Nevada (C). Within these border states, we select firms in counties with centroids within 30 miles of the state border. When a county is within 30 miles of multiple borders, the firms in that county will have multiple observations - one observation per border pair (Dube et al. (2010, 2016)).

This design compares independent firms in highly exposed industries in states that raise the minimum wage to similar firms just across the border in a state that did not have a minimum wage increase in the period. The regression specification is similar to that used in the main analysis (equation (1)), but adding fixed effects for border pairs interacted with year:

$$f(y_{jt}) = \alpha + \sum_{s \neq 2013} (\beta_s exposed_j + \Gamma_s X_j + \Psi_s I_j) \times year_{s=t} + \delta_t + \psi_j + \nu_{jt} \tag{D.1}$$

where the variables are defined as in equation (1) with the addition of I_j which represents border pair fixed effects.

The results of this analysis are presented in Table D.7. The reported estimates are DiD coefficients for the differential change in the outcome variable in treatment firms relative to control firms from 2013 to 2018 (i.e. β_{2018} from equation (D.1)). Panel A shows results for the main outcomes - differential percent changes in total wage bill, revenues, firm profits, employment and the differential probability of firm exit - separately for restaurants, all highly exposed industries and other, non-restaurant, highly exposed industries (mostly retail). Panel B reports the heterogeneous effects on exit across the distribution of baseline productivity, defined by the distribution of gross profits/revenues in 2013.

Panel A shows that for restaurants and all firms in highly exposed industries, the results are qualitatively similar when using the border firms as when using the full sample. In treated states wage bills increase on average, as do revenues such that profits do not decrease. Net employment decreases slightly and some firms exit. Panel B shows that, as in the full sample, exits are concentrated among the least productive firms.

While the results are qualitatively similar, the exit rates and employment reductions are slightly higher along the border than for the average firm in treatment states, particularly among retail firms. This suggests that it might be more difficult for firms in close proximity to the border, potentially competing in the same product markets as firms just across the border that did not experience a cost shock, to accommodate the cost shock. Though the estimates are imprecise due to the reduced sample size, it appears that even retail firms on the border are not able to raise revenues sufficiently to accommodate the cost increases and some firms exit as a result. This is consistent with the potential of cross-border shopping (Harding et al., 2012; Cawley and Frisvold, 2017) making it difficult for firms on the border to bear cost shocks through increased prices due to more elastic demand.

To investigate how the effects differ away from the border Panel C shows results for firms in the state pairs listed above, but excluding firms in counties near the border. We see that when moving away from the border, the effects are very similar to the aggregate results

(Table B.2) for all firms in the full sample of treatment and control states on average, as well as for restaurants and for other non-restaurant highly exposed firms.

Table D.7: Effects of Minimum Wage - Border Design

	Panel A: Firms in Counties within 30 miles of the Border				
	Wage bill	Revenue	Profits	Employment	Exit
Restaurants	0.0370*	0.0242**	5,212.4	-2.262***	-0.0314**
	(0.0193)	(0.0119)	(4,691.2)	(0.768)	(0.0125)
All Exposed	0.0269**	0.0088	753.9	-1.246**	-0.0263***
	(0.0125)	(0.0079)	(3,351.1)	(0.512)	(0.0089)
Other Exp.	0.0153	0.0029	-4,143.0	-1.029	-0.0231
	(0.0180)	(0.0117)	(5,345.3)	(0.764)	(0.0127)

	Panel B: Exits by Productivity (Border Counties)				
	All	Productivity quartile			
	Exposed	Q1	Q2	Q3	Q4
Exit	0.0263***	-0.0433**	-0.0294	-0.0290	-0.0084
	(0.0089)	(0.0183)	(0.0177)	(0.0181)	(0.0174)

	Panel C: Firms in Counties more than 30 miles of the Border				
	Wage bill	Revenue	Profits	Employment	Exit
Restaurants	0.0720***	0.0300***	3,879.6	-0.971	-0.0205**
	(0.0122)	(0.0083)	(7,822.0)	(0.686)	(0.0088)
All Exposed	0.0730***	0.0348***	3,373.9	0.003	-0.0086
	(0.0084)	(0.0057)	(2,465.2)	(0.419)	(0.0065)
Other Exp.	0.0652***	0.0362***	2,986.1	0.313	0.0028
	(0.0128)	(0.0087)	(3,937.9)	(0.566)	(0.0095)

Note: Table D.7 presents results from the border design and regression specification described in Appendix D. The reported coeffiecients are DiD estimates of the differential effect on each outcome from 2013-2018 using the regression specification represented in Eq. D.1, i.e. β_{2018}. Panel A reports estimates for firms in counties with centroids within 30 miles of the state border, separately for restaurants, firms in all highly exposed industries, and firms in non-restaurant highly exposed industries (largely retail). Outcomes are winsorized at the 1^{st} and 99^{th} percentiles. Exit rates are the differential probability in surviving from 2013 to 2018 where negative coefficients represent increased exit rates. Panel B shows heterogeneity in the effect on exits by quartile in the pre-reform productivity (gross profits/revenues) distribution, with Q4 being the most productive firms. Panel C reports estimates from the firms in bordering treatment and control states but that are in counties more than 30 miles from the border.

E. Cournot Competition with Heterogeneity and Firm Exit

Section 5 discusses a model of Cournot competition when firms have heterogeneous technology and a fixed production cost so that cost shocks can induce firm exit. Here we present a simple version of such a model using a linear inverse demand function to highlight the key comparative statics. While linear demand is a special case, it is useful because i) it provides closed-form solutions that illustrate of the key implications of the model and a simple example of how the introduction of heterogeneity and firm exit coincide with the empirical results, and ii) it retains a key feature for analyzing changes in market shares as in equation (2), the elasticity of demand changes as market quantity changes.

E.1. Set-up

Assume there are two types of firms differentiated by their productivity – a high productivity type with low, but constant, marginal costs of production c_h and a low productivity type with high marginal costs of production, c_l. Assume there are m high type firms and n low type firms. Each firm in the market chooses quantities, q_j, $j \in \{h, l\}$, to maximize profits, taking other firms' outputs as given:

$$\pi_j = P(Q)q_j - c_j q_j - F \tag{E.2}$$

Subscripts $j \in \{h, l\}$ index high and low productivity firms, P(Q) is a common price which is a function of market quantity Q, and F is a fixed production cost.

Assume the price is determined by a linear inverse demand function

$$P = A - bQ$$

Since all firms of a given type are identical they will have identical strategies, so total market quantity $Q = mq_h + nq_l$ and we can analyze the problem from the perspective of each of the two types of firms.

Each firm of each type chooses quantities to maximize profits:

$$\text{High productivity: } \max_{q_j} \pi_j = (A - b(mq_h + nq_l))q_j - c_h q_j - F$$

$$\text{Low productivity: } \max_{q_j} \pi_j = (A - b(mq_h + nq_l))q_j - c_l q_j - F$$

The resulting best response functions are given by:

$$\text{High productivity: } q_h = \frac{A - b((m-1)q_h + nq_l) - c_h}{2b}$$

$$\text{Low productivity: } q_l = \frac{A - b(mq_h + (n-1)q_l) - c_l}{2b}$$

Imposing symmetry within each type gives:

$$q_h = \frac{A - c_h}{(m+1)b} - \frac{n}{(m+1)}q_l$$

$$q_l = \frac{A - c_l}{(n+1)b} - \frac{m}{(n+1)}q_h$$

Substitution then gives the optimal quantities for each firm of type:

$$\begin{aligned} q_h^* &= \frac{A + nc_l - (n+1)c_h}{(m+n+1)b} \\ q_l^* &= \frac{A + mc_h - (m+1)c_l}{(m+n+1)b} \end{aligned} \tag{E.3}$$

Therefore total market quantity and price are given by

$$Q = \frac{(n+m)A - mc_h - nc_l}{(m+n+1)b} \tag{E.4}$$

$$P = \frac{a + mc_h + nc_l}{m+n+1} \tag{E.5}$$

and profits for each firm of each type is:

$$\begin{aligned}\pi_h &= \frac{(A + nc_l - (n+1)c_h)^2}{(m+n+1)^2 b} \\ \pi_l &= \frac{(A + mc_h - (m+1)c_l)^2}{(m+n+1)^2 b}\end{aligned} \tag{E.6}$$

Finally, market share for a firms of each type is given by:

$$\begin{aligned}s_{j,h} &= \frac{q_h}{Q} = \frac{A + nc_l - (n+1)c_h}{(n+m)A - nc_l - mc_h} \\ s_{j,l} &= \frac{q_l}{Q} = \frac{A + mc_h - (m+1)c_l}{(n+m)A - nc_l - mc_h}\end{aligned} \tag{E.7}$$

E.2. Comparative statics

Given the simple profit and quantity functions, we can examine the comparative statics with respect to own and other type costs and with respect to number of firms of each type in the market to explore the implications of the cost shock. First, it is clear from Equations (E.3) and (E.6) increases in own costs decrease quantity and profits, but increases in the other type's costs increase own profits and quantity. From Equations (E.4) and (E.5), any increases in cost decrease market quantity and increase market price.

Case 1: Heterogeneous costs, but no exit

First, we will assume no exit in response to the cost shock to show potential reallocation responses without closures. We will represent the cost shock for high and low productivity firms as additional marginal costs, e_h and e_l, respectively. To start, we see that there is a reallocation of market shares toward the high productivity firm when the cost shock is identical across types (for example, if both types hire the same amount of minimum wage labor, but use that labor differentially productively to produce a unit of output), or $e_h = e_l = e$. Assume $n = m$ for simplicity[55]; then market shares for each type are,

[55] Note, if there were a continuum of firms, each firm is its own type and there would just be many more specific competitor costs in the numerators of the quantity, price and profits equations.

$$
\begin{aligned}
s_{j,h}^{\bar{w}} &= \frac{q_h^{\bar{w}}}{Q^{\bar{w}}} = \frac{A + nc_l - (n+1)c_h - e}{(n+m)A - nc_l - nc_h - 2ne} \\
s_{j,l}^{\bar{w}} &= \frac{q_l^{\bar{w}}}{Q^{\bar{w}}} = \frac{A + nc_h - (n+1)c_l - e}{(n+m)A - nc_l - nc_h - 2ne}
\end{aligned}
\tag{E.8}
$$

where the $\bar{w}$ superscript denotes the post cost shock (minimum wage increase) value. Since the pre-cost shock share was higher for the high productivity firm (i.e. $A + nc_l - (n+1)c_h > A + nc_h - (n+1)c_l$), a equivalent shift in the numerator, $-e$, results in an increase in the market shares of the high productivity firm and a decrease in the market shares of the low productivity firms.

Next, if there are asymmetric costs shocks across types, the cost shocks can increase profits and quantities for the less shocked firm. Suppose low productivity firms experience a larger cost shock than high productivity firms, or $e_l > e_h$. The resulting quantity for a high productivity firm is:

$$
q_h^{\bar{w}} = \frac{A + n(c_l + e_l) - (n+1)(c_h + e_h)}{(m+n+1)b} \tag{E.9}
$$

so the change in quantity as a result of the shocks is:

$$
\Delta q_h^{\bar{w}} = \frac{ne_l - (n+1)e_h}{(m+n+1)b}
$$

which is positive if

$$
e_l > \frac{n+1}{n} e_h.
$$

This is the same relationship needed for profits to increase for high productivity firm as well. So, if there is a sufficient differential in costs shocks, average quantities and profits can increase for the firms with the smaller relative shocks even in the absence of exit. Additionally, note that the relative costs do not show-up in this inequality, so this would also be true under homogeneous ex-ante productivity or if the high productivity firms experienced a larger cost shock.

Case 2: Firm exit

First, we consider the effect of firm exit on average quantities and profits *with no cost shocks.* This can be done with a simple partial derivative for average quantities and profits with respect to n. Using the high productivity firm as an example, we see:

$$\frac{\partial q_h^*}{\partial n} = \frac{\partial q_l^*}{\partial n} = \frac{(m+1)c_l - mc_h - A}{(m+n+1)^2 b} < 0 \tag{E.10}$$

implying that a decrease in the number of firms will increase average quantities, though total quantity will decrease:

$$\frac{\partial Q}{\partial n} = \frac{A + mc_h - (m+1)c_l}{(m+n+1)^2 b} > 0.$$

Average profits will also increase:

$$\frac{\partial \pi_h}{\partial n} = 2\frac{A + nc_l - (n+1)c_h}{n+m+1} \times \frac{(m+1)c_l - mc_h - A}{(n+m+1)^2} < 0$$

as the first term is positive and the second is negative.

Next, we consider the case when firms exit as a result of the cost increase. Again, let e_j represent the marginal cost increase for type j and let d represent the number of low type firms that exit as a result of the cost shock increase.[56] Total quantity will clearly decrease, but average quantity and profits for surviving firms can increase, and they increase by more when i) there is selection on *ex ante* productivity (the lowest *ex ante* productive firms exit), and ii) there is selection on exposure (the firms with the highest cost shocks exit). Additionally, this market quantity is reduced the least when the lowest *ex ante* productivity firms exit. This is easiest to see by assessing the change in total quantity:

[56] For these comparative static exercise, we assume the *ex ante* low productivity firms exit because that is what we observe in the data. Since the problem is symmetric, it is easy to do the same analysis assuming the high type firms exit.

$$Q^{\bar{w}} = \frac{(n+m-d)A - m(c_h + e_h) - (n-d)(c_l + e_l)}{(m+n-d+1)b}$$

Assuming $n = m$ for simplicity, defining $\tilde{Q} = (n+m)A - n(c_h + c_l)$ which is the numerator for the pre-shock market quantity function (Eq. (E.4)), and rearranging we get:

$$Q^{\bar{w}} = \frac{\tilde{Q} - dA - n(e_h + e_l) + de_l + dc_l}{(m+n-d+1)b} \tag{E.11}$$

We separately define $\tilde{Q}$ because it is unaffected by the shocks or the distribution of costs between types, so the remainder of the elements inform about the effect of the shock on exits and selection. Equation (E.11) summarizes the elements that matter for the aggregate effect of cost shocks and exits: 1) Larger costs shocks $(e_h + e_l)$ decrease quantities by more; 2) When the shock induces exits among *ex ante* low productivity (high cost) firms, total quantity decreases by less $(+dc_l)$. This is because low productivity firms had smaller *ex ante* market shares. 3) When the firms that experience larger shocks are induced to exit, aggregate quantity decreases by less $(+de_l)$ because the *ex post* less productive firms are exiting.

These relationships map directly to the effect of shock induced exits on average profits and quantities in the market – average profits and quantities increase (by more) when the cost shock is not too large relative to exits; average increases are larger when there is selection on *ex ante* productivity and on the size of the shock. By the structure of the problem, if average quantities increase average profits increase. Average profits increase if

$$\frac{1}{n+m-d} Q^{\bar{w}} > \frac{1}{n+m} Q$$

so the smaller the change in market quantity, the more likely average quantities and profits increase. As shown in Eq. (E.10) more exit increases average quantities, so the left hand side is increasing in d. If those exits are a result of selection on *ex ante* productivity or differential exposure, average profits and quantities are are more likely to increase, or to increase by more, as the market is relatively less distorted through reduced market quantity.