Minimum Wage, Employment, and Margins of Adjustment: Evidence from Employer–Employee Matched Panel Data

Jungmin Lee Geumbi Park

Abstract

We decompose the employment effect of the minimum wage into changes in employment within continued establishments and changes due to the exits of establishments. For small-sized establishments, we distinguish between other labor adjustment margins, such as hours worked, hiring, and separation at the individual level. Using employer–employee matched panel data, we show that the magnitude and channels of the employment effect differ by establishment size and industry. We find a negative effect of the minimum wage on employment growth, which is highly concentrated among small establishments. In particular, in the food and lodging and manufacturing industries, a substantial part of the effect is driven by business closing.

JEL Codes: J21, J23, J38, J63

*Jungmin Lee is a Professor of Economics at Seoul National University and a Research Fellow at SIRE and IZA (jmlee90@snu.ac.kr). Geumbi Park is a Ph.D. student in the Department of Economics at Texas A&M University. We are grateful to Taehyun Ahn, Eleanor Jawon Choi, Shuaizhang Feng, Daeil Kim, Jungho Kim, Jun Hyung Kim, and Jinseong Park as well as seminar participants at Jinan University, the AASLE conference, and the WEAI conference for helpful comments and suggestions. Lee's work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2020S1A3A2A02104190). The data used in this paper are confidential, but access to the restricted data could be obtained upon approval from the Ministry of Employment and Labor. Replication materials except the data are available upon request from the authors.

I Introduction

The employment effect of the minimum wage is one of the most controversial topics among policymakers as well as in academia. This topic has been extensively studied, and various models and data types from different countries have been proposed (Card and Krueger 1995; Neumark and Wascher 2008; Belman and Wolfson 2014; Clemens 2019; Dube 2019; Manning 2021; Neumark and Shirley 2022). This study contributes to the vast literature by analyzing the channels of gross job flows—hiring, layoff, work-hour adjustment, and business closing. An assessment of job flows in different channels can highlight the nature of firms and how labor markets adjust to labor cost shocks. If firms are financially weak or technically constrained in adjusting their labor use, as the putty-clay model suggests (Johansen 1959; Sorkin 2015; Aaronson et al. 2018), minimum wage increases might push least-productive firms out of the market. Studying changes in job flows can also reveal additional implications for the minimum wage policy. For example, if minimum wage increases discourage firms from hiring new workers, younger workers will lose more than older workers. Minimum wages can impact job opportunities and earnings differentially across workers.

This study uses administrative payroll data from South Korea (hereafter, Korea). The data cover a representative sample of establishments with five or more employees. For the purpose of this study, the data have four major advantages. First, they are the employer–employee matched data providing information on employees within establishments, a random sample of employees for larger establishments, and *all* employees for small establishments with fewer than 30 employees, which informs us of wage distribution within establishments. Second, the data include payroll records from individual establishments; thus, the hours worked and the earnings are accurately reported. This enables us to quantify the impact of the minimum wage at the establishment level—the exact extent to which each establishment is affected by a minimum wage increase, referred to as *the minimum wage bite*. Third, the data are longitudinal at the establishment level. This allows us to analyze not only employment dynamics within establishments but also firm dynamics—that is, the survivals and deaths of establishments. Such information is crucial, especially among small establishments where the firm turnover rate is high. Lastly, for small establishments, we can fol-

low individual employees within establishments over the years. The employer–employee matched panel data enable us to decompose the total effect of the minimum wage into job flows along various margins. This can yield a richer picture of how firms respond to a cost shock from a minimum wage increase.

A common econometric challenge in the minimum wage literature is identifying the causal effect of the minimum wage by separating it from various confounding effects, such as the effects of business cycles or, at the individual level, unobservable characteristics of directly affected workers—those who are paid at the current minimum wage or slightly above and, thus, would be affected by a minimum wage increase, often referred to as *bound workers*. This study uses the differential impacts of a national minimum wage increase across establishments; some establishments are expected to be affected more than others. The impact of the minimum wage can differ across establishments, jointly depending on the pre-treatment wage distribution and the minimum wage growth rate.

Using the payroll records of each establishment, we construct a measure of the establishment-specific minimum wage bite, called *the establishment wage gap*, following Machin, Manning, and Rahman (2003).[1] This measure represents the relative increase in labor costs to the current wage bill necessary to maintain the current employees and their work hours while complying with the new minimum wage. The same measure or its modified versions have been used in the literature (Draca, Machin, and Van Reenen 2011; Giuliano 2013; Hirsch, Kaufman, and Zelenska 2015; Harasztosi and Lindner 2019; Jardim and van Inwegen 2019). The variable in our data provides sufficient variation in the minimum wage impact across establishments.

To ensure that our measure of the minimum wage bite picks up only the effect of the minimum wage, in our regression analysis, we control for a set of potential confounding variables: the shares of non-bound low-wage workers in different ranges and the fraction of sub-minimum wage workers who are paid below the current minimum wage. These variables are correlated with our measure of

[1]For small establishments with fewer than 30 employees, the data cover all employees within establishments. In other words, we have complete information on the establishments' payroll records.

the minimum wage bite but do not necessarily reflect the minimum wage effect.[2] We also validate the robustness of our results to using the fraction of bound workers as an alternative measure of the minimum wage bite. Lastly, we conduct a placebo test. During our sample period, only in 2010 did the minimum wage increase nominally, although it actually decreased in real terms. This provides us with an opportunity to conduct a placebo test. In particular, we estimate the effect of the minimum wage year by year and confirm that there was no real impact of the minimum wage in 2010, as predicted theoretically.

The main contribution of our paper is that we estimate the employment effect of the minimum wage and decompose it into changes in employment within continuing establishments and those from the exits of establishments. For small establishments, we further decompose the change in employment into the various margins within continuing firms and quantify the relative contribution of each subchannel, such as the adjustment of hours worked, separations, and hiring. Although small establishments are presumably most severely affected by a minimum wage increase, there is little empirical evidence on this specific group.[3] This is because most studies in the minimum wage literature have used individual-level data rather than establishment-level data. Data that not only cover a representative sample of small establishments that spread across multiple industries but also allow for a full-scale decomposition similar to that used in the present paper are scant. This is a major gap in the literature, given that the magnitude and channels of the employment effect should differ according to establishment size as well as industry.

A few studies have used establishment-level data either for sharper identification or to examine the employment effect of the minimum wage from the viewpoint of firm dynamics. Machin and Wilson (2004) collected data on individual care homes in the United Kingdom and examined the effect of the minimum wage on individual facility closure. Draca, Machin, and Van Reenen (2011) also used UK data to estimate the effects of the minimum wage on the exits of firms and industry-

[2]There might be an indirect effect of the minimum wage on low-wage workers who are paid slightly above the new minimum wage. One possible channel is a spillover effect, which we examine in Online Appendix A.

[3]Dustmann et al. (2022) found the reallocation of workers from smaller to larger firms as the mechanism by which the labor market absorbs wage increases induced by the minimum wage. They showed that after the introduction of the minimum wage in Germany, the number and share of small businesses declined in regions more exposed to the minimum wage.

level entry rates. Some recent studies have used larger employer–employee matched data. The study of Jardim and van Inwegen (2019) is the closest to the current study. Using administrative data on payroll records and business revenue, they examined the effects on businesses at both extensive and intensive margins. They found that the two margins are equally important, while there is little evidence of a price pass-through effect on consumers. Portugal and Cardoso (2006) used employer–employee matched panel data from Portugal and, similar to our study, presented decomposition results on separation, hiring, firm entry, and firm exit. However, their study was limited in that the variation in the minimum wage in their sample arose among teenagers aged 17–19.

Gopalan et al. (2021) used payroll data from more than 2,470 establishments in the United States. These data are advantageous for studying the minimum wage because they contain exact hourly wage rates. However, the data mostly comprise large firms; the average number of employees per establishment is 1,784, and the median is 204. Luca and Luca (2019) used Yelp data to examine the impact of the minimum wage on restaurant exits. Although the establishments in their sample were relatively small, they were limited to a single industry. Giuliano (2013) examined the impact of the federal minimum wage on the individual stores of a large retailer across the United States. Although the establishments were more comparable to each other, the data were also limited to a single industry. The data did not contain information on individual employees' hours worked. Moreover, there were too few store closings to allow for meaningful analysis. Harasztosi and Lindner (2019) studied the incidence of the minimum wage burden and restricted the main sample to firms that survived.

To preview our main findings, we find that the employment effect of the minimum wage is negative and statistically significant. The point estimate from our baseline model indicates that the average growth of the minimum wage decreases the employment growth rate by approximately 0.5 percentage points among bound establishments where at least one employee is bound by the new minimum wage. The implied employment elasticity with respect to the minimum wage is approximately -0.1, which is slightly larger in absolute terms than the average of the estimates

that Belman and Wolfson (2014) collected for meta-analysis.[4] However, we find that both the magnitude and channels of the employment effect differ by establishment size and industry. This effect is highly concentrated among small establishments. The elasticity for small and bound establishments is -0.57. The effect on larger establishments with 30 or more employees is small and statistically insignificant. Decomposing the total effect along different margins of adjustment, we find that a considerable part of the effect for small establishments is driven by business closings, especially those in the food and lodging (F&L) and manufacturing industries. The presence of substantial heterogeneity suggests that the effect of the minimum wage varies across time and space, depending on factors such as firm size distribution and industrial structure.

The remainder of this paper is organized as follows. Section II introduces the institutional background of the minimum wage in Korea. Section III introduces our data and the construction of employer–employee matched panel data. Section IV presents the impact of the minimum wage on employment and wage growth. Section V presents the results of decomposition into various margins of adjustment and heterogeneity by establishment size and industry. Section VI discusses the implications of our findings and their caveats.

II Institutional Background

In Korea, the minimum wage is set as a single rate at the national level and applied to all workers regardless of industry, region, or nationality.[5] The government enacted the Minimum Wage Act in December 1986, and the first national minimum wage came into effect on January 1, 1988. The minimum wage is determined by the Minimum Wage Council, which comprises 27 members: 9 members from the employee side (the Korean Federation of Trade Unions or other labor union organizations), 9 from the employer side (the Korea Employers Federation or other employer organizations), and 9 from the public interest group (mostly university professors and researchers in

[4]The implied elasticity of employment for all establishments with respect to the minimum wage is -0.02, which is in the range of modest effects in Belman and Wolfson (2014).

[5]Only a few minor exemptions exist. For example, trainees and interns are exempted from minimum wages under certain conditions. In the first year of enactment, there were two minimum wages by industry.

research institutes appointed by the government). Negotiations performed within the Council are usually not smooth, as the two sides of labor and employer confront each other fiercely.

The minimum wage is revised every year. Upon the request of the minister of the Ministry of Employment and Labor (MOEL) around March, the Council starts to hold regular meetings. They are expected to decide on the following year's minimum wage no later than August 5, which starts to take effect on January 1 of the following year.[6] Figure 1 shows the trends in minimum wages from 2004 to 2018, four years before the start of our sample and five years after its end. The minimum wages in both nominal and real terms increased during our sample period. One exception is 2010, when the nominal value of the minimum wage increased while its real value decreased. We utilize this event to conduct a placebo test to validate our empirical strategy by confirming that the effect of the nominal minimum wage increase in 2010 is not significant.

Figure 1 compares the trends of minimum wages and average monthly earnings of wage earners (both are normalized to 100 in 2004). From 2004 to 2018, minimum wages tripled, whereas average monthly earnings increased by approximately 66%. The fact that minimum wages grew faster than average earnings suggests that the minimum wage increases should bite the lower tail of the wage distribution to a certain extent.

The two trends in Figure 1 are not independent. The increases in the average monthly earnings could have been partly driven by increases in the minimum wage. Effective minimum wages not only push up the wages in the lower tail of the wage distribution but might also shift the whole distribution to the right. The wage effect of the minimum wage can extend beyond the effect on directly affected employees—a spillover effect over employees paid above the minimum wage. Previous studies have found that minimum wage increases affect not only the employees directly affected by the increases but also those who are currently paid higher than bound employees (Lee 1999; Neumark, Schweitzer, and Wascher 2004; Autor, Manning, and Smith 2016; Gopalan et al. 2021). The spillover effect can be substantial if firms have a hierarchical compensation structure

[6]The deadline is not strictly enforced. Further, during the period from 1994 to 2006, the minimum wage was set and fixed from September to August of the following year. Since 2007, a year's minimum wage has been effective from January 1 to December 31.

(where some wage differences between ranks of workers should be maintained) or if firms accommodate their employees' relative pay concerns (Breza, Kaur, and Shamdasani 2018; Dube, Giuliano, and Leonard 2019). This suggests that even a modest increase in the minimum wage can result in a significant employment effect.[7]

Lastly, firms might predict the next year's minimum wage and start their employment adjustments in advance. However, this is less concerning, since the next year's minimum wage is announced in July or August, whereas our data include the payroll records of June. In addition, theoretically, unless adjustment costs are substantial, firms might not have a strong incentive to respond to the new minimum wage, which will be realized 6 months later. Furthermore, since the negotiation process within the Council is uncertain, the exact amount of the new minimum wage is usually difficult to predict until the last moment. Nevertheless, both firms and employees can predict a minimum wage increase based on the government's political agenda, economic conditions, and social moods. In this case, the anticipation effect of the new minimum wage can be realized as early as June, the extent to which our estimates would be attenuated.

III Employer–Employee Matched Panel Data

The main contribution of our study to the already vast literature on the minimum wage originates from using unique data that follow establishments over time and providing detailed payroll records for employees within establishments. The data source is the Basic Survey of Wage Structure (BSWS), which has been conducted annually by the MOEL since 1968. In 1999, the survey's coverage was extended from establishments with 10 or more workers to those with five or more workers. We use the data from 2008 to 2013 with the information on establishment identifiers, so our sample misses microenterprises with fewer than five employees.[8] Within the sample period,

[7] We check the presence of the spillover effect in Online Appendix A and find that minimum wage increases affect approximately 67% of non-bound employees in small-sized bound establishments. This suggests that the actual impact of an increase in the minimum wage on total labor costs would be much larger than the direct impact on bound employees.

[8] This data limitation is important because low-wage workers are likely concentrated in these extremely small establishments with fewer than 5 employees. In this regard, our estimates should not be generalized to the effects on

our data include approximately 17,000 establishments and 0.7 million employees per year.

The BSWS is a panel survey that replaces the whole sample every three years. The sample we use in this study spans 2008 to 2013 (the years when establishment identifiers are available), comprising two three-year panels—one from 2008 to 2010 and the other from 2011 to 2013. Although some establishments might be included in both panels, we do not have unique identifiers that can link them between 2010 and 2011. Therefore, our dataset comprises two independent three-year panels.[9] The BSWS sample is constructed with a two-stage stratified sampling method. In the first stage, a nationally representative sample of establishments is selected from the population of the Economic Census. In the second stage, a random sample of employees is chosen within each selected establishment, and their payroll records are collected. The employee sampling rate varies by establishment size. During our sample period, the rate is 100% for establishments with fewer than 30 employees; that is, all employees are included in the data.[10]

For this reason, we begin by estimating the employment effect for all-sized establishments. However, for detailed decomposition, we focus on small establishments with fewer than 30 employees to construct panel data that follow not only establishments but also individual employees. The whole sample covering all establishments includes 67,418 establishment-year observations and 2,680,124 individual employee-year observations.[11] The sample of small establishments comprises 42,284 establishment-year observations and 478,794 employee-year observations.

The panel structure of the BSWS allows us to examine how establishments adjust employment along different margins. They might reduce the number of hours worked among existing employees or lay off some of them. An extreme response is business closing. This business closing channel is presumably important in our data because we focus on small establishments, and their

the entire labor market.

[9]Our sample period includes the period of the Great Recession. However, this is not a major problem. First, the Korean labor market was not significantly affected by the Great Recession (Lee 2020). Second, we divide our sample into two panel periods and find that our main results are consistent between the two subsamples.

[10]For regular workers, the sampling rates are 80% for establishments with 30–99 employees, 50% for those with 100–299 employees, 33% for those with 300–499 employees, 20% for those with 1,000–4,999 employees, and 10% for those with 5,000 or more employees. For irregular workers, the sampling rate similarly decreases in establishment size.

[11]We use employment growth between two consecutive years as the outcome variable.

closing rates are quite high. However, we do not have a direct indicator for business closing in our data. Thus, we use a data-driven and operational definition. We assume that the establishments that dropped in the second or third year of the three-year panel data have gone out of business. This assumption is not arbitrary. According to MOEL's report, business closing is mentioned as the sole reason for sample attrition (MOEL 2017). Furthermore, this assumption seems to be empirically supported. Applying our definition, we find that the business closing rate in our sample is 11.6%. This turns out to be close to national statistics. According to the Economic Census, which covers all establishments, the average exit rate is 13% for the same period as our sample.[12]

Using establishment-level panel data, we can decompose the total change in employment into changes within continuing establishments and those from business closings. For small establishments, the data cover all employees within establishments, so we can decompose them into changes by continuing employees' hours worked and individual-level exit-margin job flows because of hiring and separation. We match individuals across years within establishments by using the individual characteristics available in the data, such as unique establishment identifiers, industry code, and employees' time-invariant observable characteristics (i.e., gender, birth year, and the year and month of hiring). We believe that matching should be near perfect, given that there are only a few employees per establishment (29 at maximum), and we use a good set of matching variables. If we cannot find a matched observation in year t for an employee observed in year $(t-1)$, we assume that they quit or are laid off.

Our dataset is longitudinal at the establishment level rather than at the individual level, so following individuals after they separate from their original establishments is not possible. Thus, separations in our data do not mean unemployment; individuals might get new jobs in other establishments within or outside our sample. However, our operational definition seems reasonable. The one-year separation rate (i.e., the probability at which an employee is observed in year $(t-1)$ but

[12]The BSWS does not follow those that have fewer than five employees. There are only a few such establishments in our data, so we drop those establishments that have ever been fewer than five employees. To gauge any bias resulting from this problem, we check the robustness of our results by restricting the sample to those with at least 10 employees. The idea is that, if any, misclassification errors should be smaller for establishments with 10 or more employees, since they are less likely to reduce employment by more than 50%. The results do not change and are presented in Online Appendix B.4.

not observed in year t) is 60% in our sample. This is close to the national statistics obtained from the Unemployment Insurance database: 58.8% for establishments with fewer than 10 employees and 57.9% for those with 10–49 employees (Kim 2017).

Lastly, our data are obtained from the payroll records of establishments. Thus, earnings and hours worked are less likely to have measurement errors. This is a substantial advantage for the purposes of our study. In particular, the payroll records contain information on earnings (regular and overtime payments) and hours worked (regular and overtime hours) in June of each survey year. Regular wages include basic wages and fringe benefits paid on a monthly basis (excluding the annual bonus). We define the hourly wage rate as the regular wages divided by the regular work hours. This is close to the definition of the hourly wage rate in minimum wage laws. According to these laws, irregular bonuses and most fringe benefits are not included in earnings, and overtime hours are not counted.

IV Impacts on Wage and Employment Growth

We use establishment-level data to estimate the effects of the minimum wage on wage and employment growth. As mentioned earlier, we use the establishment wage gap as our main measure of the minimum wage bite at the establishment level, which we formally define as follows. Suppose that there are n_{jt-1} employees in establishment j in year $(t-1)$. We denote the hourly wage rate of employee i by w_{ijt-1} and his/her work hours by h_{ijt-1}. Suppose that the minimum wage increases: $MW_t > MW_{t-1}$. Thus, bound employees are those whose wage rates, w_{ijt-1}, are greater than or equal to MW_{t-1} but lower than MW_t.[13] They are directly affected by the minimum wage increase.

Individual bound employees are differentially affected, and the magnitude of the impact is proportionate to the distance between the current wage and the new minimum wage. For each

[13]The definition of the wage gap assumes that those below the current minimum wage are not subject to the new minimum wage either. We might drop the workers paid below the current minimum wage and re-define the wage gap. by including all workers below the next year's minimum wage, or control for the share of below-MW workers in the regression analysis. Our main results are robust to alternative ways of handling below-MW workers.

employee, the difference multiplied by work hours is defined as the wage gap:

$$gap_{ijt-1} = \begin{cases} (MW_t - w_{ijt-1}) \times h_{ijt-1} & \text{if } \ MW_{t-1} \leq w_{ijt-1} < MW_t \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

The wage gap (gap_{ijt-1}) represents the least amount of wage increase necessary to keep hiring the bound employee for the same hours while complying with the new minimum wage. Aggregating all bound employees' wage gaps in the establishment and dividing the sum by the establishment's total wage bill, we define the establishment wage gap as a percentage as follows:

$$Gap_{jt-1} = \frac{\sum_{i \in j} gap_{ijt-1}}{\sum_{i \in j} w_{ijt-1} h_{ijt-1}} \times 100 \tag{2}$$

The continuous variable is similar to the treatment intensity variable in the treatment effect literature, showing whether the establishment is affected by the minimum wage's increase and the magnitude of the impact. As an alternative measure of the minimum wage bite, we use the fraction of bound employees, which is defined as follows:

$$Fraction_{jt-1} = \frac{\sum_{i \in j} \mathbb{1}[MW_{t-1} \leq w_{ijt-1} < MW_t]}{n_{jt-1}} \tag{3}$$

This alternative measure, varying between 0 and 1, is more straightforward than the establishment wage gap. However, it is disadvantageous in that it ignores more granular variation, depending on the level of wages before the minimum wage increase. Although our preferred measure is the establishment wage gap, we present both results using the two measures for the robustness of our findings.[14]

Table 1 presents the summary statistics of establishment-level characteristics.[15] First, we

[14] Another alternative measure is to distinguish bound and non-bound establishments discretely according to whether they have at least one employee directly affected by the new minimum wage. This binary distinction is simple and clear but loses considerable variation in the impact of the minimum wage across establishments and over years. We check the robustness of our results using this alternative measure of the minimum wage impact.

[15] To compute the summary statistics, we use the number of observations in the employee sample before aggregating at the establishment level as the weight. There are two exceptions: FTE jobs and the number of employees. For these

present the statistics for the whole sample and then those for the two subsamples divided by establishment size: the sample of small establishments with 5 to 29 employees and that of larger establishments with 30 or more employees. Each subsample is further divided by whether any employee is bound by the minimum wage increase (bound versus non-bound establishments)—that is, whether Gap_{jt-1} is greater than zero (or equivalently, $Fraction_{jt-1} > 0$). In the whole sample, approximately 8.6% of the establishments are bound. The share of bound establishments is slightly lower among small establishments (6.5%). This does not mean that the minimum wage's impact is smaller for small establishments. By contrast, among small establishments, 16% of the employees are bound by the minimum wage increases during the sample period, while 4.4% are bound within larger bound establishments. The establishment wage gap is small: 0.3% of the wage bill for small establishments and 0.1% for larger ones.[16] However, there are many sub-minimum wage employees who are paid below the current minimum wage. In all establishments, sub-minimum-wage employees account for 8% of workers and 12% in small establishments. This is partly because of measurement errors and partly because of non-compliance with the minimum wage law. Alternatively, some of them might be exempted workers, such as trainees or interns.

The comparisons between bound and non-bound establishments in Table 1 reveal that bound establishments differ from non-bound ones in terms of many observable characteristics. Across establishment sizes, bound establishments tend to be larger than non-bound ones in terms of both the number of employees and full-time equivalent (FTE) jobs. We define an FTE job as a job of 40 hours per week. To count the number of FTE jobs in an establishment, we add the work hours of all employees in the establishment and divide the total by 40. A larger gap in terms of FTE jobs than the head count of employees implies that employees in bound establishments have longer work hours than those in non-bound establishments. We find that employees in bound establishments work longer than those in non-bound ones.

In addition, employees in bound establishments are older, and the share of females is slightly

variables, we compute the simple unweighted average.

[16]The minimum wage impact measure is a proxy variable for the actual shock of the minimum wage because a spillover effect occurs on non-bound employees. We present the results on the spillover effect in Online Appendix A.

higher. Bound establishments have significantly fewer college-educated employees. The average tenure is shorter in bound establishments. The rate of employment growth, which we define below more formally, is lower in bound establishments; however, bound establishments are slightly less likely to close down than non-bound ones. Overall, the employment size decreases in our sample. This is probably because we do not account for job creation by new firm entries. We check whether this missing data problem is critical by estimating the effect of the minimum wage on the firm entry rate (Online Appendix B.1). In addition, the employment growth rate in Panel B is slightly misleading since it includes closing establishments whose employment growth rate is -200%. Thus, in Panel C, we restrict the sample to continuing establishments. We still find that the employment growth rate is lower in bound establishments. By contrast, the wage growth rate is higher in bound establishments. The summary statistics show that employment growth is lower in bound establishments, which indicates a negative effect of the minimum wage on employment. We confirm this finding in a regression analysis by estimating the following equation:

$$\Delta E_{jt} = \beta_{Total} \cdot Gap_{jt-1} + X_{jt-1}\gamma + \delta_t + \epsilon_{jt} \tag{4}$$

where ΔE_{jt} is the proportionate change in the FTE employment of establishment j from year $(t-1)$ to t.[17] X_{jt-1} includes a set of control variables. δ_t is the year fixed effect, absorbing any common trends of the outcome variable, and ϵ_{jt} is the standard error term. We cluster observations by establishment and compute robust standard errors. We estimate the model in (4) by using the number of observations in the employee sample before aggregating the establishment sample as regression weights. The dependent variable is defined as follows:

$$\Delta E_{jt} = \frac{E_{jt} - E_{jt-1}}{(E_{jt} + E_{jt-1})/2} = \frac{E_{jt} - E_{jt-1}}{\bar{E}_{jt,t-1}} \tag{5}$$

[17] We use the employment growth rate as the dependent variable because we are interested in decomposing the employment effect to gross job flows in the context of the firm dynamics literature. Previous studies have found that the employment effect of the minimum wage is detectable in job flows rather than in employment level (Meer and West 2016). Dube, Lester, and Reich (2016) found a significant fall in employment flow for teens in the United States, whereas there is no significant change in the stock of employment. They found a substantial decline in new hiring as well as a significant drop in separation and turnover.

where E_{jt} is the FTE employment of establishment j in year t. The specification is advantageous for incorporating the employment change because of business closing, in which case we impute 0 to E_{jt}.

Vector X_{jt-1} includes a set of establishment-level pre-treatment characteristics in year $(t-1)$ before the next year's minimum wage is announced—the share of male employees, mean age, mean age squared, mean tenure, mean tenure squared, share of union employees, and share of college-educated employees. By controlling for these variables, we address the differences in observables between bound and non-bound establishments observed in the summary statistics, although our dependent variable is the growth rate. Thus, all establishment-specific time-invariant observables and unobservables should be differenced out.[18]

It is plausible to presume that our measure of the minimum wage bite captures the effect of low-wage workers rather than that of bound workers, given that bound workers are from a lower part of the wage distribution. To address this concern, we control for the variables that represent the shares of low-wage employees who are not bound employees but are slightly above them. In particular, we construct three variables: the wage share of employees between MW_t (the next year's minimum wage) and $MW_t + 500$, that between $MW_t + 500$ and $MW_t + 1000$, and that between $MW_t + 1000$ and $MW_t + 1500$. They are chosen somewhat arbitrarily but considering that the minimum wage increased by 1,090 (KRW) during the sample period.

Whereas non-bound low-wage workers are paid above the next year's minimum wage, low-wage workers are paid even below the current minimum wage—sub-minimum wage workers. Table 1 shows that the share of sub-minimum wage workers is large (i.e., 12% in small establishments). This is as large as the share of bound workers. Therefore, instead of ignoring them, we control for the fraction of sub-minimum wage workers and estimate its effect separately from that

[18] We try to control for establishment fixed effects and check whether our results hold. The dependent variable is the employment growth rate rather than the level of employment; thus, the fixed effects control for the establishment-specific linear trends in employment. This specification controls for most of the confounding factors that we can imagine. The results show that the size of the effect increases when we control for establishment-specific fixed effects. However, we do not consider the fixed-effect model as our main model because our sample is a short panel, which has three years or two time periods (because we construct the employment growth rate).

of the minimum wage bite.[19]

Panel A of Table 2 presents the results from estimating Equation (4).[20] Column 1 presents the results for the whole sample. We find that a one percentage point increase in the establishment wage gap decreases the employment growth rate by 4.2 percentage points. The sample mean employment for bound establishments is 168, and the mean establishment wage gap is 0.12. Thus, the estimate implies that the average increase in the minimum wage reduces the number of jobs by approximately 0.8 per establishment. The average annual minimum wage growth rate is 5.2% during the sample period. Therefore, the implied elasticity of employment with respect to the minimum wage is -0.1 for bound establishments. This can be interpreted as the treatment effect on the treated. For all establishments, including non-bound establishments, the elasticity is as small as -0.02. This conceptually corresponds to the average treatment effect.

Next, columns 2 and 3 present the results for small and larger establishments, respectively. We find that the employment effect of the minimum wage differs by establishment size. In particular, the effect is concentrated among small establishments. For small establishments, the elasticity of employment with respect to the minimum wage is -0.57 for bound establishments and -0.04 after including non-bound ones. By contrast, for larger establishments, the employment effect is small and not statistically significant.

Although our data cannot identify individual employees in larger establishments, our results across establishment sizes together suggest that, after a minimum wage increase, larger firms grew relative to small ones, and labor reallocation from small to larger establishments occurred in Korea, consistent with Dustmann et al. (2022). However, Dustmann et al. (2022) found that in Germany, the employment growth of larger firms was positive and large enough to offset the reduction in employment in small firms. This did not occur in Korea. There are many reasons why the results differ between the two countries. For example, Dustmann et al. (2022) estimated the effect of the minimum wage when it was first introduced in the country, while minimum wages in Korea have

[19]The results without these additional variables or without any control variables are presented in Online Appendix B.3.

[20]The full results are presented in Online Appendix C.

increased steadily over the years during the sample period. Moreover, labor market institutions and industrial structures are obviously very different between the two countries. One important message we can learn here is that workers' reallocation after a minimum wage increase does not always cancel out the negative effect on employment in the vulnerable sector, and the overall effect of the minimum wage depends upon labor market conditions and institutions.

The key identification assumption for our estimation is that our measure of the minimum wage bite—the establishment wage gap or the fraction of bound employees—is uncorrelated with the unobservable determinants of employment growth. As one way of checking the assumption, we evaluate the robustness of our results by applying the bounding estimator proposed by Altonji, Elder, and Taber (2005) (hereafter, AET). To do so, for each specification, we calculate a bound following Oster (2019); first, the relative degree of selection on observables and unobservables is one and, second, the R squared obtained from the regression with the full set of observables and unobservables is a minimum of one and 2.2 times the R squared obtained from the regression with observables only. The results, presented in brackets, show that the bounds exclude zero for small establishments in column 2. The bias-adjusted estimate forms the upper bound. In addition, the bounds are quite tight and close to our previous estimates.

Panel A.2 presents the impact of the minimum wage on wage growth. The dependent variable, the wage growth rate of each establishment, is similarly defined as Equation (5). The average wage in the next year of an establishment is not observed if the establishment closes down, so this estimation can be conducted only for the sample of continuing establishments. Thus, this is a selected sample, and we cannot interpret the results as the causal effect of the minimum wage on wage growth. With the caveat in mind, we find that an increase in the minimum wage increases the average wage growth significantly. The estimate in column 1 means that a one percentage point increase in the establishment wage gap increases the average wage growth rate by 8.5 percentage points. When we restrict the sample to small establishments, the effect is slightly larger (i.e., 10.2 percentage points). Given that the average establishment wage gap is 0.33 in small bound establishments, the estimated wage effect is approximately 3.4 percentage points. This is slightly

lower than the average minimum wage growth rate during the sample period. This is not surprising, given that not all employees are affected by the minimum wage. By contrast, the wage effect of the minimum wage is also significant for larger establishments, which is in contrast with the finding that the employment effect is not significant for them. The employment effect is determined by how establishments respond to a minimum wage increase, but an increase in the minimum wage should lead to a positive wage effect as long as establishments comply with the new minimum wage.

As a robustness check, we obtain the results when we use the fraction of bound employees as an alternative variable of the minimum wage bite. The results are presented in Panel B, which are similar to those in Panel A. Evaluated at the average fraction of bound workers within bound establishments, 0.06 as shown in Table 1, the elasticity of employment with respect to the minimum wage is -0.1 (= -0.088 $\times$ 0.06/0.052). This is exactly the same as what we obtained from the estimate in Panel A. In addition, the employment effect is significant and concentrated among small establishments with 5 to 29 employees. In contrast, the estimated effect for larger establishments is close to zero. The results for wage growth in Panel B.2 are also similar to those in Panel A.2.

V Decomposition by Margins of Adjustment

We decompose the total effect we found in the previous section along various margins of labor adjustment. The change in employment from year $(t-1)$ to t can be decomposed into the changes within continuing establishments and from exit of establishments:

$$E_{jt} - E_{jt-1} = \Delta E_{jt}^{Cont} + \Delta E_{jt}^{Ext} = \Delta Hour_{jt} + Hire_{jt} - Separate_{jt} - Exit_{jt} \tag{6}$$

where ΔE_{jt}^{Cont} represents the changes within continuing establishments and ΔE_{jt}^{Ext} by business closing. Decomposition into the two margins can be achieved regardless of establishment size. For small establishments, we can go deeper since we identify all individual employees within establishments. In particular, the ΔE_{jt}^{Cont} can be decomposed into three components of sub-channels:

$\Delta Hour_{jt}$ represents the employment change through the change in continuing employees' work hours, and $Hire_{jt}$ and $Separate_{jt}$ represent the changes in employment through hiring and separation, respectively. They already represent changes in employment; thus, we do not have to consider the difference over time. Finally, since we cannot observe job creation by firm entries due to the limitation of our data, E_{jt}^{Ext} is solely driven by the employment change through establishment exits, $Exit_{jt}$.[21] For example, if an establishment continues to operate, but there is neither new hiring or separation, then $E_{jt} - E_{jt-1} = \Delta Hour_{jt}$, and $\Delta Hour_{jt}$ is the FTE employment change totally driven by changes in continuing employees' work hours. If an establishment exits, $E_{jt} = 0$ and $E_{jt-1} = Exit_{jt}$.

Rearranging the identity in Equation (6) and dividing both sides by the average employment level of year $(t-1)$ and t, $\bar{E}_{jt,t-1}$, we have the following:

$$\frac{E_{jt} - E_{jt-1}}{\bar{E}_{jt,t-1}} = \underbrace{\frac{\Delta Hour_{jt}}{\bar{E}_{jt,t-1}}}_{\substack{\text{Continuing} \\ \text{employees'} \\ \text{work hours}}} + \underbrace{\frac{Hire_{jt}}{\bar{E}_{jt,t-1}}}_{\text{Hiring}} - \underbrace{\frac{Separate_{jt}}{\bar{E}_{jt,t-1}}}_{\text{Separations}} - \underbrace{\frac{Exit_{jt}}{\bar{E}_{jt,t-1}}}_{\substack{\text{Establishments} \\ \text{exits}}} \tag{7}$$

where the left-hand side represents the rate of employment change from year $(t-1)$ to t (i.e., the job growth rate in Equation (5)) as we quantify employment by FTE jobs. If we use this as the dependent variable for Equation (4) and estimate β_{Total}, it is the total employment effect of an increase in the minimum wage. For decomposition, we use the same model as Equation (4) but estimate it repeatedly with the dependent variable replaced with each component on the right-hand side of Equation (7). Then, from each separate regression, we have the coefficient estimates for the establishment wage gap (i.e., β_{Hours}, β_{Hires}, $\beta_{Separate}$, and β_{Exits}). By construction, it holds that $\beta_{Total} = \beta_{Hours} + \beta_{Hires} - \beta_{Separate} - \beta_{Exits}$. Therefore, we can calculate the contribution of the

[21] We cannot examine the job creation channel by new establishments because the data only follow establishments included in the initial year and do not cover new establishments. Even if we have such data, we need a different empirical method from that proposed in the current study to estimate the effect of minimum wage on new entries. This is because our empirical strategy exploits the variation in the minimum wage's impact across establishments, depending on the previous year's wage distribution, which does not exist for new establishments. For the same reason, Harasztosi and Lindner (2019) and Jardim and van Inwegen (2019) analyzed industry-level entry rates rather than establishment-level entries to check the effect of minimum wage on establishment births. We take a similar approach and examine the impact of the minimum wage on new entries. The results are presented in Online Appendix B.1.

change in each margin to the total effect. For example, the contribution of the change in continuing workers' hours worked is $\beta_{Hours}/\beta_{Total}$. The contribution of separation is $-\beta_{Separate}/\beta_{Total}$.

Table 3 shows the results obtained by decomposing the total effect, which can be done regardless of establishment size. Thus, as shown in Table 2, we present the results for the whole sample and those for the two subsamples divided by establishment size. In addition, there are two sets of results in the left and right panels, depending on which measure of the minimum wage bite is used.

The total effects in the first row, which are taken from Table 2 and shown here for reference, are decomposed into margins. Columns 1 and 4 show the results for the whole sample, differing by which measure of the minimum wage bite is used. We find that the estimates in both the continuing firms' margins and firm exit margins are negative, while the change within the continuing establishments accounts for most of the total effect. However, none of the four estimates in columns 1 and 4 are statistically significant. By contrast, columns 2 and 5 indicate that the results are quite different for small establishments. For small establishments, the total effect is not only significant but also a substantial part of the total effect; 54% or 43% in columns 2 or 5 is actually driven by the change by the exits of establishments. This result is not found earlier in our investigation of heterogeneity by establishment size. However, we do not find any significant effect for larger establishments. In columns 3 and 6, we find a negative effect within the continuing firms, but it is not statistically significant. The estimates of the effect on the exit margin are positive.

As explained before, for small establishments, we can decompose further into changes in the hours worked, hiring, and separation. The results are presented in columns 2 and 5. We reverse the signs of $\beta_{Separate}$ and β_{Exits}, so the effects in different margins can add up to the total effect. In column 2, a one percentage point increase in the establishment wage gap decreases the growth of continuing employees' working hours by 1.3 percentage points and reduces employment creation by new hires by 2.6 percentage points. The two channels account for approximately 43% of the total effect. By contrast, the effect induced by separation is relatively small and statistically insignificant. The results are similar in column 5, where we use the fraction of bound workers.[22]

[22] As another robustness check, we restrict the sample to those with 10 to 25 employees and re-estimate the results. The rationale behind this sample restriction is that our main sample of small establishments is a selected one because

Our findings so far corroborate several recent studies that have examined the effect of the minimum wage from the perspective of firm dynamics. The importance of business closing as a major channel of labor adjustment has been established in the literature. Bossler and Gerner (2020) used establishment panel data in Germany and found the introduction of the national minimum wage increased the establishment closing rate among severely affected establishments. Jardim and van Inwegen (2019) also found that decreased employment due to business closings accounted for most of the minimum wage effects in Seattle. Other studies found that marginal firms, which are likely to be small businesses, are unable to adjust their production well in response to a labor cost shock (Luca and Luca 2019; Chava, Oettl, and Singh 2019).[23] Moreover, reduced hiring as a response to the minimum wage increase has been found in previous studies (Brochu and Green 2013; Dube, Lester, and Reich 2016; Gopalan et al. 2021; Bossler and Gerner 2020).

Next, we examine another dimension of heterogeneity that has increasingly been considered in recent literature on the minimum wage: heterogeneity by industry. Based on the previous findings in the literature and considering our sample size, we divide our sample into three subsamples by industry: F&L, manufacturing (Mfg.), and all other service industries pooled together. We are particularly interested in F&L, as most workers in this industry are paid low wages and, thus, are more likely to be directly affected by a minimum wage increase. In addition, the market structure of the F&L industry is highly competitive. The franchise rate is low, and there are many mom-and-pop stores. These small establishments are likely to be marginal in terms of profitability; thus, they are vulnerable even to a small cost shock, such as a minimum wage increase. Table 4 shows that the effect is the largest in F&L. Across all industries, the employment effect is concentrated among small establishments. For small establishments, decomposing the total effect, we find that most of the effect (more than 80%) originates from the business closing margin, regardless of which measure of the minimum wage bite is used. In contrast, for larger establishments, the

it excludes those that shrink below 5 employees or grow above 29 employees. By restricting the sample to those with 10–25 employees, we might reduce the possibility of such bias due to sample selection, while the sample is smaller and more restricted. We find that the results remain the same.

[23] In the context of a developing economy, where market inefficiency might exist, this phenomenon is more prominent; less-productive firms exit the market, and the surviving firms increase their productivity to react to cost shocks (Mayneris, Poncet, and Zhang 2018; Bossavie, Erdoğan, and Makovec 2019).

total employment effect is statistically insignificant and is estimated to be positive. Neither the continuing margin nor the exit margin is statistically significant.

We are also interested in the employment effect of the minimum wage in the manufacturing industry. Some recent studies have found that the effect of the minimum wage is large in the tradable sector because the price pass-through channel that can mitigate the adverse effect on employment is closed (Harasztosi and Lindner 2019; Gopalan et al. 2021). Manufacturing is a representative industry of the tradable sector in Korea. Consistent with prior expectations, the total effect is significant and negative among establishments in manufacturing. As mentioned before, the effect is highly concentrated among small establishments. In addition, similar to F&L, firm exit accounts for the majority of the total effect (i.e., 75%). Again, for larger establishments, we find a negative effect on employment in both margins, but the estimates are statistically insignificant.

However, we find a significant and negative effect only within continuing establishments, especially among small establishments in other service industries (in addition to F&L and Mfg.). For this category of industries, we find no significant effect on the firm exit margin, even among small establishments. Thus, the overall results in Table 4 indicate that the effects of the minimum wage are heterogeneous across industries as well as by establishment size. There may be various reasons for such heterogeneity. Although small establishments are vulnerable to labor cost shocks, their optimal responses should differ depending on technologies, market structure, and institutions. However, it is beyond the scope of this study to explain the sources of heterogeneity.

In Table 4, we also present the results of the detailed decomposition for small establishments. The main channels of labor adjustment within continuing establishments are different across industries, even among small establishments. For the F&L industry, the main channel is the adjustment in hiring new employees. In both specifications in Panels A and B, an increase in the minimum wage decreases the hiring of new employees. For example, a one-percentage point increase in the establishment wage gap decreases the job growth rate due to a reduction in hiring new employees by 1 percentage point. By contrast, there is little effect on the hours worked or separation. The effect on separation is estimated to be positive, although it is not precisely estimated. This might

reflect the fact that the turnover rate of workers reduces as the minimum wage increases, perhaps because the opportunity cost of job search is higher or the arrival rate of better offers is lower (Hirsch, Kaufman, and Zelenska 2015; Dube, Lester, and Reich 2016). Unlike F&L, the channel of adjusting work hours for existing workers plays a significant role in manufacturing and the remaining industries. A reduction in the hiring of new employees is large for manufacturing, but it is not statistically significant.

Finally, we conduct a validity check to ensure that our findings are the causal effect of the minimum wage. The idea behind the validity check is as follows. Recall that the minimum wage increased in 2010 in the nominal value (2.75%), but its real value actually decreased by 0.18%, which is almost a minimum wage freeze, because the inflation rate is higher than the minimum wage growth rate. The new minimum wage in 2010 should not have any real impact on employment. In this sense, the validity check here is a placebo test—since there is no treatment, there should be no effect. To implement the validity check, we estimate the same equation as Equation (4) without the year fixed effect but year by year (i.e., 2009, 2010, 2012, and 2013).

The year-by-year estimation results are presented in Table 5. We present the results by establishment size. Consistent with our expectations, in columns (4) to (6), we find no significant effect for 2010. The estimate is statistically insignificant regardless of the size of establishments, and it is opposite in sign, especially in the case of small establishments. However, in the other years, we still find some negative effects, although they are less precisely estimated. A one percentage point increase in the wage gap decreases employment growth by 5.3 to 13 percentage points. We also present the results of the decomposition by margin of adjustment. Although the estimates are not precise, they indicate that the increases in the minimum wage increases the business exit rate, except for the year 2010, when the real value of the minimum wage did not increase. There is also no significant effects within continuing firms in 2010. The results are similar in Panel B, where we use the fraction of bound workers.

VI Conclusion

Firms respond to labor cost shocks in various ways, such as by reducing the number of employees or employees' working hours. Downsizing can be possible by improving workplace efficiency or work intensity. Firms might also decrease their production scale by laying off employees, perhaps the least productive ones, halting new hiring, or deferring their hiring plan. An extreme response is business closing, as they can just close down and go out of the market. This might not be uncommon for marginal firms. An increase in the minimum wage can have a significant impact on firms, and those with a small profit margin, those using labor-intensive technologies, or those using lower-skill minimum-wage workers are more vulnerable.

In this study, using unique establishment panel data with the payroll records of employees within establishments, we decompose the total effect of the minimum wage into the effects along various margins of labor adjustment—continuing employees' working hour adjustment, hiring, separations, and establishment exits. We find a negative effect of the minimum wage on employment, but the effect is concentrated among small establishments. In particular, for small establishments in the F&L and manufacturing industries, business closing accounts for most of the employment effect of the minimum wage. By contrast, the relative importance of each channel within continuing firms differs by industry.

The finding on the importance of business closing as a key channel of labor adjustment might be surprising, given that the minimum wage increases during the sample period were not extraordinarily high compared to the historical trends in Korea, and the proportion of bound employees was not large. One plausible explanation is that the minimum wage increased consistently over the years until the sample period, so firms might expect that it would keep increasing, and the real impact of the minimum wage would therefore not be diluted over time. The minimum-to-median ratio was already as high as 45% during the sample period. This situation is different from the case of the United States, where minimum wages have been revised much less frequently until recently; therefore, the real values of the minimum wages have actually dropped over time (Autor, Manning, and Smith 2016). Another explanation is the spillover effect. Minimum wage increases enforce

increases in bound employees' hourly wages, which might induce upward pressure on the wages of non-bound employees within the same establishments. The spillover effect is more likely to exist in small establishments where coworkers' wages are more observable, and in Korea, where the wage structure tends to be hierarchical. The actual impact of an increase in the minimum wage would be much larger than the direct impact on bound employees.

Our study has at least two limitations. First, our data are establishment-level panel data; thus, we cannot follow workers once they separate from their establishment. This prevents us from examining the re-employment or job switching of separated workers or those released from closed establishments. Therefore, the employment effect of the minimum wage found in this study might cannot be interpreted as the ultimate effect in the entire labor market.

Second, our establishment panel data follow only those establishments included in the initial survey for two subsequent years. Due to this data limitation and the fact that minimum wages are revised every year in Korea, we cannot examine the long-term effects of minimum wage increases. In particular, we cannot examine how minimum wage increases affect new firms' entry. The omission of the firm entry channel might be critical, given the importance of the establishment exit channel. These two channels are closely related. Increases in labor costs by the minimum wage might lower the entry rate of new firms (Draca, Machin, and Van Reenen 2011) or induce labor–capital substitution, such as automation (Lordan and Neumark 2018); in this case, the long-term effects could be larger than what we found in this study. By contrast, in response to labor cost shocks, existing firms might increase production efficiency (Riley and Bondibene 2017). Furthermore, as less efficient firms exit the market, the incentive for new ones to enter might become stronger. Thus, a full-scale decomposition analysis covering all possible channels in the longer run is warranted in future research.

References

Aaronson, Daniel, Eric French, Isaac Sorkin, and Ted To. 2018. "Industry Dynamics and the Minimum Wage: A Putty-Clay Approach." *International Economic Review* 59(1):51–84.

Altonji, Joseph G., Todd E. Elder, and Christopher R. Taber. 2005. "Selection on Observed and Unobserved Variables: Assessing the Effectiveness of Catholic Schools." *Journal of Political Economy* 113(1):151–184.

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

Belman, Dale, and Paul J. Wolfson. 2014. "What Does the Minimum Wage Do?" Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

Bossavie, Laurent, Ayşenur Acar Erdoğan, and Mattia Makovec. 2019. "The Impact of the Minimum Wage on Firm Destruction, Employment and Informality." World Bank Policy Research Working Paper 8749.

Bossler, Mario, and Hans-Dieter Gerner. 2020. "Employment Effects of the New German Minimum Wage: Evidence from Establishment-Level Microdata." *ILR Review* 73(5):1070–1094.

Breza, Emily, Supreet Kaur, and Yogita Shamdasani. 2018. "The Morale Effects of Pay Inequality." *Quarterly Journal of Economics* 133(2):611–663.

Brochu, Pierre, and David A. Green. 2013. "The Impact of Minimum Wages on Labour Market Transitions." *Economic Journal* 123(573):1203–1235.

Card, David, and Alan B. Krueger. 1995. *Myth and Measurement: The New Economics of the Minimum Wage*. Princeton: Princeton University Press.

Chava, Sudheer, Alexander Oettl, and Manpreet Singh. 2019. "Does a One-Size-Fits-All Minimum Wage Cause Financial Stress for Small Businesses?" NBER Working Paper 26523.

Clemens, Jeffrey. 2019. "Making Sense of the Minimum Wage: A Roadmap for Navigating Recent Research." Cato Institute Policy Analysis Paper 867.

Draca, Mirko, Stephen Machin, and John Van Reenen. 2011. "Minimum Wages and Firm Profitability." *American Economic Journal: Applied Economics* 3(1):129–51.

Dube, Arindrajit. 2019. "Impacts of Minimum Wages: Review of the International Evidence." London, UK: HM Treasury and Department for Business, Energy & Industrial Strategy.

Dube, Arindrajit, Laura Giuliano, and Jonathan Leonard. 2019. "Fairness and Frictions: The Impact of Unequal Raises on Quit Behavior." *American Economic Review* 109(2):620–63.

Dube, Arindrajit, T. William Lester, and Michael Reich. 2016. "Minimum Wage Shocks, Employment Flows, and Labor Market Frictions." *Journal of Labor Economics* 34(3):663–704.

Dustmann, Christian, Attila Lindner, Uta Schönberg, Matthias Umkehrer, and Philipp vom Berge. 2022. "Reallocation Effects of the Minimum Wage." *Quarterly Journal of Economics* 137(1): 267–328.

Giuliano, Laura. 2013. "Minimum Wage Effects on Employment, Substitution, and the Teenage Labor Supply: Evidence from Personnel Data." *Journal of Labor Economics* 31(1):155–194.

Gopalan, Radhakrishnan, Barton H. Hamilton, Ankit Kalda, and David Sovich. 2021. "State Minimum Wages, Employment, and Wage Spillovers: Evidence from Administrative Payroll Data." *Journal of Labor Economics* 39(3):673–707.

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

Hirsch, Barry T., Bruce E. Kaufman, and Tetyana Zelenska. 2015. "Minimum Wage Channels of Adjustment." *Industrial Relations* 54(2):199–239.

Jardim, Ekaterina, and Emma van Inwegen. 2019. "Payroll, Revenue, and Labor Demand Effects of the Minimum Wage." Upjohn Institute Working Paper 19-298.

Johansen, Leif. 1959. "Substitution versus Fixed Production Coefficients in the Theory of Economic Growth: A Synthesis." *Econometrica* 27(2):157–176.

Kim, Doosoon. 2017. "Job Stability of Wage Workers: Evidence from the Unemployment Insurance Database." Employment Trends Brief, Korea Employment Information Service (in Korean).

Lee, David S. 1999. "Wage Inequality in the United States during the 1980s: Rising Dispersion or Falling Minimum Wage?" *Quarterly Journal of Economics* 114(3):977–1023.

Lee, Jungmin. 2020. "The Labor Market in South Korea, 2000-2018." *IZA World of Labor*.

Lordan, Grace, and David Neumark. 2018. "People versus Machines: The Impact of Minimum Wages on Automatable Jobs." *Labour Economics* 52:40–53.

Luca, Dara Lee, and Michael Luca. 2019. "Survival of the Fittest: The Impact of the Minimum Wage on Firm Exit." NBER Working Paper 25806.

Machin, Stephen, Alan Manning, and Lupin Rahman. 2003. "Where the Minimum Wage Bites Hard: Introduction of Minimum Wages to a Low Wage Sector." *Journal of the European Economic Association* 1(1):154–180.

Machin, Stephen, and Joan Wilson. 2004. "Minimum Wages in a Low-Wage Labour Market: Care Homes in the UK." *Economic Journal* 114(494):C102–C109.

Manning, Alan. 2021. "The Elusive Employment Effect of the Minimum Wage." *Journal of Economic Perspectives* 35(1):3–26.

Mayneris, Florian, Sandra Poncet, and Tao Zhang. 2018. "Improving or Disappearing: Firm-level Adjustments to Minimum Wages in China." *Journal of Development Economics* 135:20–42.

Meer, Jonathan, and Jeremy West. 2016. "Effects of the Minimum Wage on Employment Dynamics." *Journal of Human Resources* 51(2):500–522.

Ministry of Employment and Labor of Korea. 2017. *Sample Design of Survey on Labor Conditions by Employment Type: Final Report*.

Neumark, David, Mark Schweitzer, and William Wascher. 2004. "Minimum Wage Effects throughout the Wage Distribution." *Journal of Human Resources* 39(2):425–450.

Neumark, David, and Peter Shirley. 2022. "Myth or Measurement: What Does the New Minimum Wage Research Say About Minimum Wages and Job Loss in the United States?" *Industrial Relations* 61(4):384–417.

Neumark, David, and William L. Wascher. 2008. *Minimum Wages*. Cambridge: MIT Press.

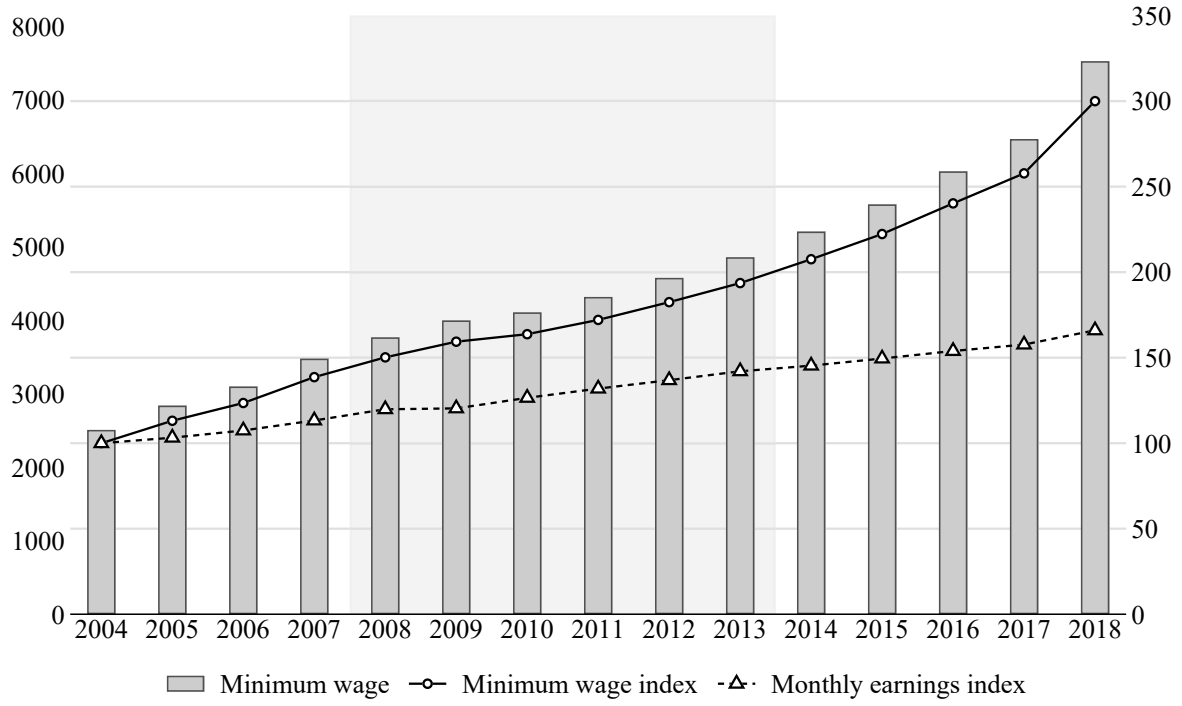
Oster, Emily. 2019. "Unobservable Selection and Coefficient Stability: Theory and Evidence." *Journal of Business & Economic Statistics* 37(2):187–204.

Portugal, Pedro, and Ana Rute Cardoso. 2006. "Disentangling the Minimum Wage Puzzle: An Analysis of Worker Accessions and Separations." *Journal of the European Economic Association* 4(5):988–1013.

Riley, Rebecca, and Chiara Rosazza Bondibene. 2017. "Raising the Standard: Minimum Wages and Firm Productivity." *Labour Economics* 44:27–50.

Sorkin, Isaac. 2015. "Are There Long-run Effects of the Minimum Wage?" *Review of Economic Dynamics* 18(2):306–333.

Figure 1: Trends in Minimum Wages and Average Monthly Earnings, 2004–2018



Note: The left vertical axis represents the minimum wage, and the right vertical axis represents the minimum wage and monthly earnings indices, normalized to 100 in 2004. The sample period is from 2008 to 2013 (shaded). Our sample consists of two sets of three-year panel data, 2008-2010 and 2011-2013. Since we examine the impacts of the minimum wage on the employment growth rate, years 2008 and 2011 are the initial/base years, and we utilize the minimum wage increases in 2009 and 2010 for the first panel and those in 2012 and 2013 for the second panel.

Table 1: Summary Statistics of Establishment-Level Characteristics

	(1)	(2)	(3)	(4)	(5)	(6)
	All		5–29		30+	
	Non-bound	Bound	Non-bound	Bound	Non-bound	Bound
A. Establishment characteristics in year $(t-1)$						
Bound employee share		0.06		0.16		0.04
		(0.10)		(0.14)		(0.08)
Establishment wage gap (%)		0.12		0.33		0.10
		(0.30)		(0.46)		(0.27)
Sub-MW employee share	0.02	0.08	0.02	0.12	0.02	0.08
	(0.10)	(0.17)	(0.10)	(0.18)	(0.10)	(0.17)
Sub-MW establishment wage gap (%)	0.72	1.34	0.49	1.86	0.78	1.28
	(7.74)	(5.10)	(4.33)	(5.59)	(8.34)	(5.04)
FTE jobs*	93.1	168.2	12.3	16.2	237.8	303.6
	(537.7)	(712.8)	(6.9)	(8.7)	(880.2)	(960.2)
Number of employees*	85.8	148.8	11.2	13.1	219.5	269.9
	(484.8)	(651.0)	(5.9)	(6.5)	(792.8)	(877.7)
Mean monthly work hours	186.4	198.1	188.0	212.0	186.0	196.5
	(29.2)	(36.8)	(29.4)	(38.9)	(29.2)	(36.3)
Mean age	39.03	41.49	39.73	43.93	38.87	41.21
	(6.15)	(7.65)	(7.03)	(9.04)	(5.91)	(7.42)
Male employee share	0.68	0.65	0.64	0.61	0.69	0.65
	(0.26)	(0.26)	(0.28)	(0.27)	(0.25)	(0.26)
Four-year college or above share	0.41	0.28	0.33	0.17	0.43	0.29
	(0.32)	(0.28)	(0.31)	(0.21)	(0.32)	(0.29)
Mean tenure	7.31	5.97	4.76	3.50	7.91	6.26
	(4.99)	(3.64)	(4.15)	(2.78)	(4.98)	(3.62)
B. Employment changes from year $(t-1)$ to t						
Net employment growth (%)	-16.13	-20.43	-28.24	-33.15	-13.28	-18.99
	(58.77)	(54.13)	(70.35)	(65.24)	(55.31)	(52.53)
Establishment exit rate (%)	6.29	4.31	12.51	10.91	4.83	3.56
	(24.28)	(20.31)	(33.08)	(31.18)	(21.44)	(18.53)
C. Employment changes for continuing establishments from year $(t-1)$ to t						
Net employment growth (%)	-3.78	-12.35	-3.68	-12.73	-3.81	-12.31
	(35.54)	(39.29)	(28.91)	(30.84)	(36.82)	(40.08)
Mean hourly wage growth (%)	3.62	11.72	4.58	15.97	3.41	11.27
	(23.92)	(26.02)	(24.45)	(24.71)	(23.80)	(26.12)
Individual employees	2,328,475	351,649	442,923	35,871	1,885,552	315,778
All establishments	61,593	5,825	39,539	2,745	22,054	3,080
Bound establishments		8.6%		6.5%		12.3%
Continuing establishments	54,261	5,331	33,378	2,373	20,883	2,958

Note: Sample means are presented and standard deviations are in parentheses. All statistics are weighted by the number of observed employees in establishments in year $(t-1)$, except for the variables with an asterisk (FTE jobs and the number of employees). Columns are divided by establishment size and, within each size, further by bound versus non-bound establishments.

Table 2: The Effects of the Minimum Wage on Employment and Wage Growth

	(1)	(2)	(3)
	All	5–29	30+
A.Establishment wage gap			
A.1 Net employment growth			
MW bite	-0.042	-0.090	-0.022
	(0.022)	(0.028)	(0.029)
AET bounds	[-0.042,0.075]	[-0.090,-0.019]	[-0.022,0.099]
Observations	67,418	42,284	25,134
R-squared	0.018	0.016	0.013
A.2 Wage growth			
MW bite	0.085	0.102	0.081
	(0.011)	(0.011)	(0.015)
Observations	59,592	35,751	23,841
R-squared	0.086	0.101	0.084
B.Fraction of bound workers			
B.1 Net employment growth			
MW bite	-0.088	-0.218	-0.001
	(0.063)	(0.073)	(0.092)
AET bounds	[-0.088,0.341]	[-0.218,0.014]	[-0.001,0.532]
Observations	67,418	42,284	25,134
R-squared	0.018	0.016	0.013
B.2 Wage growth			
MW bite	0.285	0.323	0.274
	(0.030)	(0.028)	(0.044)
Observations	59,592	35,751	23,841
R-squared	0.086	0.102	0.084

Note: All estimates are obtained from separate regressions. As a minimum wage bite, Panel A uses the establishment wage gap, and Panel B uses the fraction of bound employees. The dependent variables are the net employment growth from year $(t-1)$ to t (Panels A.1 and B.1) and the average hourly wage growth between year $(t-1)$ to t (Panels A.2 and B.2). Control variables include the share of male employees, average age, average age squared, tenure, tenure squared, the percentage of union members, the share of four-year college workers, and both the proportions of non-bound low-wage workers and sub-minimum wage workers. All control variables are the establishment characteristics in $(t-1)$ and year dummies are also controlled for. Columns are divided by the establishment sizes. All regressions are weighted by the number of observed employees in each establishment in year $(t-1)$. Robust standard errors, clustered by the establishment, are presented in parentheses. The AET bounds in brackets are computed by psacalc at Stata.

Table 3: Decomposing the Employment Effect of the Minimum Wage

	(1)	(2)	(3)	(4)	(5)	(6)
	Establishment wage gap			Fraction of bound workers		
	All	5–29	30+	All	5–29	30+
A. Net employment growth	-0.042	-0.090	-0.022	-0.088	-0.218	-0.001
	(0.022)	(0.028)	(0.029)	(0.063)	(0.073)	(0.092)
B. Within continuing firms	-0.030	-0.041	-0.024	-0.064	-0.125	-0.031
	(0.014)	(0.013)	(0.020)	(0.040)	(0.032)	(0.063)
B.1 Continuing workers' hours		-0.013			-0.037	
		(0.003)			(0.010)	
B.2 Hiring		-0.026			-0.049	
		(0.012)			(0.033)	
B.3 Separation		-0.002			-0.038	
		(0.015)			(0.039)	
C. Firm exit	-0.013	-0.049	0.002	-0.024	-0.093	0.030
	(0.018)	(0.028)	(0.023)	(0.053)	(0.072)	(0.073)
Observations	67,418	42,284	25,134	67,418	42,284	25,134

Note: All estimates are obtained from separate regressions. The first three columns use the establishment wage gap as a measure of the minimum wage bite, and the last three columns use the fraction of bound employees. Further, columns are divided by the establishment sizes. The dependent variables are indicated in each panel. Control variables include the share of male employees, average age, average age squared, tenure, tenure squared, the percentage of union members, the share of four-year college workers, and both the proportions of non-bound low-wage workers and sub-minimum wage workers. All control variables are the establishment characteristics in $(t-1)$ and year dummies are also controlled for. All regressions are weighted by the number of observed employees in each establishment in year $(t-1)$. Robust standard errors, clustered by the establishment, are presented in parentheses.

Table 4: Heterogeneity by Establishment Size and Industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		F&L			Mfg.			Others	
	All	5–29	30+	All	5–29	30+	All	5–29	30+
A. Establishment wage gap									
A.1 Net employment growth	-0.113	-0.270	0.078	-0.089	-0.155	-0.071	-0.001	-0.029	0.012
	(0.070)	(0.080)	(0.123)	(0.053)	(0.058)	(0.067)	(0.025)	(0.033)	(0.033)
A.2 Within continuing firms	-0.007	-0.043	0.062	-0.046	-0.038	-0.045	-0.023	-0.042	-0.015
	(0.052)	(0.025)	(0.121)	(0.032)	(0.023)	(0.044)	(0.016)	(0.018)	(0.023)
Continuing workers' hours		-0.011			-0.013			-0.015	
		(0.007)			(0.005)			(0.005)	
Hiring		-0.102			-0.034			-0.007	
		(0.030)			(0.024)			(0.015)	
Separation		0.070			0.008			-0.021	
		(0.035)			(0.029)			(0.019)	
A.3 Firm exit	-0.105	-0.226	0.017	-0.043	-0.117	-0.026	0.022	0.014	0.027
	(0.061)	(0.085)	(0.041)	(0.042)	(0.063)	(0.052)	(0.020)	(0.031)	(0.026)
B. Fraction of bound workers									
B.1 Net employment growth	-0.213	-0.616	0.583	-0.295	-0.288	-0.299	0.024	-0.092	0.089
	(0.195)	(0.208)	(0.371)	(0.157)	(0.155)	(0.243)	(0.072)	(0.090)	(0.099)
B.2 Within continuing firms	0.069	-0.106	0.482	-0.147	-0.093	-0.172	-0.053	-0.147	-0.010
	(0.121)	(0.065)	(0.345)	(0.089)	(0.058)	(0.145)	(0.048)	(0.044)	(0.072)
Continuing workers' hours		-0.021			-0.037			-0.046	
		(0.014)			(0.012)			(0.014)	
Hiring		-0.202			-0.013			-0.029	
		(0.086)			(0.071)			(0.042)	
Separation		0.116			-0.042			-0.072	
		(0.101)			(0.078)			(0.050)	
B.3 Firm exit	-0.282	-0.510	0.101	-0.148	-0.195	-0.127	0.077	0.055	0.100
	(0.164)	(0.211)	(0.164)	(0.142)	(0.159)	(0.215)	(0.056)	(0.086)	(0.073)
Observations	4,021	2,934	1,087	14,745	8,653	6,092	48,652	30,697	17,955

Note: All estimates are obtained from separate regressions. Columns 1–3 present results within the F&L industry, and the next three columns are for the results within the Manufacturing industry. The last three columns show the results in other industries excluding F&L and Mfg. As a minimum wage bite, Panel A uses the establishment wage gap, and Panel B uses the fraction of bound employees. In each panel, the dependent variables are indicated. Columns are also divided by the establishment sizes. Control variables include the share of male employees, average age, average age squared, tenure, tenure squared, the percentage of union members, the share of four-year college workers, and both the proportions of non-bound low-wage workers and sub-minimum wage workers. All control variables are the establishment characteristics in $(t-1)$ and year dummies are also controlled for. All regressions are weighted by the number of observed employees in each establishment in year $(t-1)$. Robust standard errors, clustered by the establishment, are presented in parentheses.

Table 5: Year-by-Year Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
		2008–2009			2009-2010			2011-2012			2012-2013	
Nominal MW growth rate		6.10%			2.75%			6.02%			6.11%	
Real MW growth rate		3.25%			-0.20%			3.74%			4.74%	
	All	5-29	30+	All	5-29	30+	All	5-29	30+	All	5-29	30+
A. Establishment wage gap												
A.1 Net employment growth	-0.052	-0.124	-0.019	-0.021	0.058	-0.081	-0.031	-0.130	0.010	-0.025	-0.053	-0.010
	(0.040)	(0.065)	(0.050)	(0.156)	(0.176)	(0.230)	(0.037)	(0.049)	(0.046)	(0.036)	(0.039)	(0.053)
A.2 Within continuing firms	-0.060	-0.008	-0.088	-0.028	-0.039	-0.025	-0.010	-0.058	0.014	-0.015	-0.044	0.004
	(0.033)	(0.023)	(0.048)	(0.078)	(0.073)	(0.119)	(0.023)	(0.022)	(0.033)	(0.021)	(0.022)	(0.031)
Continuing workers' hours		-0.016			-0.008			-0.016			-0.009	
		(0.007)			(0.013)			(0.007)			(0.004)	
Hiring		-0.053			-0.014			-0.053			0.009	
		(0.024)			(0.065)			(0.019)			(0.019)	
Separation		0.060			-0.018			0.011			-0.043	
		(0.027)			(0.086)			(0.027)			(0.024)	
A.3 Firm exit	0.008	-0.115	0.068	0.007	0.097	-0.055	-0.020	-0.072	-0.004	-0.010	-0.009	-0.014
	(0.028)	(0.065)	(0.026)	(0.137)	(0.174)	(0.196)	(0.032)	(0.051)	(0.038)	(0.032)	(0.038)	(0.046)
B. Fraction of bound workers												
B.1 Net employment growth	-0.117	-0.440	0.151	-0.175	0.031	-0.312	-0.065	-0.272	0.089	-0.029	-0.109	0.016
	(0.134)	(0.177)	(0.184)	(0.235)	(0.229)	(0.360)	(0.115)	(0.124)	(0.171)	(0.101)	(0.109)	(0.151)
B.2 Within continuing firms	-0.141	-0.101	-0.178	-0.148	-0.063	-0.214	0.004	-0.179	0.137	-0.027	-0.107	0.028
	(0.102)	(0.067)	(0.171)	(0.136)	(0.088)	(0.214)	(0.073)	(0.055)	(0.120)	(0.059)	(0.055)	(0.089)
Continuing workers' hours		-0.044			-0.003			-0.045			-0.032	
		(0.015)			(0.019)			(0.024)			(0.013)	
Hiring		-0.144			0.043			-0.091			0.021	
		(0.072)			(0.101)			(0.053)			(0.056)	
Separation		0.087			-0.104			-0.043			-0.096	
		(0.084)			(0.116)			(0.070)			(0.064)	
B.3 Firm exit	0.025	-0.339	0.329	-0.027	0.095	-0.098	-0.069	-0.092	-0.048	-0.002	-0.003	-0.011
	(0.097)	(0.180)	(0.089)	(0.212)	(0.224)	(0.317)	(0.097)	(0.124)	(0.136)	(0.087)	(0.104)	(0.129)
Observations	16,331	10,074	6,257	16,863	10,599	6,264	16,667	10,415	6,252	17,557	11,196	6,361

Note: All estimates are obtained from separate regressions. As a minimum wage bite, Panel A uses the establishment wage gap, and Panel B uses the fraction of bound employees. In each panel, the dependent variables are indicated. Columns present the minimum wage impact within the specified years. Columns 4-6 present the results for the minimum wage increase from 2009 to 2010 which are of particular interest because the year 2010 is the only year when the minimum wage did not increase in real terms. Control variables include the share of male employees, average age, average age squared, tenure, tenure squared, the percentage of union members, the share of four-year college workers, and both the proportions of non-bound low-wage workers and sub-minimum wage workers. All control variables are the establishment characteristics in $(t-1)$. All regressions are weighted by the number of observed employees in each establishment in year $(t-1)$. Robust standard errors, clustered by the establishment, are presented in parentheses.