The effects of minimum wage increases on employment and average wages of affected workers in Canada

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Abstract

The effects of minimum wage increases on employment and average wages of affected workers in Canada

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The employment effects of the minimum wage are debated among economists, with traditional competitive models suggesting potential job losses for low-wage workers, while alternative models like institutional and dynamic monopsony suggest potential positive impacts. The institutional model posits that raising the minimum wage could boost employment if wages are below the marginal product of labor, and the dynamic monopsony model suggests that higher minimum wages could reduce turnover costs in low-wage labor markets, mitigating predicted job losses. Empirical studies, even within the competitive model, show mixed results, with some indicating significant disemployment effects and others not. This thesis provides a comprehensive analysis of the impacts of minimum wage increases on employment and wages across Canada, utilizing a robust methodological framework including the bunching approach, event study analysis, and difference-in-difference methods to examine the effects of varying provincial minimum wages over time.

To accomplish this, I first employ the bunching approach to detect any concentration of wages just above the minimum wage threshold, providing insights into employer behavior in response to wage regulations. This technique identifies subtle adjustments in wage distribution that might not be apparent through other methods. Next, I utilize event study analysis to explore the immediate and long-term effects of minimum wage hikes, comparing employment and wage data from periods before and after the increases. This method captures both short-term disruptions and long-term adjustments in the labor market.

Additionally, the difference-in-difference method is employed to compare outcomes between provinces with and without minimum wage increases, isolating the specific effects of these policies by controlling for other influencing variables. This approach underscores the importance of regional economic conditions in shaping the effectiveness of wage regulations.

The empirical analysis begins with Labor Force Survey data from Ontario, which experienced significant real minimum wage increases in January 2018. The study estimates the counterfactual frequency distribution of hourly wages in Ontario for three years before and two years after the minimum wage increase. The findings show a significant decrease in jobs paying below the new minimum wage and a proportional increase in jobs paying up to $4 above the real minimum wage, indicating no significant overall employment impact. Contrary to anticipated employment effects, the average wage of affected workers increased significantly by 22.7% over the two years following the minimum wage shock. The only exception in the Ontario study was for the teen group; contrary to much of the existing Canadian literature such as Fossati and Marchand (2024), I found a significant positive employment effect for teenagers. However, overall, I did not observe a significant negative employment effect for young adults.

Further analysis includes other provinces, such as Alberta, and cities such as Gatineau versus Ottawa, which also experienced substantial nominal and real minimum wage increases. The study applies the same methodology to assess the employment and wage effects, finding similar results to the Ontario study. Contrary to the Ontario study, in the Alberta study, I found a significant negative employment effect for the teen group, but overall, I did not find a significant negative employment effect for young adults. Since referring to a single minimum wage is inherently problematic, I also investigated a pooled analysis of hourly wage data from all Canadian provinces from 1999 to 2019. This analysis, covering 56 minimum wage increases, reveals no significant employment effect (-2%) over six months following minimum wage increases but a significant average wage increase (6.4%) for affected workers.

The study also investigates potential employment shifts from low-skilled to high-skilled workers, finding no indication of such shifts. Subgroup analyses by education level, age, and other demographics show approximately similar employment and wage effects, suggesting that the consequences of minimum wage policies are shared among different worker groups. Additionally, sectoral analyses show no negative employment effect in the food industry, aligning with Card and Krueger (1993)'s findings on the impact of minimum wage increases in the fast-food industry. However, a significant negative employment effect (-4%) was observed in the retail sector, highlighting the influence of local industry composition on minimum wage impacts.

Finally, in the Canada study (pooling all 56 minimum wage increase across all provinces), I assess the size of wage spillovers, finding that only 7% of the impact on average wages of affected workers comes from wage spillovers at the lower part of the wage distribution, which was statistically insignificant. This aligns with Canadian literature, such as Campolieti (2015), which found modest wage spillovers based on Canadian data compared to American data. Overall, this thesis provides robust evidence on the employment and wage effects of minimum wage increases in Canada. The findings suggest that, contrary to the traditional competitive model, minimum wage increases do not significantly reduce overall employment of low-wage workers and can lead to substantial wage gains for them. This has important implications for policymakers considering minimum wage adjustments to improve labor market outcomes for low-wage workers.

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Chapter 1

Introduction

The employment effect of the minimum wage remains a contentious issue among economists. Traditionally, within the competitive model, minimum wage increases were associated with potential job losses for many low-wage or unskilled workers. This perspective, once more prevalent among neoclassical economists, contrasts with alternative models like institutional and dynamic monopsony models.

These alternative models propose that a minimum wage increase not only fails to reduce employment for low-wage workers but could potentially positively impact employment within this specific group. They challenge some fundamental assumptions of the competitive model. For example, the institutional model challenges the notion that wages equal the marginal product of labor. It argues that if wages fall below the marginal product of labor, increasing the minimum wage could potentially result in higher employment.

Dynamic monopsony model as another alternative approach questions the argument of the competitive model in which Employers can hire as much labor as needed by offering the prevailing market wage. This model mentions that even employers in low-wage labor markets encounter actual costs when replacing workers who have quit (Manning, 2003). As a result, an increase in the minimum wage has the potential to decrease the cost of turnover for low-wage employers and consequently we may not see the adverse employment effect as the competitive model predicts.

These alternative theoretical approaches challenge the traditional belief that raising the minimum wage would invariably lead to job losses. Even within the same theoretical model, such as the competitive one, empirical studies do not show a uniform result. Various empirical studies within this framework show divergent findings and interpretations, leading to a lack of consensus on the precise impact of minimum wage increases on employment.

Some empirical studies (e.g., Neumark and Wascher,1993; Neumark and Wascher, 2008; Campolieti, Gunderson, and Riddell, 2006) show significant dis-employment effect of minimum wage increases while other empirical studies (e.g., Card and Krueger,1993; Dube, Lester, and Reich, 2010; Allegretto, Dube, Reich, and Zipperer, 2017) employing similar comparative methodologies have failed to confirm the negative employment effects associated with higher minimum wages.

In addition, the effect of minimum wage increase generally applies to teen employment, low-educated workers, or workers in specific sectors like restaurants or fast food as a proxy for the low-wage or unskilled workers but less studies has investigated the overall employment effect of minimum wage. This lack of study on the overall employment effect becomes notably significant, considering the emphasis policymakers put on comprehending the overall impact on employment for low-wage workers rather than only considering specific low-wage groups or sectors of the economy.

This study aims to use the Cengiz, Dube, Lindner, and Zipperer (2019)'s research design and replicate it on Canadian data. Canadian data is especially appropriate for estimating the employment effect of minimum wages. First, minimum wages fall under provincial jurisdiction, leading to significant cross-sectional and time series variation in these rates. Second, minimum wage increases tend to last for long periods and are eroded by inflation slowly. In addition, in Canada, the coverage rates and bite of the minimum wages are generally high and extend across the wage distribution. (Campolieti, 2020).

In this thesis, following Cengiz et al. (2019), I apply the bunching approach in the context of minimum wage with Canadian data to investigate the overall employment and average wage effect of minimum wage changes. This empirical approach in economics studies how individuals or firms respond behaviorally to incentives or policy changes. This method focuses on observing whether there is an unusual concentration or "bunching" of observations at certain points in a distribution, often around thresholds or specific values.

The application of this method in the context of minimum wage was proposed by Cengiz et al. (2019) to investigate the overall employment and average wage effect of minimum wage on low-wage jobs in the U.S. This bunching method allows us to assess the impact of minimum wage shock on the whole frequency distribution of wages and more importantly, focuses on changes in the number of jobs at the bottom of the wage distribution to estimate the impact on employment and average wages of affected workers.

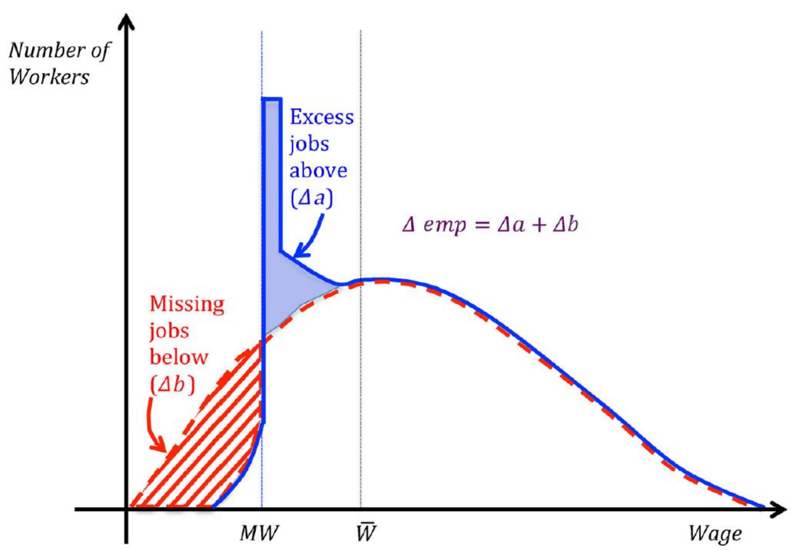
Cengiz et al. (2019) explained the intuition behind this approach which is depicted in Figure 1.1. As you see in Figure 1.1 total employment and wage effects of the minimum wage shock can be assessed from the localized employment changes around the minimum wage shock. When a minimum wage shock happens, it will directly affect low-wage workers whose hourly wages were previously below the new minimum wage. Some of these low-wage workers, who are paid below the new minimum wage, may lose their jobs but others will keep their jobs with a new minimum wage which is now higher.

On the other side with increasing the minimum wage now even some part of the labor force who did not have the incentive to look for a job will do it and some of them may end up finding jobs with the new minimum wage. So the low-wage workers who did not lose their jobs and shifted to jobs with the higher minimum wage plus those who entered the market with the new minimum wage job create a spike that we call "excess jobs" at and slightly above the new minimum wage.

The reason that I consider also slightly above the new minimum wage is that in practice following the minimum wage increase, employers may shift pay at affected jobs somehow above the new minimum wage which we call it spillover or indirect effects of minimum wages. First, this wage spillover may happen because with increasing price of low-wage workers, employers have more incentive to substitute skilled workers for low-skilled workers and this substitution will increase the demand and wages of the skilled workers. Second, it may happen because employers want to keep the wage differentials between low-skill workers whose wage is at the minimum wage and more highly skilled workers who are paid above the minimum wage (Campolieti, 2020).

Regardless of the reason behind this wage spillover, it is very improbable to see this shift in wages to the very top of the wage distribution and this effect will fade out somewhere higher but relatively close to the new minimum wage. Therefore, the difference between the number of excess jobs at and slightly above the minimum wage and the number of missing jobs below the minimum will give us the changes in employment.

Figure 1.1: An Illustration of the Bunching Approach



Notes: Figure 1 illustrates the impact of the minimum wage on the distribution of hourly wages. Before the implementation of the minimum wage, represented by the red solid line, and following its introduction, denoted by the blue solid line, changes in the wage distribution are evident. Due to imperfect compliance, some workers remain below the minimum wage threshold, resulting in the post-event distribution beginning before the minimum wage level. For certain workers falling within the red-shaded area between the origin and the minimum wage (Δb), the introduction of the minimum wage could lead to either an increase in their wages or the potential loss of their jobs. This group contributes to the creation of “excess jobs above” (Δa), represented by the blue shaded area between MW and the upper limit of any minimum wage effect on the earnings distribution ($\bar{W}$).The overall employment change resulting from the minimum wage (Δe) is calculated as the sum of two areas (Δa+Δb).(source: Cengiz et al., 2019)

Cengiz et al. (2019) highlights several advantages of using this bunching method to investigate the employment effect of minimum wage increases. First, they illustrate a direct connection between bunching and dis-employment for the workers directly affected, by the standard friction-less model of labor demand. Additionally, the size of the bunching determines a fundamental structural aspect of labor demand—the elasticity of substitution between different labor types. Their approach expands on what Saez (2010) did to identify the compensated elasticity of labor supply in the standard model through the bunching of taxable earnings around tax kinks and then use it in the labor demand context.

Furthermore, Cengiz et al. (2019)'s methodology clearly shows the specific part of the wage distribution where potential dis-employment effects might be occurring, by systematically tracing changes in employment across the wage distributions. Based on vast theoretical models, I expect to see this bunching spike or change in employment at the bottom of the wage distribution. Moreover, this approach focuses on jobs around the minimum wage. So it enhances precision by effectively mitigating the impact of random fluctuations in employment within the upper part of the wage distribution.

Finally, Cengiz et al. (2019)'s approach also enables us to follow the employment changes in the upper tail of the wage distribution as an additional falsification test. This is because any significant changes in the upper part of the wage distribution are very improbable to show the causal effect of the minimum wage and show more of a problem in identification strategy rather than the causality effect of minimum wage.

I applied this bunching approach to the Canadian context, specifically examining significant minimum wage increases in regions such as Ontario, Alberta, and the Ottawa-Gatineau area. Subsequently, I extended this analysis to 56 minimum wage increases across all Canadian provinces from 1999 to 2019. According to Neumark, Salas, and Wascher (2014, p. 610), "the identification of minimum wage effects requires both a sufficiently sharp focus on potentially affected workers and the construction of a valid counterfactual control group for what would have happened absent increases in the minimum wage." In the existing literature, there are several ways to construct a valid counterfactual control group such as ad hoc functional forms Dickens, Machin, and Manning (1998); Meyer and Wise (1983), using the distribution before the minimum wage increase as a counterfactual Harasztosi and Lindner (2019) or using synthetic control method (Fossati and Marchand, 2024).

In my study, I follow what Cengiz et al. (2019) did to construct the counterfactual wage distribution. I use provincial-level variation in the minimum wage and compared provinces with and without minimum wage changes employing a difference-in-difference style estimation.

Following Cengiz et al. (2019) I added an event study analysis. This event study analysis also can be used to test if there are any pre-treatment differences between the treated and control groups as a way to pretest parallel trends, a critical assumption of a difference-in-differences method.

I started my empirical study by using Labor Force Survey (LFS) data on hourly wages from Ontario. Over the past 15 years, the nominal minimum wage experienced a gradual progression until 2017. Starting at $8.00 in 2007, it increased to $8.75 in 2008, $9.50 in 2009, and remained at $10.25 from 2010 to 2013. Subsequently, it rose to $11.00 in 2014, $11.25 in 2015, $11.40 in 2016, and $11.60 in 2017. There was a substantial jump to $14.00 in 2018, followed by a freeze for the next two years. It then climbed to $14.25 in 2020, $14.35 in 2021, reached $15 in January 2022 and increased to $15.50 in October 2022. After October 2020, we observed a renewed gradual increase in the nominal minimum wage, which is tied to the rate of inflation.

Between 2017 and 2018, Ontario increased the real hourly minimum wage from $8.7 to $10.37 (in 2002 dollars). I assess the effect of this largest change in the real minimum wage that happened in one step, in the history of minimum wage changes in Canada from 1999 to 2019.

I estimated the counterfactual frequency distribution of hourly wages in Ontario for three years before and two years following the minimum wage increase by incorporating the average change in per-capita employment observed in the control provinces to the pre-treatment per-capita employment count in Ontario by each dollar wage bin. When comparing this counterfactual distribution to the actual one, a significant decrease in the number of jobs paying below $10 per hour is evident after the minimum wage increase. Simultaneously, I observe a proportional increase in jobs paying hourly wages between $10 and $14, indicating a restrained overall impact on employment due to the minimum wage increase.

Additionally, the distribution of jobs paying above $14 per hour remained relatively stable compared to the counterfactual after the minimum wage increase, strengthening the confidence in the similarity between the treatment and control groups.

I can also assess the impact of this large real minimum wage increase on the average wage of affected workers which increased significantly by 22.7% over two years following the minimum wage shock.

There are other provinces in recent years like Alberta and British Colombia that have also experienced large nominal and real minimum wage shocks but the difference is their large shocks are distributed over a longer period. For example, Alberta increased its nominal and real minimum wage by 47% and 39%, respectively but in four annual increments over three years from 2015 to 2018.

I applied the same methodology for the real minimum wage shock of the province of Alberta in 2018 (with four four-step increases in minimum wage shock over three years). In the end, I got approximately the same overall employment and wage effect result as the Ontario study. It is important to note that the Ontario study relies on only one specific minimum wage shock so the inference is inherently problematic.

Fossati and Marchand (2024) assessed the employment effects of a significant increase in the nominal minimum wage in Alberta, which was implemented in four annual increments from 2015 to 2018. Their study found a notable negative employment effect outside Alberta's major cities, Calgary and Edmonton, but not within these urban centers. Given that Ontario is home to one of the most concentrated labor markets in Canada, particularly due to the Greater Toronto Area (GTA), the insignificant negative employment effect I observed aligns with Fossati and Marchand (2024)'s findings. However, while Fossati and Marchand (2024) reported a significant negative impact on employment for young workers (aged 15-24), my Ontario study revealed only a -2.6% decrease in employment for this age group, which was statistically insignificant. This difference may come from different research designs, so I applied my research design to the Alberta study and again I could not find a significant negative employment effect for young workers.

Another hypothesis for this difference could be how I construct the counterfactual wage distribution. Fossati and Marchand (2024) implement the synthetic control method to construct the counterfactual wage distribution in the absence of minimum wage. The synthetic control method uses pre-intervention data, a weighted average, or a combination of control group units to form a 'synthetic control' that closely matches the treated unit's characteristics.

Ontario provides us with a good opportunity to find a good match for the treated unit without using the synthetic control method. This opportunity comes from a City called Gatineau. Gatineau is situated in the province of Quebec, positioned directly across the Ottawa River from Ottawa, Ontario. This geographical adjacency has fostered a unique relationship, often depicting the cities as a twin-city region due to their intimate connection. In addition to this geographical proximity, there is a strong economic and cultural interdependence between the two cities. Many residents of Gatineau work in Ottawa, and vice versa. This creates a flow of labor, services, and cultural exchanges among these two cities. So investigating the effect of Ontario's minimum wage shock on the employment effect of Ottawa vs Gatineau can give us a further clue about our different results. Again the results were in the same direction as what I found in the Ontario case study. I could not find a significant negative employment effect for the young workers. Moreover, like the Ontario case study, teen employment was significantly positive. So it is not very probable that this difference between my study and Fossati and Marchand (2024) comes from a different approach to constructing the counterfactual wage distribution.

Additionally, the difference in findings between Alberta and Ontario regarding the impact of minimum wage shocks cannot be attributed to the disparity in the magnitude of the shocks or the proportion of teenage and young workers in each province's workforce, the contrasting outcomes suggest that pooling multiple minimum wage shocks for inference is essential rather than focusing solely on individual cases.

To overcome this problem, I used the hourly wage data from the LFS in all provinces of Canada from 1999 to 2019 to assess both the employment and average wage effects on affected workers. I am pooling 56 minimum wage increases with the same approach covering 5 months before and 6 months following each increase.

Again like the Ontario study, an average minimum wage hike creates a large and significant decrease in the number of jobs below the new minimum wage and simultaneously a significant spike of excess jobs at or slightly above the minimum wage during the six-month following average minimum wage shock. On the other side, there is no sign of employment changes in the upper part of the wage distribution—providing further validation to the empirical design.

Based on the estimation, the number of excess jobs and the number of missing jobs closely match each other. The overall employment for affected workers decreases by 2%. However, this decrease is not statistically significant.

Like the Ontario study, I can calculate the impact of the minimum wage increase on the average wage of affected workers which increases by around 6.4% (std. err. 0.8%). Given the estimated changes in affected employment and wages, the labor demand elasticity is -0.307 (std. err. 0.422). In the Canada study, I have been monitoring job changes across the wage distribution between five months before and 6 months following minimum wage increases.

Again like the Ontario study, both missing jobs below the new minimum and excess jobs above were close to zero before the minimum wage increase, which implies a parallel trend between the treatment and control provinces. Following the minimum wage increase, there is an immediate decrease in the number of jobs below the new minimum wage, accompanied by a simultaneous emergence of excess jobs at, or slightly above, this threshold. In both Ontario and Canada studies the evolution of missing and excess jobs relatively matches together in their window period.

Another benefit of investigating the impact of the minimum wage on the wage frequency distribution is the ability to measure how the direct wage effects of the minimum wage are magnified by wage spillovers. In my study, the spillover share of wage increase for all low-wage workers is only 7% and statistically insignificant. Interestingly, I only found a significant spillover of 11.6% for the teen group. My estimates suggest relatively small spillover effects in the Canadian data. However, I should mention that Cengiz et al. (2019) found a significant spillover of 40% which was not equally shared among different types of low-wage workers based on U.S. data.

Time-varying heterogeneity in investigating the effect of minimum wage policy has a key role in the existing literature. It has created different and sometimes opposite results (e.g., Allegretto et al., 2017; Neumark and Wascher, 1993). So to decrease this problem I used different specifications and variant approaches to control for time-varying heterogeneity like the approaches that Cengiz et al. (2019) used in their work and the estimates that I found are highly robust to a variety of approaches. I demonstrate that the inclusion of wage-bin-by-province-specific linear or quadratic trends does not alter our main conclusion. I have additionally demonstrated that my findings remain robust when focusing solely on the most significant real minimum wage shock, as seen in the Ontario case study.

Although I observe no decrease in the overall employment effect of low-wage jobs, this observation might obscure a potential shift in employment from low-skilled to high-skilled workers. I can investigate the existence of this shift by categorizing workers into four groups of education and three age brackets. My analysis, which compares the excess jobs paying at or above the new minimum wage with the missing jobs paying below it within each age-by-education group, reveals no indication that low-skilled workers are being substituted by high-skilled workers following a minimum wage hike.

Additionally, I conduct separate examinations focusing on individuals with less than high school, those with a high school education or less, those with some post-secondary education and a college degree, those with bachelor's certificates, women, teens, aged [20-25) and those over 25. Following Cengiz et al. (2019), I also utilize demographic factors to anticipate the probability of individuals being affected by the minimum wage increase and then categorize them into high, medium, and low probability groups, following a method similar to Card and Krueger (1995). Again the employment effects in these subgroups are close to zero and not statistically significant. This similar reaction regarding the employment and wage effect among these different subgroups also implies that the consequences of minimum wage policies were almost equally shared among them.

By using the bunching approach, I can also investigate the impact of minimum wages on employment and wages for different sectors of the economy. I show that the minimum wage is likely to have a negative effect on employment in the oil, wholesale, retail, information, finance, real estate, healthcare, and public sectors. Among them, I only found a significant negative employment effect of 4% in the retail sector. The employment elasticity with respect to own wage for this sector is -0.618, although the standard error is large. At the same time, the effect of the minimum wage is close to zero in sectors like food, agriculture, arts, transport, and utilities. As we know, the food and retail sectors in Canada are the ones with the highest proportion of minimum wage workers, but these two sectors show different signs. This aligns with Harasztosi and Lindner (2019) argument that the composition of industries within the local economy likely influences the impact of minimum wage increases.

Following Cengiz et al. (2019), I also investigate whether changes in minimum wages affect incumbent workers differently than new entrants to the labor market. My findings indicate some differences in terms of employment and wage changes between these groups. However, I should mention that I can only investigate the impact of a minimum wage increase on employment and on the average wage of affected workers for incumbent vs new entrants only for the month before the shock and the month after the shock. However, the data Cengiz et al. (2019) used allows them to follow individuals for up to one year after the minimum wage increase. This is not possible in LFS data. Cengiz et al. (2019) did not find any significant negative employment effects for the incumbent or for the new entrant. However, they found significant wage spillovers up to $3 above the minimum wage for the incumbent and no spillover for the new entrant. In my study, neither new entrants nor incumbents experience a spillover, but I observe a negative employment effect of 3% for the incumbent. This is statistically significant.

I also conducted an investigation into the impact of minimum wage shocks, focusing on both Ontario-specific and Canada study data from alternative workforces. A key aspect of my analysis centered on examining the effects on tipped and hourly workers. Regarding hourly workers, my analysis did not reveal any significant negative employment effects in either the Ontario-specific or Canada study datasets. However, significant negative employment effects were observed for workers who received tips in the Ontario study. This result may be biased, as some of these workers in Ontario, such as those in liquor-serving establishments, receive lower minimum wages. Due to limitations in my data, I cannot exclude liquor servers to precisely assess the impact of minimum wage increases on the targeted groups. Therefore, in the Canadian context, focusing solely on these types of workers might yield misleading results because of the variation in sub-minimum wage policies among them across provinces. To address this issue, I separately investigated the employment and wage effects of minimum wage increases in provinces where the minimum wage is consistent across both tipped and non-tipped workers. In these provinces, there was no significant negative employment effect.

Furthermore, when considering the distinction between permanent and non-permanent jobs, the Ontario-specific case study did not show any significant negative employment effects. In contrast, the Canada study revealed a significant negative employment effect for permanent positions. This aligns with the findings of Campolieti, Gunderson, and Lee (2014), who suggested that the effects of minimum wage changes may be more pronounced among individuals holding permanent positions compared to those in temporary roles. Overall, these findings highlight the nuanced nature of the impact of minimum wage shocks, emphasizing the importance of considering various factors, including worker classifications and industry-specific dynamics, in understanding their effects on employment.

This thesis adds some contributions to the existing literature on minimum wages. The literature on the employment effects of minimum wage changes generally focused on specific groups thought to be more sensitive to wage changes such as teens (e.g., Card and Krueger, 1993; Neumark and Wascher, 1993; Campolieti, Fang, and Gunderson, 2005; Neumark et al., 2014; Allegretto et al., 2017), workers in specific sectors (e.g., Katz and Krueger, 1992; Card and Krueger, 1993; Dube et al., 2010), or workers earning low wages before the minimum wage increase (e.g., Currie and Fallick, 1996; Abowd, Kramarz, Lemieux, and Margolis, 2000; Clemens and Wither, 2019), while the overall impact of minimum wage changes on employment across all affected workers. This limitation is especially significant given the priority policymakers place on understanding the broader employment effects on low-wage workers. The impact of the minimum wage increase on overall employment is better understood by looking at the distribution of jobs across different wage levels and then focusing on jobs at or below the new minimum wage and comparing these with jobs above the new minimum up to a certain wage level.

One of the empirical studies of the overall employment effect is Meer and West (2016), which used U.S. data to assess the relationship between aggregate employment at the state level and minimum wage changes. However, they did not estimate the wage effect. In their study, they demonstrated a considerable negative employment effect by employing the classic two-way fixed effects regression on the logarithm of the minimum wage.

Another study is Cengiz et al. (2019) which investigated the overall employment effect of minimum wage by dis-aggregating employment into wage bins and using a bunching estimator and event study analysis. They focus on jobs at or below the new minimum wage and compare these with jobs up to $4 above the new minimum. They also investigated the effect of the minimum wage policy on the average wage of affected workers. In contrast to Meer and West (2016), they did not find any significant negative overall employment effect.

Another relevant study was conducted by Fossati and Marchand (2024). They examine the impacts of minimum wage changes on employment following Alberta's nominal minimum wage increase, which occurred in four annual increments from 2015 to 2018. To focus on potentially affected workers, they organize their data analysis according to three criteria: wages, ages, and regions. Their wage bin approach is similar to that of Cengiz et al. (2019).

Overall, the evidence from their wage bins indicates that employers in Alberta complied with the incremental minimum wage increases from 2015 to 2018. When examining the employment effects of minimum wage increases by age, they found a significant negative impact on young workers (ages 15-24) but not on older workers. Additionally, the negative employment effect was observed in areas outside Alberta's two main cities, whereas it was not present within those cities.

My contribution relative to the article of Fossati and Marchand (2024) involves examining the largest real minimum wage increase in Canada and encompassing all minimum wage increases in Canada from 1999 to 2019. This comprehensive approach provides a more robust reference compared to relying solely on a single minimum wage increase. Furthermore, I explore the impact of minimum wage increase on the average wage of affected workers and quantify the spill-over effect on wages. In this thesis, I replicate what Cengiz et al. (2019) did in their paper but using Canadian data.

The rest of this thesis is organized as follows. Chapter 2 explains the empirical literature review for the employment effect of minimum wage. Chapter 3 describes the history of minimum wage changes in Canada. Chapter 4 details the economic models of minimum wage concerning employment and wage effects. Chapter 5 covers the methodology, including bunching in the standard labor demand framework, the difference-in-difference estimator, event study analysis, and the empirical implementation of my study for both single and multiple minimum wage increases. Chapter 6 explains the data and sample construction of my study. Chapter 7 presents the main empirical results on overall employment effects, wage spillovers, and heterogeneous responses to the minimum wage increases based on different types of workers and industries. Chapter 8 concludes the thesis.

Chapter 2

Literature Review

2.1 Empirical Research on the Minimum Wage

Extensive research explores how the minimum wage affects employment. Despite its vastness, I have aimed to present a summary of the debate's essence up to the early 2000s. Following this, I focus on key empirical studies post-2000, predominantly centered on the U.S. and Canada, offering a closer examination of recent developments in this domain. I also included the results of three important meta-studies regarding the effect of minimum wage on employment.

2.1.1 Before the 2000s

In 1977, the Minimum Wage Study Commission (MWSC) delved into minimum wage research in the U.S. and Canada, primarily concentrating on assessing the probable effects of minimum wage increase (after adjusting for inflation) specifically for younger workers. After a four-year, $17 million effort, they published a 250-page report and six additional research volumes. The report, analyzed employment effects by age group. They found that a 10 percent minimum wage increase decreased teen employment by 0 to 1.5 percent, with smaller negative impacts on young adults. Their overall consensus from theoretical and empirical research until the late 1970s suggested minimal dis-employment effects, primarily among teenagers and possibly younger workers (Commission, 1981).

For about a decade, the MWSC's findings dominated economic perspectives. However, by the early 1990s, a new wave of minimum wage research emerged. This "new minimum wage research" introduced innovative methods like natural experiments and examining variations across states to reassess the minimum wage's impact on employment. Natural experiments in the context of the minimum wage aimed to replicate laboratory experiments in real-world settings. These experiments observed how a policy change, like a minimum wage increase, affected employment by comparing workers impacted by the change to a similar group unaffected by the change (Schmitt, 2013).

Among the studies employing a natural experiment, Card and Krueger (1993)'s research on the effects of the 1992 New Jersey state minimum wage hike on fast-food employment stands out as the most influential. This study examines employer responses in a low-wage labor market following a minimum wage increase. This paper presents new evidence from an analysis of 410 fast-food restaurants in New Jersey and Pennsylvania after New Jersey raised its minimum wage. Comparing employment, wages, and prices before and after the increase and within New Jersey's high- and low-wage stores offers insight into the impact. Significantly, the increase in the minimum wage happened during a recession, providing a clearer context to assess its impacts. Comparing stores in eastern Pennsylvania with those in New Jersey provides a natural control group, while variations in wages within New Jersey offer additional insights. The study closely tracked store's pre- and post-wage hikes, capturing overall employment changes, including store closures. However, it does not account for the potential influence of minimum wages on new store openings. To estimate this, growth rates of fast-food outlets were correlated with relative minimum wage measures across states from 1986 to 1991. In the end, they did not find any signs suggesting that the increase in the minimum wage resulted in reduced employment at fast-food restaurants.

The "New Minimum Wage" research also highlighted research methodologies that focused on significant differences in how the federal minimum wage impacted various states. Regarding this issue, Card (1992b) utilized the impact of the April 1990 federal minimum wage increase to evaluate its effects on teenagers in the U.S. The national wage standard created a natural experiment where the effect in each state depended on the proportion of workers initially earning less than the new minimum. By the late 1980s, there was a notable disparity in teenage wages among states, with many having their minimum wages above the federal standard. The percentage of teenagers affected by the federal wage hike varied significantly across states. Predictions based on estimation of Brown, Gilroy, and Kohen (1982) suggested a potential decrease of 1 to 4 percentage points in overall teenage employment due to the increase. However, the study found that while the wage increase did elevate average teenage wages, it did not significantly impact teenage employment rates or school enrollment patterns. These results challenged traditional predictions but aligned with "case studies" (Card, 1992a; Lester, 1960) using a similar approach, supporting the notion that minimum wage changes may not significantly affect teenage employment.

Card and Krueger (1995)'s book, "Myth and Measurement" stands as the definitive summary of the "New Minimum Wage" research. Card and Krueger (1995)'s exploration in "Myth and Measurement" began with states raising their minimum wages in reaction to a federal freeze during the late 1980s. Over the past two decades, most states have established minimum wages above the federal level, rendering the federal wage less significant. The book, challenging traditional views, demonstrated that minimum wages did not reduce employment but instead increased income for low-wage workers. This contradicted earlier U.S. minimum wage research. studies, utilizing similar methodologies to Lester (1960)'s, continued to confirm minimal employment effects of minimum wage changes (Lemieux, 2017).

The "Myth and Measurement" approach pioneered by Card and Krueger (1995), examining the impact of minimum wage changes on employment, continued to shape labor economics. Their approach, such as difference-in-differences analyses, was widely adopted. Their work emphasized the importance of credible research designs and showed the insufficiency of simplistic competitive labor market models. By presenting more robust empirical methods and challenging the conventional labor market models, the book spurred a transformation in labor economics research. Even after two decades, "Myth and Measurement" remains influential. It has affirmed the lack of substantial adverse employment effects resulting from minimum wage adjustments, particularly noticeable in the UK after the introduction of their minimum wage in 1999. The book's legacy lies in its groundbreaking research methods, challenging conventional models, and shaping contemporary labor economics with more realistic approaches (Lemieux, 2017).

2.1.2 From the 2000s Onward

As we entered the 21st century, the discourse on minimum wage centered around two main perspectives. On one side were researchers associated with the "new minimum-wage research," excluding Card and Krueger (2000), who, after their 2000 re-analysis of their renowned New Jersey fast-food study, did not contribute further to the minimum wage discussion. The opposing viewpoint came from critics of the minimum wage and the new research, with Neumark and Wascher (2008) being among the most prolific dissenters. Both camps have continued to produce extensive research, giving rise to what economist Dube (2011) refers to as a "fourth generation" of minimum wage research, aimed at reconciling sometimes conflicting evidence.

Neumark and Wascher (2008) offers a critical perspective on the minimum wage, responding to the ideas presented in "Myth and Measurement." They emphasize their work alongside critiques from economists critical of the minimum wage. Their assessment indicates that recent reliable research, based on time-series analysis using modern econometric techniques with state-level data, suggests that minimum wages tend to reduce the employment of low-wage workers, particularly teenagers and sometimes less-educated workers. They also observe that raising minimum wages increases wages for those directly affected, extending some benefits to slightly higher-skilled workers with marginally increased wages. However, the diminishing real value of the federal minimum wage in the U.S. has worsened the difference in wages over time.

2.1.2.1 Some Meta-Studies on Minimum Wage

A meta-study, also known as a meta-analysis, is a research approach that involves systematically collecting and analyzing data from multiple individual studies on a particular topic. Instead of conducting new experiments or investigations, a meta-study gathers existing research findings, combines them, and applies statistical techniques to draw overall conclusions or identify patterns across the body of work. Its goal is to offer a thorough and integrated comprehension of a topic by consolidating and analyzing data derived from diverse independent studies.

Doucouliagos and Stanley (2009) replicated and extended Card and Krueger (1995)'s meta-analysis of the minimum-wage effect employing valid meta-analytic methods that differentiate genuine empirical effects from publication selection bias. They showed that although there were problems with Card and Krueger (1995)'s meta-analysis, their conclusion regarding publication selection in this literature was largely correct. More importantly, once the effects of publication selection were filtered out, this large and rich research record did not support an adverse employment effect on the employment effects of minimum-wage regulations. This conclusion is drawn from an extensive meta-analysis of 64 minimum-wage studies that combined 1,474 estimates of employment elasticity.

Belman and Wolfson (2014) conducted an exclusive meta-analysis on minimum wage studies published post-2000. They selected 27 studies providing essential elasticity estimates and standard errors, totaling 201 employment estimates. Their analysis factored in various study features like the demographics studied (e.g., teens or fast food workers), the labor market perspective (supply or demand), and other relevant traits. Despite generating diverse estimates, none indicated any statistically significant negative impacts on employment due to the minimum wage increase.

However, meta-studies based on Canadian data show different results than the U.S. ones. Campolieti (2020) conducts a meta-analysis of Canadian studies exploring the impact of minimum wage on employment. The author uses various meta-regression methods to assess publication bias and ascertain the empirical effect after correcting for this bias. His findings focus on teenagers, a key interest for policymakers, revealing no publication bias, suggesting a minimum wage employment elasticity of approximately -0.27. While some Canadian studies indicate a higher range of elasticity estimates (-0.3 to -0.6), the meta-regressions in this paper indicate a moderate but still notable adverse employment effect. Expanding the analysis to include young adults and youths slightly reduces the minimum wage elasticity, yet no evidence of publication bias is found. These results contrast with meta-analyses from other countries like the US and the UK, which typically identify publication bias and minimal employment effects after accounting for it. This analysis provides crucial insights for Canadian policymakers, emphasizing that minimum wage adjustments in Canada notably impact employment among individuals aged 15–19.

2.1.2.2 More Recent Empirical Studies on Minimum Wage

Dube et al. (2010) investigated the employment effect of minimum wage increases in the U.S. between 1990 and 2006. They employed a local identification strategy utilizing differences in minimum wages between neighboring counties to overcome biases in traditional methods. Like many studies on the employment effect of minimum wage effect, they selected restaurants as the key industry for investigating the impacts of minimum wage. Restaurants employed a substantial portion of minimum wage workers, with nearly 30% of workers within 10% of the minimum wage in 2006. They stand as the leading employer of minimum wage workers at this minimum wage level and utilize such workers more intensely than any other industry. Due to this, changes in minimum wage laws have a more pronounced impact on restaurants compared to other businesses.

While Dube et al. (2010)'s main emphasis remains on restaurants, they also provided findings for the broader accommodation and food services sector, as well as for the retail sector. Additionally, they presented results for manufacturing as a counterfactual scenario, considering it is an industry with minimal presence of minimum wage workers. They constructed their research framework emphasizing comparisons between neighboring economic areas with similar characteristics but varying minimum wages. For comprehensive employment and earnings data at the county level, they used the Quarterly Census of Employment and Wages (QCEW), offering detailed industry-specific payroll information quarterly.Their Findings indicate significant earnings effects but no employment impact from minimum wage hikes across contiguous counties. In sectors with higher average wages, the estimated treatment effects are reduced, and there are no notable employment effects observed across any of these sectors.

Dube et al. (2010) also pointed out that differences in estimated elasticities between local and national studies stem from unaccounted heterogeneity in employment trends, not short-term windows in local studies. Based on their paper, regional employment trends unrelated to minimum wage policies primarily drive negative elasticities seen in traditional analyses. Their research suggests that minimum wage increases do raise overall earnings at affected jobs but might have varied effects among demographic groups due to labor-labor substitution. Their study emphasizes the need to account for heterogeneity in future research and notes limitations in predicting the impacts of significantly larger minimum wage increases or assessing impacts on hours due to data constraints.

Dube et al. (2010)'s approach extends Card and Krueger (1993)'s study on New Jersey and Pennsylvania, offering distinct advantages. Firstly, their considerably larger sample size enabled a more comprehensive examination of employment outcomes compared to the limited scope of the single 1992 case. Secondly, spanning 16 years across counties allowed for investigating potential longer-term effects. Lastly, the varying relative minimum wage across counties and periods provided substantial experimental variation beyond the constraints of previous studies. Leveraging these statistical advantages and a large sample of border counties, Dube et al. found notable impacts on earnings but no discernible effects on employment resulting from increases in the minimum wage.

Addison, Blackburn, and Cotti (2012), separately from Dube et al. (2010), utilized analogous county-level data within the restaurant and bar sector, reaching comparable conclusions. Their primary data source for estimating their models stems from the Quarterly

Census of Employment and Wages (QCEW) provided by the Bureau of Labor Statistics (BLS). In their study, they highlight the fact that existing research using cross-state variation in minimum wages might overstate estimate precision due to a statistical issue highlighted by Bertrand, Duflo, and Mullainathan (2004). They mention difference-in-difference estimates may involve policy-related variables measured at a more aggregated level than the dependent variable, leading to biased inferences if error term correlations across observations exist. While clustered standard errors can mitigate this bias, Neumark and Wascher (1993)'s results are only partly robust to this correction. The study by Card and Krueger (1993) suffers from limited geographic focus and potential unreliability due to error term correlations.

Addison et al. (2012) also implied that Dube et al. (2010) avoids this limitation by utilizing data from the restaurant sector, comparing state-border counties, and incorporating specific time-period county-pair effects. Yet, their modeling approach presented challenges by including a county's employment multiple times, each with different controls, which can affect precision. In contrast, Addison et al. (2012) adopts an approach akin to Neumark and Wascher (1993), focusing on the restaurant-and-bar sector at the county level. This approach allows for more precise control over local economic factors and incorporates county-specific employment and earnings trends. Their analysis does not indicate employment reduction due to minimum wages in this sector.

Allegretto, Dube, and Reich (2011) built upon the insights of Dube et al. (2010) in their examination of teen employment from 1990 to 2009. This study challenged the conventional wisdom regarding minimum wage increases and their impact on teen employment. Using typical fixed-effects specifications, the estimated employment elasticity aligns with previous national studies, indicating a slight dis-employment consensus. However, controlling for Census division variations and state-specific trends renders employment elasticities statistically indistinguishable from zero.

Furthermore, Allegretto et al. (2011) pointed out that by analyzing dynamic specifications through distributed lags they could see some flaws in the fixed-effects model, revealing unusual employment trends before actual wage increases, which discounts the anticipation effect. Based on their study Spatial controls also reduce the effect on hours, supporting the failure of the fixed-effects model to address state heterogeneity effectively. Moreover, they implied exploring treatment effect heterogeneity during business cycle phases did not show systematic differences between high and low unemployment periods. Comparisons with similar studies reflected closely aligned estimated minimum wage employment elasticities, reinforcing the significance of controlling for spatial heterogeneity.

Allegretto et al. (2011)'s study offered two significant contributions to the policy discourse. Firstly, they focused on teen employment rather than industry employment, aligning their findings more closely with previous research on the minimum wage. Additionally, their inclusion of data encompassing the deep recession between December 2007 and June 2009 enabled the exploration of potential correlations between the minimum wage and severe economic downturns. Overall, their analysis emphasizes the substantial concerns of unobserved state heterogeneities in conventional minimum wage studies, challenging previous interpretations and suggesting that minimum wage increases in the US, within the existing range, do not diminish teen employment.

Sabia, Burkhauser, and Hansen (2012) employed methods akin to the original Card and Krueger New Jersey study. They investigated the impact of a New York state minimum wage increase from $5.15 to $7.15 over three steps between 2004 and 2007. The study explored employment trends and employed a synthetic control design. In their article, they compared the effect of a minimum wage hike on the employment of less-educated 16-to-29-year-olds in New York to similar workers in neighboring states without a wage hike (Pennsylvania, Ohio, and New Hampshire).

Additionally, Sabia et al. (2012) contrasted the employment outcomes of less-educated 16-to-29-year-olds in New York with those of better-educated peers in the same age group within the state. While the wage hike boosted the earnings of less-skilled younger workers in New York compared to similar workers and their educated counterparts, their analysis also revealed a substantial reduction in employment rates among this demographic, indicating a median elasticity around -0.7, larger than the typically reported consensus estimates of -0.1

to -0.3 in the literature.

Sabia et al. (2012)'s study faces a similar critique as Card and Krueger (1993)'s study. Their analysis focused on a single instance of the minimum wage increase. Even if the true effects were zero, we would expect a mix of positive and negative estimates around zero. Doucouliagos and Stanley (2009)'s extensive meta-study on teenage employment effects demonstrated a broad range of estimates but a concentration of the most accurate ones around zero. Similarly, Belman and Wolfson (2014)'s meta-study from the 1990s to 2010 reaffirms this pattern. Sabia et al. (2012) estimates fall far outside this established consensus range.

Hirsch, Kaufman, and Zelenska (2011) delve into various "channels of adjustment" (CoA) related to the minimum wage, analyzing effects across multiple dimensions like employment, hours, prices, profits, training, and other operational facets. They focus on the three-step increase in the U.S. minimum wage from 2007 to 2009 and examine data from quick-service restaurants in Georgia and Alabama, providing insights into adjustments made by these establishments in response to the wage hikes. Their study employs a unique dataset sourced from individual worker payroll records, surveys with franchise owners and restaurant managers, and interviews with owners and managers. The analysis covers various adjustments beyond employment and hours and aims to provide empirical insights, mainly concentrating on the practical implications rather than solely on theoretical aspects. They find no significant impact of the minimum wage increases on employment or working hours over the three years.

Hirsch et al. (2011)'s research addresses the controversy surrounding MW employment effects by examining compliance costs across restaurants and time. The findings align with other industry-specific studies, suggesting highly variable and statistically insignificant employment and hours impacts across establishments. They also identify that MW costs are absorbed through multiple channels, including price increases, operational adjustments, enhanced employee performance, and changes in wage structures, showcasing how firms navigate the minimum wage's impact.

Hirsch et al. (2011)'s article proposes a new perspective for explaining the frequently observed small or insignificant MW employment effects. It suggests that substantial cost increases in other areas, multiple adjustment channels, and managerial reluctance towards employment cuts contribute to negligible employment effects despite significant MW hikes. Their research does not extensively explore various labor market models, but it hints that different models: competitive, monopsony, and institutional models each hold valuable aspects in understanding the effects of the minimum wage. Collectively, these models provide valuable insights into how the minimum wage influences adjustments in the labor market.

In conclusion, the employment effects Hirsch et al. (2011) found indicated minimal to no negative impacts on employment. They also suggest that all three labor market models have merits but face challenges in fully explaining MW effects. A broader channel of adjustment framework, as employed in this study, could provide valuable insights not only for understanding the MW but also for analyzing other labor market issues which is one of the key contributions of this study.

I should also mention that Hirsch et al. (2011)'s study on the federal minimum wage's effects faces several valid criticisms. Similar to Card and Krueger (1993) and Sabia et al. (2012), a key concern is the challenge of generalizing conclusions from a single minimum wage experiment. Their analysis, limited to 81 restaurants from the same chain and owned by only three franchisees across two states, may lack the necessary diversity and scope for comprehensive generalizations.

The research of Meer and West (2016) challenges approaches used in the literature, suggesting that the minimum wage might not drastically reduce employment levels. They offer theoretical and rational support for the idea that the minimum wage impacts employment gradually over time instead of causing an immediate reduction in its level. They also argue that prevalent practices, such as incorporating state-specific time trends as control variables, could misrepresent the true effects of the minimum wage if they are dynamic over time. By employing various empirical methods using state panels, Meer and West (2016) confirms that minimum wage increases significantly reduce employment over several years. They conduct multiple robustness checks to validate their identification strategy. By including leads of the minimum wage in their specifications they confirm that employment is not negatively affected before the increases ruling out unobserved trends. Their findings are robust even when accounting for state-specific shocks, demographic factors, business cycles, spatial and temporal controls, the financial crisis, and inflation indexing of state minimum wage increases.

By using multiple administrative datasets such as the Business Dynamics Statistics (BDS), the Quarterly Census of Employment and Wages (QCEW), and the Quarterly Workforce Indicators (QWI), the research of Meer and West (2016) consistently reveals the negative impacts of the minimum wage on job growth, contrary to the prevailing focus on immediate effects. These findings persist across various specifications, indicating that the minimum wage diminishes employment over a longer duration, diverging from recent literature that primarily emphasizes short-term impacts. However, Cengiz et al. (2019) will challenge the findings of Meer and West (2016) which will be explained shortly.

Jardim et al. (2017) investigate the impact of Seattle's substantial local minimum wage hikes on employment, earnings, and labor hours in Washington State. Examining data from \$9.47 to \$13 per hour wage increases, reveals significant employment losses, leading to a reduction in payroll expenses and overall employee earnings in low-wage job markets. The study observes nonlinear effects on employment, with the increase to \$13 triggering a substantial drop in employment compared to the rise to \$11, which had a minor impact.

Jardim et al. (2017) challenge the oversimplification of low-skilled labor market models. This is because basic models, assuming all participants possess equal skill levels, generate similar productivity on the job. However, the reality may be different; minimum wages might affect the least-skilled, least-productive workers while leaving more experienced workers at the same firm unaffected. Identifying the precise market for which reduced employment is predicted becomes challenging when direct observation of wages is not feasible.

Jardim et al. (2017) also highlight the point that past studies, often define the relevant market by focusing on specific sectors like the restaurant industry or particular groups such as teenagers. However, these studies might not accurately represent the entire low-wage labor market, as they blend workers affected and unaffected by the minimum wage. Moreover, previous research typically analyzes 'headcount' employment measures, overlooking the prevalence of part-time low-wage jobs where the adjustment in hours worked can be significant. They emphasize their paper takes a broader approach, evaluating the impact of a minimum wage increase across diverse low-wage employee categories, encompassing various industries and worker demographics. Their paper considers both headcount and hours-based measures of labor quantity, using data collected by Washington's Employment Security Department (ESD) for administering unemployment insurance

Additionally, Jardim et al. (2017)'s study evaluates methodological choices, highlights previous approaches' shortcomings, and presents elasticity estimates that suggest substantial dis-employment effects following the minimum wage hikes. However, the study acknowledges limitations in capturing earnings from the informal sector, contractor work, and the potential migration of jobs outside Seattle, emphasizing the need for further investigation into the welfare implications and distributional aspects of minimum wage changes.

A critique has been raised regarding Jardim et al. (2017)'s article, suggesting that it predominantly focuses on a single substantial minimum wage increase. The critic highlights the significance of incorporating multiple events for inference rather than relying solely on a specific change in the minimum wage, citing Cengiz et al. (2019). Cengiz et al. (2019) looked into multiple shocks instead of just one, showing the importance of a more inclusive analysis.

Jales (2018) investigated the effect of minimum wage in a developing country with a large informal sector. He highlights this point that in an economy featuring a substantial informal sector where certain employers disregard the minimum wage, minimum wage increases might not trigger unemployment effects, even within a one-sector competitive model, as long as workers can easily shift between formal and informal sectors and the informal sector has enough capacity to absorb these transitions.

In this paper, Jales (2018) investigates the impact of minimum wage policies by employing a dual-economy model inspired by Doyle (2006). He assesses the effects of minimum wage adjustments on various aspects, including unemployment, average wages, wage inequality, sector mobility, informal sector size, and labor tax revenues. Unlike Doyle (2006)'s approach, Jales (2018) models the joint distribution of wages and sectors (both latent and observed), allowing for an estimation of the formal sector's hypothetical size in the absence of the minimum wage. This approach also helps find the proportion of workers transitioning to the informal sector due to the policy. He defines the criteria for identifying the parameters of the dual-economy model and the latent joint distribution of sector and wages, using wage density discontinuities and the differential responses to minimum wage changes in formal and informal sectors as key identification tools.

The approach of Jales (2018)'s study aligns closely with an expanding body of research utilizing "bunching" and discontinuities in density functions to pinpoint structural parameters and the effects of minimum wage increases (Saez, 2010; Kleven and Waseem, 2013; Kleven, 2016; Jales and Yu, 2017). His model relies on data gathered from 2001 to 2009 sourced from an annual household survey that represents the Brazilian population through repeated cross-sections (PAND).[1]

Jales (2018) discovers that the probability of a worker transitioning from the formal to the informal sector due to the policy is relatively low, roughly around 12%. The joint impact of both unemployment and shifts to the informal sector prompted by the minimum wage introduction results in a 9% reduction in the formal sector's size compared to a scenario without the minimum wage.

Jales (2018) also finds that the impact of the minimum wage on unemployment tends to align with expectations, showing a strong correlation with the actual value of the minimum wage. The minimum wage significantly influences average wages, leading to an approximate 16% increase. It also contributes to changes in wage inequality and has a notable effect on labor tax revenues, resulting in a decrease of about 6%.

However, Jales (2018)'s approach has some limitations. It lacks a fully structural model

[1]PAND: Pesquisa Nacional por Amostra de Domicílios

encompassing both workers' and firms' behavior, which prevents the recovery of fundamental economic parameters like the elasticity of labor demand. Moreover, in developed countries like Canada, the informal sector of the economy, even if it exits, is a small part of the economy. So lack of overall employment effect of minimum wage in Canada or other developed countries is unlikely to be explained by the economy's informal sector. However, the bunching approach that is used here is also used in my thesis.

Jales (2018) utilized Survey of Income and Program Participation (SIPP) data to examine the repercussions of the 2007 to 2009 escalations in the federal minimum wage on the employment and income paths of low-skilled workers. The study delved into the impacts on employment rates, income levels, and income growth. Findings from the SIPP data indicate that the upsurge in the minimum wage during this period decreased overall employment rates by at least half a percentage point in states fully subjected to the federal minimum wage hike from \$5.15 to \$7.25.

Jales (2018) highlight that the impact of the minimum wage hinges significantly on the economic circumstances influencing the wages of low-skilled individuals. Its anticipated consequences can be substantial when low wages stem from vulnerabilities in the bargaining power of low-skilled workers. Conversely, its unintended outcomes can be significant when the low wage rates are a result of reduced demand for the output of low-skilled workers.

Wage and productivity data indicate that the minimum wage hikes Jales (2018) examined had a more profound and enduring impact on the wage distributions of low-skilled groups compared to previous increases. This is influenced by both the scale of the analyzed minimum wage increments and the influence of trade, technology, and the housing market on the demand for low-skilled labor. Their conclusion underscores the importance of examining future minimum wage increases in the context of the evolving demand for low-skilled labor. Jales (2018) use the difference-in-difference method for their estimation. Still, rather than the overall employment effect of the minimum wage increase, their focus is on the workers earning low wages before the minimum wage increase.

The study of Cengiz et al. (2019) delves into the impact of minimum wage increases on low-wage jobs in the U.S. using 138 state-level changes from 1979 to 2016. Employing a bunching and difference-in-differences method, the analysis evaluates the effect of minimum wage increases on employment changes across the wage distribution. The research utilizes hourly wage information extracted from the 1979–2016 Current Population Survey to gauge the impact of the minimum wage across different wage bins. Its focus narrowed to the lower end of the wage distribution, comparing the surplus of jobs meeting or slightly exceeding the new minimum wage to the deficit of jobs paying below it to gauge the employment consequences.

The findings of Cengiz et al. (2019) reveal that the total count of low-wage jobs remained largely unchanged over the five years following the wage increase. However, the direct impact of the minimum wage on average earnings was strengthened by modest wage spillovers at the lower end of the wage distribution. Detailed demographic analysis suggests that the absence of job loss cannot be attributed to labor-labor substitution at the bottom wage levels. Moreover, higher minimum wages did not exhibit signs of dis-employment, adding more credibility to the empirical framework of their study, but there was evidence of reduced employment in tradeable sectors.

Additionally, Cengiz et al. (2019) challenge the findings of Meer and West (2016) by dis-aggregating the wage distribution rather than using the aggregate wage bins. Meer and West (2016)'s study showed a substantial negative employment estimate using fixed effects regression on log minimum wage using aggregate wage distribution. However, Cengiz et al. (2019) mention that the notably negative employment effects in Meer and West (2016)'s study seem driven by an implausibly significant drop in jobs at the higher wage levels, which is not a direct consequence of the minimum wage increase.

Cengiz et al. (2019)'s analysis demonstrates that the substantial negative impact on employment that Meer and West (2016) found stems entirely from the incorporation of data from the 1980s and early 1990s, periods characterized by minimal minimum wage adjustments. Surprisingly, employment fluctuations in the 1980s align with minimum wage changes in the 2000s. While this inclusion biases estimations in the two-way fixed effect approach, it doesn't affect Cengiz et al. (2019)'s event study approach, which centers on localized employment shifts around the event window. All in all, Cengiz et al. (2019)'s study demonstrates the transparency of assessing estimates by decomposing the overall employment effect across the wage distribution, providing a clearer understanding of the plausibility of the results.

2.1.2.3 Some Empirical Studies on Minimum Wage in Canada

Baker, Benjamin, and Stanger (1999) investigated the impact of minimum wage laws in Canada spanning from 1975 to 1993. Their analysis showed that among teenagers, a 10% rise in the minimum wage led to approximately a 2.5% reduction in employment. However, they noted that this outcome is predominantly influenced by low-frequency fluctuations in the data. The employment effect becomes positive but statistically insignificant when observing more frequent variations. The disparity in these employment effects across different data frequencies holds significance for understanding the effects of minimum wage policies on employment dynamics. It shapes the methodology in minimum wage research. This variance also helps reconcile conflicting findings in the "new minimum wage research," which reports either minimal negative or positive correlations.

Yuen (2003) used data from the Labour Market Activity Survey, to investigate the impact of provincial minimum wage increases in Canada from 1988 to 1990. Over this period, ten provinces experienced a total of 19 distinct changes in minimum wages. Initially, he employed the US panel methodology, encompassing high-wage individuals in the control group. The fixed effect estimates suggested a significant negative effect of the minimum wage on employment probability for both teens and young adults, consistent with previous US panel estimates.

Yuen (2003) also restricted the control group to low-wage workers in provinces without any minimum wage change. The resulting estimates of the minimum wage effect were insignificant, nearly zero. This disparity in outcomes between the two methods appears to support criticisms of prior panel studies on minimum wages. The negative and significant estimates from the first method seemed driven by differences in employment stability between high-wage and low-wage workers.

Furthermore, Yuen (2003) analysis uncovered nuanced impacts within seemingly uniform groups of low-wage workers. Workers with extended periods of low-wage employment between 1988 and 1990 experienced significant and economically substantial dis-employment effects following minimum wage increases. For instance, teens with over three-quarters of low-wage employment during this period were 7% less likely to be re-employed after an 8.4% minimum wage hike. Similar trends were observed for young adults, with a 10% decrease in re-employment likelihood.

Yuen (2003) findings remained robust across various control groups, suggesting that the inclusion of high-wage workers in the control group did not bias the minimum wage effect. Conversely, "transitory" low-wage workers, like full-time students in low-paid summer jobs or high-wage workers temporarily in low-paid positions exhibited minimal and insignificant effects from the minimum wage increase. This difference in impact between the two groups might be explained by the fact that their current wage rates could be lower than their actual productivity levels, thus lessening the influence of the minimum wage on their employment prospects in a supply-and-demand framework.

Campolieti et al. (2005) use Canadian data to assess the impact of minimum wages on the employment transitions of low-wage youths. their approach offers several contributions to the existing empirical literature. First, it allows for a direct comparison between low-wage workers in both at-risk and comparison groups, sidestepping the reliance on high-wage workers as a comparison group, a limitation often present in US data.

Second, Campolieti et al. (2005) utilize data spanning from 1993 to 1999, encompassing economic fluctuations, including a recession in the early 1990s and subsequent economic expansion.Third, their study includes the effects of 24 distinct minimum wage changes across various provinces and time frames.

Fourth, by employing alternative comparison groups, Campolieti et al. (2005) test the sensitivity of their results to factors like including high-wage comparison groups and examine differences in unobserved factors affecting wages and employment.

Fifth, Campolieti et al. (2005)'s analysis delves into not just the effect of being at risk due to a minimum wage increase but also measures the extent of that risk by considering the individual's wage adjustment compared to the new minimum wage. They introduce a novel "gap" methodology, allowing them to control for differences in within-group heterogeneity between treatment and comparison groups.

Sixth, Campolieti et al. (2005)'s research explores the sensitivity of their estimates to factors such as the impact of pre-announced minimum wage increases and the effects of substantial minimum wage hikes, providing a comprehensive examination of various influencing factors on employment transitions due to minimum wage increases.

Campolieti et al. (2005)'s primary findings, derived from employing suitable low-wage comparison groups, indicate that these minimum wage increases generally resulted in increased transitions from employment to non-employment among low-wage youths at risk. This increase ranged from about 4 to 8 percentage points, with their preferred estimate hovering around 6 percentage points.

Moreover, Campolieti et al. (2005) reveal that a 1% increase in the minimum wage corresponds to a rise in the transition from employment to non-employment, varying between approximately 1 to 2%. Their preferred estimate for this impact is 1.5%. These outcomes suggest 'minimum wage elasticities' of roughly -0.3 to -0.5, with an estimate around -0.4 falling within a reasonable mid-range.

In summary Campolieti et al. (2005)'s results exhibit robustness across different models and estimation strategies. They also indicate that the adverse effects on employment transitions are not significantly influenced by whether the minimum wage hikes are pre-announced or occur regularly. However, these effects are notably more substantial when there is a significant single increase in the minimum wage compared to a series of smaller incremental changes of the same magnitude.

The study of Sen, Rybczynski, and Van De Waal (2011) investigates the effects of minimum wage increases on teen employment and the percentage of families below the Low Income Cut Offs (LICOs) in Canada, using data from 1981 to 2004 across different provinces. This analysis delves into the potential for simultaneous biases and attempts to establish a connection between teen unemployment and household poverty. The findings reveal elasticities of -0.3 to -0.5 concerning the minimum wage's impact on teen employment. Regarding the percentage of families beneath the LICOs, the estimates suggest elasticities between 0.4 and 0.6, indicating a link between minimum wage and increased family poverty.

Despite the argument that a higher minimum wage might not severely affect the overall labor force due to the relatively low proportion of minimum wage earners, the study of Sen et al. (2011) indicates paradoxical outcomes. Although a higher minimum wage leads to increased earnings for some, it may trigger higher teen unemployment, resulting in reduced household income among low-income families. Therefore, the anticipated benefits from increased earnings could be offset by the negative spillovers, mitigating the positive impact on the working poor. The analysis questions the effectiveness of minimum wage legislation in alleviating poverty and calls for further research on its connection to poverty levels.

In summary, the article of Sen et al. (2011) suggests that a higher minimum wage might not necessarily benefit low-income households as expected. It emphasizes the need for more comprehensive research on the relationship between minimum wages and poverty, challenging the assumption that such legislation directly diminishes poverty.

The paper of Lemieux (2011) introduces a novel distribution regression method to explore how the minimum wage impacts wages and employment jointly. It complements the commonly used difference-in-differences approach by pinpointing where in the wage distribution the minimum wage effects are concentrated. The study also evaluates the validity of this approach by examining if the minimum wage influences the upper end of the distribution. The study focuses on Canada's labor market between 1997 and 2010, utilizing detailed wage data from the Labour Force Survey (LFS) and implementing the distribution regression approach.

Regarding teenagers, the findings of Lemieux (2011) suggest a pattern consistent with a model showing a spike in the distribution of the minimum wage, accompanied by some reduction in employment. No significant secondary effects are evident in these wage data, and the minimum wage does not seem to affect higher wage levels, reinforcing the study's credibility. However, for young adults, the minimum wage does not show any distinct impact on wage distribution or employment. Methodologically, the paper bridges two research areas employment and wage distribution effects of the minimum wage using a unified framework based on distribution regressions. This method is user-friendly and holds potential for application in various contexts beyond this study. Overall, this research addresses the limitations of conventional approaches in estimating minimum wage effects, aiming to provide a more detailed understanding of how minimum wage policies impact wages and employment across various wage levels.

This empirical study of Campolieti et al. (2014) explores the impact of minimum wage changes from 1997 to 2008 in Canada, highlighting differences between permanent and temporary minimum wage workers. During that time frame, the rise in minimum wage led to a roughly 2-percentage-point decrease in employment probability for teens aged 15–19 and young adults aged 20–24. Notably, this effect was more pronounced among teens compared to young adults, to the extent that it was statistically insignificant for the latter group. These negative impacts on employment imply minimum wage elasticities around -0.16 for both teens and young adults together. This falls towards the lower end of the typical range found, which spans from -0.3 to -0.6.

The adverse effects were more significant for permanent workers than temporary ones, with statistically insignificant effects observed for the latter. This distinction between permanent and temporary workers is crucial, as adverse employment effects seem to impact those in permanent low-wage jobs more significantly.Employers appear less inclined to adjust their hiring or layoffs for workers in temporary positions, given the fixed termination dates associated with such roles. In contrast, workers in more permanent low-wage jobs, characterized by lower skill levels, face higher risks of adverse employment effects due to employers finding it more cost-effective to make adjustments in these situations (Campolieti et al., 2014).

The absence of adverse effects on temporary workers implies that minimum wages do not impede employers from using temporary roles as a screening mechanism for future promotions. However, adverse employment effects predominantly affect individuals who might have permanent low-wage jobs, potentially trapping them in disadvantaged positions. For these individuals, having a permanent low-wage job might still be preferable to unemployment, highlighting the complexity of the impact of minimum wage changes on different segments of the workforce (Campolieti et al., 2014).

The article of Campolieti (2015) examines the impact of minimum wage on wage distribution and spillover effects among men and women aged 15 to 64 using Statistics Canada's LFS data from 1997 to 2010. Additionally, it explores the minimum wage's effects on the wages and wage distribution of individuals aged 15 to 24 in a separate analysis. The study employs two methodologies: one leverages cross-sectional and time-series variation in the minimum wage to assess its impact across different wage percentiles, while the other estimates spillover effects using the model of Manning (2003) defining a latent wage distribution—wages in the absence of minimum wage.

Notably, the analysis suggests that estimates of spillover effects might encompass some dis-employment outcomes associated with minimum wage changes. Earlier research has focused on employment effects among teenagers, young adults, and low-skilled workers, highlighting significant dis-employment effects. Evidence from Canadian studies during the period considered shows slight dis-employment effects for teens and young adults compared to prior research in Canada (Campolieti, 2015).

For individuals aged 15 to 64, the estimates indicate that the minimum wage affects wages up to the 5th percentile for men and extends to the 10th percentile for women. Modest spillover effects, smaller than those in the U.S. but larger than UK-based estimates, are observed in this age group. However, for those aged 15 to 24, the spillover effects are more substantial, impacting a broader spectrum of the wage distribution. Overall, the findings of Campolieti (2015) support the existence of wage spillovers from the minimum wage, particularly highlighting compression in the lower wage distribution tail, notably pronounced among women.

The study of Fossati and Marchand (2024) analyzed the impact of Alberta's $15 minimum wage policy on employment using synthetic control methods applied to Statistics Canada's Labour Force Survey data. Compared to the existing literature on minimum wages, this study stands out due to Alberta's unique and sudden policy shift, its robust control group, and its focused approach to analyzing impacts based on wage, age, and region. It primarily compared Alberta, with its sudden policy change, to Saskatchewan, which followed a formula-based minimum wage strategy akin to Alberta's prior approach. The study also segmented workers into wage bins aligned with Alberta's wage increments to refine the analysis further.

Examining employment changes based on wage bins revealed a consistent upward movement due to the policy, though not all workers moved into higher wage brackets. Analysis by age group indicated employment losses among younger individuals (aged 15 to 24) but no significant losses among older individuals (aged 25 and above). Regarding regional analysis, employment losses were found in non-urban areas while urban areas showed insignificant losses (Cengiz et al., 2019).

The interpretation of the evidence was carefully presented, acknowledging the bifurcated state of the minimum wage literature. Fossati and Marchand (2024)'s findings, while indicating modest employment losses due to the wage increases, were significant among the younger age group and non-urban regions. These results are crucial for evaluating forthcoming regions implementing or surpassing the $15 minimum wage threshold, highlighting the importance of considering wage-to-median-wage ratios for anticipating employment impacts in different geographies. Alberta, with its high wage-to-median-wage ratio, experienced notable employment effects among specific demographics and regions, underscoring the importance of these points for future policy evaluations.

However, a similar criticism, similar to the one raised in the study by Jardim et al. (2017), applies to the research of Fossati and Marchand (2024), as it solely concentrates on a single significant minimum wage hike. so in my study, I investigated not only the most substantial one-step real minimum wage shock that happened in Ontario. but also, rather than depending solely on one shock, I pooled multiple minimum wage shocks following what Cengiz et al. (2019) did in their study.

Chapter 3

Minimum Wage Changes in Canada

3.1 Historical Overview of Minimum Wage Rates Across Provinces in Canada

Canada's approach to minimum wage has historically been a provincial matter, with each province and territory setting its rate based on regional economic conditions, cost of living, and political climate. This overview provides a snapshot of how minimum wage rates have evolved across Canada's provinces, highlighting the diversity in policy approaches and economic contexts.

3.1.1 Early Beginnings

The concept of a minimum wage originated in Canada in the early 20th century with several provinces enacting legislation to establish wage floors. this concept was first introduced to protect women and children from exploitative wages. Over time, these protections extended to all workers. The first provincial minimum wage law was introduced in Manitoba in 1920, followed by similar measures in other provinces. British Columbia was also One of the first provinces to establish a minimum wage, in 1918, initially for female workers. province of

Ontario followed suit in 1920, with rates varying by industry. However, these initial initiatives were often limited in scope and enforcement, resulting in wide disparities in minimum wage rates between jurisdictions (Derry and Douglas, 1922).

3.1.2 The Post-War Period To the Late 20th Century

the history of minimum wage in Canada during the Post-War Period to the Late 20th Century reflects a dynamic interplay of economic, social, and political factors. Minimum wage policies evolved in response to changing circumstances, with governments striving to strike a balance between protecting workers' incomes and supporting economic growth and competitiveness (Benjamin, 2001).

3.1.2.1 Post-World War II Reconstruction (1940s-1950s)

Following the conclusion of World War II, Canada entered a phase of post-war reconstruction and economic expansion. This era, spanning from the 1940s through the 1950s, marked a pivotal period in Canadian history characterized by significant social and economic changes. In response to the challenges posed by the shifting labor market landscape, several provinces across Canada took proactive measures to establish or enhance minimum wage policies. Recognizing the need to provide fair compensation for workers and address labor market challenges, provincial governments embarked on initiatives to introduce or expand minimum wage regulations. These efforts were aimed at ensuring that workers received adequate remuneration for their contributions to the workforce. As a result, laws were passed to set minimum wage rates specifically for different industries and jobs. These rates were designed to meet the specific needs of the labor market in different parts of the country, taking into account the unique characteristics of each region (Benjamin, 2001).

The expansion of minimum wage policies during this period reflected a broader societal commitment to improving working conditions and promoting economic security for Canadian workers. By setting minimum wage standards, provincial governments sought to uphold principles of fairness and equity in the workplace, laying the foundation for the development of more comprehensive labor rights and social welfare policies in the years to come (Douglas Belshaw, 2016).

3.1.2.2 Expansion and Standardization (1960s-1970s)

During the 1960s and 1970s, there was a time when the rules about minimum wages in Canada got bigger and more similar across different places. This is called "Expansion and Standardization."What happened was that more and more types of jobs and industries started to have rules about minimum wages. Before this time, not every job or industry had these rules. But during the 1960s and 1970s, provinces decided to make these rules cover more areas to make sure more workers were protected. Also, the rules about minimum wages became more similar between provinces. This means that the lowest wages for similar jobs were closer to each other across Canada. It was like making sure that workers in one province had similar protections and pay as workers in another province. This made things fairer for workers, no matter where they lived in Canada. Minimum wage rates varied widely across provinces during the early 1960s, typically ranging from around $0.50 to $1.00 per hour. Minimum wage rates continued to increase gradually during the 1970s, with most provinces raising their rates to keep pace with inflation and rising living costs. By the end of the 1970s, minimum wage rates had generally doubled compared to the early 1960s, reaching around $2.00 to $3.00 per hour in many provinces (Battle, 2015).

3.1.2.3 Pressures from Inflation and Necessary Adjustments(1980s)

During the 1980s, Canada experienced economic instability and inflationary pressures, which affected various aspects of the economy, including minimum wage policies. In response to inflationary pressures, provincial governments adjusted minimum wage rates periodically. Several provinces implemented minimum wage reforms and adjustments to ensure that workers received a living wage, with rates surpassing $4.00 per hour in some regions by the end of the decade. However, these adjustments posed challenges for provincial governments.

On one hand, there was a need to protect workers' incomes and ensure that they could afford necessities. On the other hand, policymakers had to consider the potential impact of increasing minimum wage rates on inflation and economic competitiveness. Raising minimum wages too quickly or by too much could potentially lead to higher prices for goods and services, affecting overall inflation rates. Additionally, concerns were raised about the impact of higher wage costs on businesses' competitiveness, particularly in industries with thin profit margins (Longworth, 2002; Galarneau and Fecteau, 2015).

Therefore, provincial governments faced the delicate task of balancing the interests of workers with broader economic considerations. They had to strike a balance between supporting workers' incomes and ensuring the stability and competitiveness of the economy. This balancing act required careful deliberation and decision-making by policymakers during a period of economic uncertainty and inflationary pressures.

3.1.2.4 Social and Economic Reforms (1990s)

During the 1990s, Canada experienced a period of significant social and economic reforms, which also influenced minimum wage policies. These reforms aimed to address emerging challenges and promote social equity in the face of changing economic conditions. One notable change during this time was the importance of measures to index minimum wage rates to inflation or other economic indicators. Indexing minimum wage rates meant that they would automatically adjust in line with changes in the cost of living or other economic factors. This approach ensured that minimum wage rates remained responsive to economic conditions, allowing them to keep pace with changes in the economy over time. By indexing minimum wages, policymakers sought to provide more stable and predictable income for low-wage workers, reducing the risk of their purchasing power eroding due to inflation (Clemens and Veldhuis, 2013).

Furthermore, there was a growing recognition of the importance of minimum wage policies in addressing poverty and promoting social equity. Policymakers and advocacy groups increasingly understood that ensuring fair wages for all workers was essential for reducing income inequality and improving living standards for vulnerable populations. As a result, there was heightened attention to the role of minimum wage policies as a tool for poverty reduction and social justice (Addison and Blackburn, 1999).

Overall, minimum wage rates continued to rise throughout the 1990s, albeit at a slower pace compared to previous decades, with rates reaching around $5.00 to $7.00 per hour in many provinces by the end of the decade. due to this slower pace, the 1990s also can be considered as a period of stagnation for minimum wages in many provinces, with some rates remaining unchanged for years, despite inflation. For example, the province of Alberta had one of the lowest rates during this period, reflecting a conservative approach to labor market interventions. On the other hand Quebec and Ontario, in contrast, saw more active adjustments to their minimum wages, influenced by stronger labor movements and differing political ideologies (Galarneau and Fecteau, 2014).

3.1.2.5 Mid 2000s to 2010s Renewed Focus on Living Wages

During the late 2000s and early 2010s, there was a growing acknowledgment and consensus among policymakers, economists, labor advocates, and the public that minimum wage policies should not only serve to prevent worker exploitation but also ensure that wages are sufficient to cover the basic cost of living. This shift in perspective reflected a broader recognition of the challenges faced by low-wage workers in meeting their essential needs, such as housing, food, healthcare, transportation, and education, with their earnings from minimum-wage jobs (Evans and Fanelli, 2016). Ontario, for example, introduced a series of phased-in increases that raised the minimum wage from around $7.00 per hour to approximately $10.25 per hour by 2010, marking a substantial increase over the mid-2000s rates. Other provinces, such as British Columbia, Alberta, and Quebec, also implemented moderate increases to minimum wage rates, although the pace and magnitude varied (Dionne-Simard and Miller, 2019).

3.1.2.6 Late 2010s and Early 2020s: The Drive Towards $15 and Beyond

In recent years, particularly in the late 2010s and early 2020s, there has been a notable push across North America for a $15 minimum wage, driven by advocacy groups, labor unions, and a growing awareness of income inequality. This movement gained significant momentum in Canadian provinces, leading to various responses and commitments from the provincial government. Several provinces in Canada experienced significant minimum wage changes from 2010 to 2020, but the magnitude of these changes varied across regions. Here are some provinces that underwent notable minimum wage increases during this period. Alberta emerged as a trailblazer in the push for a $15 minimum wage by becoming the first province to commit to this target. The province implemented a phased approach to reach the $15 minimum wage goal, with incremental increases over several years. In 2018, Alberta successfully achieved the $15 minimum wage, marking a significant milestone for low-wage workers in the province (Dionne-Simard and Miller, 2019; Fossati and Marchand, 2024).

During this time frame, Ontario embarked on a significant minimum wage increase plan, aiming to raise the minimum wage to $14 per hour in 2018, followed by a further increase to $15 per hour in 2019. However, subsequent changes in government leadership led to adjustments and postponements to the $15 target. Initially planning to align with Alberta's timeline to reach a $15 minimum wage by 2019, Ontario faced challenges when a newly elected government decided to revise the implementation timeline. This decision triggered debates and controversies, with proponents emphasizing the importance of fair wages for workers, while opponents raised concerns about potential negative impacts on businesses and employment levels (Moreau, 2018).

British Columbia also responded to the movement for a $15 minimum wage by announcing a gradual increase plan. The province introduced incremental wage hikes over a specified period, aiming to reach a minimum wage of $15.20 by 2021. This phased approach allowed for adjustments to be made in consideration of economic conditions, labor market dynamics, and the overall impact on businesses and workers (Dionne-Simard and Miller, 2019).

Quebec experienced moderate minimum wage increases during the period, with adjustments made to keep pace with inflation and rising living costs. While the province did not undergo as significant of an increase as Ontario or Alberta, there were notable changes to minimum wage rates over the decade (Dionne-Simard and Miller, 2019).

Table 3.1 presents a history of nominal and real minimum wage increases from 1999 to 2019 across all provinces in Canada. These increases have been selected based on the sample construction, which will be explained in Chapter 6.

Table 3.1: Summary of Minimum Wage Changes in Canadian Provinces (1999-2019)

Province	Year	Month	MW	CPI	MW_real	DMW	DMW_real
Newfoundland	1999	10	5.5	94.6	5.81	0.25	0.25
Newfoundland	2007	10	7.5	111.2	6.74	0.50	0.44
Newfoundland	2008	4	8	113.6	7.04	0.50	0.40
Newfoundland	2009	1	8.5	112.9	7.53	0.50	0.46
Newfoundland	2009	7	9	115.2	7.81	0.50	0.47
Newfoundland	2010	1	9.5	116.5	8.15	0.50	0.34
Newfoundland	2010	7	10	117.6	8.50	0.50	0.39
Prince Edward	2005	1	6.8	106.5	6.38	0.30	0.33
Prince Edward	2007	4	7.5	113.7	6.60	0.35	0.29
Prince Edward	2008	10	8	118.6	6.75	0.25	0.31
Prince Edward	2010	6	8.7	119.2	7.30	0.30	0.25
Prince Edward	2011	6	9.3	123.3	7.54	0.30	0.28
Prince Edward	2012	4	10	126.3	7.92	0.40	0.28
Prince Edward	2019	4	12.25	137.8	8.89	0.70	0.46
Nova Scotia	2003	10	6.25	103.1	6.06	0.25	0.27
Nova Scotia	2005	10	6.8	109.8	6.19	0.30	0.30
Nova Scotia	2007	5	7.6	113.1	6.72	0.45	0.36
Nova Scotia	2008	5	8.1	117.1	6.92	0.50	0.34
Nova Scotia	2009	4	8.6	115	7.48	0.50	0.41
Nova Scotia	2010	4	9.2	117.9	7.80	0.60	0.49
Nova Scotia	2010	10	9.65	119.3	8.09	0.45	0.35
Nova Scotia	2011	10	10	123.9	8.07	0.35	0.28
Nova Scotia	2019	4	11.55	137.4	8.41	0.55	0.37
New Brunswick	2000	1	5.75	93	6.18	0.25	0.29
New Brunswick	2007	1	7	109.2	6.41	0.30	0.27
New Brunswick	2008	4	7.75	112.8	6.87	0.50	0.40
New Brunswick	2010	9	9	116	7.76	0.50	0.43
New Brunswick	2011	4	9.5	120	7.92	0.50	0.38
New Brunswick	2012	4	10	123.1	8.12	0.50	0.35
New Brunswick	2015	1	10.3	123.1	8.37	0.30	0.31
Quebec	2008	5	8.5	113.6	7.48	0.50	0.36
Quebec	2010	5	9.5	114.9	8.27	1.00	0.87
Quebec	2017	5	11.25	127.1	8.85	0.50	0.39
Ontario	2008	4	8.75	112.5	7.78	0.75	0.62
Ontario	2009	4	9.5	113.2	8.39	0.75	0.69
Ontario	2010	4	10.25	115.7	8.86	0.75	0.62
Ontario	2014	6	11	126.9	8.67	0.75	0.57
Ontario	2018	1	14	133.2	10.51	2.30	1.65
Manitoba	1999	4	6	93.1	6.44	0.60	0.60
Manitoba	2006	4	7.6	108.5	7.00	0.35	0.26
Manitoba	2008	4	8.5	112.7	7.54	0.50	0.38
Manitoba	2011	10	10	119.3	8.38	0.50	0.40
Saskatchewan	2002	11	6.65	101.5	6.55	0.30	0.27
Saskatchewan	2006	3	7.55	108.2	6.98	0.50	0.45
Saskatchewan	2008	1	8.25	113	7.30	0.30	0.26
Alberta	2017	10	13.6	137.6	9.88	1.40	0.97
Alberta	2018	10	15	141.4	10.61	1.40	0.97
British Columbia	2000	11	7.6	97.2	7.82	0.45	0.46
British Columbia	2001	11	8	97.5	8.21	0.40	0.48
British Columbia	2011	11	9.5	117.5	8.09	0.75	0.64
British Columbia	2012	5	10.25	118.6	8.64	0.75	0.60
British Columbia	2016	9	10.85	123.2	8.81	0.40	0.34
British Columbia	2017	9	11.35	125.7	9.03	0.50	0.41
British Columbia	2018	6	12.65	128.6	9.84	1.30	1.00
British Columbia	2019	6	13.85	131.9	10.50	1.20	0.90

Source: extracted data from minimum wage database of Statistics Canada, note that DMW is the change in the nominal minimum wage and DMW_real is the change in the real minimum wage.

3.2 Historical Evolution of Wage and Minimum Wage Workers in Canada

A Statistics Canada study investigates the evolution of minimum wage workers from 1998-2018 using annual data from the Labour Force Survey (LFS). It also compares changes in the average minimum wage in Canada with average hourly wages for all employees, which will be briefly discussed here.

3.2.1 Historical Trends on the Share of Minimum Wage Workers in Canada (1998-2018)

As shown in Table 3.2, the proportion of employees earning minimum wage in Canada fluctuated between 4.1% and 5.2% from 1998 to 2007. This proportion increased just before and throughout the 2008-2009 recession, as changing economic conditions led more new and existing employees to accept minimum wage jobs. By 2010, 7.1% of employees earned minimum wage, a proportion that remained stable until 2017 (Dionne-Simard and Miller, 2019).

From 2017 to 2018, the proportion of minimum wage workers among all employees rose to 10.4%. This surge corresponded with significant minimum wage hikes in several provinces across Canada. The substantial growth in minimum wage workers during this period was primarily due to increases in Ontario. Most of the additional minimum wage employees were in Ontario (77.8%), followed by Quebec (10.1%), Alberta (7.0%), and British Columbia (5.6%) (Dionne-Simard and Miller, 2019).

From 1998 to 2018, the prevalence of minimum wage employees increased significantly in Ontario, Alberta, British Columbia, Quebec, and Prince Edward Island, primarily due to increases between 2008 and 2018 (see Table 3.3). Conversely, during the same period, the percentage of employees earning minimum wage decreased in Newfoundland and Labrador and Saskatchewan (Dionne-Simard and Miller, 2019).

Table 3.2: Share of Minimum Wage Workers in Total Wage Bill (1998-2018)

Year	Percent
1998	4.1
1999	5.2
2000	4.7
2001	4.8
2002	4.8
2003	4.1
2004	4.6
2005	4.3
2006	4.4
2007	5.1
2008	5.3
2009	5.9
2010	7.1
2011	7.1
2012	7.2
2013	6.9
2014	7.2
2015	7.1
2016	6.9
2017	6.5
2018	10.4

Source: (Dionne-Simard and Miller, 2019)

Table 3.3: Share of Minimum Wage Workers in Total Wage Bill (percent), Canada, and provinces, 1998, 2008 and 2018

	1998	**2008**	**2018**
Canada	5.2	5.3	10.4
Newfoundland and Labrador	9.6	7.6	6.4
Prince Edward Island	4.9	5.6	7.5
Nova Scotia	6.6	6.4	7.2
New Brunswick	6.7	4.9	7.1
Quebec	5.9	6.0	8.0
Ontario	5.3	6.8	15.1
Manitoba	3.5	5.4	5.6
Saskatchewan	4.1	3.9	3.0
Alberta	2.9	1.6	8.3
British Columbia	5.1	2.7	6.8

Source: (Dionne-Simard and Miller, 2019)

3.2.2 Historical Trends on the Average Wage in Canada (1998-2018)

From 1998 to 2018, minimum wage employees in Canada saw relative improvements (see Table 3.4). The average nominal minimum wage grew by 3.5% annually, outpacing the 2.7% annual increase in average wages. The ratio of the average minimum wage to the average wage initially decreased from 0.41 in 1998 to 0.38 in 2007, indicating slower growth in minimum wage compared to average wages. However, this ratio began to rise steadily after 2007, reaching 0.43 by 2017 and peaking at 0.48 in 2018 due to significant increases in Ontario, Alberta, and British Columbia. Between 1998 and 2008, Quebec, Ontario, and British Columbia saw declines in this ratio (see Table 3.5), while other provinces either saw increases or stability. Post-2008, all provinces except Saskatchewan experienced an increase in the ratio, reflecting faster growth in minimum wages relative to average wages, with the most notable increases occurring in Ontario, Alberta, and British Columbia (Dionne-Simard and Miller, 2019).

Table 3.4: Ratio of Average Minimum Wage to Average Nominal Wage for all Employees (1998-2018)

Year	Ratio
1998	0.41
1999	0.41
2000	0.40
2001	0.39
2002	0.39
2003	0.38
2004	0.38
2005	0.38
2006	0.39
2007	0.38
2008	0.39
2009	0.40
2010	0.42
2011	0.42
2012	0.42
2013	0.42
2014	0.42
2015	0.42
2016	0.43
2017	0.43
2018	0.48

Source: (Dionne-Simard and Miller, 2019)

Table 3.5: Ratio of Average Minimum Wage to Average Nominal Wage for all Employees (1998, 2008, 2018)

Province	**1998**	**2008**	**2018**
Canada	0.41	0.39	0.48
Newfoundland and Labrador	0.40	0.42	0.43
Prince Edward Island	0.45	0.46	0.52
Nova Scotia	0.42	0.44	0.46
New Brunswick	0.42	0.43	0.49
Quebec	0.44	0.42	0.46
Ontario	0.42	0.39	0.51
Manitoba	0.38	0.44	0.46
Saskatchewan	0.41	0.42	0.40
Alberta	0.34	0.35	0.45
British Columbia	0.41	0.37	0.45

Source: (Dionne-Simard and Miller, 2019)

Chapter 4

Economics Models of Minimum Wage

Understanding the impact of minimum wage increases on employment requires exploring various economic models that predict different outcomes. In this chapter, I will delve into the competitive, monopsony, and institutional models, examining why these frameworks yield varying expectations regarding employment effects.

4.1 Competitive Model

The competitive model of minimum wage is a fundamental concept in labor economics that seeks to explain how changes in the minimum wage impact employment levels. This model operates under the assumption of perfect competition in the labor market, where numerous employers and workers interact freely, leading to market-determined wages and employment levels. According to this model, increases in the minimum wage can lead to negative employment effects. This paper explores the assumptions of the competitive model, its theoretical framework, and the reasons it predicts adverse employment outcomes when the minimum wage is raised.

4.1.1 Assumptions of the Competitive Model

The competitive model of minimum wage is based on several key assumptions that characterize perfectly competitive labor markets:

1. Many Employers and Workers: The model assumes a large number of employers and workers in the labor market, ensuring no single entity can influence wages or employment levels. Each employer is a wage taker, accepting the prevailing market wage rate (Mas-Colell, Whinston, and Green, 1995).

2. Homogeneous Labor: Workers are assumed to be homogeneous, meaning they possess similar skills and productivity levels, making them interchangeable from the perspective of employers (Mas-Colell et al., 1995).

3. Perfect Information: Both employers and workers have perfect information about wage rates, job opportunities, and working conditions. This ensures that all market participants make informed decisions (Mas-Colell et al., 1995).

4. Free Entry and Exit: There are no barriers to entry or exit in the labor market. Firms can enter or leave the market freely, and workers can change jobs without restrictions (Mas-Colell et al., 1995).

5. Profit Maximization: Employers aim to maximize profits by minimizing costs, including labor costs. This drives their hiring decisions and wage offers (Mas-Colell et al., 1995).

4.1.2 Theoretical Framework

Under the competitive model, the equilibrium wage and employment levels are determined by the intersection of the labor supply and demand curves. The labor supply curve represents the relationship between the wage rate and the quantity of labor workers are willing to supply. Conversely, the labor demand curve represents the relationship between the wage rate and the quantity of labor employers are willing to hire. In equilibrium, the wage rate (W*) and employment level (E*) are determined by the intersection of the supply and demand curves. At this point, the quantity of labor supplied equals the quantity of labor demanded, ensuring full employment.

4.1.3 Impact of Minimum Wage Increases

When the government imposes a minimum wage (MW) above the equilibrium wage (W*), the labor market experiences a disruption. According to the competitive model, this intervention leads to several adverse effects:

1. Surplus of Labor (Unemployment): A minimum wage set above the equilibrium wage creates a surplus of labor, as the quantity of labor supplied (E_s) exceeds the quantity of labor demanded (E_{mw}) at the higher wage rate. This surplus manifests as unemployment, where more workers are willing to work at the minimum wage than there are jobs available.

2. Reduction in Employment: Employers respond to the higher wage rate by reducing the number of workers they hire. The increased labor cost leads firms to cut back on hiring, automate processes, or find other cost-saving measures. Consequently, the quantity of labor demanded decreases from E* to E_{mw}, resulting in a reduction in overall employment (Giotis and Mylonas, 2022).

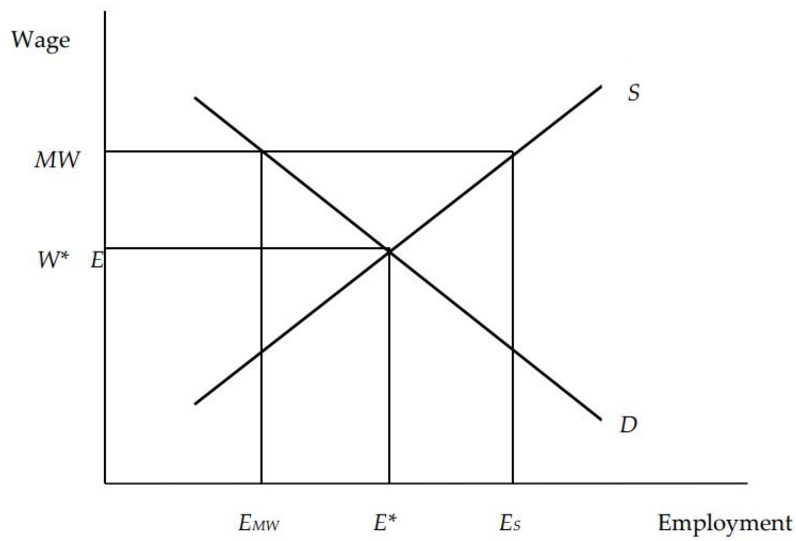
3. Wage Distribution Effects: The minimum wage increase benefits workers who retain their jobs and receive higher wages. However, those who become unemployed or are unable to find new jobs face adverse effects. This leads to a redistribution of income among workers, with potential negative consequences for those who lose their employment (Cengiz et al., 2019).

4. Long-Term Adjustments: In the long term, firms may adjust to higher labor costs by investing in automation or relocating to regions with lower labor costs. These adjustments can further exacerbate unemployment and reduce the availability of low-wage jobs in the

affected labor market (Hirsch et al., 2011).

The diagram below illustrates the impact of a minimum wage set above the equilibrium wage.

Figure 4.1: The Impact of a Minimum Wage Set Above the Equilibrium Wage



Notes: The figure shows that when the minimum wage (MW) is set above the equilibrium wage (W*), the quantity of labor supplied (E_s) exceeds the quantity of labor demanded (E_{mw}), leading to a surplus of labor, or unemployment.

4.1.4 Criticisms and Limitations

While the competitive model provides a clear framework for understanding the potential negative employment effects of minimum wage increases, it has several limitations:

1. Simplistic Assumptions: The model's assumptions of perfect competition, homogeneous labor, and perfect information are often unrealistic in real-world labor markets. Labor markets are typically characterized by various frictions, such as search costs, bargaining power disparities, and information asymmetries (Hirsch et al., 2011).

2. Ignores Non-Wage Benefits: The model focuses solely on wage rates and does not account for non-wage benefits, such as job training, work conditions, and career advancement opportunities, which can influence employment decisions (Hirsch et al., 2011).

3. Static Analysis: The competitive model provides a static analysis of the labor market, ignoring dynamic adjustments and long-term effects. Firms and workers may adapt to minimum wage changes in ways that mitigate the initial negative impacts (Hirsch et al., 2011).

4. Alternative Channels of Adjustment: Even though the competitive model highlights adjustment through declining employment as a primary response to increased minimum wages, this model also recognizes alternative channels of adjustment. These include reduced working hours, elevating prices for consumers, cutting non-wage benefits like health insurance and retirement plans, diminishing investment in training programs, and altering the composition of the workforce (Hirsch et al., 2011).

In scenarios where the sole means of adjustment is limited to employment reduction, the competitive model predicts that minimum wage increases will lead to a decline in employment. Nevertheless, the presence of multiple channels for adjustment implies that minimum wages might have negligible or even no discernible impact on employment levels. This observation challenges the conventional assumption that within a standard competitive labor market framework, binding minimum wages unequivocally reduce employment.

Overall, the competitive model of minimum wage offers a theoretical framework for understanding the potential negative employment effects of minimum wage increases. Based on assumptions of perfect competition and profit maximization, the model predicts that higher minimum wages lead to labor surpluses and reduced employment. While empirical evidence supports some of these predictions, the model's limitations and the mixed results from empirical studies highlight the need for a nuanced understanding of labor market dynamics. Future research should continue to explore the complex interactions between minimum wage policies and employment outcomes, considering the broader economic context and the diverse characteristics of labor markets.

4.2 Monopsony Model

Minimum wage policies are a crucial aspect of labor market regulation, aiming to improve the living standards of low-wage workers. Traditional competitive labor market models suggest that imposing a minimum wage above the equilibrium wage results in unemployment due to an excess supply of labor. However, the monopsony model presents a different perspective. In a monopsonistic labor market, a single employer or a few employers possess significant market power, enabling them to set wages below competitive levels. This section explores the effect of minimum wage on employment and wages under the monopsony model, elucidating how minimum wage policies can potentially increase both wages and employment.

4.2.1 Definition and Characteristics

A monopsony in the labor market occurs when a single employer or a small group of employers dominate hiring, granting them significant control over wage determination. Unlike in competitive markets, where wages are set by the intersection of supply and demand, monopsonistic employers can set wages lower than the marginal productivity of labor due to the lack of alternative employment opportunities for workers. Key characteristics of a monopsonistic labor market include: 1. Employer Market Power: Employers can set wages below the competitive equilibrium. 2. Worker Mobility Constraints: Workers face significant barriers to switching employers, such as geographic immobility, skill specialization, or lack of information. 3. Wage Setting below Marginal Revenue Product (MRP): Employers set wages lower than the MRP of labor, resulting in reduced employment and wages compared to a competitive market (Boal and Ransom, 1997).

4.2.2 Labor Supply and Demand in Monopsony

In a monopsony, the labor supply curve faced by the employer is upward-sloping. This means that to attract additional workers, the employer must offer higher wages. However, unlike in competitive markets, the monopsonist hires workers up to the point where the marginal cost of labor (MCL) equals the marginal revenue product of labor (MRP), leading to a wage lower than the equilibrium wage in a competitive market (Giotis and Mylonas, 2022).

4.2.3 Wage and Employment Effects

In a monopsonistic market, introducing a minimum wage can lead to outcomes contrary to those predicted by competitive market models. Specifically, setting a minimum wage above the monopsony wage but below the competitive equilibrium wage can increase both wages and employment. The minimum wage forces the monopsonist to pay a higher wage, aligning closer to the workers' marginal productivity, which increases the overall wage level in the labor market, improving workers' income and living standards. The higher wage attracts more workers to the labor market, increasing the labor supply. Consequently, the monopsonist's employment decision now depends on the minimum wage rather than the marginal cost of labor (MCL). In some cases depending on the level of the minimum wage it may lead to an increase in employment (Robinson, 1969).

4.2.4 Classical and New Monopsony Models

An emerging alternative to examine the impact of minimum wage (MW) is through various forms of the monopsony model. Originating from Robinson (1969), it manifests in different types: commonly referred to as the "classic" (structural) or "new" (dynamic) monopsony models. The former assumes the presence of a single or a few employers in a labor market, while the latter incorporates market frictions related to hiring, turnover, and search, among others (Manning, 2003).

While the specifics vary, the essence of monopsony models involves an upward-sloping labor supply curve for firms and some flexibility in wage-setting due to market limitations like spatial constraints or specific skill demands. In terms of MW adjustments, the most significant disparity between competitive and monopsony models lies in their predictions concerning employment effects. When MW raises wages closer to competitive levels, classic and new monopsony models anticipate a rise in employment or work hours, unlike the competitive model. However, if MW surpasses competitive levels, employment decreases, similar to the competitive model's prediction. This holds, although with some subtle differences, in models of oligopoly and monopolistic competition (Bhaskar and To, 1999; Manning, 2003).

4.2.5 Differences in Anticipated Consequences

Additionally, the monopsony model presents divergences in anticipated consequences compared to the competitive model. For instance, an increase in employment resulting from MW elevation expands industry output until MW reaches competitive wage levels, potentially leading to reduced product prices. In the classic monopsony model, profits diminish, possibly leading firms to exit in the long run. Conversely, in the new monopsony model, reduced turnover might counterbalance the profit effect (Card and Krueger, 1995). Unlike the competitive model, expenditures on general training could rise under monopsony, as employers may gain from investing in training programs.

In structural monopsony with homogenous workers, MW impacts the internal wage structure similarly to the competitive model, raising wages for all. In contrast, the concept of dynamic monopsony suggests that within companies, it could lead to a more uniform wage distribution by removing the differing pay scales for lower-wage workers. This could potentially level out the pay differences among employees in various positions within a company (Booth and Zoega, 2004). All in all, the monopsony model suggests that within a certain range, increasing MW might enhance labor market efficiency.

4.3 Institutional Model

The institutional model, once the primary framework for evaluating the impact of the minimum wage, was instrumental in the passage of the Fair Labor Standards Act in 1938 but has gradually receded from focus in labor economics over the past half-century. Its decline stems from a lack of formalization and the assimilation of its key ideas into neoclassical-based models like efficiency wage theory and search models. Rooted in a behavioral/social model of human behavior, the institutional paradigm draws from behavioral economics concepts (Kaufman, 1999; Thaler, 2000).

Historical and contemporary writings in the institutional tradition highlight several core notions: the rejection of a well-defined downward-sloping labor demand curve; emphasis on imperfectly competitive and institutionally segmented labor markets; recognition of technological and psycho-social influences in firm-level production systems and internal labor markets (ILMs) (Pierson, 1957; Arrowsmith, Gilman, Edwards, and Ram, 2003; Brosnan, 2005; Kaufman, 1988; Kaufman, 2010; Osterman, 2011). In terms of efficiency and welfare, the institutional model, akin to the monopsony model, suggests that a moderate MW increase might enhance efficiency and welfare within a certain range, albeit with differing sources of welfare gain (Hirsch et al., 2011).

One fundamental aspect of the institutional perspective is that a moderate minimum wage raise might, particularly in the short run, have a near-zero or slightly positive employment effect (Lester, 1946, 1960). This stems less from a monopsony supply argument and more from characteristics of the firm's labor demand curve and its accompanying production/Internal labor market system. Institutional theories depict short-term labor demand as a broad range rather than a fixed-line. Consequently, a moderate MW increase might not lead to employment/hours decline if factors like production complementarities, increased productivity, tighter labor standards, and higher consumer spending counterbalance the negative cost effect (Hirsch et al., 2011).

Furthermore, the institutional model suggests that increasing the minimum wage could lead to the removal of inefficient or exploitative businesses. This change aims to benefit society by promoting more effective and fair economic practices (Arrowsmith et al., 2003; Kaufman, 2010). It also addresses other aspects such as the typical firm's production function, which suggests that firms are demand-constrained rather than cost-constrained. This implies that firm owners, in response to a MW increase, may not immediately reduce output or lay off workers as in the competitive model. Instead, they might aim to absorb the cost impact by increasing volume through expanded sales, improving services,(Lester, 1946), and enhancing operational efficiency (Hirsch et al., 2011).

Human-related determinants of productivity and cost are emphasized in this model, suggesting that firms, faced with a MW hike, might focus on maintaining headcount and hours by leveraging tighter human resource practices, increased performance standards, and improved customer service. Additionally, the institutional model anticipates that firms might adjust their internal wage structure in response to MW increases to maintain morale and relative pay levels among employees (Hirsch et al., 2011).

Chapter 5

Methodology

In this section, inspired by Cengiz et al. (2019), I first utilize a standard model of labor demand under perfect competition to derive the employment and wage effects of a minimum wage. This analysis is directly related to the bunching estimator. Following the approach of Cengiz et al. (2019), I also discuss the implications of deviations from perfect competition. Subsequently, I describe the event study analysis and difference-in-differences (DiD) methodology. Finally, I elaborate on the empirical implementation of the bunching estimator using both the event study and DiD approaches. This implementation considers the effects of a single minimum wage increase in Ontario as a case study and 56 minimum wage increases across all provinces from 1999 to 2019.

5.1 Bunching in the Standard Labor Demand Model

I adopt the standard model of labor demand, incorporating a continuous distribution of skill types, to comprehensively evaluate the employment impact of minimum wage hikes across the entire wage distribution. My analysis excludes the impact of changes in overall production (aggregate production) when analyzing how minimum wage changes affect labor demand. I focus solely on the effects on the conditional labor demand function, which refers to the demand for labor given certain conditions (like wages) while ignoring the broader effects of changes in production levels (scale effects). By isolating the effect of the minimum wage on the conditional labor demand function, I streamline the analysis while still capturing its essential dynamics. This simplifying assumption carries minimal drawbacks as scale effects are likely to be small given the small portion of the workforce works at the minimum wage within the context of Canadian minimum wage policies.

I assume that firms operate under a CES production function.

$$\text{Y}=\left(\int_{j\in\Theta} \eta_j l_j^{\frac{\sigma-1}{\sigma}} \, dj \right)^{\frac{\sigma-1}{\sigma}}$$

Where Θ denotes the set or group of all possible worker types being analyzed in the model. For example, if workers are categorized by their occupation, education level, or other characteristics, Θ would represent the entire range of these categories, and j is one specific category or type of worker within that set.

σ is the substitution elasticity across different types of workers. I define l_j as the number of type j workers employed in production, with η_j representing their productivity. Firms aim to minimize costs, treating wages as fixed; however, equilibrium is achieved when wages adjust to balance labor supply and demand. I assume that the labor supply for each worker type exhibits an upward-sloping pattern with a constant elasticity, denoted by γ:

$$l_j^s = k_j w_j^\gamma$$

where k_j serves as a scaling factor or parameter that determines the relationship between the wage rate and the quantity of labor supplied by worker type j. It reflects factors that might influence the supply of labor aside from productivity and wages, such as individual preferences, demographic characteristics, or external economic conditions.

Minimizing costs while adhering to an output constraint results in the formulation of the conventional conditional labor demand function (see Appendix B):

$$l_j^d = Yc(w)^{\sigma}(\frac{\eta_j}{w_j})^{\sigma} \tag{1}$$

Here, $c(w) = (\int_{\underline{w}}^{\bar{w}} \eta_j{}^{\sigma} w_j{}^{1-\sigma}\, dj)^{\frac{1}{1-\sigma}}$ represents the unit cost of production. Consequently, an increase in wages w_j diminishes the demand for type j workers, while an overall escalation in wage levels, as indicated by a higher $c(w)$, amplifies this demand. At equilibrium, the equilibrium wage distribution is determined by the $l_j^d = l_j^s$ across all worker types. Wages at the lower end of the distribution mirror either the lower productivity levels of workers η_j or the abundance of labor supply k_j.[1] I should note that $\underline{w}$ is the lower wage limit and $\bar{w}$ is the upper wage limit. The lower limit in my model is $4 below the new minimum wage and upper wage limit is $4 above the new minimum wage.

As illustrated in Appendix Figure A.1, implementing a minimum wage (MW) results in a notable phenomenon: all workers earning wages below MW, who retain their employment, are pushed upward to meet the newly established minimum wage threshold. This creates a noticeable spike in the wage distribution. Additionally, the increase in wages for directly affected workers leads to a decrease in conditional labor demand. The size of this reduction is intricately linked to the variable σ the elasticity of substitution across different labor types.

When the value of σ is high, the replacement of workers at the lower end of the wage distribution with those at the higher end becomes more feasible. This results in job losses for many low-wage workers, contributing to a relatively modest spike at the minimum wage level. Conversely, when σ is low, such substitution becomes more challenging, allowing a greater number of low-wage workers to retain their jobs and causing a more pronounced spike in the minimum wage. Consequently, the extent of the spike concerning the workers directly affected by the minimum wage reflects the impact of the minimum wage on the targeted low-wage population.[2]

[1] To streamline the notation, I make the simplifying assumption that k_j is weakly decreasing in η_j; however, it is important to note that none of the results presented here rely on this assumption (see Appendix B).

[2] If labor supply is inelastic ($\gamma < \infty$), some workers who were initially earning below the minimum wage may experience their wages being pushed slightly above the minimum. This underscores the importance of

Equation (1) reveals that the demand for workers earning above the minimum wage also undergoes a shift due to an increase in the unit product cost, $c(w)$. This occurs because the rise in labor costs for low-wage workers can prompt an increase in the demand for high-wage labor, particularly when substitution between different types of labor is easy (i.e., the value of σ is high). Whether this surge in labor demand translates into higher wages or increased employment hinges on the elasticity of labor supply. In scenarios where labor supply is perfectly elastic, an increase in employment at higher wages occurs without impacting wage levels. Conversely, when labor supply is not perfectly elastic, changes in employment for higher-wage workers are dampened, with some of the effect being absorbed as wage increases rather than increased employment.

The rise in wages, as a consequence, mitigates the extent of job losses for low-wage workers. In any scenario, an exclusive focus on the lower end of the wage distribution may lead to an overestimation of the overall job loss across all demographic groups. Therefore, if the objective is to gauge the impact of minimum wages on the total number of jobs in the labor market, the size of the spike relative to the missing numbers of jobs can be considered a conservative lower bound. However, when the aim is to precisely estimate the employment change among lower-wage workers (those directly impacted by the policy) a comparison of employment at the spike relative to the missing number of jobs serves as an exact and meaningful estimate.

This empirical methodology discerns the employment effects of minimum wage by leveraging variations in the minimum wage. I quantify the impact by summing the changes in the size of the spike (or the number of excess jobs) at the minimum wage, (Δa), and the changes in the number of missing jobs below the new minimum wage, (Δb). The sum, $(\Delta a + \Delta b) = \Delta e$, serves as an indicator of the employment effect attributable to the minimum wage on low-wage workers. However, the percentage change in the employment of affected workers is $\%\Delta e = \dfrac{\Delta e}{b}$. I note that b is the share of the workforce earning below the new minimum wage before the treatment.

considering changes in jobs paying slightly above the minimum wage when estimating the number of excess jobs. This approach holds even when aiming to assess the employment change of low-wage workers directly affected by the minimum wage.

In Appendix B, I provide a detailed exposition demonstrating that the employment elasticity concerning the minimum wage can be expressed through the following formula:

$$\frac{\%\Delta e}{\%\Delta MW} = \frac{\Delta a + \Delta b}{b}\frac{1}{\%\Delta MW} = -\sigma(\frac{\gamma - s_{MW}\gamma}{\gamma + s_{MW}\sigma}) \tag{2}$$

where $s_{MW} = \frac{\int_{\underline{\eta}}^{\eta(MW)} \eta_j^{\sigma} MW^{1-\sigma}\, dj}{\int_{\underline{\eta}}^{\eta(MW)} \eta_j^{\sigma} MW^{1-\sigma}\, dj + \int_{\eta(MW)}^{\bar{\eta}} \eta_j^{\sigma} w_j^{1-\sigma}\, dj}$ represents the proportion of costs attributed to minimum wage workers.[3]

The formula embodies the fundamental principles of the Hicks-Marshall laws of derived demand, providing clarity on the relationship between variables. Specifically, when s_{MW} is approximately equal to zero, the size of bunching closely aligns with $-\sigma$. This observation emphasizes that our estimator serves as a direct indicator of the uncompensated elasticity of substitution across various worker types.

A pronounced spike in the data indicates a significant shift from jobs below the new minimum wage to jobs with new or slightly above the minimum wage. This shift can interpreted as a small change in employment, denoted as Δe, alongside a corresponding decrease in the substitution elasticity σ. Conversely, in cases where there is minimal bunching at the minimum wage, the magnitude of Δe is substantial, accompanied by a higher σ. It is worth noting that the practical significance of the cost share of minimum wage workers denoted as s_{MW}, tends to be negligible. In my sample, approximately 9.6% of the workers (refer to Column 1 in Table 1) are directly impacted by the minimum wage. Moreover, the minimum-to-mean wage ratio stands at around 0.42, implying that the cost share of the minimum wage earners (s_{MW}) is approximately 0.04 (calculated as 0.42 multiplied by 0.096). Consequently, the estimates regarding employment bunching will have a strong correlation with this factor σ.

[3] In the equation for s_{MW}, $\underline{\eta}$ denotes the productivity level of workers earning the lowest wage, while $\eta(MW)$ represents the productivity threshold below which workers are directly affected by the minimum wage.

5.2 Bunching Framework

The standard labor demand model suggests that when the minimum wage increases, it typically leads to a reduction in employment levels among low-wage workers, although this effect may be relatively small if the elasticity of substitution is low. However, when considering frictions within the labor market, the relationship between the minimum wage and employment becomes more complex and uncertain. In such cases, it is possible to observe an ambiguous effect on employment (Flinn, 2011; Manning, 2003) and can rationalize a minimal or negligible dis-employment effect, even when there is a substantial elasticity of substitution across different skill groups.

Furthermore, the existence of frictions within the labor market can give rise to additional effects that extend beyond just employment outcomes. These frictions can lead to spillover effects on wages, particularly concentrated around the minimum wage threshold. For example, as illustrated in Flinn (2011), the implementation of a minimum wage may encourage certain low-wage workers to actively engage in job search activities. Consequently, some of these individuals may succeed in being employed in jobs that offer wages above the minimum wage level. This phenomenon highlights how changes in minimum wage policies can influence not only employment dynamics but also the broader wage distribution and labor market participation patterns among low-wage workers.

Moreover, the phenomenon of wage spillover can occur due to the rise in the wage floor for low-wage workers. As the price of employing low-wage workers increases, employers may find it more advantageous to substitute these workers with those possessing higher skill levels. Consequently, this substitution effect can increase the demand for and subsequently elevate the wages of more skilled workers (Campolieti, 2020). Alternatively, according to Campolieti (2020), Manning (2003) and Van den Berg and Ridder (1998) firms that already pay wages above the minimum wage may need to adjust their wage structures to maintain wage differentials in the new equilibrium. However, the magnitude of these adjustments is likely to diminish for workers earning significantly above the minimum wage. This happens because workers earning higher wages usually work in different job markets, so changes in the minimum wage have less of an effect on them (see Van den Berg and Ridder, 1998; Engbom and Moser, 2022 for examples of these models).

To account for spillover effects, I examine the level of concentration at and slightly above the minimum wage. This scenario is illustrated in Figure 1, where all spillover effects diminish by wage $\bar{W}$. Additionally, the number of excess jobs refers to the difference in jobs between MW and $\bar{W}$. Specifically, $\Delta a = Emp^1[MW \leq w \leq \bar{W}] - Emp^0[MW \leq w \leq \bar{W}]$.[4] As I lack prior knowledge of $\bar{W}$ I will conduct robustness checks using a range of plausible values.

In practice, there could be instances of measurement errors in reported wages. Consequently, some jobs that are intended to pay precisely the minimum wage might be perceived as paying slightly above or below it Autor, Manning, and Smith (2016). This underscores the importance of including jobs slightly above the new minimum wage in the excess jobs estimate, rather than solely focusing on jobs at that precise level. Additionally, in cases where there are reporting errors in wage data, not all workers earning below the minimum wage will necessarily vanish from the wage distribution. Hence, the increase in the number of directly affected jobs, denoted by $\Delta b = Emp^1[w < MW] - Emp^0[w < MW]$, might be less than the number of directly affected workers, represented by b in Figure 1.[5]

Assessing the impact of a minimum wage increase often revolves around gauging the extent of missing jobs below the new minimum wage threshold (Δb). This measure is widely regarded as the most intuitive way to evaluate the effectiveness of a minimum wage hike. In the absence of any missing jobs, it becomes challenging to attribute observed changes in employment to minimum wage adjustments. However, despite its significance, this measure of missing jobs is seldom reported in the existing literature. Instead, researchers frequently turn to alternative measures, with one of the most common being the change in average wages among specific groups. Yet, this alternative measure can be prone to contamination due to shifts in the distribution of wages significantly above the minimum wage threshold,

[4]Here, $Emp^1[.]$ evaluates the employment using the actual frequency distribution of wages, while $Emp^0[.]$ evaluate the employment using the counterfactual frequency distribution.

[5]The existence of sub-minimum wage jobs can also arise due to imperfect coverage, where employers are permitted to pay below the minimum wage, or due to imperfect compliance with the policy.

thus complicating the interpretation of observed changes in average wages.

I evaluate the impact of the minimum wage on low-wage workers' employment by aggregating the missing and excess jobs, denoted as $\Delta b + \Delta a$. This sum is indeed equivalent to the employment change below $\bar{W} : \Delta b + \Delta a = Emp^1[w < \bar{W}] - Emp^0[w < \bar{W}]$. The core concept underlying the bunching estimator is to concentrate on employment fluctuations at the lower end of the wage distribution, disregarding employment shifts at the higher wage levels for identification purposes. However, it is crucial to note that my analysis extends beyond merely estimating the combined sum $\Delta b + \Delta a$. Instead, I differentiate between changes in employment below and above the new minimum wage threshold. Consequently, I am able to identify both the missing and surplus of jobs, even in the absence of any overall changes in aggregate employment.

There are two significant advantages to directing my attention toward the lower end of the wage distribution. Firstly, changes in employment at the higher wage levels are less likely to accurately reflect alterations in the employment of low-wage workers, who are the primary beneficiaries of minimum wage policies. This distinction is especially crucial when considering the standard labor demand model, as illustrated earlier, where the overall employment effects may differ substantially in magnitude from the actual impact on low-wage workers.

Secondly, concentrating on bunching phenomena helps mitigate biases stemming from confounding factors that could influence employment estimates at the higher end of the wage distribution. By focusing on instances of bunching, I can more effectively isolate and analyze the genuine effects of minimum wage policies on employment levels among low-wage workers. For example, trends at the province level such as skill-biased technical advancements or tax policy adjustments that predominantly impact higher-wage earners might exhibit correlation with minimum wage alterations. This potential bias stemming from confounding factors becomes particularly pronounced when only a small proportion of the workforce is directly affected by the minimum wage, as is the case in Canada. In such scenarios, the influence of these omitted variables could be substantial compared to the relatively modest anticipated effect of the minimum wage on overall employment.

5.3 Difference-in-Differences Estimator Approach

The Difference-in-Differences (DID) approach is a powerful econometric tool used to estimate the causal effects of policy interventions, such as minimum wage increases. It is particularly useful in observational studies where randomized controlled trials are not feasible. The DID method compares the changes in outcomes over time between a treatment group (subject to the policy change) and a control group (not subject to the policy change). This approach effectively controls for unobserved confounders that are constant over time, thereby isolating the impact of the intervention (Angrist and Pischke, 2009).

In the context of estimating the effect of minimum wage increases, the bunching estimator is employed to detect changes in the distribution of wages and employment levels around the minimum wage threshold. The DID approach complements this by providing a robust framework for constructing counterfactual scenarios that what would have happened to wages and employment in the absence of the minimum wage increase.

By using DID, first, I can isolate causal effects. DID helps to control for time-invariant unobserved factors that could confound the relationship between minimum wage changes and labor market outcomes. Moreover, I can construct counterfactual distributions. DID creates a counterfactual distribution by comparing the pre- and post-intervention outcomes of the control group with the treatment group. This allows for a clearer understanding of the true effect of the minimum wage increase. Additionally, DID enhances internal validity: By accounting for differences that might exist between the treatment and control groups before the intervention, DID enhances the internal validity of the estimated effects. The DID estimator mathematically can be expressed as Card and Krueger (1993):

$$Y_{it} = \alpha + \delta D_t + \gamma T_i + \beta (T_i \times D_t) + \epsilon_{it}$$

where:

- Y_{it} is the outcome variable (employment or wage) for individual i at time t,
- D_t is a binary variable indicating the post-treatment period,
- T_i is a binary variable indicating membership in the treatment group,
- $T_i \times D_t$ is the interaction term capturing the treatment effect,
- β is the DiD estimator of interest, representing the causal effect of the treatment.
- ϵ_{it} is the error term.

5.4 Event Study Analysis

A critical assumption of the Difference-in-Differences (DID) estimator is the parallel trend assumption. This assumption states that, in the absence of treatment, the average change in the outcome variable would have been the same for both the treatment and control groups. In other words, any differences between the treatment and control groups are constant over time, and any observed deviations in the post-treatment period can be attributed to the treatment itself. This assumption is crucial for the validity of the DID approach, as it underpins the causal interpretation of the estimated treatment effect. To verify the parallel trend assumption, I will employ an event study analysis. Event study analysis is a method used to examine the impact of an intervention or event at multiple points in time. In the context of minimum wage changes, event study analysis can be used to assess the impact of a minimum wage increase on employment levels by examining the trend in employment before and after the policy change. The event study approach involves estimating the following regression model as in MacKinlay (1997):

$$Y_{it} = c + \sum_{T=-\tau}^{\tau} \beta_\tau I_{it}^{\tau} + \alpha_i + \mu_t + U_{it}$$

where:

- Y_{it} is the outcome variable (e.g., employment level) for unit i at time t.
- c is a constant term.
- $\sum_{T=-\tau}^{\tau} \beta_\tau I_{it}^{\tau}$ represents the sum of the coefficients β_τ for the dummy variables I_{it}^{τ} indicating the time periods relative to the event.
- α_i are unit fixed effects, which control for time-invariant characteristics of the units.
- μ_t are time-fixed effects, which control for shocks that are common across units at a given time.
- U_{it} is the error term, capturing unobserved factors affecting the outcome.

To check the parallel trend assumption, I analyze the coefficients β_τ for the periods before the β_τ intervention. If the parallel trend assumption holds, β_τ for the pre-treatment periods should be close to zero, indicating no significant differences in the trends between the treatment and control groups before the intervention. This visual inspection can be complemented with statistical tests for the joint significance of the pre-treatment coefficients. In Chapter 7, which covers the results, I will plot a figure to verify the parallel trend assumption.

Moreover, event study analysis provides insights into both the immediate and long-term effects of minimum wage increases over time. By plotting the treatment effects at various points before and after the intervention, researchers can observe how the policy impacts unfold. This temporal aspect is crucial for understanding the dynamics of policy effects, capturing both short-term adjustments and longer-term outcomes in the labor market. For example, immediate effects might show initial disruptions or adjustments, while long-term effects can reveal persistent changes in employment and wage patterns.

In the context of minimum wage changes, event study analysis provides a detailed illustration of how employment levels evolve in the treatment group compared to the control group over time. This methodology is instrumental not only in checking the parallel trend assumption but also in observing the immediate and long-term effects of minimum wage increases on both employment and wage levels. In the empirical implementation section, I will demonstrate how this regression is applied in my study. By plotting the coefficients with their confidence intervals, I can visually inspect whether the pre-treatment trends are parallel and whether any significant changes occur post-treatment. This visual representation is crucial for validating the parallel trend assumption, which is a cornerstone of the difference-in-differences (DID) approach. Additionally, it allows for a clear observation of the dynamic effects of minimum wage changes, showing how these effects evolve. I will present a detailed figure in Chapter 7 to examine the parallel trend assumption, providing a comprehensive view of the treatment effects before and after the policy change. In summary, event study analysis not only estimates the dynamic effects of minimum wage changes on employment but also serves as a robustness check for the critical parallel trend assumption in DID analysis. This dual functionality makes it a valuable tool in the methodological framework of my thesis.

5.5 Empirical Implementation

In this section, I will delve into the empirical implementation of the methodologies discussed previously—specifically, the bunching approach, the event study analysis, and the Difference-in-Differences (DID) estimator. To illustrate the application of these methods, I first focus on a single case study: the largest real minimum wage increase in Ontario province. Following the Ontario case study, I expand my analysis to include all minimum wage increases across all provinces in Canada from 1999 to 2019. By pooling these events, I aim to generalize my findings and explore the broader impacts of minimum wage policies across different regions and periods. This comprehensive approach allows me to capture variations in the labor market responses and provides a more robust understanding of the effects of minimum wage increases on employment and wages.

5.5.1 Empirical Implementation in Single Minimum Wage Increase (Ontario)

To put the bunching method into practice, I begin by examining one of the most significant province-level changes to the minimum wage in Canada. Specifically, I analyze the Ontario province of Canada, where the real hourly minimum wage rose by approximately 19.2%, increasing from $8.7 to $10.37 from 2017 to 2018 (in 2002 dollars). Furthermore, the increase in the real minimum wage due to subsequent increases in the minimum wage is automatically adjusted to match the rate of inflation.

By using the usual hourly wage data in LFS, it is straightforward to compute the actual post-reform wage distribution, represented by the blue line in Figure 1.1. However, the primary obstacle in implementing the bunching method lies in the unavailability of direct observations regarding the wage distribution in the absence of the minimum wage hike, depicted by the red line in Figure 1.1. To address this obstacle, prior studies have relied on constructing the counterfactual by imposing stringent parametric assumptions such as Meyer and Wise (1983) or by utilizing the pre-reform wage distribution as a proxy like Harasztosi and Lindner (2019). In this study, Following Cengiz et al. (2019) I enhance upon these research methodologies by employing a difference-in-differences style estimator.[6]

Specifically, I discretize the wage distribution and count per-capita employment for each dollar wage bin, denoted as h. For instance, the $9 wage bin includes jobs paying between $9 and $9.99 (in 2002$). I normalize these counts by the pre-treatment employment-to-population rate in Ontario.

$$e_{ON,h,Post} = \frac{1}{\frac{E_{ON,Pre}}{N_{ON,Pre}}} \frac{E_{ON,h,post}}{N_{ON,Post}}$$

where $\frac{E_{ON,h,t}}{N_{ON,t}}$ is per-capita employment for each dollar wage bin h in the Ontario at

[6] As demonstrated in Dickens et al. (1998), estimates obtained through the Meyer and Wise (1983)'s approach are greatly influenced by the parameterization of the wage distribution

time t, and $N_{ON,t}$ is the size of the population. I use LFS data on hourly wages from Ontario province to compute $e_{ON,h,Post}$. I compute the post-treatment counterfactual wage distribution for each wage bin, $e^{CF}_{ON,h,Post}$ by incorporating the (population-weighted) average per capita employment change observed in the 4 provinces[7] that did not undergo a real minimum wage shock between 2017 and 2019 into Ontario province's pre-treatment per-capita wage distribution. Following normalization, this yields the following expression:

$$e^{CF}_{ON,h,Post} = \underbrace{\frac{1}{\frac{E_{ON,Pre}}{N_{ON,Pre}}}}_{\text{Normalization}} \times \Big[\underbrace{\frac{E_{ON,h,pre}}{N_{ON,Pre}}}_{\text{Pre-treatment in ON}} + \underbrace{\sum_{p \in \text{Control}} \frac{1}{4} \Big(\frac{E_{p,h,Post}}{N_{p,Post}} - \frac{E_{p,h,Pre}}{N_{p,Pre}} \Big)}_{\text{Change in control Provinces}} \Big]$$

where $\frac{E_{p,h,t}}{N_{p,t}}$ is per-capita employment for each dollar wage bin h, in province p at time t, and $N_{p,t}$ is the size of the population in province p at time t. To compute the above equation, I use hourly wage data from the Labor Force Survey (LFS). Overall, I have 675 wage bin-province-period observations, which I get from 133,952 individual-level observations, producing a count of 200 workers per 1$ bin but the count per bin in the [MW-4$, MW+4$] is around 250 in my sample. When I investigate the overall employment effect, I also compute the sum of 1$-bin estimates between 4$ below and 4$ above the new minimum wage, and I consider 2-year averages. So it means on average I use 4500 individual worker observations in Ontario's event study. This is a sufficiently large sample size, enabling a reliable estimation of the actual counts of employment for the Ontario event. I will explain the data in more detail in chapter 6.

In the first segment of this expression, normalization entails representing the counterfactual employment counts in terms of pre-treatment total employment in Ontario. It is important to note that this normalization procedure does not enforce equivalence between the areas under the counterfactual and actual wage distributions. In essence, the minimum wage can impact aggregate employment.

The difference between the observed, $e_{ON,h,Post}$, and counterfactual frequency

[7] Manitoba, Saskatchewan, New Brunswick and Newfoundland and Labrador

distributions of wages, $e^{CF}_{ON,h,Post}$ shows the causal impact of the minimum wage on the wage distribution. This difference can be shown as:

$$
\begin{aligned}
e_{ON,h,Post} - e^{CF}_{ON,h,Post} = \underbrace{\frac{1}{\frac{E_{ON,Pre}}{N_{ON,Pre}}}}_{\text{Normalization}} \times \Bigg[&\underbrace{\left(\frac{E_{ON,h,Post}}{N_{ON,Post}} - \frac{E_{ON,h,Pre}}{N_{ON,Pre}} \right)}_{\text{Change in treatment}} \\
&+ \underbrace{\sum_{p \in \text{Control}} \frac{1}{4} \left(\frac{E_{p,h,Post}}{N_{p,Post}} - \frac{E_{p,h,Pre}}{N_{p,Pre}} \right)}_{\text{Change in control}} \Bigg]
\end{aligned} \tag{3}
$$

This represents the classic difference-in-differences estimator that forms the foundation of the primary estimates in this thesis. I will explain the details of how I compute the percentage change in employment and wages in the next section.

5.5.2 Empirical Implementation in Many Minimum Wage Increases (All Provinces in Canada)

The empirical estimation when I pool many minimum wage increases follows the same difference-in-differences approach as the Ontario case study (e.g., equation 3). Similar to other difference-in-differences estimators, equation (3) can be implemented using a regression model. This method is particularly useful when aggregating data across multiple events, as I do in this section. In my empirical implementation, I start by constructing a dataset organized by province, month, and \$0.25 wage bins. The details of this construction are explained in Chapter 6. Using this data, I analyze the effect of minimum wage changes on per-capita employment counts, $\frac{E_{pbt}}{N_{pt}}$, where E_{pbt} represents the employment in wage bin b in province p at time t, and N_{pt} denotes the population size in province p at time t.

In my initial setup, I adopt a treatment event window spanning 11 months, covering a period from $t = -5$ to $t = 5$ in terms of monthly event time (In Chapter 7, I will explain why, in the multiple minimum wage increase study, I chose the monthly data rather than yearly data and selected an 11-month window period instead of the 8 years used by Cengiz et al. (2019)). Here, $t = 0$ signifies the month of the shock (event) or the month the real minimum wage increases. Likewise, $t = -1$ represents the month preceding the treatment, while $t = 5$ denotes the fifth month after. my treatment variables are not solely a function of province and time, but also of the wage bins considerations. I define a \$1 interval relative to the new minimum wage as h, where $h = 0$ denotes the four \$0.25 bins spanning between MW and MW + \$0.99. The "below" bins encompass those with h in the set -4, -3, -2, -1, representing wages ranging from MW - \$0.01 to MW - \$4.00. While this approach focuses on wage bins proximate to the new minimum wage, I comprehensively estimate and report employment changes across the entire wage distribution. Hence, I extend the "above" bins to include h in the set 0, 1, 2, 3, ..., 17, where $h = 17$ encompasses jobs paying \$17 above the new minimum wage or higher. To evaluate the impact of the minimum wage on the wage distribution within an event study framework, I employ the following regression specification:

$$\frac{E_{pbt}}{N_{pt}} = \sum_{\tau=-5}^{5} \sum_{h=-4}^{17} \beta_{\tau h} I_{pbt}^{\tau h} + \alpha_{pb} + \mu_{bt} + u_{pbt} \tag{4}$$

Here, $I_{pbt}^{\tau h}$ is an indicator variable that equals 1 if the minimum wage was raised τ months from date t and for the \$0.25 wage bins b that fall between h and $h+1$ dollars of the new minimum wage. I examine the effects between five months before and six months following the minimum wage change. the benchmark specification also controls for province-by-wage bin and period-by-wage bin effects, α_{pb} and μ_{bt}. This allows me to control for province-specific factors in the earnings distribution and also the nationwide evolution of wage inequality. I cluster the standard errors by province, which is the level where policies are implemented. By doing so, the standard errors consider that employment changes at various points of the wage distribution may be correlated within each province.

The estimated $\beta_{\tau h}$ enables me to compute the change in employment across the wage distribution in response to the policy. The change in the number of jobs (per capita) paying below the new minimum wage between the event date -1 and τ can be calculated as $\sum_{h=-4}^{-1} \beta_{\tau h} - \sum_{h=-4}^{-1} \beta_{-1h}$. This is a difference-in-differences estimate, as it nets out the change in the counterfactual distribution implicitly defined by regression equation (4). Similarly, the change in the number of jobs (per capita) paying between the minimum wage and $\overline{W}$ is $\sum_{h=0}^{\overline{W}-MW} \beta_{\tau h} - \sum_{h=0}^{\overline{W}-MW} \beta_{-1h}$. For the baseline estimates, following Cengiz et al. (2019) I set $\overline{W} = MW + 4$, but I show robustness to different choices of this cutoff.

I define the excess jobs at or above the minimum wage as $\Delta a_\tau = \frac{\sum_{h=0}^{4} \beta_{\tau h} - \sum_{h=0}^{4} \beta_{-1h}}{\overline{EPOP}_{-1}}$, and the missing jobs below as $\Delta b_\tau = \frac{\sum_{h=-4}^{-1} \beta_{\tau h} - \sum_{h=-4}^{-1} \beta_{-1h}}{\overline{EPOP}_{-1}}$. Let $\overline{EPOP}_{-1}$ represent the sample average employment-to-population ratio in the treated provinces during the month before treatment. By dividing the employment changes by $\overline{EPOP}_{-1}$, I normalize the excess and missing jobs relative to the pre-treatment total employment. Δa_τ and Δb_τ values illustrate the evolution of excess and missing jobs over the event timeline τ. I also report the excess and missing employment estimates averaged over the six months following the minimum wage increase, $\Delta a = \frac{1}{6} \sum_{\tau=0}^{5} \Delta a_\tau$, and $\Delta b = \frac{1}{6} \sum_{\tau=0}^{5} \Delta b_\tau$.

Given my normalization, $\Delta e = \Delta a + \Delta b$ shows the bunching estimate for the percentage change in total employment due to the minimum wage increase. By dividing this by the average percentage change in the minimum wage across our events $\%\Delta MW$, I obtain the employment elasticity with respect to the minimum wage as follows:

$$\frac{\%\Delta e}{\%\Delta MW}$$

I define the percentage change in affected employment as the change in employment divided by the share of the workforce earning below the new minimum wage the month before the treatment, denoted as $\bar{b}_{-1}$.[8]

$$\%\Delta\text{Affected Employment} = \%\Delta e = \frac{\Delta a + \Delta b}{\bar{b}_{-1}}$$

I can also use the estimated coefficients to calculate the percentage change in the average hourly wage for affected workers. The average wage is calculated by taking the ratio of the total wage bill received by workers earning below the new minimum wage to the number of these workers. before the treatment, it equals $\overline{w}_{-1} = \dfrac{\overline{wb}_{-1}}{\bar{b}_{-1}}$. Here, the wage bill, $\overline{wb}_{-1}$, and the number of workers earning below the new minimum wage just before the increase $\bar{b}_{-1}$ are averages across the full sample of events. The minimum wage increase leads to changes in both the wage bill and employment levels. The new average wage in the post-treatment period is calculated as $w = \dfrac{(\overline{wb}_{-1} + \Delta wb)}{(\bar{b}_{-1} + \Delta e)}$.[9] Therefore, the percentage change in the average wage is as follows:

[8] Notice that following Cengiz et al. (2019) I divide by the actual share of the workforce rather than by the change in it. As mentioned earlier, these two measures differ if there is imperfect compliance, imperfect coverage, or measurement errors in wages. While both approaches have value, dividing by the actual share is more relevant for policy purposes. This is because policymakers can calculate the actual share of workers earning the new minimum wage and use the estimates provided in this paper. In contrast, the change in the number of jobs below the new minimum wage is only known after the increase takes effect, making it unsuitable for prospective policy impact analysis

[9] The change in the wage bill can be expressed as a function of my regression coefficients. By averaging these coefficients over the 6-month post-treatment period, $\beta_h = \frac{1}{6}\sum_{\tau=0}^{5} \beta_{\tau,h}$, I can write $\Delta wb = \sum_{h=-3}^{4}(h + \overline{MW})(\beta_h - \beta_{-1h})$, where $\overline{MW}$ is approximately the sample average of the new minimum wage. I say approximately because h is based on 1$ increment, and so $\overline{MW}$ is computed as the sample mean of [MW, MW+1).

$$\%\Delta w = \frac{w}{\overline{w}_{-1}} - 1 = \frac{\dfrac{\overline{wb}_{-1} + \Delta wb}{\overline{b}_{-1} + \Delta e}}{\dfrac{\overline{wb}_{-1}}{\overline{b}_{-1}}} - 1 = \frac{\%\Delta wb - \%\Delta e}{1 + \%\Delta e} \tag{5}$$

The percentage change in the average wage is calculated by subtracting the percentage change in the wage bill from the percentage change in employment and then dividing it by the retained employment share. This formula assumes that the average wage change of workers exiting or entering due to the policy is the same as the wage change for affected workers who remain employed.

Finally, equipped with the change in employment and wages for impacted workers, I can calculate the elasticity of employment concerning own wage (or the "labor demand elasticity" in a competitive market):

$$\frac{\%\Delta\text{Affected Employment}}{\%\Delta\text{Affected Wage}} = \frac{1}{\%\Delta w}\frac{\Delta a + \Delta b}{\overline{b}_{-1}}$$

I compute the standard errors around this elasticity using the delta method.

5.5.3 Empirical Implementation of Wage Spillover

One key advantage of estimating the impact of minimum wages on the wage distribution is that I can directly assess the size and scope of wage spillovers (or ripple effects). These spillovers are important for understanding the impact of minimum wages on wage inequality and for learning about the economic mechanisms operating in low-wage labor markets.

In Canada, several researchers have worked on quantifying the spillover effects of minimum wage increases on wages. Notably, Campolieti (2015) has conducted significant research in this area. His study, "Minimum Wages and Wage Spillovers in Canada," uses data from the Canadian Labour Force Survey from 1997 to 2010 to estimate these effects and suggests that the spillover impacts are relatively modest compared to those in the U.S.

In this section, following the methodology of Cengiz et al. (2019), I quantify the spillover effect by comparing the actual average wage increase to the hypothetical increase that would occur without spillovers. To estimate the "no spillover" wage increase, I move each missing job under the new minimum wage exactly up to the new minimum wage level:

$$\%\Delta w_{\text{no spillover}} = \frac{\sum_{h=-4}^{-1} h(\beta_h - \beta_{-1h})}{\overline{wb}_{-1}} \tag{6}$$

I will present my estimates of wage spillovers in Chapter 7.

Chapter 6

Data and Sample Construction

For my empirical work, I used the master files of the Labor Force Survey (LFS) collected by Statistics Canada. The LFS gathers monthly information on the labor market activities of Canada's working-age population, including usual and actual hours of work, employees' hourly and weekly wages, industry and occupation of current or most recent jobs, public and private sector employment, union status, and more. This dataset provides appropriate information for investigating the effect of minimum wage changes on employment and the average wage of affected workers. Households surveyed for the LFS remain in the survey for 6 months before being rotated out and replaced by new households. This longitudinal aspect of the LFS is crucial when investigating the effects of minimum wage shocks on incumbents versus new entrants.

I used data from 1999 to 2019 to estimate the model. Although 1997 marked the first full year that the LFS included wage data, which is essential for investigating changes in employment and wages for affected workers, I chose to start the sample from 1999 instead of 1997. The reason for this decision is that in 1997 and 1998, there were some differences in the categorization of certain variables, such as marital status, making it impossible to ensure consistency with years after 1998. Therefore, I focused on years 1999 and onwards for consistency.

Additionally, I decided not to include the years 2020 and 2021. This decision was made to isolate the effect of the minimum wage as much as possible. The years 2020 and 2021 were heavily affected by the COVID-19 pandemic, and including these years has the potential to confound the causal effect of the minimum wage.

I adjust wages to 2002 dollars using the CPI from Statistics Canada. Wages between \$0 and \$2 are grouped into a single bin, while wages above \$30 are placed in the \$30 bin. This results in 114 wage bins: (0.00, 2.00), [2.00, 2.25), ..., [29.75, 30.00), [30, ∞). For each of these bins, I aggregate the data into monthly province-level employment counts (E_{pbt}) using the final individual weight. Additionally, I calculate the province-level population aged 15 and over (N_{pt}) from the LFS data using the final individual weight, which serves as the denominator for creating per-capita counts. In the primary sample, I consider all wage earners up to the age of 70 years old, excluding the self-employed individuals.

To investigate the change in jobs paying below and above a new minimum wage, I need to define the minimum wage increase events. These increases can be considered shocks if the real minimum wage rises by more than 25 cents. I used a series of minimum wage changes in all provinces of Canada from 1999-2019, based on data from Statistics Canada. For the 56 minimum wage events identified, an average of 9.5% of workers were below the new minimum wage in the month before these events, and the mean real minimum wage increase was 8.1

I selected the threshold of 25 cents to define minimum wage shocks for the following reasons: In most U.S. studies such as (Cengiz et al., 2019; Godoey, Reich, and Allegretto, 2019) examining the effects of minimum wage shocks, a threshold of 25 cents is commonly used. This threshold captures most policy changes in the U.S. context. Although there are differences in the number and distribution of minimum wage shocks between the U.S. and Canada, one commonality is the limited number of sharp events (based on real minimum wage) in both countries. However, it is important to note that the number of sharp events is still greater in Canada compared to the U.S. Typically, provinces in Canada, like states in the U.S., index their minimum wage to inflation, resulting in smaller changes in real minimum wages. The largest real minimum wage hikes in Canada after 2017 occurred in provinces like

Ontario, British Columbia, and Alberta.

As explained in Chapters 3 and 4, the largest increase in real minimum wage from 1999 to 2019 happened in January 2018 in Ontario, with a rise of $1.65. The second largest increase occurred in British Columbia in June 2018, with a $1 increase. The third largest increases were in Alberta in October 2018 and October 2017, with real minimum wage rises of about 97 cents each. All real minimum wages and their changes are measured in 2002 dollars.

From 1999 to 2019, the average change in real minimum wage in 10 provinces of Canada, measured in 2002 dollars, was around 29 cents. Thus, choosing events where the real minimum wage increase is more than 25 cents is well-justified. Note that I only considered real minimum wage changes that were accompanied by changes in nominal minimum wages. Real minimum wage changes without corresponding nominal wage changes were not considered shocks, even if they exceeded 25 cents.

Table 6.1: Summary Statistics for Changes in the Real Minimum Wage (DMW_real).

Variable	Observation	Mean	Std. Dev	Min	Max
DMW_real	176	0.293	0.219	-0.1	1.65

Source: extracted data from Statistics Canada

When I consider only the shocks that did not overlap with any minimum wage changes within 5 months before or after them (an 11-month window period), and where at least 4% of the workers were directly affected by the increase, I identified 56 minimum wage shocks. These shocks are shown in Table 3.1.

Overall, I investigate employment changes within eleven-month windows around 56 minimum wage increases. These shocks occurred in provinces that increased their real minimum wage by more than 25 cents ($0.25) and where at least 4% of workers were directly affected by the increase. Specifically, for the years 1999-2008, at least 3% of workers were affected; for 2009-2017, at least 4%; and for 2018-2019, at least 7%. This differentiation is necessary because, between 1998 and 2018, the proportion of employees earning minimum wage in Canada grew from 5.2% to 10.4%, with most of this increase occurring between 2017 and 2018. This rise coincided with notable minimum wage increases in Ontario, Alberta, and British Columbia (Statistics Canada).

As shown in Table 3.2 in Chapter 3, the average share of the wage bill for minimum wage workers in Canada over my sample period (1999-2019) is around 6%. Considering that roughly one-third of production is related to capital and two-thirds to labor, the low-skilled share of production is approximately 4% ($\frac{6}{100} \times \frac{2}{3} = 0.04$).

As I explained in section 5.5.2, I divide aggregate employment into 0.25 wage bins using the LFS data. One concern is that some bins may be sparse, with very few or no workers. However, it is important to highlight that the employment estimate is based on the sum of employment changes in 36 cells covering a 9$ range [MW-4$, MW+4$] summed over at least one month (usually 6 months). Therefore, small or zero employment in particular cells is not a significant concern.

Overall, I have 287,280 wage bin-province-period observations derived from 12,998,207 individual-level observations, resulting in an average count of 45.24 workers per 0.25$ bin. The count per bin is higher than 45.24 in the [MW-4$, MW+4$] windows for all 56 events because the upper tail wage bins are more scattered. Thus, in each province, on average, there are more than 45 workers each month in each of the 0.25$ bins within the [MW-4$, MW+4$] window in the sample. Because the coefficients for my event dummies are estimated at the 1$-bin-month-province level, on average, I have more than 180 individual-level observations per event. Additionally, when investigating the overall employment effects, I also compute the sum of the 1$-bin estimates between 4$ below and 4$ above the minimum wage and consider 6-month averages. This means, on average, I use more than 9,720 individual worker observations per event. This is a well-sized sample that allows for reliable estimates of employment counts for each event.

Consistent with this approach, similar to the method used by Cengiz et al. (2019), I demonstrate that this technique aligns with a simpler method of estimating a regression using province-by-month data. In this method, the dependent variables are the number of jobs or total wage bill under \$19, divided by the population. The \$19 threshold is chosen because it is at least \$4 above the new minimum wage in all 56 events defined in this study. As I will show in results section in Table 7.1, the estimated employment, wage outcomes, and standard error are very similar when using this simpler method. Nevertheless, I refrain from adopting this simpler approach as my primary specification, as it lacks the capability to independently track both the missing and excess jobs.

Another potential concern regarding the data is the possibility of wage misreporting in the LFS, which may introduce bias into my estimates. If reported wages contain measurement errors, some workers earning above the minimum wage may erroneously appear to earn below it, potentially attenuating the estimate for Δb. However, Cengiz et al. (2019) explains that this does not compromise the consistency of the estimate for $\Delta a+\Delta b$ as long as the minimum wage solely impacts reported wages below $\overline{W}$.

The rationale is straightforward: Assuming 1% of the workforce mistakenly reports earning below the new minimum wage in the post-treatment period, the estimate of the missing jobs would be slightly underestimated: $\widehat{\Delta b} = \Delta b + 0.01$. Yet, this misreporting would also lead to a proportional reduction in the number of excess jobs above, resulting in the estimate $\widehat{\Delta a} = \Delta a - 0.01$. This holds true as long as these misreported workers originate from the range [MW,$\overline{W}$), a condition likely met across various classical and non-classical measurement error processes where the error's support is confined within $[MW - \overline{W}, \overline{W} - MW]$. Consequently, the employment estimate $\widehat{\Delta a} + \widehat{\Delta b}$ remains largely unaffected by measurement errors in reported wages. Finally, before finishing this Chapter, I must explain why I opted for an 11-month window period instead of the 8-year window period used by Cengiz et al. (2019). There are several reasons for this:

1. Data Granularity: Yearly data only allow me to observe annual employment transitions, but minimum wage increases can occur in any month of the year. Using yearly data can result in an aggregation problem. Although I estimate the average effect of employment for six months (the month of the shock and the following five months), I will also show the effect for each month separately in Figure 7.3. To mitigate this issue, some studies like Cengiz et al. (2019) dis-aggregated the year into four quarters to analyze

the changes in employment and minimum wage quarterly and then yearly. Other studies, like Campolieti et al. (2005), restricted their sample to minimum wage increases occurring in the first four months of the year and used provinces that did not have a minimum wage increase in the previous 12 months as a comparison group. By using monthly data, I avoid the averaging effect and, consequently, my window period is monthly.

2. Variations in Minimum Wage Changes: Expanding the window period to 8 years, as Cengiz et al. (2019), did, would result in only around 16 minimum wage shocks instead of 56 due to the closer proximity of shocks in Canada. Choosing shocks without other shocks within the considered window period, and given the frequency of shocks in Canada, using yearly data would significantly reduce the number of shocks analyzed.

3. Focus on Short-term Effects: In my Ontario study, alongside with Alberta and Ottawa vs Gatineau study, I used yearly data and collapsed monthly data into yearly data to observe the longer-term effects of minimum wage shocks. However, when I pooled all 56 minimum wage increases across Canada from 1999-2019, my focus is on the short-term effects of minimum wage changes. To isolate the impact of minimum wage on employment as much as possible, analyzing periods closer to the timing of the shock is more effective than examining periods further away from the shock. The results sections will show that a significant 4 percent decrease in employment for affected workers occurs only in the month of the shock, an effect not visible when collapsing data annually. Therefore, focusing on monthly data within a shorter window period provides more precise results.

Chapter 7

Results

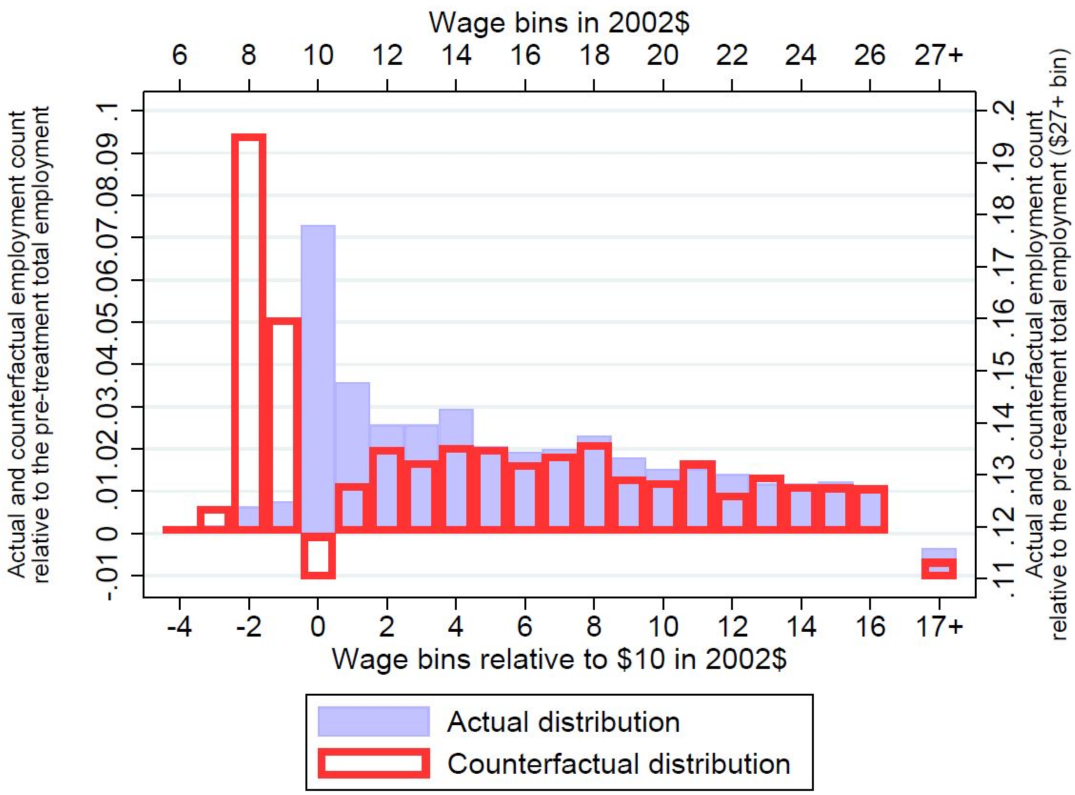
In this chapter, I will present the results of the employment and wage effects using tables and graphs, employing all the methodologies previously explained. First, I will analyze the impact of a single minimum wage increase, using Ontario as an example, followed by Alberta, and comparing Ottawa to Gatineau. Next, I will extend the analysis to encompass all minimum wage increases. Subsequently, I will examine the heterogeneity in responses among different demographic groups, alternative workforce categories, industries, and new entrants and incumbents. Finally, I will quantify the size of the wage spillover.

7.1 Estimating Employment and Wage Effects

7.1.1 Ontario Study Using Bunching and DID Approach

In Figure 7.1, I report the actual (blue filled bar) and the counterfactual (red empty bars) frequency distributions of wages, normalized by the pre-treatment total employment in Ontario. I define the years 2015-2017 as the pre-treatment period and the post-treatment period as 2018-2019. The post-treatment actual wage distribution in Ontario province (blue filled bars), indicates that a small proportion of workers earn less than the mandated wage, with a prominent spike observed at the new real minimum wage of $10 (in 2002 values). The post-treatment counterfactual distribution varies significantly. This distribution suggests that without the minimum wage increase, there would have been a higher number of jobs in the $8 and $9 wage bins, but fewer jobs in the $10 bin and above.

Figure 7.1: Employment by Wage Bins in Ontario between 2018-2019

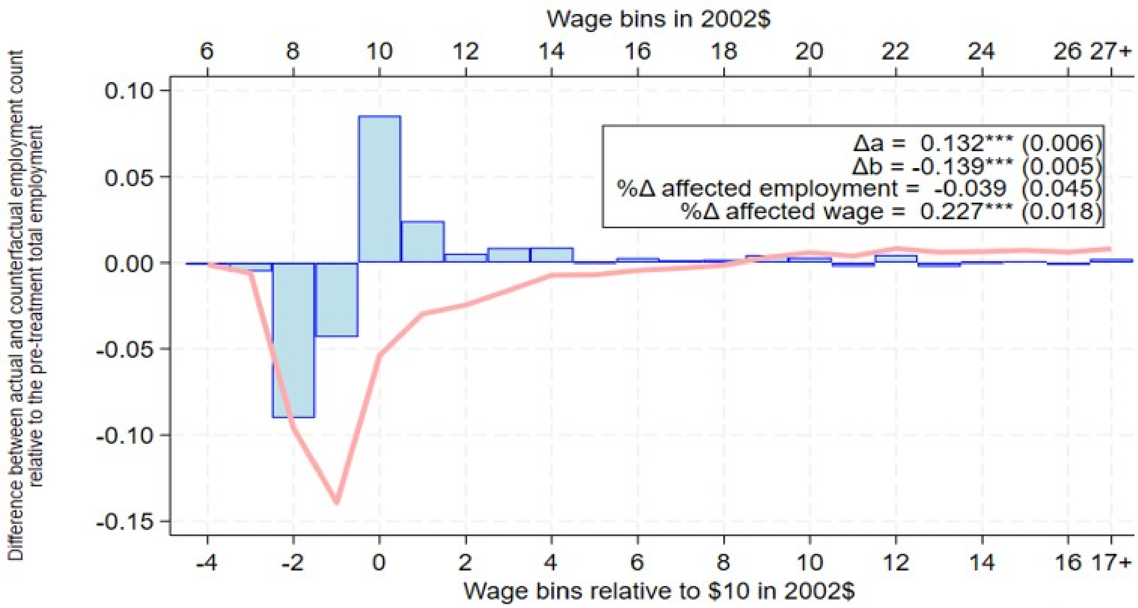


Notes: I analyze the impact of the 2018 minimum wage increase in Ontario province on the frequency distribution of wages. This analysis aggregates wages into $1 bins and normalizes them by the 2017 level of employment in Ontario. The minimum wage was raised from 8.7$ to 10.37$ (in 2002 values) and subsequently indexed to inflation. The above figure displays both the actual (represented by purple solid bars) and counterfactual (outlined in red) wage frequency distributions following the minimum wage increases in Ontario. The actual distribution, reflecting the post-treatment period, illustrates the average employment between 2018 and 2019 by wage-bin relative to the 2017 total employment in Ontario, utilizing LFS data on hourly wages from 2018 to 2019. In contrast, the counterfactual distribution incorporates the average change in employment between 2018 and 2019 in provinces without any real minimum wage adjustments, added to the mean job counts from 2015 to 2017 (refer to the text for detailed methodology). The bin labeled $27+ (indicating wages $17 or more above the new minimum wage) encompasses all workers earning above $27, with its values depicted on the right y-axis.

In comparison to the counterfactual wage distribution, the actual distribution is also raised by $1 above the minimum wage, indicating that minimum wages lead to some small spillover effects. However, the ripple effect of the minimum wage diminishes beyond $11, with no discernible difference observed between the actual and counterfactual distributions beyond this threshold. I will explain the extent and scope of spillovers further in section 7.3. The resemblance between the actual and counterfactual distributions mirrors the depiction of the bunching method illustrated in Figure 1.1.

The blue bars depicted in Figure 7.2 illustrate the differences in job counts across various wage bins. The difference-in-differences estimate reveals a noticeable decline in counts for wage bins situated just below the newly implemented minimum wage. I present my calculation of missing jobs (Δb), derived from the aggregate of employment changes. $\sum_{h=\$6}^{\$9}(e_{ON,h,Post} - e_{ON,h,Post}^{CF})$ between $6 and $9, under the new minimum wage. The absence of jobs paying below $10 accounts for approximately 13.9% of Ontario's total pre-treatment employment. I also compute the number of excess jobs paying between $10 and $14, Δa, which is $\sum_{h=\$10}^{\$14}(e_{ON,h,Post} - e_{ON,h,Post}^{CF})$. The excess jobs constitute approximately 13.2% of Ontario's total pre-treatment employment.

Figure 7.2: Employment by Wage Bins in Ontario



Notes: Figure 3.2 illustrates the difference between the actual and counterfactual wage distributions. The blue bars represent the variation in employment at each wage bin relative to the 2017 total employment in Ontario. Meanwhile, the red line indicates the cumulative employment changes up to that specific wage bin. In the upper right panel, estimates are provided for various aspects: the number of missing jobs below \$10 (Δb), the surplus jobs between \$10 and \$14 (Δa), and the estimated employment and wage effects.

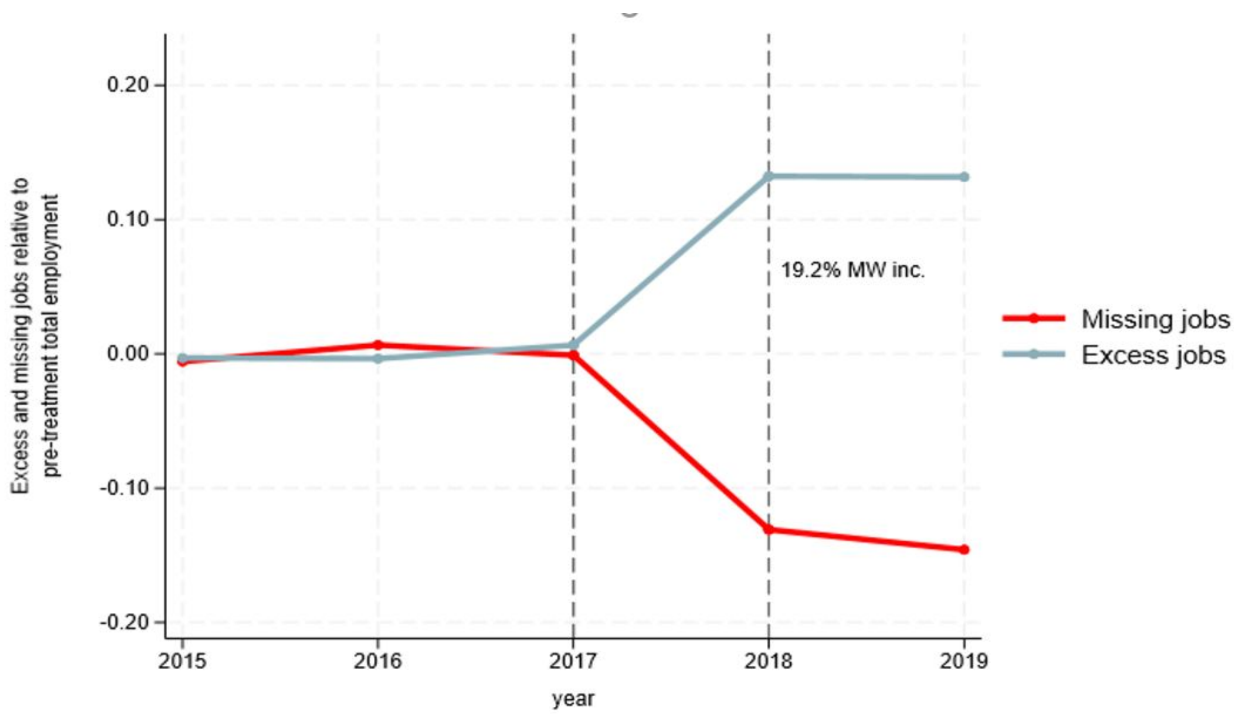
As I explained in the bunching approach, the impact of the minimum wage on low-wage jobs is equivalent to the sum of the missing jobs below and the excess jobs above the new minimum wage of \$10. My findings reveal a negative net change in employment, with the decrease representing 0.7% of the total pre-treatment employment in Ontario. This indicates a 3.9% decrease in employment for workers earning below the new minimum wage in 2018. however, I should mention that this decrease is statistically insignificant. I additionally discovered that the average wages of affected workers at the lower end of the wage distribution rose by approximately 22.7% which is completely significant.

In Figure 7.2, the red line illustrates the cumulative sum of employment changes up to each wage bin. This running sum experiences a significant decrease, reaching a notably negative value just below the new minimum wage, but gets close to zero by \$5 above the minimum wage (at 8\$ is completely zero) after 5\$ above the new minimum wage the change in employment is very small and approximately flat. by around $8 above the minimum wage, the running sum remains constant after that, with zero to minimal alterations in upper-tail employment. This further solidifies the argument for a causal interpretation of these findings.

7.1.2 Ontario Study Using Event Study Analysis

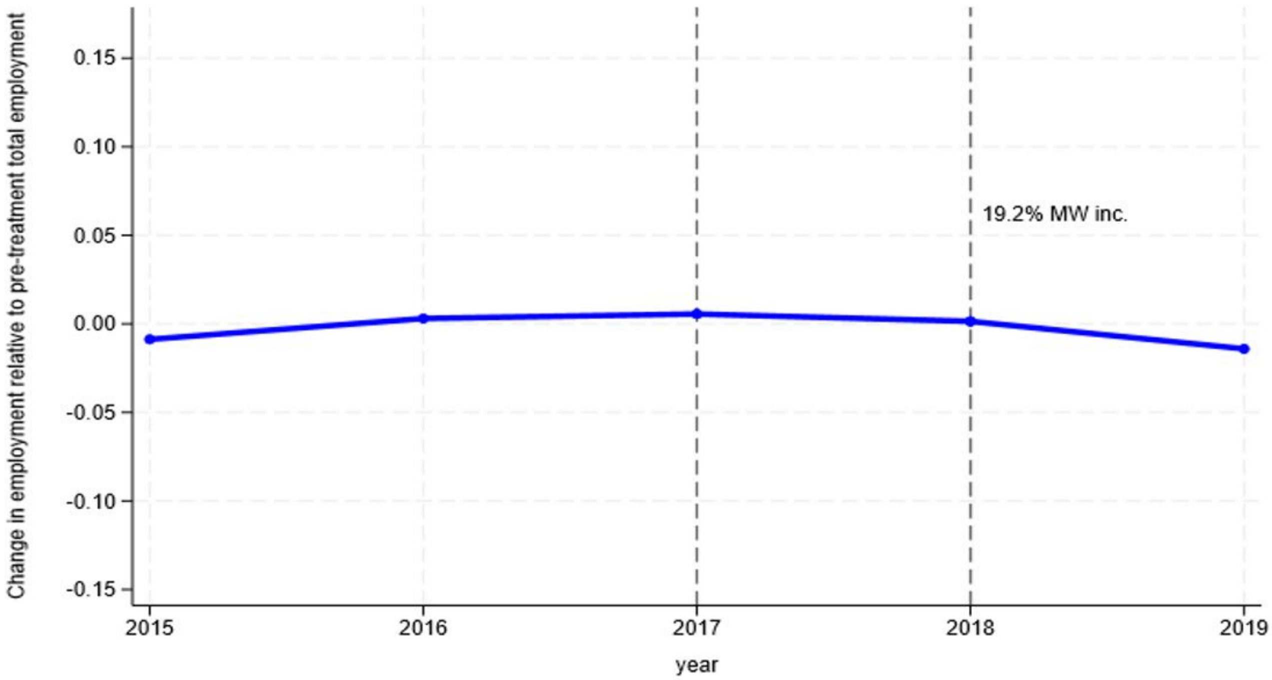
Moreover, I investigate the evolution of missing jobs (red line) and excess jobs (blue line) over time using event study analysis to check the parallel trend assumption. in Figure 7.3. The figure illustrates that both excess and missing jobs were near zero before 2018, with no discernible systematic pre-existing trends. Once the minimum wage is increased in 2018, there is a clear decline in jobs below the new minimum wage compared to the counterfactual. for the year 2019, the evolution of missing jobs becomes flat. As you see in Figure 7.3, the evolution of excess jobs for the years 2018 and 2019 closely matches the evolution of missing jobs. Consequently, the net employment change including both missing and excess jobs remains close to zero in all subsequent years following the minimum wage hike (refer to Figure 7.4). As demonstrated, the parallel trend assumption is satisfied, thereby validating the research design of my study.

Figure 7.3: Impact of Minimum Wages on Missing and Excess Jobs Over Time in Ontario Study



Notes: The Figure illustrates the evolution of missing and excess jobs over time in Ontario province, with data aggregated in $1 bins. the red line depicts the missing jobs, which signifies the difference between the actual and counterfactual wage distributions within the $6 to $9 wage range. Conversely, the light blue line represents the excess jobs, indicating the difference between the actual and counterfactual frequency distributions for wages between $10 and $14

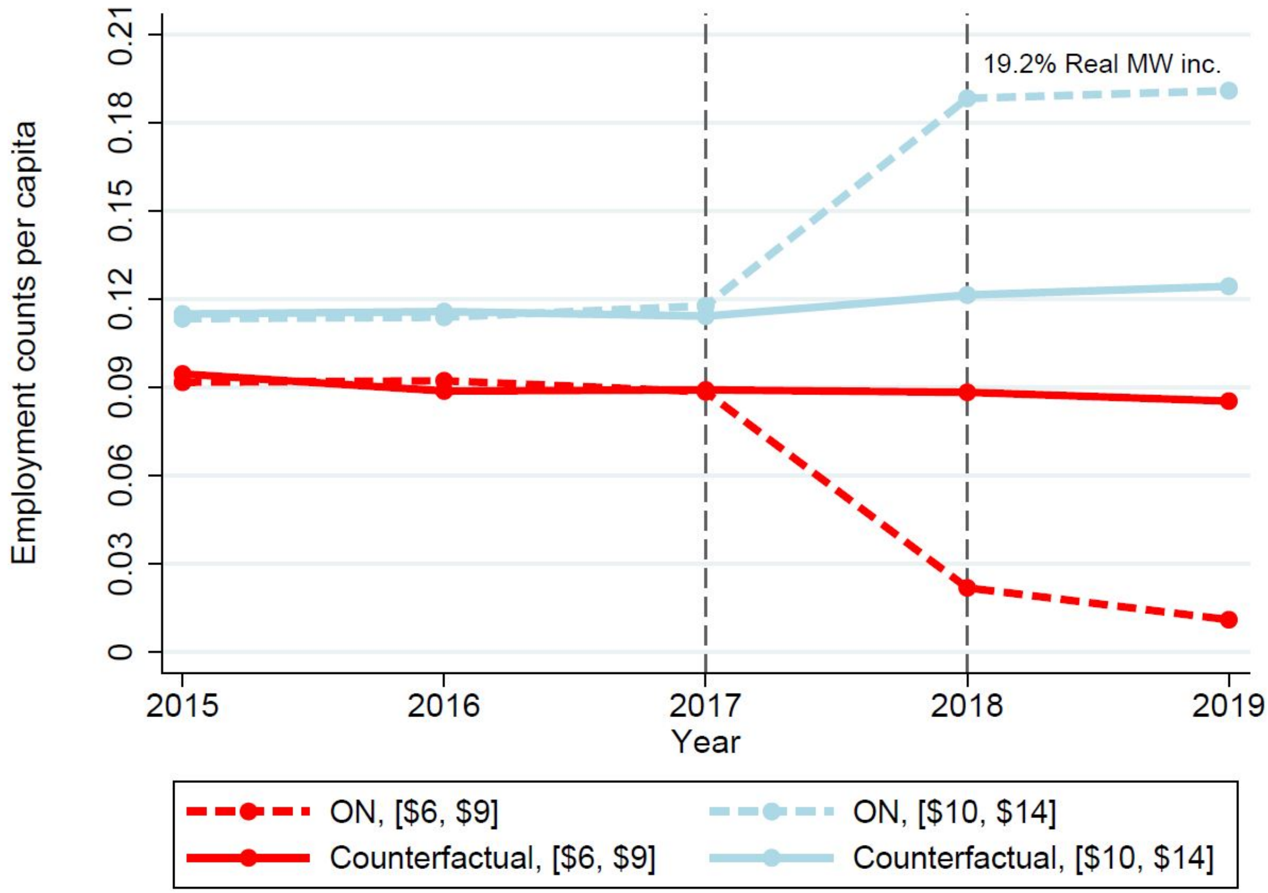
Figure 7.4: Impact of Minimum Wages on Employment Change Over Time in Ontario Study



Notes: The Figure illustrates the employment change over time as the total of excess jobs and missing jobs. The counterfactual distribution is derived by incorporating the average job change observed in control provinces into the mean job counts in Ontario from 2015 to 2017 (refer to the text for comprehensive details). Additionally, the vertical dashed black lines in 2017 and 2018 highlight the increase in the real minimum wage, from 8.7$ to 10.37$ (in 2002 values).

Finally, as you see in Figure 7.5, I explored the trend in the number of jobs per capita within hourly wage ranges of $6 to $9, and $10 to $14, both in Ontario and the counterfactual scenario. This analysis involved aggregating data into $1 bins.

Figure 7.5: Comparision of Per-Capita Employment Counts of Ontario and the Counterfactual



Notes: The diagram depicts the trend in the number of jobs per capita with hourly wages ranging between $6 and $9, as well as between $10 and $14, in Ontario and in the counterfactual scenario. Data is aggregated in $1 bins. Counterfactual jobs are computed using provinces that did not experience any real minimum wage increase during the 2015-2019 period. Specifically, I augment the average change in per capita employment between $6 and $9 (and between $10 and $14) in the control provinces to the mean job counts in Ontario from 2015 to 2017 (refer to the text for detailed methodology). The two vertical dashed black lines in 2017 and 2019 denote the increase in the real minimum wage, from 8.7$ to 10.37$ (in 2002 values).

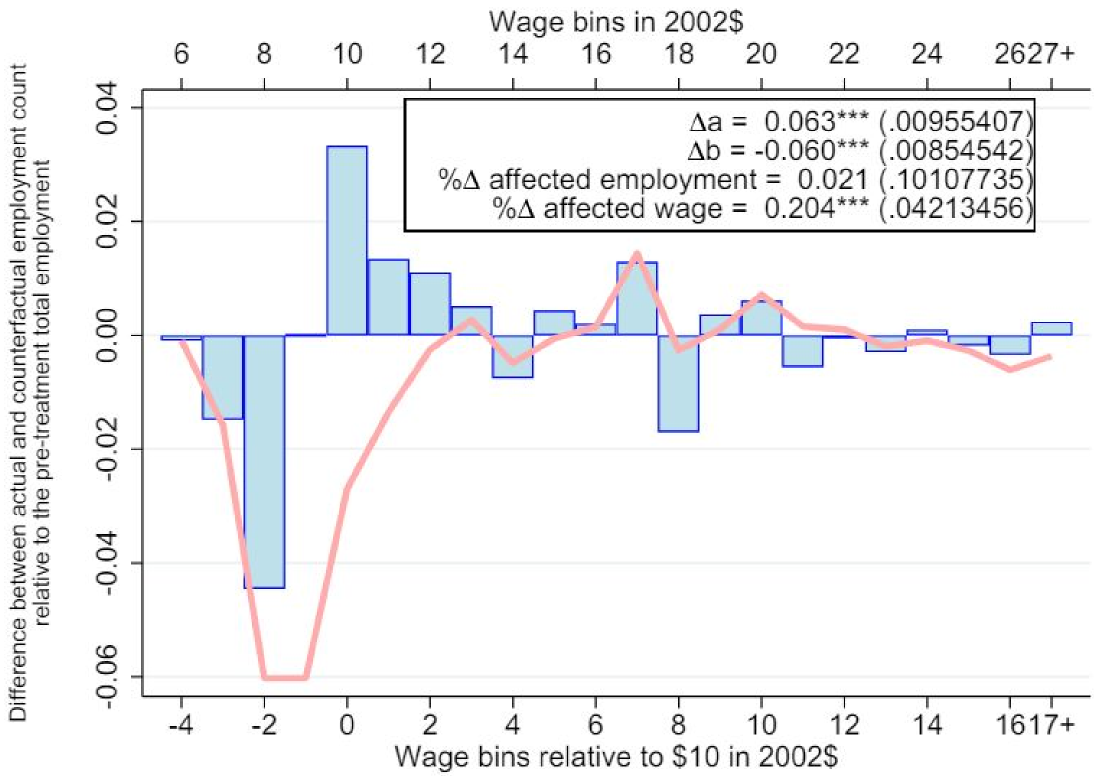
7.1.3 Alberta Study Using Bunching and DID Approach

In recent years, provinces like Alberta and British Columbia have undergone substantial nominal and real minimum wage increases. However, unlike Ontario, these increases were phased in over a more extended period. For instance, Alberta saw its nominal and real minimum wage rise by 47% and 39%, respectively, implemented in four annual increments spanning from 2015 to 2018.

Fossati and Marchand (2024) examined the employment impact of a substantial increase in the nominal minimum wage in Alberta, implemented through four annual increments over three years from 2015 to 2018. Their research revealed a notable negative employment effect among young workers (aged 15-24). Fossati and Marchand (2024) investigated the effects of minimum wage increases in Alberta, focusing on employment and income distribution outcomes. Their study utilized a Synthetic Control Method (SCM) rather than a Difference-in-Differences (DiD) approach. The SCM allows for the creation of a synthetic version of Alberta by combining data from other regions, which serves as a control group. They found that the minimum wage hikes led to a significant reduction in employment among young workers, though they did not find any significant negative employment effect for adults.

This motivates me to apply the bunching approach along with DiD and event study analysis to see if my results align with those of Fossati and Marchand (2024). I will first start with the overall effect and then, in subsequent sections, examine different demographic groups such as teenagers and individuals aged 15-24. For the Alberta study, as seen in Figure 7.6 below, the employment effect is 2.1%, but it is not statistically significant. However, like in the Ontario study, there was a significant increase of 20.4% in the average wage of affected workers. So far, in my analysis of both Ontario and Alberta, I have not found any significant changes in the employment of low-wage workers following the minimum wage increases.

Figure 7.6: Employment by Wage Bins in Alberta

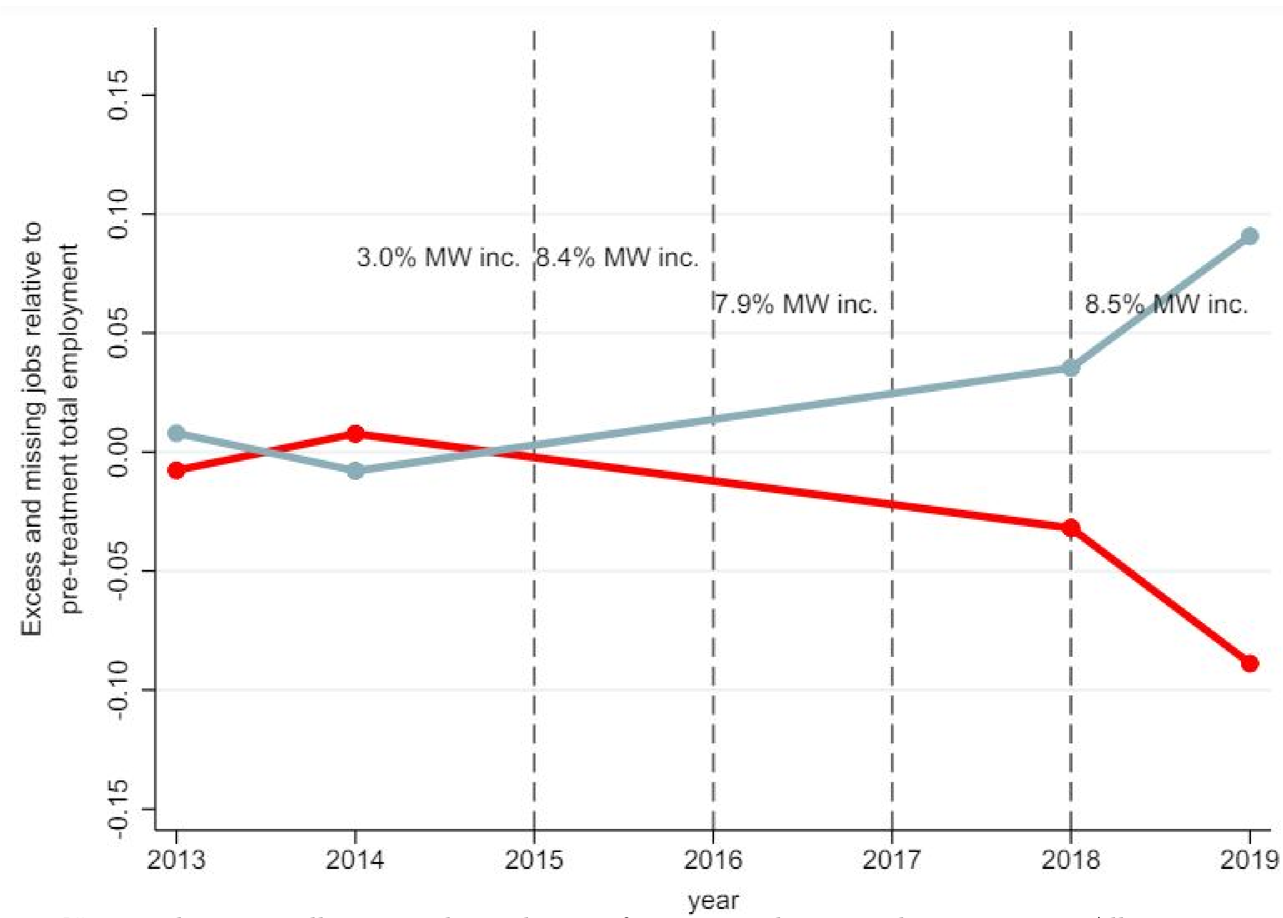


Notes: Figure 7.6 illustrates the difference between the actual and counterfactual wage distributions. The blue bars represent the variation in employment at each wage bin relative to the 2014 total employment in Alberta. Meanwhile, the red line indicates the cumulative employment changes up to that specific wage bin. In the upper right panel, estimates are provided for various aspects: the number of missing jobs below \$10 (Δb), the surplus jobs between \$10 and \$14 (Δa), and the estimated employment and wage effects.

7.1.4 Alberta Study Using Event Study Analysis

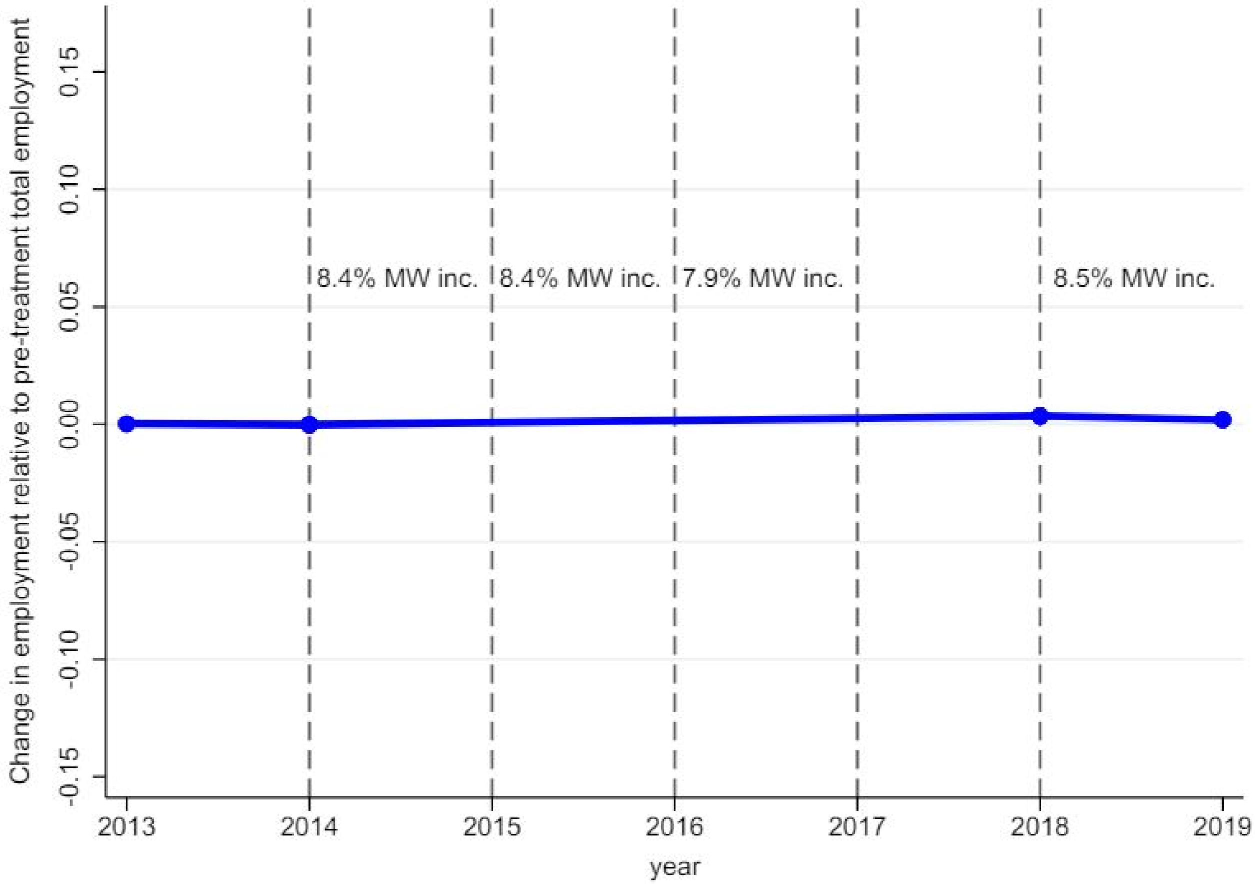
Similar to the Ontario study, I investigated the evolution of missing jobs (red line) and excess jobs (blue line) over time using event study analysis to check the parallel trend assumption. In the Alberta study, I compared the last step of the minimum wage increase, which occurred in 2018, and the following year, 2019, with the two years before the first step of the minimum wage increase (2013, and 2014). Figure 7.7 illustrates that both excess and missing jobs were near zero before 2015, with no discernible systematic pre-existing trends. However, with the increase in the minimum wage, there is a clear decline in jobs below the new minimum wage compared to the counterfactual, and this reduction continues through 2019. As explained in the Data section, I cannot continue the analysis beyond 2019 due to the deletion of data that includes the pandemic period. The evolution of excess jobs for the years 2018 and 2019 closely matches the evolution of missing jobs. Consequently, the net employment change, including both missing and excess jobs, remains close to zero in all subsequent years following the minimum wage hike (refer to Figure 7.8). As demonstrated, the parallel trend assumption is satisfied, thereby validating the research design of my study.

Figure 7.7: Impact of Minimum Wages on Missing and Excess Jobs Over Time in Alberta Study



Notes: The Figure illustrates the evolution of missing and excess jobs over time in Alberta province, with data aggregated in $1 bins. the red line depicts the missing jobs, which signifies the difference between the actual and counterfactual wage distributions within the $6 to $9 wage range. Conversely, the light blue line represents the excess jobs, indicating the difference between the actual and counterfactual frequency distributions for wages between $10 and $14

Figure 7.8: Impact of Minimum Wages on Employment Change Over Time in Alberta Study



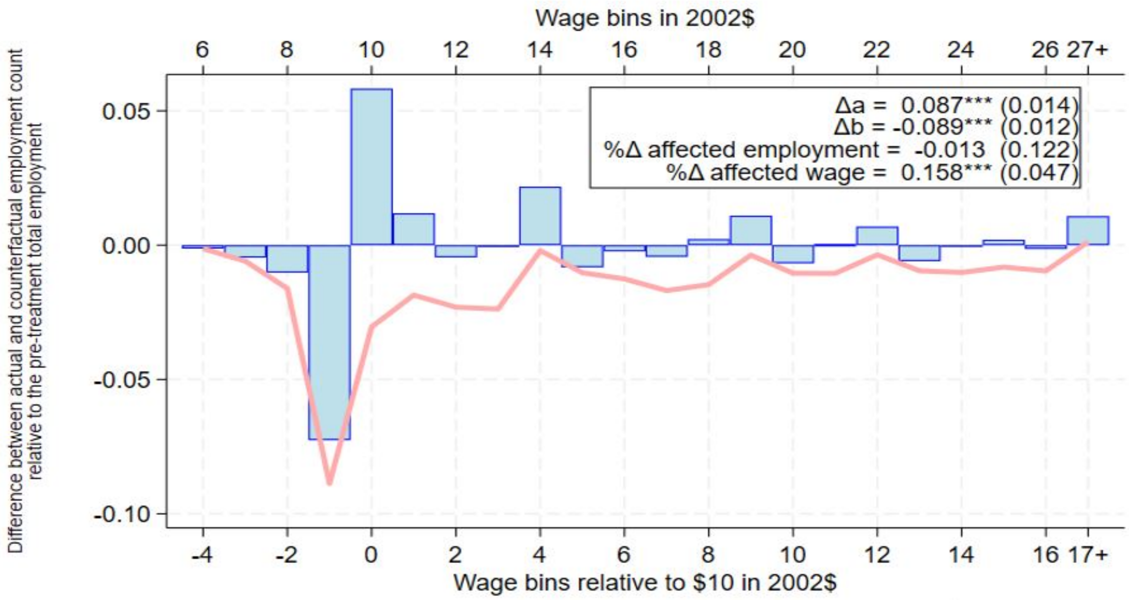
Notes: The Figure illustrates the employment change over time as the total of excess jobs and missing jobs. The counterfactual distribution is derived by incorporating the average job change observed in control provinces into the mean job counts in Alberta from 2013 to 2014. Additionally, the vertical dashed black lines in 2015,2026,2017, and 2018 highlight the increase in the real minimum wage, from 3%, 8.4%, 7.9%, 8.7$, and 8.5$ (in 2002 values).

7.1.5 Ottawa vs Gatineau Study by Using Bunching and DID Approach

To delve deeper into understanding the variance between my findings in the Alberta study and those of Fossati and Marchand (2024), I took an additional step. Fossati and Marchand (2024) utilized the synthetic control method to craft a counterfactual wage distribution in the absence of minimum wage changes. This method leverages pre-intervention data, employing a weighted average or a blend of control group units to form a 'synthetic control' closely mirroring the characteristics of the treated unit.

In contrast, the Ontario province offers a unique opportunity to find a suitable match for the treated unit without resorting to the synthetic control approach. This opportunity arises from the city of Gatineau, located in the province of Quebec, directly across the Ottawa River from Ontario's capital, Ottawa. This geographical adjacency has fostered a distinct relationship, often depicting the cities as a twin-city region due to their close connection. Besides geographical proximity, strong economic and cultural ties further intertwine the two cities. Many residents of Gatineau commute to work in Ottawa, and vice versa, resulting in a continuous flow of labor, services, and cultural exchanges between them. Consequently, investigating the impact of Ontario's minimum wage adjustments on employment in Ottawa versus Gatineau can provide additional insights into the divergent outcomes observed in our respective studies. so I applied the same methodology as the Ontario study for the Ottawa vs Gatinew study. the result is shown in Figure 7.9. The results align with the Ontario study but with a smaller magnitude. There is an insignificant negative employment effect of -1.3%. However, there is a significant increase of 15.8% in the average wage of affected workers.

Figure 7.9: Employment by Wage Bins in Ottawa vs Gatineau

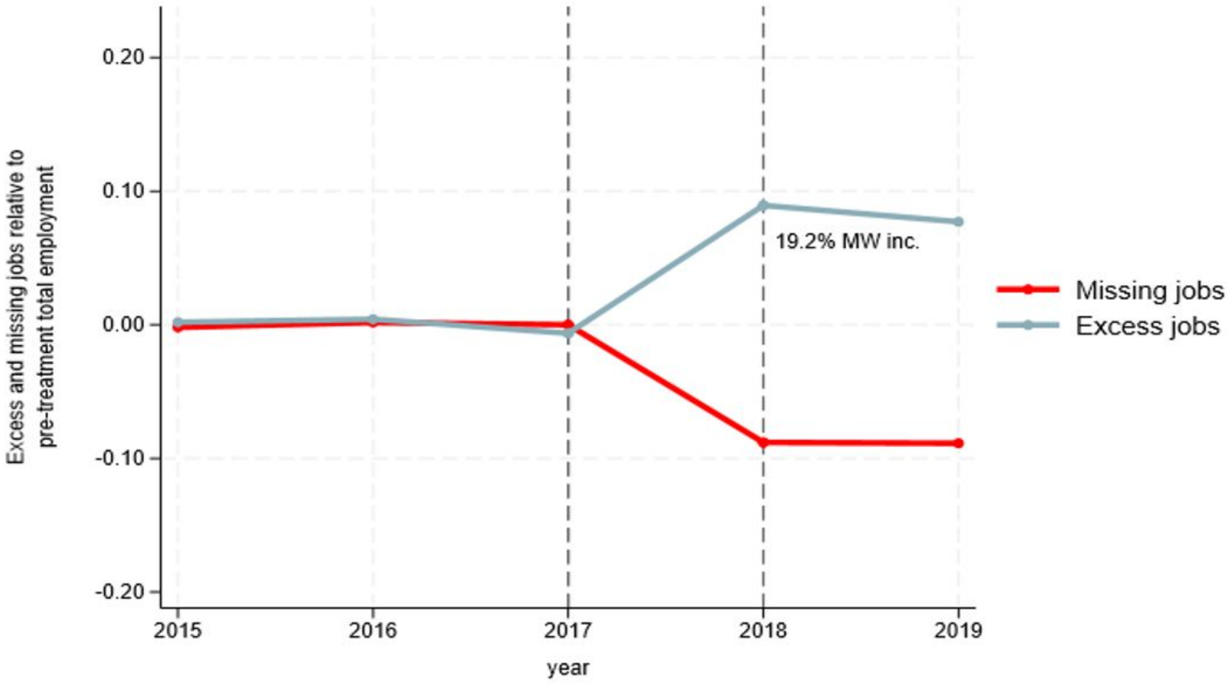


Notes: Figure 3.9 illustrates the difference between the actual and counterfactual wage distributions. The blue bars represent the variation in employment at each wage bin relative to the 2017 total employment in Ottawa. Meanwhile, the red line indicates the cumulative employment changes up to that specific wage bin. In the upper right panel, estimates are provided for various aspects: the number of missing jobs below $10 ($\Delta b$), the surplus jobs between $10 and $14 ($\Delta a$), and the estimated employment and wage effects.

7.1.6 Ottawa vs Gatineau Study Using Event Study Analysis

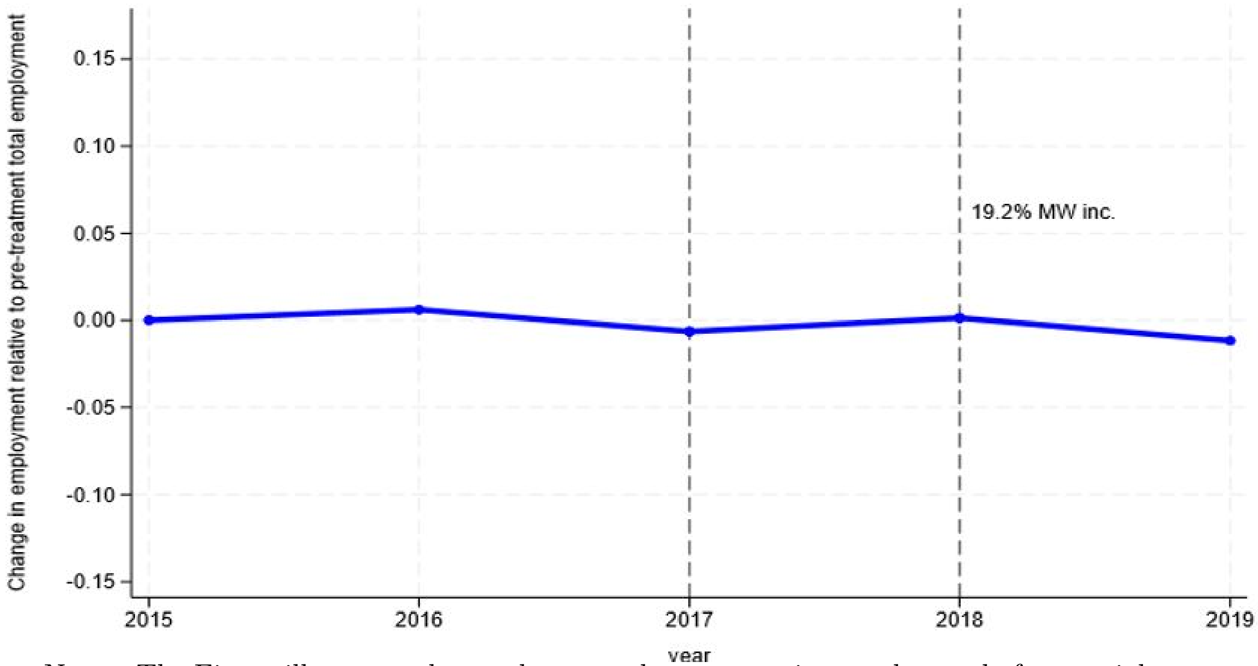
Similar to the Ontario study, I investigated the evolution of missing jobs (red line) and excess jobs (blue line) over time using event study analysis to check the parallel trend assumption. As shown in the Figure 7.10 and Figure 7.11, the results and the diagram are consistent with those explained in the Ontario study. The evolution of excess jobs for 2018 and 2019 closely matches the evolution of missing jobs. Consequently, the net employment change, including both missing and excess jobs, remains close to zero in all subsequent years following the minimum wage hike.

Figure 7.10: Impact of Minimum Wages on Missing and Excess Jobs Over Time in Ottawa vs Gatineau Study



Notes: The Figure illustrates the evolution of missing and excess jobs over time in Ottawa, with data aggregated in $1 bins. the red line depicts the missing jobs, which signifies the difference between the actual and counterfactual wage distributions within the $6 to $9 wage range. Conversely, the light blue line represents the excess jobs, indicating the difference between the actual and counterfactual frequency distributions for wages between $10 and $14

Figure 7.11: Impact of Minimum Wages on Employment Change Over Time in Ottawa vs Gatineau Study



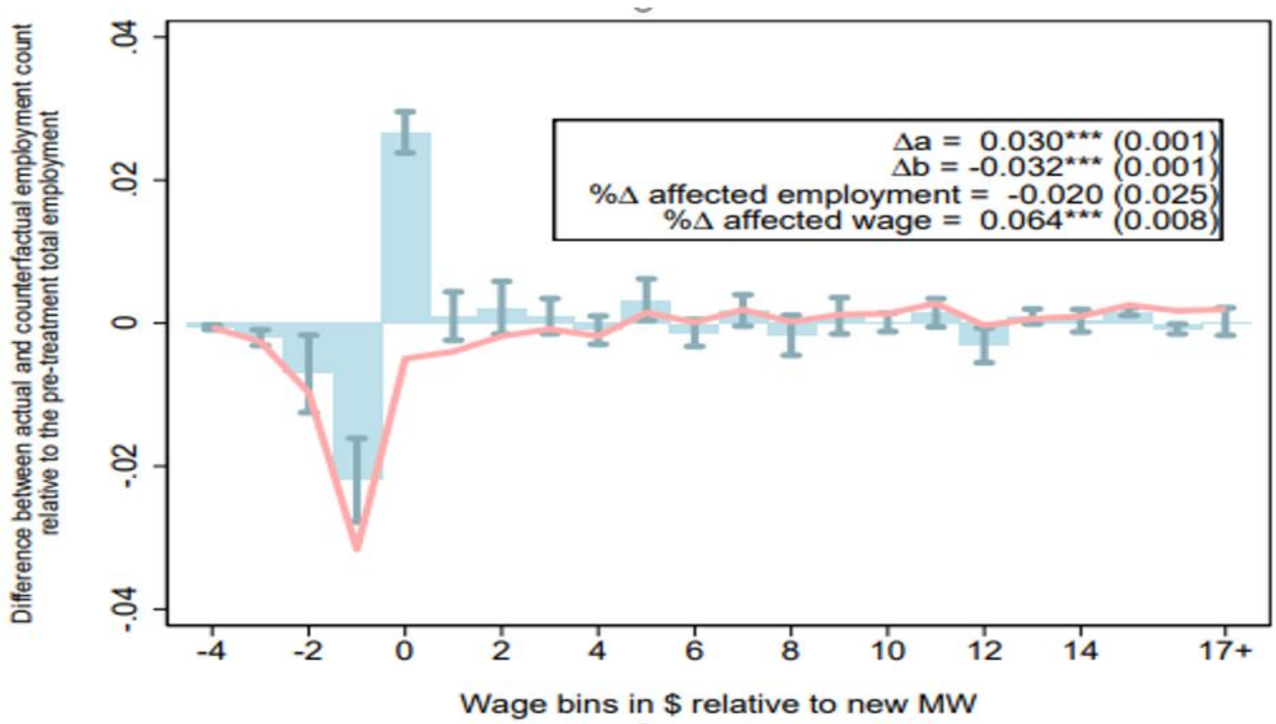
Notes: The Figure illustrates the employment change over time as the total of excess jobs and missing jobs. The counterfactual distribution is derived by incorporating the average job change observed in the control province (Gatineau) into the mean job counts in Ottawa from 2015 to 2017. Additionally, the vertical dashed black lines in 2017 and 2018 highlight the increase in the real minimum wage, from 8.7$ to 10.37$ (in 2002 values).

7.1.7 Canada Study Using Bunching and DID Approach

The Ontario Province study, along with the Alberta and the Ottawa vs. Gatineau study, provides valuable insights into how bunching at the minimum wage can help identify the employment effects of minimum wage increases. Additionally, it demonstrates how a difference-in-differences strategy can be used to construct a counterfactual wage distribution. However, making inferences based on a single minimum wage change can be inherently problematic. To address this, I implement the same methodology by pooling data across various provincial-level minimum wage changes occurring between 1999 and 2019.

I begin my analysis by estimating the effect of the minimum wage on the distribution frequency of hourly wages. Figure 7.12 presents the results from the baseline specification, which includes wage-bin-by-period and wage-bin-by-province fixed effects (refer to Equation 4). I first report the employment changes averaged over the six-month post-treatment period, $\frac{1}{6}\sum_{\tau=0}^{5}\beta_{\tau h}$, for each dollar wage bin (h) relative to the minimum wage. Recall that all employment changes are relative to the pre-treatment total employment in the province. Figure 7.12 highlights that the estimated effects on the wage distribution are very similar to those estimated from the Ontario case (see Figure 7.2).

Figure 7.12: Impact of Minimum Wages on the Wage Distribution (Canada Study)



Notes: The figure displays the main results from my event study analysis (see Equation 4), utilizing 56 province-level minimum wage changes between 1999 and 2019. The blue bars represent the estimated average employment changes for each dollar bin (relative to the minimum wage) during the 6-month post-treatment period, compared to the total province employment one month before the treatment. The error bars indicate the 95% confidence interval, with standard errors clustered at the province level. The red line represents the cumulative sum of employment changes up to the corresponding wage bin.

First, there is a clear and significant decrease in the number of jobs below the new minimum wage, accounting for 3.2% (s.e. 0.1%) of the total pre-treatment employment.[1]The

[1]The difference between the actual number of jobs below the new minimum wage, which is 9.5% of total pre-treatment employment on average, and the change in the number of jobs below it, which is 3.2% on average, can be explained by two factors. First, some jobs below the minimum wage are exempt from

majority of this decrease is concentrated in the wage bin just below the new minimum wage. Additionally, there is a noticeable and substantial rise in employment precisely at the new minimum wage (at the \$0 wage bin). There are minimal and insignificant employment fluctuations in wage bins \$1, \$2, \$3, and \$4 above the new minimum wage. This trend in employment changes aligns with the notion of limited wage spillovers in Canadian data stemming from the minimum wage increase, as proposed in Campolieti (2015). The excess jobs between the new minimum and \$4 above it represent 3% (s.e. 0.1%) of the total pre-treatment employment.[2]Finally, Figure 7.12 illustrates the employment changes in the upper tail wage bins, ranging from \$5 above the minimum wage to \$17 or higher (the final bin). These alterations are all minimal in magnitude and lack statistical significance, both on an individual basis and cumulatively, as depicted by the red line representing the running sum of employment changes.

The bunching estimate for employment change combines the missing jobs below and excess jobs above the minimum wage: $\Delta a + \Delta b$. Dividing this change by the jobs below the new minimum wage ($\bar{b}_{-1}$) yields a change in the affected employment of -2% (standard error 2.5%), which is negative but statistically insignificant. I can further divide the employment change $\Delta a + \Delta b$ by the sample-averaged minimum wage increase of 8.1% to compute the employment elasticity concerning the minimum wage, resulting in -0.023 (standard error 0.03). This estimate is statistically insignificant, and the 95% confidence interval excludes significant reductions in aggregate employment, including the baseline aggregate employment elasticity of -0.074 reported in the study of Meer and West (2016).

minimum wage regulations in most provinces. In some provinces in Canada, certain categories of minimum wage workers were exempt from standard minimum wage regulations or had different minimum wage rates during the considered period from 1999 to 2019. These exemptions varied by province and typically applied to specific types of employment or worker categories. For example, tipped employees in Quebec, Manitoba, and Newfoundland and Labrador received a lower minimum wage than non-tipped workers. Additionally, liquor servers in Alberta, Ontario, and British Columbia had a separate, lower minimum wage. Moreover, students under 18 years old who worked 28 hours a week or less during the school year or full-time during school breaks or summer holidays had a lower minimum wage rate in Ontario. In Ontario, homeworkers, and hunting and fishing guides were also subject to specific minimum wage rules. Second, there is some wage growth even without a minimum wage increase, and the event study design accounts for these changes.

[2]In the Appendix part, I explore the use of alternative wage windows to calculate excess jobs, revealing highly similar results across different wage windows. Consequently, this consistency approximately extends to the employment and wage effect.

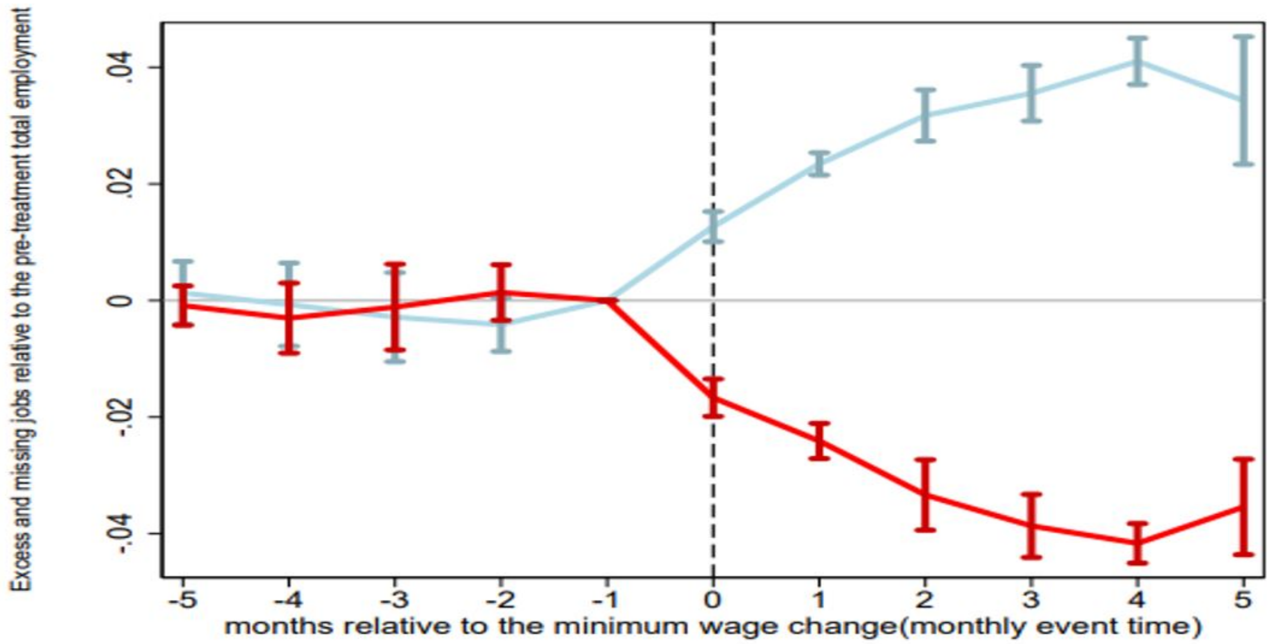
The bunching estimate for employment change combines the missing jobs below and excess jobs above the minimum wage: $\Delta a + \Delta b$. Dividing this change by the jobs below the new minimum wage ($\bar{b}_{-1}$) yields a change in the affected employment of -2% (standard error 2.5%), which is negative but statistically insignificant. I can further divide the employment change $\Delta a + \Delta b$ by the sample-averaged minimum wage increase of 8.1% to compute the employment elasticity concerning the minimum wage, resulting in -0.023 (standard error 0.03). This estimate is statistically insignificant, and the 95% confidence interval excludes significant reductions in aggregate employment, including the baseline aggregate employment elasticity of -0.074 reported in the study of Meer and West (2016).

Secondly, by utilizing the formula in equation (5), I can calculate both the change in the average wage and the employment elasticity concerning own wage (i.e., the labor demand elasticity in the competitive model). The estimation suggests that the impact of the minimum wage on average wages is 6.4% (standard error 0.8%), which is statistically significant. Additionally, the estimate for the elasticity of employment concerning own wage is -0.307 (standard error 0.422). The confidence intervals rule out any own-wage elasticities more negative than -0.450 at the 95 percent confidence level.

7.1.8 Canada Study Using Event Study Analysis

Figure 7.13 depicts the change in missing jobs paying below the new minimum wage (Δb_τ) and the excess jobs paying up to $4 above the minimum wage (Δa_τ) over the monthly event time, employing my baseline specification with wage-bin-period and wage-bin-province fixed effects. All estimates are presented as changes from the event date $\tau = -1$, or the month immediately preceding treatment, with the estimates for this period normalized to zero.

Figure 7.13: Impact of Minimum Wages on the Missing and Excess Jobs Over Time (Canada Event Study Analysis)

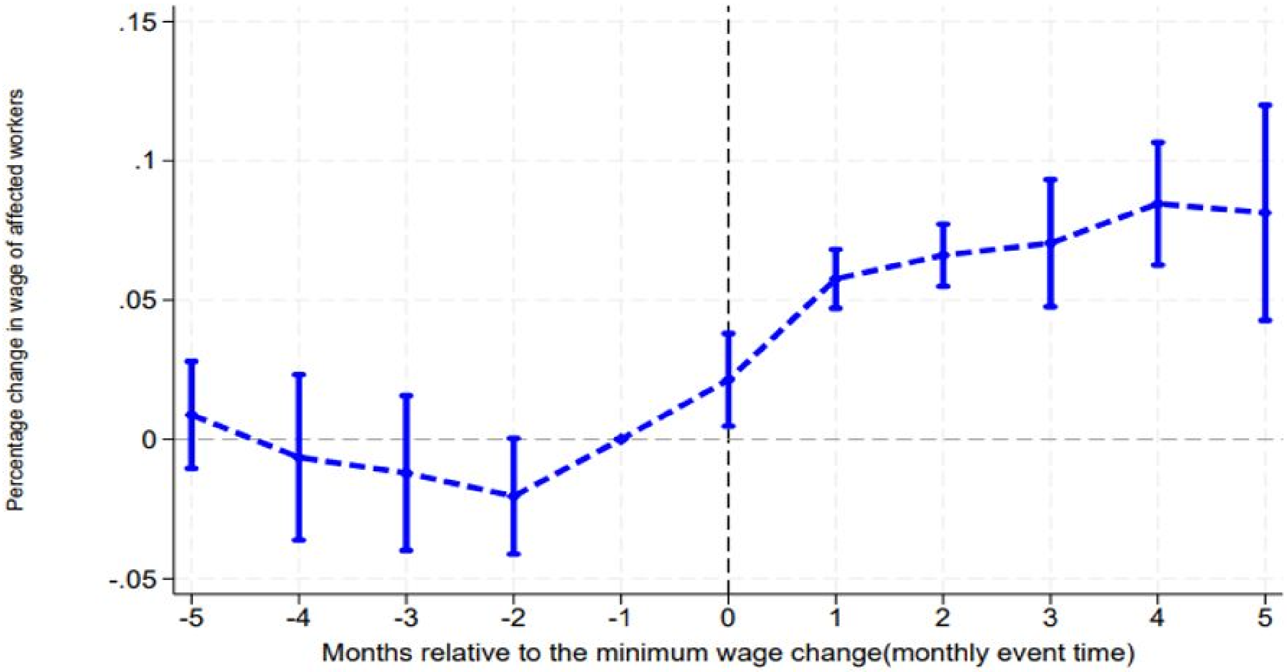


Notes: The figure presents the key findings from my event study analysis (as per equation 4), utilizing data on 56 province-level minimum wage adjustments spanning from 1999 to 2019. It illustrates the impact of a minimum wage hike on both the missing in jobs below the new minimum wage (depicted by the blue line) and the excess jobs at and slightly above it (illustrated by the red line) over time. The blue line tracks the progression of job numbers (relative to total employment one month before the intervention) between \$4 below the new minimum wage and the new minimum wage (Δb), while the red lines indicate job figures between the new minimum wage and \$4 above it (Δa). Additionally, I display the 95% confidence interval based on standard errors clustered at the province level.

There are four key findings I would like to emphasize. First, I observe a significant reduction in jobs paying below the new minimum wage (indicated in red) between the month immediately before the treatment ($\tau = -1$) and the month of treatment ($\tau = 0$). This demonstrates that the minimum wage increases under study are indeed having a measurable impact. Second, the magnitude of missing jobs (Δb) remains substantial and statistically significant six months later, indicating that the effects of the treatments are quite durable over this period. Third, the response of excess jobs at or above the new minimum wage (Δa) follows a similar pattern in magnitude, but with the opposite sign. There is a clear increase in excess jobs at $\tau = 0$, and a significant portion of this increase persists and remains statistically significant even after six months. Fourth, for both the changes in excess and missing jobs, there is only a slight indication of a pre-existing trend before the treatment. The $\tau = -2$ leads are statistically indistinguishable from zero, and while there is some evidence of changes five months before the treatment, these leading effects are very small compared to the post-treatment effect estimates. Overall, the sharp upward jump in both excess and missing jobs at $\tau = 0$, the lack of significant pre-treatment trends, and the persistent post-treatment gap between the two shares all strongly validate the research design.

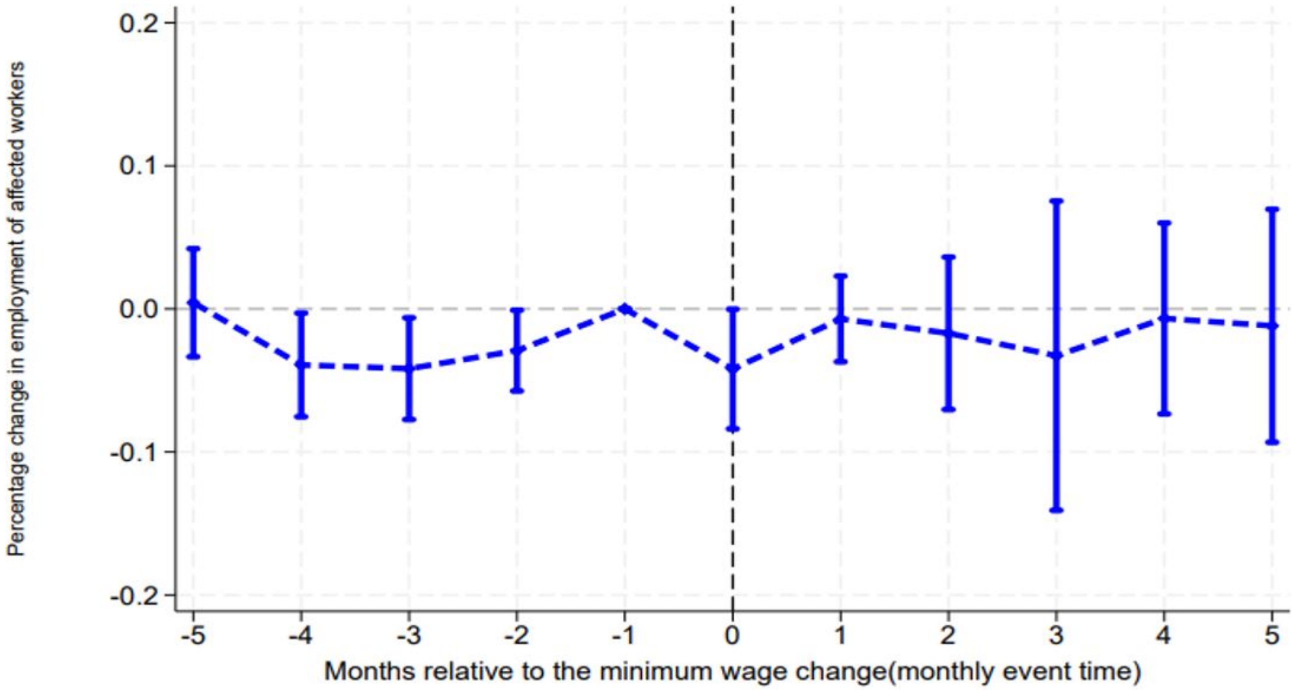
Figure 7.14 and Figure 7.15 depict the evolution of wage and total employment changes for affected workers over monthly event time using my baseline specification, which includes wage-bin-period and wage-bin-province fixed effects. Figure 7.14 illustrates a clear, statistically significant rise in the average wage of affected workers at date zero, persisting over the six-month post-intervention period. In contrast, Figure 7.15 shows no corresponding change in employment over the six months following treatment. However, it is worth noting that there is a significant decrease of 4.2% in employment in the month of the shock ($\tau = 0$), but no significant employment change in the subsequent months. Additionally, employment changes were similarly small during the five months prior to treatment.

Figure 7.14: Impact of Minimum Wages on Average Wage Over Time (Canada Event Study Analysis)



Notes: The figure presents the main results from my event study analysis (see Equation 4), which examines 56 province-level minimum wage changes between 1999 and 2019. Figure 4.3 displays the effect on the average wage over time, calculated using Equation 5.

Figure 7.15: Impact of Minimum Wages on Employment Over Time (Canada Event Study Analysis)



Notes: The figure presents the main results from my event study analysis (see Equation 4), which examines 56 province-level minimum wage changes between 1999 and 2019. Figure 7.15 shows the evolution of employment for wages between \$4 below and \$4 above the new minimum wage (relative to total employment one year before the treatment), representing the sum of missing jobs below and excess jobs at or slightly above the minimum wage ($\Delta a + \Delta b$). The figure highlights that the minimum wage increase had a positive and significant effect on the average wage of the affected workers, with no significant disemployment effects.

In summary, there is scant evidence of a decline in employment among low-wage workers impacted by the policy, despite clear proof that the new minimum wage is effective and raises wages for those affected. The impact of the minimum wage primarily affects the lower end of the wage spectrum, with no discernible changes in the higher wage brackets. This aligns with the standard (frictionless) labor demand model outlined in Section 5.1, where the substitution elasticity σ approaches zero (see equation 2). However, this model can not anticipate the limited spill-over effects just above the minimum wage. I will discuss the size and nature of these spillovers in Section 7.3.

7.1.9 Robustness Checks in Canada Study

In Table 7.1, I examine the robustness of the main findings by incorporating additional controls for time-varying heterogeneity. This step is crucial as findings in existing literature often depend on the inclusion of various forms of time-varying heterogeneity (e.g., Allegretto et al., 2017; Neumark et al., 2014). In Column 1, I present the six-month-averaged post-treatment estimates for the baseline specification illustrated in Figure 7.12 and Figure 7.13. Columns 2 and 3 introduce wage-bin-by-province specific linear and quadratic time trends, respectively. Note that with 5 pre-treatment and 6 post-treatment dummies, the trends are calculated using variation outside the 11-month window surrounding the treatment period. Therefore, they are unlikely to be influenced by either lagged or anticipation effects. In Column 4, I incorporate interactions between wage bin-by-province fixed effects and the province-level average wages of workers earning hourly wages greater than $19. This helps isolate any province-level wage shocks.[3]

Overall, the estimates from the additional specifications closely align with the baseline estimate. In all instances, there is a noticeable impact of the policy, reflected in the reduction of jobs paying below the minimum wage, Δb. This substantial effect is corroborated by a statistically significant increase in real wages for affected workers across all specifications, ranging from 6% to 7.4%. On the other hand, the proportional change in employment for affected workers is consistently not statistically significant and tends to be numerically smaller than the wage change, varying between -2% and 1.5% across the four specifications. The employment elasticity with respect to the minimum wage ranges between -0.023 and 0.017, while the employment elasticity with respect to the wage ranges between -0.307 and 0.198. As observed in Table 7.1, the employment estimates are predominantly small and negative. The sole exception is in Column 4, where the employment estimate remains small and insignificant but shows a positive sign.

[3]Like what Cengiz et al. (2019) did in their study, I show that this approach is somehow similar to a simpler method of estimating a regression using province-by-month data, where the dependent variables are the number of jobs or total wage bill under 19$ divided by the population. (This 19$ threshold comes from the fact that this 19$ is at least 4$ above the new minimum wage in all of the 56 events that I define in this study).

Table 7.1: Impact of Minimum Wages on Employment and Wages (Canada Study)

	(1)	**(2)**	**(3)**	**(4)**
Missing jobs below new MW (Δb)	-0.032***	-0.031***	-0.031***	
	(0.001)	(0.001)	(0.001)	
Excess jobs above new MW (Δa)	0.030***	0.029***	0.029***	
	(0.001)	(0.001)	(0.002)	
% Δ affected wages	0.064***	0.061***	0.060***	0.074***
	(0.008)	(0.008)	(0.008)	(0.006)
% Δ affected employment	-0.020	-0.022	-0.022	0.015
	(0.025)	(0.026)	(0.027)	(0.022)
Employment elasticity w.r.t. MW	-0.023	-0.026	-0.025	0.017
	(0.030)	(0.030)	(0.031)	(0.026)
Emp. elasticity w.r.t. affected wage	-0.307	-0.361	-0.363	0.198
	(0.422)	(0.461)	(0.479)	(0.294)
Jobs below new MW ($\bar{b}_{-1}$)	0.095	0.095	0.095	0.095
$\%MW$	0.081	0.081	0.081	0.081
Number of events	56	56	56	56
Number of observations	287280	287280	287280	287280
Number of workers in the sample	12998207	12998207	12998207	12998207
Controls				
Bin-prov FE	Y	Y	Y	
Bin-period FE	Y	Y	Y	
Bin-prov linear trends		Y	Y	
Bin-prov quadratic trends			Y	
prov-period FE				Y

Note: The table presents the impacts of minimum wage increases using event study analysis (refer to equation 4), leveraging 56 province-level minimum wage adjustments from 1999 to 2019. It displays six-month averaged post-treatment estimates on missing jobs up to $4 below the new minimum wage, and excess jobs at and up to $4 above it. Column 1 represents the benchmark specification, while Columns 2-3 assess robustness by considering bin-province linear and quadratic time trends. In Column 4, adjustments are made for province-level wage shocks by incorporating interactions between wage-bin-by-province specific effects and province-level average wages of workers earning hourly wages exceeding $19. Regressions are weighted by province-month aggregated population. Standard errors (in parentheses) are clustered by province, and significance levels are denoted as * 0.10, ** 0.05, *** 0.01.

7.2 Heterogeneous Responses to the Minimum Wage

Apart from estimating the overall employment effect for the low-wage workforce, the bunching approach can also calculate employment estimates for specific subgroups. In this section, I present responses from various demographic groups, sectors, and labor force statuses before the minimum wage shock. The impact of the minimum wage on these subgroups is likely to be of significant interest to policymakers. Furthermore, comprehending diverse responses across multiple dimensions can offer new perspectives on the functioning of the low-wage labor market.

7.2.1 Ontario Study by Demographic Groups

As demonstrated in section 7.1.2, I observe no significant evidence of substantial employment declines at the lower end of the wage distribution in the Ontario study. Nevertheless, a key concern regarding my estimates is that the absence of an employment response might obscure a transition in employment from low-skilled to high-skilled workers. Such labor-labor substitution occurring at the bottom of the wage distribution could diminish the attractiveness of minimum wage policies, even in the absence of an overall employment effect.

In Table 7.2, I examine the impact of the minimum wage on certain low-wage subgroups, which are often of particular concern to policymakers regarding employment prospects. I present estimates for individuals without a high school degree, those with a high school or less, teenagers, aged 20-24, youth (aged 15-24), and all individuals 25 and above. As anticipated, limiting the sample by education and age results in a more substantial impact. For instance, among those without a high school degree, the estimate for missing jobs, Δb, is -31% while for those with a high school degree or less schooling, it is -25.7%. These estimates for the missing jobs are, respectively, 123.02% and 84.89% larger than the baseline estimate for the overall population (-13.9%).

Restricting by age also demonstrates a more pronounced effect compared to my estimates for the overall population. Teen (-61.7%), aged [20-25) (-37%), and aged [15-25) (-45.6%) workers observe substantial and comparatively larger estimates of missing jobs as a proportion of their pre-treatment employment. As you see in Table 7.2, while there is considerable variation in the number of missing jobs across different demographic groups, they are closely matched by the number of excess jobs above the new minimum wage.

As seen in Table 7.2, the employment effect for individuals without a high school degree is notably significant and positive 9.7%. However, upon including those with a high school diploma in this group, the effect diminishes to zero. This finding contrasts somewhat with the literature, which typically suggests a decrease in employment among individuals with lower levels of education. However, this trend is not observed in the targeted groups within the Ontario study.

Moreover, based on Table 7.2, it is evident that there is a significant positive employment effect of 6.6% for teenagers. This finding contradicts the majority of empirical research conducted on the impact of minimum wage on teenagers in both Canada and the U.S. I only discovered a significant negative employment effect of -12.6% for young adults [15-25). However, overall, I did not find any significant negative employment effect for youth [15-25). The average wage is approximately the same 22.4% and 22.6% for young adults [15-25) and teenagers respectively.

This contradiction may arise due to a substitution effect between teenage and young adult workers. In Ontario, students under 18 who work 28 hours or less per week during the school year, or work full-time during school breaks or summer holidays, are subject to a lower minimum wage. Although both the sub-minimum wage and the regular minimum wage have increased, firms might have a greater incentive to hire teenagers, most of whom are covered by the lower wage rate, rather than young adults, who are subject to a slightly higher minimum wage.

This result aligns somewhat with the findings of Cengiz et al. (2019) in U.S. data. However, it diverges from the findings of Fossati and Marchand (2024) for age [15-25), in the context of the Alberta minimum wage increase. this difference in the findings is unlikely due to the difference in magnitude of Alberta's minimum wage increase and Ontario's. The minimum-to-median wage ratio in 2018 for Ontario was 0.48 as compared to 0.55 for the province of Alberta in 2018 after the minimum wage increase. It is also not related to the share of teen and young workers in the workforce of each province. In Ontario, in years 2018 and 2019 the share of teen and young workers in the workforce (after dropping the self-employed ones) in the sample are 5% and 15%. In Alberta, in the years 2018 and 2019 are 4.5% and 10%. Instead, this difference between these two case studies emphasizes the importance of pooling many minimum wage increases across Canada for inference rather than studying one specific minimum wage shock.

Table 7.2: Impact of Minimum Wages on Employment and Wages by Demographic Groups in Ontario Study

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Missing jobs below new MW (Δb)	-0.139***	-0.617***	-0.370***	-0.456***	-0.080***	-0.310***	-0.257***
	(0.005)	(0.017)	(0.012)	(0.011)	(0.005)	(0.011)	(0.009)
Excess jobs above new MW (Δa)	0.132***	0.674***	0.315***	0.441***	0.073***	0.356***	0.257***
	(0.006)	(0.019)	(0.013)	(0.013)	(0.006)	(0.012)	(0.008)
% Δ affected wages	0.227***	0.224***	0.226***	0.225***	0.230***	0.201***	0.229***
	(0.018)	(0.011)	(0.017)	(0.011)	(0.031)	(0.012)	(0.014)
% Δ affected employment	-0.039	0.066**	-0.126***	-0.026	-0.066	0.097***	-0.002
	(0.045)	(0.030)	(0.041)	(0.029)	(0.075)	(0.034)	(0.035)
Total number of observations	675	675	675	675	675	675	675
Total number of observations from 6$ to 14$	225	225	225	225	225	225	225
Total number of workers in the sample	133952	7585	12110	19695	114257	12435	41203
Total number of workers in the sample from 6$ to 14$	55486	7386	9462	16848	38638	8841	24975
Sample	overall	Teen	Age[20-25)	Age[15-25)	Age[25+)	High school dropped out	High school or less

7.2.2 Alberta Study by Demographic Groups

As observed in Table 7.3, the overall employment effect in Alberta reflects a 2 percent increase, rendering it statistically insignificant. However, a notable divergence emerges concerning teen employment. Unlike the Ontario study, teen employment experiences a significant 11 percent decrease. Conversely, individuals aged 20 to 25 witness a significant 35 percent increase in employment. Yet, when considering the broader age group of young people aged 15 to 25, the employment effect amounts to approximately 9 percent positively, albeit statistically insignificant. Conversely, for individuals aged over 25 years, the employment effect approaches zero. However, it is important to highlight that in Alberta, when examining teenagers and young adults, there are signs of preexisting trends that violate the parallel trend assumption. As a result, the findings for teenagers and young adults [20-25) in Alberta may not be valid.

Table 7.3: Impact of Minimum Wages on Employment and Wages in Alberta Study

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Missing jobs below new MW (Δb)	-0.060***	-0.341***	-0.127***	-0.200***	-0.035***
	(0.008)	(0.023)	(0.017)	(0.017)	(0.008)
Excess jobs above new MW (Δa)	0.063***	0.272***	0.218***	0.233***	0.035***
	(0.009)	(0.025)	(0.019)	(0.019)	(0.009)
% Δ affected wages	0.204***	0.194***	0.282***	0.243***	0.189***
	(0.042)	(0.028)	(0.032)	(0.027)	(0.065)
% Δ affected employment	0.021	-0.111**	0.387***	0.090	-0.002
	(0.101)	(0.056)	(0.111)	(0.070)	(0.156)
Total number of observations	756	756	756	756	756
Total number of observations from 6$ to 14$	252	252	252	252	252
Total sample size	114186	6499	10896	17395	96791
Sample size from 6$ to 14$	45127	6191	7703	13894	31233
Sample	Overall	Teen	Age[20-25)	Age[15-25)	Age[25+)]

7.2.3 Ottawa vs Gatineau Study by Demographic Groups

As evident from Table 7.4 once more, the results align with the findings from my Ontario study. The overall employment effect is around a 1.3% decrease which is insignificant. Notably, there was insignificant positive employment effect detected for young workers age[15,25). Furthermore, akin to the Ontario study, teen employment exhibited a significant positive trend (3.9%). Thus, it seems unlikely that the variance between my study and that of Fossati and Marchand (2024) stems from a divergence in approaches to constructing the counterfactual wage distribution.

Table 7.4: Impact of Minimum Wages on Employment and Wages by Demographic Groups in Ottawa vs Gatineau Study

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Missing jobs below new MW (Δb)	-0.089***	-0.553***	-0.218***	-0.331***	-0.045***	-0.326***	-0.241***
	(0.012)	(0.007)	(0.027)	(0.018)	(0.013)	(0.030)	(0.020)
Excess jobs above new MW (Δa)	0.087***	0.586***	0.269***	0.374***	0.032***	0.352***	0.283***
	(0.014)	(0.007)	(0.030)	(0.020)	(0.015)	(0.034)	(0.022)
% Δ affected wages	0.158***	0.090***	0.15***	0.126***	0.196*	0.142***	0.181***
	(0.047)	(0.013)	(0.089)	(0.050)	(0.050)	(0.034)	(0.028)
% Δ affected employment	-0.013	0.039**	0.125	0.079	-0.165	0.051	0.117
	(0.122)	(0.012)	(0.098)	(0.050)	(0.243)	(0.089)	(0.084)
Total number of observations	270	270	270	270	270	270	270
Total number of observations from 6$ to 14$	190	190	190	190	190	190	190
Total number of workers in the sample	8452	447	758	1205	7247	627	1844
Total number of workers in the sample from 6$ to 14$	2578	436	552	988	1590	420	1032
Sample	overall	Teen	Age[20-25)	Age[15-25)	Age[25+)	High school dropped out	High school or less

7.2.4 Canada Study by Demographic Groups

In Table 7.5 and Table 7.6 like what I did for the Ontario study I examine the impact of the minimum wage on certain low-wage subgroups, which are often of particular concern to policymakers regarding employment prospects. I present estimates for individuals without a high school degree, those with a high school diploma or less education, those who graduated from high school, those who have college or diploma or some post-secondary education, those who have below bachelor degree, those with a bachelor degree, women, teenagers, aged 20-24, youth (aged 15-24), and all individuals who have 25 and more. As anticipated, limiting the sample by education, age, and gender results in a more substantial impact. For instance, among those without a high school degree, the estimate for missing jobs, Δb, is -8.6% while for those with a high school degree or less schooling, it is -5.5%. These estimates for the missing jobs are, respectively, 168.75% and 71.87% larger than the baseline estimate for the overall population (-3.2%). Restricting by age and gender also demonstrates a more pronounced effect compared to my estimates for the overall population. Teen (-587.5%), aged [20-25) (-121.87%), aged [15-25) workers (-290.62%), and women (-25%) observe substantial and comparatively larger estimates of missing jobs as a proportion of their pre-treatment employment.

Table 7.5: Impact of Minimum Wages on Employment and Wages by Demographic groups (Canada Study)

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Missing jobs below new MW (Δb)	-0.220***	-0.071***	-0.125***	-0.014***	-0.086***	-0.055***	-0.039***
	(0.029)	(0.004)	(0.011)	(0.001)	(0.006)	(0.003)	(0.003)
Excess jobs above new MW (Δa)	0.221***	0.077***	0.130***	0.011***	0.080***	0.056***	0.044***
	(0.023)	(0.006)	(0.007)	(0.002)	(0.010)	(0.004)	(0.005)
% Δ affected wages	0.073***	0.077***	0.075***	0.048**	0.058***	0.061***	0.066***
	(0.007)	(0.013)	(0.008)	(0.020)	(0.008)	(0.007)	(0.014)
% Δ affected employment	0.003	0.030	0.014	-0.064	-0.025	0.006	0.037
	(0.013)	(0.030)	(0.016)	(0.044)	(0.030)	(0.033)	(0.050)
Employment elasticity w.r.t. MW	0.022	0.073	0.056	-0.038	-0.085	0.014	0.056
	(0.096)	(0.072)	(0.065)	(0.026)	(0.101)	(0.070)	(0.075)
Employment elasticity w.r.t. affected wage	0.043	0.387	0.182	-1.324	-0.436	0.106	0.566
	(0.187)	(0.350)	(0.215)	(1.388)	(0.568)	(0.532)	(0.679)
Jobs below new MW ($\bar{b}_{-1}$)	0.577	0.199	0.338	0.048	0.261	0.170	0.123
$\%MW$	0.081	0.082	0.082	0.081	0.078	0.080	0.082
Number of event	56	56	56	56	56	56	56
Number of observations	287280	287280	287280	287280	287280	287280	287280
Number of workers in the sample	867753	1263428	2131181	10867026	1735821	4470585	2734764
Sample	Teen	Age[20-25)	Age[15-25)	Age[25+)	High school dropped out	High school or less	High school graduate

Note: The table presents the impacts of minimum wage increases by demographic groups using event study analysis (refer to equation 4), leveraging 56 province-level minimum wage adjustments from 1999 to 2019. It displays six-month averaged post-treatment estimates on missing jobs up to $4 below the new minimum wage, and excess jobs at and up to $4 above it. Regressions are weighted by province-month aggregated population. Standard errors (in parentheses) are clustered by province, and significance levels are denoted as * 0.10, ** 0.05, *** 0.01.

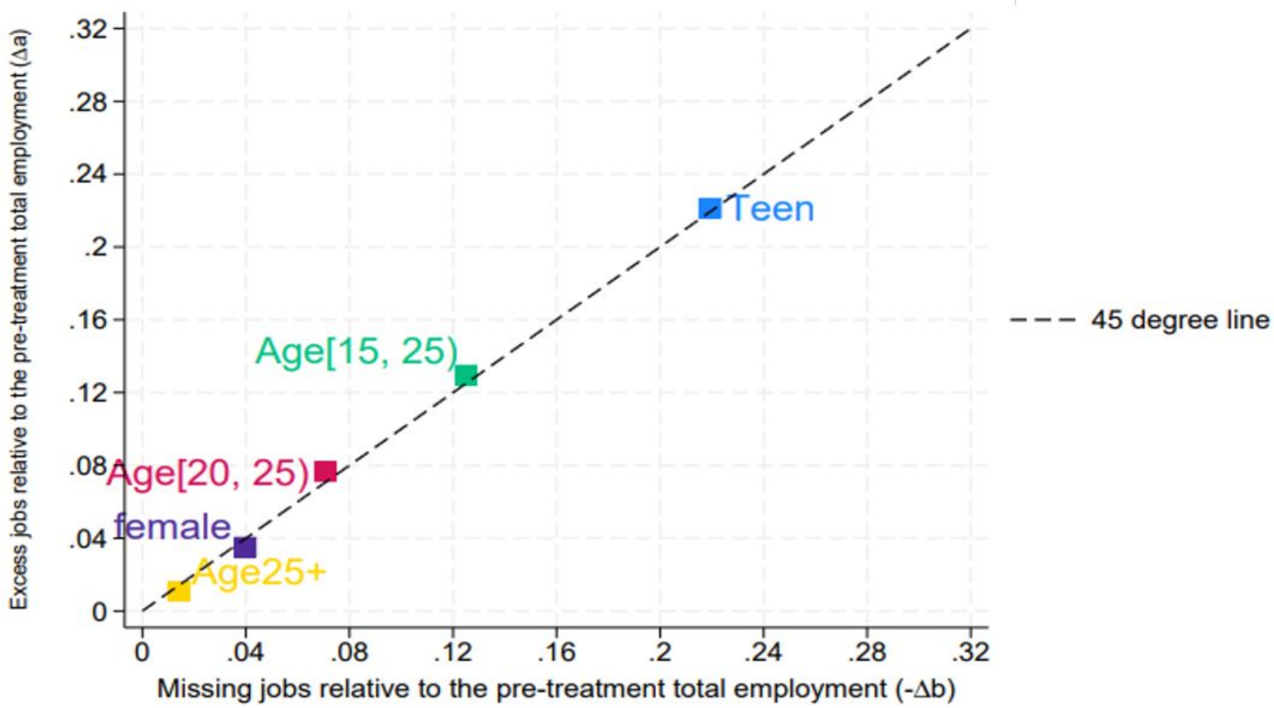
Table 7.6: Impact of Minimum Wages on Employment and Wages by Demographic Groups (Canada Study)

	(8)	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**
Missing jobs below new MW (Δb)	-0.029***	-0.021***	-0.010***	-0.040***	-0.171***	-0.030***	-0.007***
	(0.002)	(0.004)	(0.001)	(0.002)	(0.017)	(0.002)	(0.001)
Excess jobs above new MW (Δa)	0.025***	0.011	0.011**	0.035***	0.174***	0.027***	0.005**
	(0.001)	(0.007)	(0.003)	(0.002)	(0.011)	(0.003)	(0.002)
% Δ affected wages	0.076***	-0.023	0.057*	0.061**	0.076***	0.059***	0.038
	(0.009)	(0.061)	(0.030)	(0.009)	(0.007)	(0.011)	(0.035)
% Δ affected employment	-0.060**	-0.162	0.018	-0.041	0.006	-0.034	-0.063
	(0.026)	(0.148)	(0.057)	(0.027)	(0.015)	(0.031)	(0.054)
Employment elasticity w.r.t. MW	-0.059**	-0.127	0.009	-0.058	0.031	-0.036	-0.023
	(0.026)	(0.116)	(0.028)	(0.038)	(0.081)	(0.033)	(0.020)
Employment elasticity w.r.t. affected wage	-0.796*	7.094	0.313	-0.666	0.075	-0.565	-1.65
	(0.395)	(13.42)	(0.851)	(0.512)	(0.201)	(0.591)	(2.728)
Jobs below new MW ($\bar{b}_{-1}$)	0.078	0.061	0.042	0.115	0.453	0.09	0.032
$\%MW$	0.080	0.078	0.084	0.081	0.084	0.084	0.086
Number of event	56	56	56	56	56	56	56
Number of observations	287280	287280	287280	287280	287280	287280	287280
Number of workers in the sample	5480834	341352	1915920	6507573	1329795	5298175	6370237
Sample	College diploma some post-secondary	Below bachelor	Bachelor	Women	High prob	Medium prob	Low prob

Note: The table presents the impacts of minimum wage increases by demographic groups using event study analysis (refer to equation 4), leveraging 56 province-level minimum wage adjustments from 1999 to 2019. It displays six-month averaged post-treatment estimates on missing jobs up to $4 below the new minimum wage, and excess jobs at and up to $4 above it. Regressions are weighted by province-month aggregated population. Standard errors (in parentheses) are clustered by province, and significance levels are denoted as * 0.10, ** 0.05, *** 0.01.

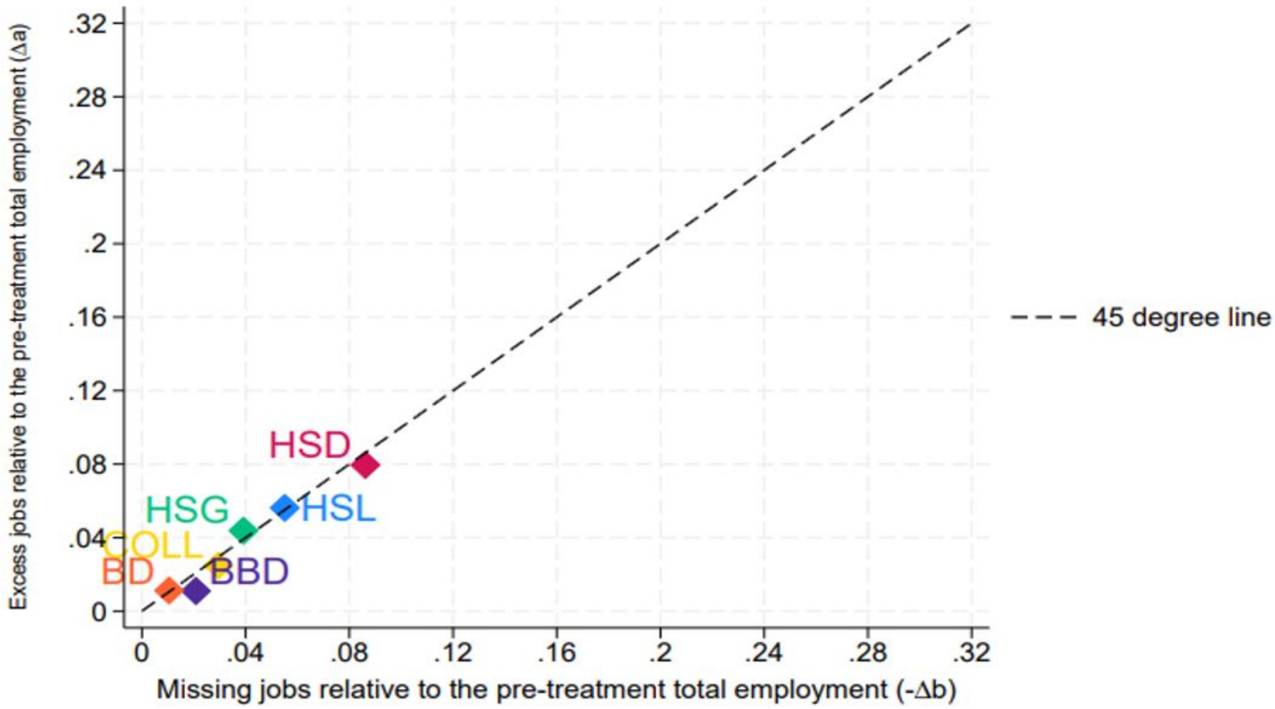
While considerable variation exists in the number of missing jobs across different demographic groups, they are closely matched by the number of excess jobs above the new minimum wage. Figure 7.16 and Figure 7.17 illustrates the relationship between the missing jobs below (multiplied by -1) and the excess jobs above the new minimum wage. The dashed line represents the 45-degree line and marks the points where the missing and excess jobs are equal in magnitude ($\Delta a = -\Delta b$).

Figure 7.16: Impact of the Minimum Wage by Demographic Groups (Canada Study)



Notes: The above figure displays the excess jobs (relative to the pre-treatment total employment in that group) above the new minimum wage (Δa) and the magnitude of missing jobs below it (Δb) for various demographic groups. The black dashed line represents the 45-degree line, indicating the locus of points where the excess number of jobs above and the missing jobs below the new minimum wage is equal, resulting in a zero employment effect. Estimates above this line indicate positive employment effects, while estimates below the line indicate negative effects. This figure illustrates some estimates for demographic groups presented in Table 7.5.

Figure 7.17: Impact of the Minimum Wage by Demographic Groups (Canada Study)



Notes: The above figure displays the excess jobs (relative to the pre-treatment total employment in that group) above the new minimum wage (Δa) and the magnitude of missing jobs below it (Δb) for various demographic groups. The black dashed line represents the 45-degree line, indicating the locus of points where the excess number of jobs above and the missing jobs below the new minimum wage is equal, resulting in a zero employment effect. Estimates above this line indicate positive employment effects, while estimates below the line indicate negative effects. This figure illustrates some estimates for demographic groups presented in Table 7.5 and Table 7.6.

As you can see in Figure 7.16 and Figure 7.17, the groups are approximately located on the dashed line, indicating that the magnitude of missing jobs and excess jobs is approximately equal in all cases. In some instances, such as those with less than a high school diploma (high school dropped out), individuals with college or diploma or some post-secondary education, those with below a bachelor's degree, individuals aged 25 and older, and women, the missing jobs is slightly greater than the excess jobs, but in other groups, the excess jobs slightly exceed the missing. However, except for individuals with college or diplomas or some post-secondary education, who experience a significant decrease in employment by 6 percent, there is no significant employment effect, whether negative or positive, in other groups (refer to Table 7.5 and Table 7.6).

As shown in Table 7.5 and Table 7.6 in all cases but one, the elasticities are statistically indistinguishable from zero. The sole exception is those with a college diploma or some post-secondary education, for whom the employment elasticity with respect to their wage is -0.796 (s.e. 0.395), and is marginally significant at the ten percent level. The minimum wage elasticity for teens and youth [15,25) is 0.022 and 0.056, respectively, which is in the opposite direction compared to the minimum wage elasticities for teens and youth in the Canadian literature. However, it is important to note that these elasticities are not statistically significant, given standard errors of 0.096 and 0.065, respectively.

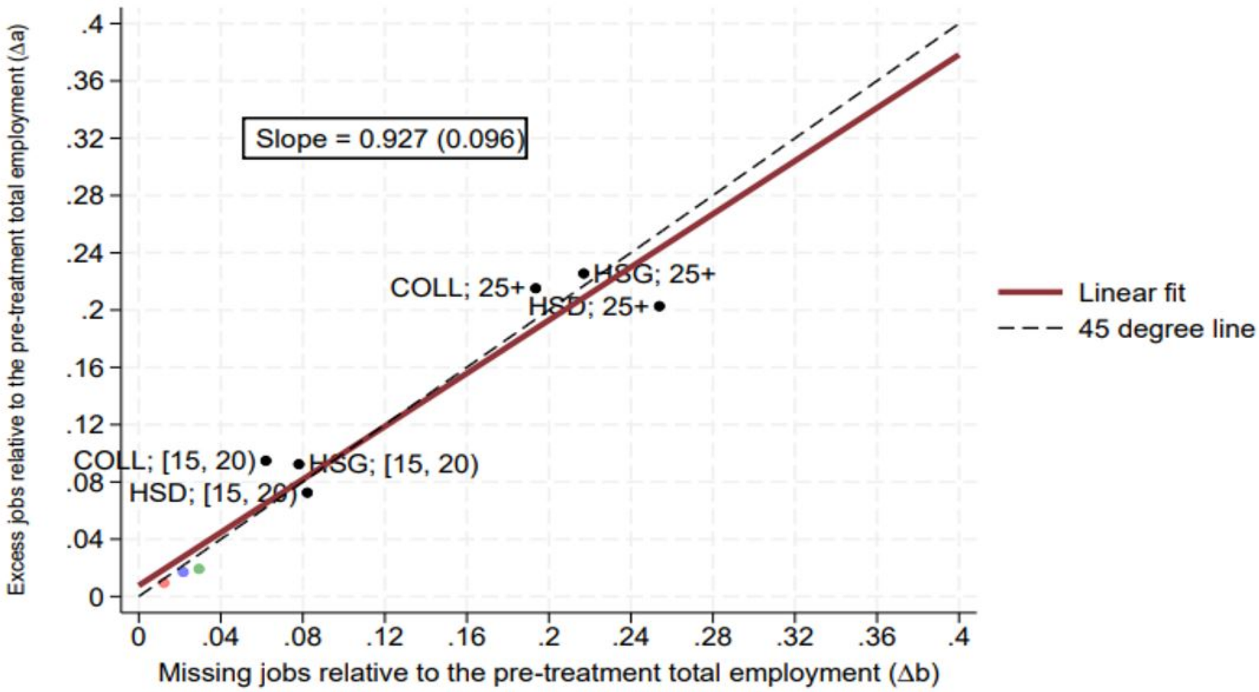
Following Cengiz et al. (2019) I also directly assess labor-labor substitution by fully segmenting the population into age-by-education groups. I use 3 education categories and 3 age categories, resulting in a total of 9 education-by-age groups[4] For each of these 9 groups, I separately estimate a regression using my baseline specification and calculate changes in missing (Δb_g) and excess jobs (Δa_g) for each of them. Figure 7.18 illustrates the relationship between missing and excess jobs, with each circle representing an age-education group.[5] I also include the linear fit (red line) and the 45-degree (dashed) line, which indicates the points where the missing and excess jobs are equal in magnitude ($\Delta a = \Delta b$).

If there is no employment effect in any of the 9 education-age groups, the slope coefficient ρ_1 from regression $\Delta a_g = \rho_0 + \rho_1(-\Delta b_g)$ should be close to one; In this scenario, the differences across groups in the number of excess jobs at or above the minimum wage would exactly mirror the differences in the number of missing jobs below. Conversely, if employment declines are more severe for lower-skilled groups—who are expected to experience a larger bite ($-\Delta b$)—then I should expect the slope to be less than one, particularly for larger values of $-\Delta b$. As shown in Figure 7.18, the slope of the fitted line is very close to one, with $\hat{\rho_1} = 0.927$ (s.e. 0.096). While some specific groups fall above the 45-degree line (e.g., less than high school [20, 25), high school graduate [20, 25), and others), others fall below it.

[4]The education categories include less than high school, high school graduate, and those with a college or diploma or some post-secondary education. The age categories are teens,[20, 25) and [25, 70).

[5]Red circle: less than high school[20, 25), green circle: high school graduate [20, 25) and blue circle: those with a college or diploma or some post-secondary education [20, 25)

Figure 7.18: Impact of the Minimum Wage by Demographic Groups (Canada Study)



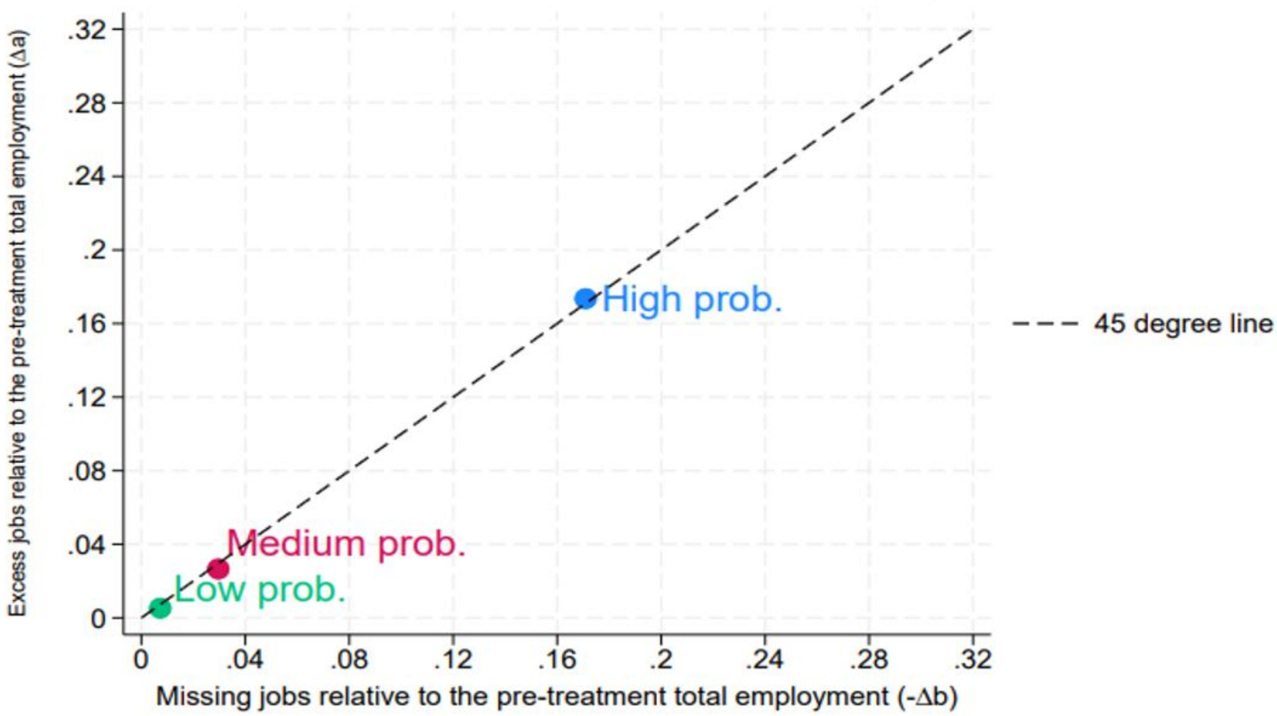
Notes: The above figure displays the excess jobs (relative to the pre-treatment total employment in that group) above the new minimum wage (Δa) and the magnitude of missing jobs below it (Δb) for various demographic groups. The black dashed line represents the 45-degree line, indicating the locus of points where the excess number of jobs above and the missing jobs below the new minimum wage is equal, resulting in a zero employment effect. Estimates above this line indicate positive employment effects, while estimates below the line indicate negative effects. This figure displays the estimates for education-by-age groups derived from three age categories and three education categories. The small circles represent each of these groups, while the red line shows the linear fit. A slope of this line below one would indicate the presence of labor-labor substitution across age and education groups.

Furthermore, I analyze how various groups of workers are impacted by changes in the minimum wage, considering their differing probabilities of exposure. To assess exposure likelihood, I developed a predictive model similar to the one employed by Card and Krueger (1995). I utilize observations spanning five months preceding the 56 events, which are also beyond any of the six-month post-treatment windows. I estimate a linear probability model, considering a comprehensive array of demographic predictors, to analyze the likelihood of earning less than 125% of the statutory minimum wage.[6] I utilize the estimated model to

[6] I employ similar predictors to those utilized in Card and Krueger (1995). However, it is noteworthy

generate predicted probabilities of exposure to minimum wage increases for all individuals in the sample, irrespective of their current employment status. These predicted probabilities are then utilized to categorize individuals into three groups: a "high-probability" group consisting of individuals in the top 10% of the predicted probability distribution; a "low-probability" group comprising workers in the bottom 50% of the predicted probabilities; and a middle group encompassing the remaining individuals.

Figure 7.19: Impact of the Minimum Wage by Demographic Groups (Canada Study)



Notes: The above figure displays the excess jobs (relative to the pre-treatment total employment in that group) above the new minimum wage (Δa) and the magnitude of missing jobs below it (Δb) for various demographic groups. The black dashed line represents the 45-degree line, indicating the locus of points where the excess number of jobs above and the missing jobs below the new minimum wage is equal, resulting in a zero employment effect. Estimates above this line indicate positive employment effects, while estimates below the line indicate negative effects. This figure illustrates some estimates for demographic groups presented in Table 7.6.

that I could not incorporate ethnicity due to its absence in the LFS data. The predictors include all two-way interactions involving gender and teen indicators; all two-way interactions involving gender and age indicators for individuals aged 20–25; an indicator denoting less than high school education; a third-order polynomial reflecting labor market experience; and interactions between education, experience variables, and gender.

As anticipated and shown in Figure 7.19, the high-probability group exhibits a substantially larger impact ($\Delta b = -17.1\%$) compared to both the middle group ($\Delta b = -3\%$) and the low-probability group ($\Delta b = -0.7\%$). As you see in Table 4.6, the employment elasticities for own wage range for these three groups are between -1.65 and 0.075. It's noteworthy that the most accurate estimates of the own-wage employment elasticity, as reported by demographic groups, are for the teen group (s.e. 0.187), the high-probability group (s.e. 0.201), and the age [15-25) group (s.e. 0.215), respectively. In these three groups with more precise estimates, the employment elasticity for own wage is positive and statistically insignificant. These groups are the ones based on the literature that are more exposed to changes in the minimum wage. Overall, these findings offer little evidence of heterogeneity in the employment effect by skill level. The absence of a reduction in low-wage jobs does not seem to be driven by labor-labor substitution at the lower end of the wage distribution.

7.2.5 Ontario Study by Industrial Sectors

As you see in Table 7.7, I examined the impact of the Ontario minimum wage increase on industries such as food and retail, where a significant portion of the workforce comprises minimum-wage workers. In contrast to the prevailing literature, I did not observe any significant negative employment effect on the food and accommodation industry. Conversely, I found a notable positive employment effect of 8.5% in the retail industry. This difference serves as further impetus to advocate for pooling many minimum wage increases across Canada rather than solely relying on individual case studies. Regarding the average wage of affected workers, there is a notable increase of 23.1% and 21.7% in the food and retail industry respectively.

Table 7.7: Impact of Minimum Wages on Employment and Wages by Sectors in Ontario Study

	(1)	(2)
Missing jobs below new MW (Δb)	-0.508***	-0.379***
	(0.012)	(0.010)
Excess jobs above new MW (Δa)	0.487***	0.421***
	(0.013)	(0.011)
% Δ affected wages	0.231***	0.217***
	(0.011)	(0.010)
% Δ affected employment	-0.033	0.085***
	(0.027)	(0.030)
Total number of observations	675	675
Total number of observations from 6$ to 14$	225	225
Total number of workers in the sample	9410	16513
Total number of workers in the sample from 6$ to 14$	8445	12481
Sample	Food and Accommodation	Retail

7.2.6 Ottawa vs Gatineau Study by Industrial Sectors

Regarding the food and retail industry, as observed in Table 7.8, the results of Ottawa versus Gatineau are not entirely aligned with those of the Ontario study. Ottawa versus Gatineau does not exhibit a significant positive employment effect for the retail industry. Based on the Ottawa versus Gatineau study, there is a significant positive employment effect of 22.7% for the food industry. While the retail industry shows a negative effect, it is not statistically significant. This further underscores the importance of considering many minimum wage studies across Canada rather than solely focusing on specific ones.

Table 7.8: Impact of Minimum Wages on Employment and Wages by Sectors in Ottawa vs Gatineau Study

	(1)	**(2)**
Missing jobs below new MW (Δb)	-0.273***	-0.359***
	(0.029)	(0.020)
Excess jobs above new MW (Δa)	0.403***	0.334***
	(0.032)	(0.022)
% Δ affected wages	0.139***	0.161***
	(0.024)	(0.022)
% Δ affected employment	0.227***	-0.049
	(0.075)	(0.057)
Total number of observations	270	270
Total number of observations from 6$ to 14$	190	190
Total number of workers in the sample	528	946
Total number of workers in the sample from 6$ to 14$	443	711
Sample	Food and Accommodation	Retail

7.2.7 Canada Study by Industrial Sectors

This bunching method enables me to provide a comprehensive assessment of the minimum wage's effect across various industries. Much of the existing literature focuses on specific sectors, such as restaurants, where the policy is more binding and its impact on the average wage is easier to detect. In contrast, the bunching approach, which tracks employment changes at the lower end of the wage distribution, can capture employment and wage responses in industries where only a small fraction of workers are directly affected by the minimum wage increase.[7] In Table 7.9, Table 7.10, and Table 7.11, I report estimates for 18 different industry categories.[8]

[7] Even a small fraction of workers can represent a significant number of employees if the sector is large. Thus, having a small fraction of workers earning near the minimum wage does not necessarily imply that responses in those industries are irrelevant for understanding the overall impact of the minimum wage.

[8] These categories are derived from the NAICS variable in the LFS data. In my sample, the shares of employment are approximately 18%, 3%, 12%, 3%, 13%, 5%, 2%, 4%, 1%, 4%, 0.01%, 3%, 8%, 13%, 2%, 7%, 7%, and 4% for agriculture, oil, utilities, wholesale, retail, transport, information, finance, real estate, professional, management, administrative, education, healthcare, art, food, public, and other sectors, respectively.

Table 7.9: Impact of Minimum Wages on Employment and Wages by Sectors (Canada Study)

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Missing jobs below new MW (Δb)	-0.032***	-0.033***	-0.004	-0.012***	-0.011***	-0.097***	-0.009***
	(0.001)	(0.014)	(0.004)	(0.002)	(0.003)	(0.007)	(0.002)
Excess jobs above new MW (Δa)	0.030***	0.036*	-0.008	0.017***	0	0.087***	0.012***
	(0.001)	(0.019)	(0.005)	(0.004)	(0.006)	(0.004)	(0.003)
% Δ affected wages	0.064***	0.079	-2.706	0.117***	0.042	0.065***	0.117***
	(0.008)	(0.067)	(8.846)	(0.021)	(0.083)	(0.007)	(0.054)
% Δ affected employment	-0.020	0.018	-0.845	-0.158	-0.222	-0.040*	0.061
	(0.025)	(0.156)	(0.430)	(0.115)	(0.192)	(0.020)	(0.103)
Employment elasticity w.r.t. MW	-0.023	0.029	-0.153	0.069	-0.130	-0.126*	0.031
	(0.030)	(0.248)	(0.078)	(0.050)	(0.112)	(0.064)	(0.052)
Employment elasticity w.r.t. affected wage	-0.307	0.229	0.312	1.35	-5.239	-0.618*	0.522
	(0.422)	(1.869)	(0.863)	(0.840)	(14.472)	(0.293)	(0.710)
Jobs below new MW ($\bar{b}_{-1}$)	0.095	0.129	0.015	0.035	0.047	0.253	0.041
$\%MW$	0.081	0.081	0.081	0.081	0.081	0.081	0.081
Number of event	56	56	56	56	56	56	56
Number of observations	287280	287280	287280	287280	287280	287280	287280
Number of workers in the sample	12998207	238665	297732	1615880	430762	1670542	632618
Sample	Overall	Agriculture	Oil	Utilities	Wholesale	Retail	Transport

Note: The table presents the impacts of minimum wage increases by industries using event study analysis (refer to equation 4), leveraging 56 province-level minimum wage adjustments from 1999 to 2019. It displays six-month averaged post-treatment estimates on missing jobs up to $4 below the new minimum wage, and excess jobs at and up to $4 above it. Regressions are weighted by province-month aggregated population. Standard errors (in parentheses) are clustered by province, and significance levels are denoted as * 0.10, ** 0.05, *** 0.01.

Table 7.10: Impact of Minimum Wages on Employment and Wages by Sectors (Canada Study)

	(8)	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**
Missing jobs below new MW (Δb)	-0.034***	-0.007	-0.024***	-0.006	-0.006	-0.035***
	(0.009)	(0.002)	(0.006)	(0.003)	(0.016)	(0.003)
Excess jobs above new MW (Δa)	0.026***	0	0.006	0.009	0.019	0.031***
	(0.004)	(0.004)	(0.013)	(0.006)	(0.051)	(0.008)
% Δ affected wages	0.105***	-0.115	-.037	0.077	0.640	0.058***
	(0.031)	(0.157)	(0.088)	(0.080)	(0.985)	(0.016)
% Δ affected employment	-0.095	-0.321	-0.186	0.137	2.144	-0.038
	(0.095)	(0.168)	(0.175)	(0.128)	(8.798)	(0.047)
Employment elasticity w.r.t. MW	-0.095	-0.083	-0.223	0.047	0.162	-0.054
	(0.095)	(0.044)	(0.210)	(0.044)	(0.665)	(0.068)
Employment elasticity w.r.t. affected wage	-0.901	2.794	5.026	1.777	3.349	-0.653
	(0.719)	(2.787)	(7.893)	(0.885)	(14.745)	(0.964)
Jobs below new MW ($\bar{b}_{-1}$)	0.081	0.021	0.097	0.028	0.006	0.116
$\%MW$	0.081	0.081	0.081	0.081	0.081	0.081
Number of event	56	56	56	56	56	56
Number of observations	287280	287280	287280	287280	287280	287280
Number of workers in the sample	267278	500644	155093	548127	1461	424568
Sample	Information	Finance	Real state	Professional	Management	Administrative

Note: The table presents the impacts of minimum wage increases by industries using event study analysis (refer to equation 4), leveraging 56 province-level minimum wage adjustments from 1999 to 2019. It displays six-month averaged post-treatment estimates on missing jobs up to $4 below the new minimum wage, and excess jobs at and up to $4 above it. Regressions are weighted by province-month aggregated population. Standard errors (in parentheses) are clustered by province, and significance levels are denoted as * 0.10, ** 0.05, *** 0.01.

Table 7.11: Impact of Minimum Wages on Employment and Wages by Sectors (Canada study)

	(14)	**(15)**	**(16)**	**(17)**	**(18)**	**(19)**
Missing jobs below new MW (Δb)	-0.007***	-0.010***	-0.060***	-0.121***	-0.004*	-0.027***
	(0.002)	(0.002)	(0.020)	(0.006)	(0.002)	(0.005)
Excess jobs above new MW (Δa)	0.006	0.003	0.093***	0.128***	0.002	0.038***
	(0.008)	(0.004)	(0.010)	(0.008)	(0.004)	(0.007)
% Δ affected wages	0.079*	-0.030	0.112***	0.068***	-0.108	0.066
	(0.040)	(0.088)	(0.012)	(0.005)	(0.235)	(0.041)
% Δ affected employment	-0.018	-0.217	0.195	0.021	-0.124	0.082**
	(0.119)	(0.137)	(0.157)	(0.014)	(0.341)	(0.036)
Employment elasticity w.r.t. MW	-0.009	-0.077	0.413	0.092	-0.023	0.126**
	(0.061)	(0.049)	(0.333)	(0.062)	(0.064)	(0.055)
Employment elasticity w.r.t. affected wage	-0.228	7.342	1.739	0.314	1.444	1.242
	(1.610)	(18.737)	(1.528)	(0.202)	(0.996)	(0.689)
Jobs below new MW ($\bar{b}_{-1}$)	0.041	0.029	0.172	0.352	0.015	0.125
$\%MW$	0.081	0.081	0.081	0.081	0.081	0.081
Number of event	56	56	56	56	56	56
Number of observations	287280	287280	287280	287280	287280	287280
Number of workers in the sample	1069281	1718210	248172	931616	872042	467504
Sample	Education	Health care	Arts	Food and Accommodation	Public	Other

Note: The table presents the impacts of minimum wage increases by industries using event study analysis (refer to equation 4), leveraging 56 province-level minimum wage adjustments from 1999 to 2019. It displays six-month averaged post-treatment estimates on missing jobs up to $4 below the new minimum wage, and excess jobs at and up to $4 above it. Regressions are weighted by province-month aggregated population. Standard errors (in parentheses) are clustered by province, and significance levels are denoted as * 0.10, ** 0.05, *** 0.01.

The most binding minimum wage is found in the food and retail sectors. This is evident from both the jobs below the new minimum wage ($\bar{b}_{-1}$) and the change in the number of jobs below the new minimum wage (Δb). Column 17 shows that the estimated missing job, Δb, for the food sector is -12.1% (s.e. 0.6%), the largest estimate among the sectors studied. The impact of the minimum wage in the food industry, along with the high share of minimum wage workers in this sector, explains why this industry is frequently studied in the literature. Additionally, the number of excess jobs ($\Delta a = 12.8\%$) is similar in size to the missing jobs, resulting in little net change in food employment. These small effects align with other recent studies that find little to no employment effects for restaurant workers overall (Allegretto et al., 2017; Cengiz et al., 2019; Neumark et al., 2014). However, unlike most prior studies that examine overall restaurant employment, my estimates, following Cengiz et al. (2019), indicate that the impact specifically on low-wage food employment is also minimal.

The retail sector presents a somewhat different story compared to the food industry. Like the food industry, the estimated missing jobs, Δb, is notably large at -9.7% (s.e. 0.07%), the second largest estimate among the sectors studied. However, the difference lies in the number of excess jobs ($\Delta a = 8.7\%$), which is smaller than the missing jobs, resulting in a significant negative net change in retail employment. For the retail sector, as shown in column 6, I found a significant employment effect of -4%, which is statistically significant at the 90% confidence interval. Among all the industries studied, the retail sector is the only one showing a significant negative employment effect, with a significant employment elasticity with respect to its own wage of -0.618 (s.e. 0.293).

In most sectors, the effect of the minimum wage is less binding, as reflected in both the level (Δb) and the change in the number of jobs below the new minimum wage ($\bar{b}_{-1}$). In some sectors, such as wholesale, information, real estate, administrative, education, and health care, the number of excess jobs at and above the minimum wage is smaller than the missing jobs, resulting in a negative employment effect, albeit not statistically significant. Conversely, in sectors such as agriculture, utilities, transportation, and arts, the number of excess jobs at and above the minimum wage is larger than the missing jobs, leading to a positive employment effect, although this is also not statistically significant.

I find no indication that minimum wage increases are binding in some industries, such as oil, professional, management, finance, and the public sector. In these sectors, both the jobs below the new minimum wage ($\bar{b}_{-1}$) and the missing jobs (Δb) are close to zero. For the remaining industries in the "other" category in column (19), the bite of the minimum wage is statistically significant but somewhat smaller than the estimates for all industries (Δb equal to -2.7% versus -3.2% in column 1). Moreover, the missing job count is fully offset by the excess job count, resulting in a slightly positive (but statistically insignificant) own-wage employment elasticity of 1.242 (s.e. 0.689).

Regarding the impact of the minimum wage on the average wage of affected workers, the only sectors showing significant increases are utilities, transport, arts, information, education, food, retail, and administrative. The average wage effects in these sectors are 11.7%, 11.7%, 11.2%, 10.5%, 7.9%, 6.8%, 6.5%, and 5.8%, respectively.

7.2.8 Ontario Study by Alternative Workforce

I will now investigate the effects of minimum wage changes on various alternative workforce categories to discern whether there are heterogeneous responses to minimum wage shocks within different segments. For this, I examined categories such as tipped vs. non-tipped workers, hourly vs. non-hourly workers, full-time vs. part-time employees, and permanent vs. non-permanent workers. I sought to uncover any differential impacts and understand how minimum wage adjustments influence employment outcomes across these diverse groups.

As observed in Table 7.12, a significant negative employment effect of -5% and -10.8% is evident exclusively among part-time and tipped workers, respectively. However, for other groups, no significant negative employment effect is apparent. As I explained in the previous section (refer to Table 7.12), the employment effect in the food and accommodation sector was around -3.3%, but it was insignificant. Historically, around 60 to 70 percent of the food and accommodation sector consists of tipped workers. When focusing solely on tipped workers, the employment effect is -10.8% and is significant at the 90% confidence interval.

For workers who receive tips, it is important to note that in Ontario, during the considered period, some, such as liquor servers, were paid a sub-minimum wage.[9] To obtain an exact estimation of workers who receive tips and workers in the food and accommodation sector subject to the minimum wage, one would need to subtract the portion of liquor servers from the total number of workers who receive tips. However, accessing detailed employment records or specific industry surveys conducted is not practical based on the LFS data.

[9]In 2018, the minimum wage for liquor servers was $12.20 per hour, compared to the general minimum wage of $14.00 per hour. Notably, there was a jump in the minimum wage for liquor servers from $10.10 per hour to $12.20 per hour starting January 1, 2018. This change was part of a series of adjustments to minimum wage rates across different categories in Ontario.

Table 7.12: Impact of Minimum Wages on Employment and Wages by Alternative Workforce in Ontario Study

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Missing jobs below new MW (Δb)	-0.120***	-0.268***	-0.082***	-0.403***	-0.225***	-0.133***	-0.217***	-0.019***
	(0.005)	(0.011)	(0.006)	(0.008)	(0.013)	(0.005)	(0.008)	(0.005)
Excess jobs above new MW (Δa)	0.114***	0.254***	0.078***	0.378***	0.190***	0.128***	0.204***	0.021***
	(0.006)	(0.012)	(0.006)	(0.009)	(0.014)	(0.006)	(0.009)	(0.005)
% Δ affected wages	0.237***	0.197***	0.251***	0.202***	0.218***	0.228***	0.229***	0.225***
	(0.02)	(0.018)	(0.03)	(0.01)	(0.025)	(0.019)	(0.019)	(0.065)
% Δ affected employment	-0.039	-0.039	-0.028	-0.05**	-0.108*	-0.029	-0.049	-0.036
	(0.05)	(0.044)	(0.076)	(0.024)	(0.057)	(0.048)	(0.048)	(0.013)
Total # of observations	675	675	675	675	675	675	675	675
Total # of observations from 6$ to 14$	225	225	225	225	225	225	225	225
Total # of workers in the sample	116142	17809	110455	23497	8754	125197	89902	44049
Total # of workers in the sample from 6$ to 14$	44893	10593	38089	17397	5445	50041	47549	7937
Sample	Permanent	Non permanent	Full-time	Part-time	Tipped	Non Tipped	Hourly	Non Hourly

7.2.9 Ottawa vs Gatineau Study by Alternative Workforce

I also examined the employment effect of minimum wage increases in the Ottawa versus Gatineau study using alternative workforce analyses, similar to those conducted in the Ontario study. The results closely align with those of the Ontario case study. As you see in Table 7.13 there is a significant negative employment effect of -11.5% for part-time workers. For tipped workers, although there is a negative employment effect of -18.4%, it is not statistically significant and lacks precision. As with the Ontario case study, there is no significant effect observed for the other categories.

Table 7.13: Impact of Minimum Wages on Employment and Wages by Alternative Workforce in Ottawa vs Gatineau Study

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Missing jobs below new MW (Δb)	-0.075***	-0.168***	-0.042***	-0.300***	-0.246***	-0.770***	-0.176***	-0.009
	(0.013)	(0.026)	(0.013)	(0.018)	(0.040)	(0.014)	(0.025)	(0.013)
Excess jobs above new MW (Δa)	0.070***	0.180**	0.052***	0.245***	0.175***	0.087***	0.182***	0.013
	(0.015)	(0.029)	(0.015)	(0.020)	(0.045)	(0.015)	(0.028)	(0.015)
% Δ affected wages	0.166***	0.139***	0.218***	0.098***	0.267***	0.139***	0.156***	0.157
	(0.059)	(0.050)	(0.083)	(0.024)	(0.092)	(0.053)	(0.046)	(0.249)
% Δ affected employment	-0.035	0.043	0.119	-0.115**	-0.184	0.065	0.023	0.056
	(0.150)	(0.135)	(0.246)	(0.056)	(0.157)	(0.132)	(0.127)	(0.316)
Total # of observations	270	270	270	270	270	270	270	270
Total # of observations from 6$ to 14$	190	190	190	190	190	190	190	190
Total # of workers in the sample	7216	1235	7059	1392	525	7927	4522	3929
Total # of workers in the sample from 6$ to 14$	1954	623	1590	987	294	2283	2235	342
Sample	Permanent	Non permanent	Full-time	Part-time	Tipped	Non Tipped	Hourly	Non Hourly

7.2.10 Canada Study by Alternative Workforce

Now, similar to the Ontario study, I aim to investigate the effects of minimum wage changes on various alternative workforce categories to discern whether there are heterogeneous responses to minimum wage shocks within different segments. To achieve this, I will examine categories such as tipped vs. non-tipped workers, hourly workers, full-time vs. part-time employees, and permanent vs. non-permanent workers. My objective is to uncover any differential impacts and understand how minimum wage adjustments influence employment outcomes across these diverse groups.

Table 7.14: Robustness of the Impact of Minimum Wages on Employment and Wages by Alternative Workforce and Sample Definition (Canada Study)

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Missing jobs below new MW (Δb)	-0.025***	-0.073***	-0.015	-0.102***	-0.023***	-0.030***	-0.046***
	(0.001)	(0.008)	(0.001)	(0.004)	(0.003)	(0.001)	(0.002)
Excess jobs above new MW (Δa)	0.022***	0.085***	0.015***	0.091***	0.023***	0.030***	0.045***
	(0.001)	(0.007)	(0.002)	(0.004)	(0.005)	(0.001)	(0.002)
% Δ affected wages	0.053***	0.089***	0.067***	0.062***	0.085*	0.069***	0.067***
	(0.008)	(0.014)	(0.019)	(0.011)	(0.033)	(0.008)	(0.007)
% Δ affected employment	-0.048**	0.059	0.002	-0.035	-0.008	-0.001	-0.01
	(0.020)	(0.050)	(0.069)	(0.020)	(0.040)	(0.024)	(0.025)
Employment elasticity w.r.t. MW	-0.048**	0.142	0.001	-0.126	-0.011	-0.001	-0.015
	(0.020)	(0.140)	(0.041)	(0.072)	(0.052)	(0.027)	(0.040)
Employment elasticity w.r.t. affected wage	-0.904*	0.657	0.034	-0.559	-0.097	-0.014	-0.146
	(0.453)	(0.652)	(1.031)	(0.410)	(0.501)	(0.352)	(0.389)
Jobs below new MW ($\bar{b}_{-1}$)	0.080	0.197	0.048	0.295	0.066	0.090	0.126
$\%MW$	0.081	0.081	0.081	0.081	0.051	0.081	0.081
Number of event	56	56	56	56	37	56	56
Number of observations	287280	287280	287280	287280	172368	287280	287280
Number of workers in the sample	11211402	1786805	10621577	2376630	4131310	12093910	8811061
Set of events	Full-sample	Full-sample	Full-sample	Full-sample	No tip credit provinces	Full-sample	Full-sample
Sample	Permanent workers	Non-Permanent workers	Full-time workers	Part-time workers	All workers	Non-tipped workers	Hourly workers

Note: The table presents robustness checks for the impacts of minimum wage increases using event study analysis (refer to equation 4) and minimum wage adjustments from 1999 to 2019. It displays six-month averaged post-treatment estimates on missing jobs up to $4 below the new minimum wage, and excess jobs at and up to $4 above it. Regressions are weighted by province-month aggregated population. Standard errors (in parentheses) are clustered by province, and significance levels are denoted as * 0.10, ** 0.05, *** 0.01.

In columns 1 and 2 of Table 7.14, I restrict the sample to permanent and non-permanent workers. The minimum wage is more binding for non-permanent workers in both the level (Δb) (-7.3% vs. -2.5%) and the change in the number of jobs below the new minimum wage ($\bar{b}_{-1}$) (14.2% vs. 4.8%). However, the level of excess jobs (Δa) is also higher for non-permanent workers compared to permanent workers (8.5% vs. 2.2%). Consequently, the employment effect for permanent workers is negative and statistically significant (-4.8%), while for non-permanent workers, it is positive but statistically insignificant (5.9%). This finding somewhat aligns with the research by Campolieti et al. (2014), which suggests that permanent employees might experience more significant impacts from minimum wage adjustments due to factors such as job security, benefits, and long-term employment prospects. In contrast, temporary workers, who typically have less job security and may be more easily replaced, might experience less pronounced effects.[10] In contrast, for non-permanent workers (column 2), the employment effect is a positive 0.059 but statistically insignificant. The estimated wage effect for both groups is significant and positive, with increases of 5.35% for permanent workers and 8.9% for non-permanent workers.

In column 3 and column 4, I restrict the sample to full-time and part-time workers, respectively. As you can see, the minimum wage is much more binding for part-time workers, both in terms of the level (Δb) (-10.2% vs. -1.5%) and the change in the number of jobs below the new minimum wage ($\bar{b}_{-1}$) (12.6% vs. 0.1%). However, the level of excess jobs (Δa) is also higher for part-time workers compared to full-time workers (9.1% vs. 1.5%). Consequently, the employment effect for full-time workers is close to zero, while for part-time workers, it is negative but statistically insignificant (-3.5%). The estimated wage effects for both full-time and part-time workers are 6.7% and 6.2%, respectively, and both are statistically significant.

In certain Canadian provinces, tipped workers may legally be paid hourly wages below the minimum wage, potentially reducing the number of workers affected by minimum wage

[10] Campolieti et al. (2014) utilized the master file of LFS by Statistics Canada. The data covered the period from 1997 to 2007. For example, they explain that employers have less flexibility in managing permanent staff compared to temporary workers. Temporary workers can be more easily hired or let go based on immediate business needs, whereas permanent workers require more structured workforce planning. As a result, changes in wage policies might impact permanent workers more significantly as employers navigate the less flexible employment structure.

regulations. In column 5 of Table 7.14, I specifically examine the impact on events occurring in the six provinces where both tipped and non-tipped employees are subject to the same minimum wage.[11] I would expect the minimum wage to be more impactful in provinces where the minimum wage for tipped workers is the same as for non-tipped workers. This is because a significant portion of low-wage workers are employed as tipped employees, and these workers are fully affected by minimum wage changes in provinces with uniform minimum wage laws. However, provinces with the same minimum wage for both tipped and non-tipped workers experience smaller minimum wage shocks compared to those with different rates. In fact, the average percentage increase in the minimum wage in these provinces is 5.1%, which is much lower than the 8.1% average increase in the full sample. The impact of the policy is smaller in provinces without a tip credit: the job loss rate is 2.3% of pre-treatment employment, compared to 3.2% in the full sample. As in the full sample, the lost jobs are almost completely offset by an increase in jobs above the minimum wage, amounting to 2.3% of pre-treatment employment. The resulting employment elasticity with respect to own wage is -0.097 (s.e. 0.501). The estimated wage effect is 8.5% (s.e. 0.033), somewhat higher than the estimated wage effect in the full sample, which stands at 6.4% (s.e. 0.008).

In column 6, I omit workers in tipped occupations. Tipped workers are often allowed to work for sub-minimum wages in some provinces,[12] potentially reporting hourly wages below the minimum wage since tips are not always factored into reported hourly wages. As detailed in Section 4.2, this incomplete coverage results in a disparity between the actual level ($\bar{b}_{-1}$) and the change (Δb) in the number of workers earning below the new minimum wage. However, it doesn't introduce bias in the estimation of bunching for the change in employment ($\Delta a + \Delta b$). Excluding tipped workers results in a slight reduction in the average impact, with ($\bar{b}_{-1}$) at 9%, and the estimate of missing jobs at -3% aligns closely with the benchmark estimate of -3.2% in Table 7.1. Consequently, the estimated wage effects also closely resemble the benchmark estimation (6.9% compared to 6.4% in Table 7.1). Overall, excluding tipped workers has a minimal effect on the employment estimates: the employment

[11] These provinces are Newfoundland and Labrador, Nova Scotia, Prince Edward Island, New Brunswick, Manitoba, and Saskatchewan

[12] Including Ontario, Quebec, Alberta, and British Columbia

impact is close to zero and the employment elasticity with respect to own wage is -0.014 (s.e. 0.352), all of which are statistically insignificant.

In column 7 following Cengiz et al. (2019) I limit the sample to hourly workers. This restriction is based on the expectation that hourly workers provide more accurate hourly wage information compared to the calculation of hourly earnings (derived from weekly earnings divided by usual hours) for salaried workers. While the actual number of workers below the new minimum wage closely aligns with my benchmark sample (12.6% vs. 9.5% in Table 7.1), the estimate for missing jobs is larger compared to the full sample (4.6% vs. 3.2% in Table 7.1). However, similar to the full sample, the loss of jobs is nearly entirely compensated by an increase in jobs above the minimum wage, accounting for 4.5% of pre-treatment employment. Consequently, the overall employment effect remains similar to the benchmark specification (-1% vs. -2% in Table 7.1 and both are statistically insignificant). The same holds for the wage estimate (6.7 vs. 6.4 in Table 7.1).

7.2.11 Canada Study by Pre-treatment Employment Status

Following Cengiz et al. (2019), I examine the impact of the minimum wage separately on workers who were employed before the minimum wage increase (incumbent workers) and on new entrants into the labor market. This breakdown of overall employment changes might be of interest in its own right, especially if policymakers prioritize the employment prospects of these two groups differently.

I partition the sample of wage earners into incumbent workers and new entrants by exploiting the fact that the LFS follows a rotating panel design where households are surveyed for six consecutive months. Each month, 1/6th of the sample is rotated out and replaced by new households. Given this design, each individual in the LFS is followed for only six months, making it impossible to track individuals for a full year or longer with LFS data. This contrasts with the approach taken by Cengiz et al. (2019), who used CPS data, where respondents are interviewed twice, exactly one year apart. The CPS design allows for a one-year follow-up but does not capture pre-treatment employment status for periods more than a year after the minimum wage increase. As a result, Cengiz et al. (2019) restricted their analysis to one year around the minimum wage increase, rather than the five years in their baseline sample.

In my study, based on LFS data, I can track individuals for up to six months. However, I choose to limit the analysis to tracking individuals for just one month after the shock for two reasons. First, by restricting the follow-up to one month, my sample will include all individuals surveyed before and after the shock, resulting in a larger sample size (5 out of 6 households, or approximately 83.33% of those followed). If I were to track individuals for the full six-month period, the sample would be smaller because not all individuals are followed for the entire six months due to the rotating panel design (in that case, I would end up with only 1 out of 6 households, or approximately 16.67% of those followed).

The second reason is that the overall employment effect of tracking for six months following the minimum wage shock was found to be small and insignificant (refer to Table 7.1 or column 1 in Table 7.15). However, when focusing on the month of the shock, a significant negative employment effect of -4.2% was observed (refer to column 2 in Table 7.15). This motivates me to investigate how much of this significant negative employment effect is attributable to incumbents versus new entrants. I hypothesize that extending the follow-up to six months would not yield significant employment effects among either incumbents or new entrants, and the smaller sample size would further limit the robustness of the analysis. Therefore, for these estimates, I also restrict the time window to one month around the minimum wage increase, rather than six months in my baseline sample. The results are shown in Table 7.15.

Table 7.15: Impact of Minimum Wage Increase by Pre-treatment Employment Status: New Entrants and Incumbents (Canada study)

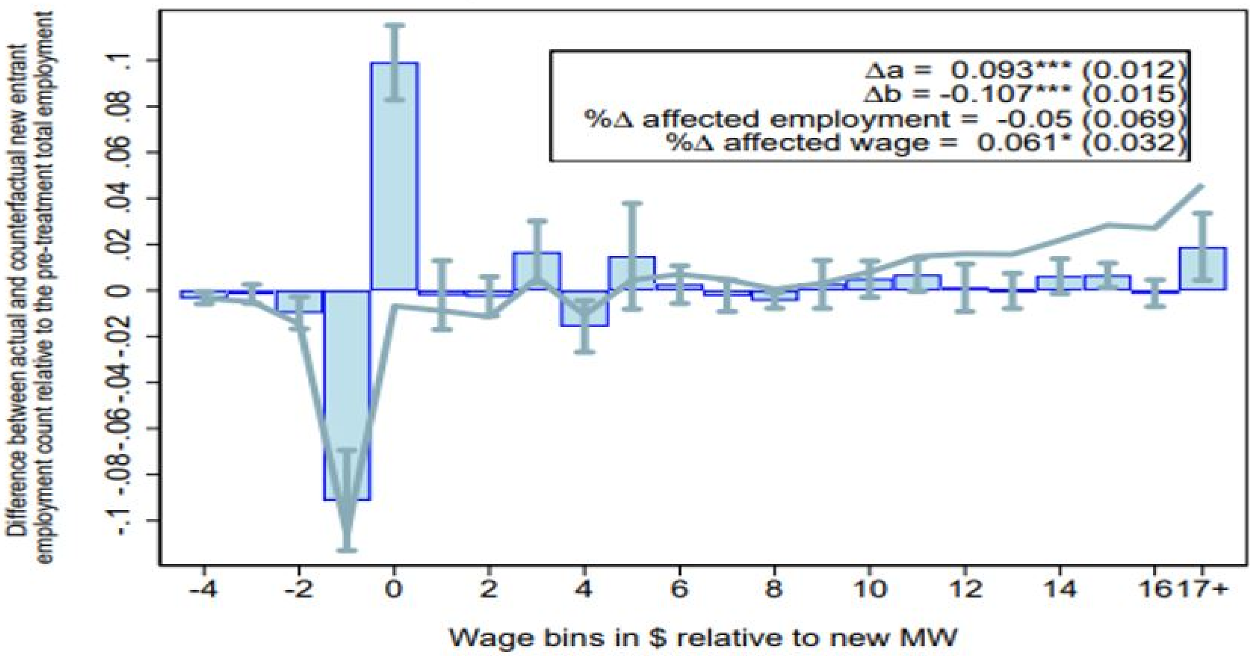
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Missing jobs below new MW (Δb)	-0.032***	-0.017***	-0.009***	-0.006***	-0.106***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.015)
Excess jobs above new MW (Δa)	0.030***	0.013***	0.006***	0.003	0.095***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.012)
% Δ affected wages	0.064***	0.021**	0.009	0.005	0.063*
	(0.008)	(0.007)	(0.007)	(0.008)	(0.031)
% Δ affected employment	-0.020	-0.042**	-0.032**	-0.030*	-0.050
	(0.025)	(0.018)	(0.012)	(0.014)	(0.069)
Employment elasticity w.r.t. MW	-0.023	-0.049**	-0.038**	-0.034*	-0.128
	(0.030)	(0.022)	(0.015)	(0.016)	(0.175)
Employment elasticity w.r.t. affected wage	-0.307	-1.971	-3.428	-6.389	-0.794
	(0.422)	(1.508)	(3.801)	(13.421)	(1.195)
Jobs below new MW ($\bar{b}_{-1}$)	0.095	0.095	0.097	0.093	0.207
$\%MW$	0.081	0.081	0.081	0.081	0.081
Number of event	56	56	56	56	56
Number of observations	287280	287280	286140	286140	286140
Number of workers in the sample	12998207	12998207	10316073	9885684	430389
Sample	All workers	All workers	All matched workers	Incumbents	New entrants
Time window	6 months	1 month	1 month	1 month	1 month

Note: The table represents 1-month post-treatment estimates of employment and wages of the affected bins for all workers (incumbents and new entrants) using province-month-wage bin aggregated LFS and matched LFS data from 1999-2019. The first column replicates column 1 in Table 7.1 for comparability. The second column includes all workers in the primary LFS sample and employs the baseline specification, but reports only the first month effects. The third, fourth, and fifth columns use matched LFS and consider only the first-month effects on all matched workers, incumbent, and new-entrant workers. Specifications include wage bin-by-province, wage bin-by-period, and province-by-period fixed effects. Regressions are weighted by province-month aggregated population. Robust standard errors in parentheses are clustered by province; significance levels are * 0.10, ** 0.05, *** 0.01.

Figure 7.20 and Figure 7.21 show the bunching estimates for new entrants and incumbents for each dollar wage bin relative to the new minimum wage, respectively. I report the immediate effect of the minimum wage hike, β_{0h}, for each dollar wage bin h. The figures highlight that for both subgroups, the new minimum wages clearly bind, with significantly fewer jobs just below and significantly more at the new minimum. The missing jobs estimate is larger for new entrants (-10.6%, s.e. 1.5%) than for incumbents (-0.6%, s.e. 0.3%). However, for both groups, the excess jobs are slightly smaller than the missing jobs (for incumbents, ($\Delta a = 0.3\%$) and ($\Delta b = -0.6\%$); for new entrants, ($\Delta a = 9.5\%$) and ($\Delta b = -10.6\%$). Consequently, the net employment changes are negative for both groups, resulting in a negative employment effect of -3% for incumbents and -5% for new entrants. However, this decrease is statistically significant for incumbents at the 90% confidence interval but is insignificant for new entrants. The green and blue solid lines show the running sums of employment changes up to the corresponding wage bin for each group. The lines indicate that there is little change in employment in the upper tail for both groups. The affected wage increase for incumbents (0.5%, s.e. 0.8%) is significantly smaller than it is for new entrants (6.3%, s.e. 3.1%).

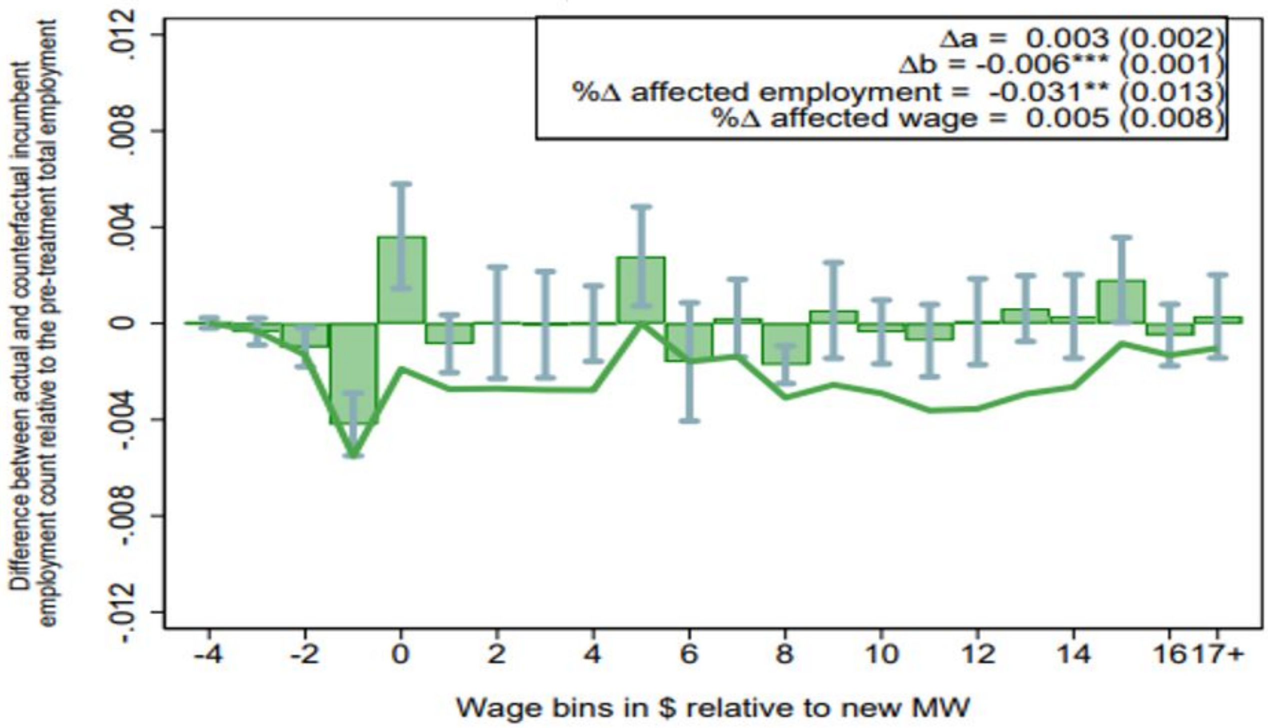
To sum up, like Cengiz et al. (2019), I found no evidence that the employment responses differ substantially between new entrants and incumbents, at least in the short run. However, my findings on the wage effect contrast with those of Cengiz et al. (2019). While they observed a significant increase in wages for incumbents, my study found a significant wage effect only for new entrants. Nevertheless, since I detect clear changes in the missing and excess jobs for new entrants, along with a significant wage effect for this group, studies focusing solely on incumbent workers will provide at best a partial characterization of the full effects of the minimum wage increase. Therefore, the bunching approach expands on prior research that limits its sample to workers earning positive wages before the minimum wage increase (Abowd et al., 2000; Clemens and Wither, 2019).

Figure 7.20: Impact of the Minimum Wages on the Wage Distribution by Pre-treatment Employment Status: New Entrants (Canada Study)



Notes: The figure shows the main results for new entrants from my event study analysis(see equation 4) exploiting 56 province-level minimum wage changes between 1999-2016. The blue bars show for each dollar bin the estimated change in the number of new entrants in that bin 1 month post-treatment relative to the total employment of the new entrants 1 month before the treatment. New entrants workers were not employed a month before the minimum wage increase. The error bars show the 95% confidence interval calculated using standard errors that are clustered at the province level. The blue line shows the running sum of employment changes up to the wage bin they correspond to for new entrants.

Figure 7.21: Impact of the Minimum Wages on the Wage Distribution by Pre-treatment Employment Status: Incumbents (Canada Study)



Notes: The figure shows the main results for incumbents from my event study analysis(see equation 4) exploiting 56 province-level minimum wage changes between 1999-2016. The green bars show for each dollar bin the estimated change in the number of new entrants in that bin 1 month post-treatment relative to the total employment of the incumbents 1 month before the treatment. Incumbent workers were employed a month before the minimum wage increase. The error bars show the 95% confidence interval calculated using standard errors that are clustered at the province level. The blue line shows the running sum of employment changes up to the wage bin they correspond to for new entrants

7.3 Estimates of Wage Spillovers in Canada Study

I present my estimates of wage spillovers in Table 7.16. The columns display the estimates of the total wage effect ($\%\Delta w$), the "no spillover" wage effect ($\%\Delta w_{\text{no spillover}}$), and the spillover share of the total wage increase, calculated as ($\frac{\%\Delta w - \%\Delta w_{\text{no spillover}}}{\%\Delta w}$). The first row displays the estimated impacts on the entire workforce. Column 1 repeats the total wage effect from Column 1 in Table 7.1, which is 6.4% (s.e. 0.8%). Column 2 shows that without spillovers, wages would rise by 5.9% (s.e. 0.7%). Column 3 reveals that 6.7% (s.e.

13.6%) of the total wage effect is due to the ripple effect of the minimum wage, a statistically insignificant result.

Table 7.16: The Size of the Wage Spillovers (Canada Study)

	%Δaffected wage		spillover share of wage increase
Type of sample	$\%\Delta w$	$\%\Delta w_{\text{No spillover}}$	$\frac{\%\Delta w - \%\Delta w_{\text{No spillover}}}{\%\Delta w}$
Overall	0.064***	0.059***	0.067
	(0.008)	(0.007)	(0.136)
Teen	0.073***	0.065***	0.112**
	(0.007)	(0.009)	(0.035)
Age[20,25)	0.077***	0.063***	0.186*
	(0.013)	(0.008)	(0.087)
Age[15,25)	0.075***	0.064***	0.143**
	(0.008)	(0.008)	(0.049)
Age25+	0.048***	0.054***	-0.122
	(0.020)	(0.008)	(0.446)
High school dropout	0.058***	0.058***	0.010
	(0.008)	(0.005)	(0.181)
High school graduate	0.066***	0.055***	0.170
	(0.014)	(0.008)	(0.186)
High school or less	0.061***	0.056***	0.090
	(0.007)	(0.006)	(0.143)
College, Diploma and some Post-secondary education	0.076***	0.069***	0.093
	(0.009)	(0.009)	(0.117)
Woman	0.061***	0.061***	0
	(0.009)	(0.006)	(0.152)
Permanent workers	0.053***	0.056***	-0.051
	(0.008)	(0.006)	(0.173)
Non-permanent workers	0.089***	0.069***	0.233*
	(0.014)	(0.010)	(0.113)
Utility	0.117***	0.056***	0.525***
	(0.021)	(0.013)	(0.114)
Retail	0.065***	0.064***	0.024
	(0.007)	(0.008)	(0.079)
Information	0.105***	0.087***	0.171
	(0.031)	(0.025)	(0.113)
Administrative	0.058***	0.061***	-0.046
	(0.016)	(0.010)	(0.238)
Education	0.079*	0.060***	0.241
	(0.040)	(0.014)	(0.41)
Arts	0.112***	0.058**	0.485***
	(0.012)	(0.020)	(0.136)
Food	0.068***	0.060***	0.110*
	(0.005)	(0.005)	(0.056)
Incumbents	0.005	0.010***	-1.093
	(0.008)	(0.003)	(3.227)
New entrants	0.063*	0.080***	-0.260
	(0.031)	(0.013)	(0.516)

Note: The table reports the effects of a minimum wage increase on wages based on the event study analysis (see equation 4) exploiting 56 province-level minimum wage changes between 1999 and 2019. Robust standard errors in parentheses are clustered by province; significance levels are * 0.10, ** 0.05, *** 0.01.

As noted by Cengiz et al. (2019). in their study, the wage spillover estimates derived from the bunching estimates effectively address some challenges found in previous literature on wage spillovers. Earlier research (Card and Krueger, 1995; DiNardo, Fortin, and Lemieux, 1995; Lee, 1999; Autor et al., 2016) identified spillovers by estimating changes in wage density. However, this focus on density could lead to the possibility that some measured spillovers are artifacts caused by dis-employment truncating the wage distribution. In contrast, the approach that I used avoids this issue by concentrating on the frequency distribution of wages, allowing for a simultaneous estimation of the minimum wage's effect on both employment and wage distribution.

In Table 7.16, I also report estimates for several subgroups that experienced significant wage effects. The share of spillovers in the total wage increase varies across key demographic groups: high school dropouts (1%), high school graduates (17%), those with a high school diploma or less education (9%), those with some post-secondary education (14.3%), and women (0%). In most cases, the spillover share is statistically insignificant. However, there are some exceptions where the spillover share is statistically significant, such as for teens (11.2%), individuals aged 20-25 (18.6%), individuals aged 15-25 (14.3%), and non-permanent workers (23.3%).

I also report the spillover share among different sectors of the economy, focusing on those that experienced significant wage effects. The share of spillovers in the total wage increase varies among sectors, such as retail (2.4%), the information sector (17.1%), and education (24.1%), with these shares being statistically insignificant. Significant spillover shares in total wage increases were found in only three sectors: utilities (52.5%), arts (48.5%), and food services (11%). Although overall I found only a small share of spillover in total wage increases among low-wage workers, there is notable heterogeneity among different subgroups and industries regarding the extent of this wage spillover.

As I explain in Appendix B, the standard labor demand model with heterogeneous workers can account for wage spillovers primarily through significant substitution from lower-paid to higher-paid workers. This mechanism aligns somewhat with my findings because I only observed a minor spillover effect, which was statistically insignificant. Additionally, there was no noticeable employment effect at the lower end of the wage distribution, no labor-labor substitution among lower-wage groups based on observable characteristics, and no significant responses in the upper tier of the wage distribution.

7.4 Summary of Results

My study analyzed the employment and wage effects of minimum wage increases across various Canadian provinces, with a focus on Ontario, Alberta, and the Ottawa-Gatineau region. I employed methodologies such as bunching, Difference-in-Differences (DID), and event study analysis using Labour Force Survey (LFS) data. Across all regions and methodologies, there was no significant negative effect on overall employment for low-wage workers. However, there was a significant increase in the average wages of low-wage workers. These results are consistent with the empirical literature, including studies by Cengiz et al. (2019) in the U.S. and Fossati and Marchand (2024) in Canada, which also found no significant negative employment effects in the two largest urban areas in Alberta as a result of minimum wage increases.

7.4.1 Ontario

In the Ontario study, I found a slight decrease in employment by -3.9%, which is statistically insignificant. This overall insignificant negative employment effect in Ontario aligns with the recent findings of Azar, Huet-Vaughn, Marinescu, Taska, and Von Wachter (2023); Cengiz, Dube, Lindner, and Zentler-Munro (2022); Cengiz et al. (2019); Fossati and Marchand (2024). In contrast to the employment effects observed, I found a significant 22.4% increase in the average wage of affected workers. This increase aligns with the real minimum wage increase of 19.2% implemented in January 2018. There is only a small sign of wage spillover in the Ontario study, which is consistent with findings of Campolieti (2015). Campolieti (2015)'s study, using data from the Canadian Labour Force Survey, finds that while minimum wage increases do lead to higher wages for those directly affected, the impact on the average wages of low-wage workers in Canada is less pronounced compared to the U.S.

Fossati and Marchand (2024) investigated the employment effect of Alberta's minimum wage increase in 2018 and found a significant negative effect only outside Alberta's two main cities, Calgary and Edmonton, but not within them. They noted that the employment effects of minimum wage increases might differ by geography. For example, large urban areas can better absorb the employment impacts of significant minimum wage increases compared to non-urban areas due to their higher price levels. They cited New York State's geographic roll-out of its $15 minimum wage, from New York City to its suburbs and beyond, as an example.

Cengiz et al. (2022) found that being "rural" is the fifth most important predictor of being affected by a minimum wage. Similarly, Azar et al. (2023) demonstrated that less concentrated labor markets experience more negative employment effects from minimum wage increases, while more concentrated markets see less negative effects, potentially even positive effects in the most concentrated labor markets. Given that Ontario is one of the most concentrated labor markets in the country, particularly due to the presence of the Greater Toronto Area (GTA), the insignificant negative employment effect I found is consistent with the literature, including (Cengiz et al., 2019; Cengiz et al., 2022; Azar et al., 2023; Fossati and Marchand, 2024).

Regarding demographic groups, I investigated the employment and wage effects based on age and education levels. Among them, the most interesting results were found for teenagers and young adults. Teenagers showed a significant positive employment effect of 6.6%. However, for those aged [20-25), there was a significant negative employment effect of -12.6%. Notably, no significant negative employment effect was found for young adults aged [15-25). This finding contradicts most empirical studies in Canada, such as Fossati and Marchand (2024), which found a significant negative employment effect for young adults.

One possible explanation for the inverse relationship between teenagers and those aged 20-25 that I found in the Ontario study is the existence of a sub-minimum wage for students under 18 in Ontario in 2018. Even though both the minimum wage and sub-minimum wage increased in January 2018, the new sub-minimum wage was still lower than the new minimum wage, possibly giving employers an incentive to substitute students under 18 for those aged 20-25. However, this does not fully explain why there was no significant negative employment effect for the entire young adult group aged 15-25. This inconsistency between the employment effect of young adults in my Ontario study and Alberta's minimum wage study done By Fossati and Marchand (2024) motivated me to look at Alberta's minimum wage increase by using the same methodology that I applied in the Ontario study.

Moreover, for the industry analysis, the retail sector showed a significant positive employment effect of 8.5%, whereas the food sector did not show significant negative employment effects. This result aligns with the findings of Card and Krueger (1994), who discovered that there was no significant decrease in employment in fast-food restaurants following a minimum wage increase in New Jersey. In fact, employment levels either remained stable or even increased. Additionally, there is a significant increase in the average wage by 21.7% in the retail sector and 23.1% in the food sector.

7.4.2 Alberta

In the Alberta study, I found a slight increase in employment by 2.1%, which is statistically insignificant but a significant increase in the average wages of affected workers by 20.4%. Again, these overall employment and wage results, as discussed in Section 7.4.1 of the Ontario study, are consistent with both the empirical literature and previous findings. The only exception is that for demographic groups, individuals aged [20-25) showed a significant positive employment effect, while teenagers experienced a notable decrease in employment of -11.1%. Overall, there was no significant negative employment effect for young adults aged [15-25). The employment trends for teenagers and individuals aged [20-25) diverge between my Ontario and Alberta studies. However, similar to Ontario, there is no significant negative employment effect for young adults aged [15-25) in Alberta.

This insignificant negative employment effect among young adults [15-25) again contradicts Canadian literature, such as the study by Fossati and Marchand (2024), which found a significant negative employment effect for young adults in Alberta following a minimum wage increase in 2018. Unlike Fossati and Marchand (2024), who used the synthetic control method to construct the counterfactual wage distribution, I attempted to replicate this by comparing the Ottawa vs Gatineau study using the same method that I used in the Ontario and Alberta study.

7.4.3 Ottawa vs Gatineau

In the Ottawa Vs Gatineau study, I found a slight decrease in employment by -1.3%, which is statistically insignificant but a significant increase in the average wages of affected workers by 15.8%. these results are in the same direction as what I found in the Ontario study but with a lower magnitude.

Regarding demographic groups, teenagers showed a significant positive employment effect of 3.9%. However, no significant negative employment effect was found for young adults (15-25). Additionally, in both groups, there is a significant increase in the average wage by 9% and 19.6%, respectively. Again these results are consistent with my demographic findings in the Ontario study but with a lower magnitude.

In the industry analysis of both Ontario and the Gatineau vs. Ottawa study, I did not find significant negative employment effects in the major low-wage sectors of the economy, namely the food and retail industries. However, in the Ottawa vs. Gatineau study, I observed a significant positive employment effect of 22.7% in the food industry and no significant negative employment effect in the retail industry. Conversely, in the Ontario study, there was a significant positive employment effect in the retail sector, with no significant negative employment effect in the food industry. These findings align with Card and Krueger (1993)'s study, which found no significant decrease in employment in fast-food restaurants following a minimum wage increase in New Jersey. Additionally, there is a significant increase in the average wage by 16.1% in the retail sector and 13.9% in the food sector.

All in all, comparing Ottawa vs Gatineau did not resolve the discrepancy between the insignificant negative employment effects of young adults [15-25) observed in my study—whether related to Alberta's or Ontario's minimum wage increases—and the significant negative employment effects of young adult found in Fossati and Marchand (2024)'s study. This difference in employment effect of young adults between my study and Fossati and Marchand (2024)'s study motivates me to examine a broader range of minimum wage increases across all Canadian provinces from 1999 to 2019, rather than focusing solely on a single minimum wage increase.

7.4.4 Canada (All Provinces from 1999-2019)

In the Canada study, I found a slight decrease in employment by -2%, which is statistically insignificant but a significant increase in the average wages of affected workers by 6.4%. Regarding demographic groups, teenagers showed an insignificant employment effect of 0.3%. Consistent with the findings in Ontario, Alberta, and Ottawa-Gatineau, no significant employment effect was found for young adults (15-25). following (Card and Krueger, 1995; Cengiz et al., 2019) I also analyzed how various groups of workers are impacted by changes in the minimum wage, considering their differing probabilities of exposure. Based on Card and Krueger (1995)'s model, I created three groups: a "high-probability" group, a "low-probability" group, and a "middle group". I did not find any significant negative employment effect in the high-probability group. Additionally, the greatest increases in average wages for affected workers were observed in this group. These results align with the findings of (Card and Krueger, 1995; Cengiz et al., 2019).

Regarding industry analysis, I estimated 18 different industry categories and found a significant negative employment effect of -4% with a 90% confidence interval in the retail sector. In other sectors, including the food industry, I did not find a significant employment effect. Regarding the impact of the minimum wage on the average wage of affected workers, the only sectors showing significant increases are utilities, transport, arts, information, education, food, retail, and administrative services.

I also investigated the employment effects among various alternative workforces, such as permanent versus non-permanent workers and full-time versus part-time workers. I found a significant negative employment effect of -4.8% only for permanent workers. This finding aligns somewhat with the research by Campolieti et al. (2014), which suggests that permanent employees might experience more significant impacts from minimum wage adjustments due to factors such as job security, benefits, and long-term employment prospects. In contrast, temporary workers, who typically have less job security and may be more easily replaced, might experience less pronounced effects. For non-permanent workers, the employment effect was a positive 0.059 but statistically insignificant. The estimated wage effect for both groups was significant and positive, with increases of 5.35% for permanent workers and 8.9% for non-permanent workers.

Finally, I quantified the wage spillover effects in the Canadian study and found that compared to the findings of Cengiz et al. (2019) in U.S. data, there was only a small share of spillover in total wage increases among low-wage workers in my study. This result somewhat aligns with Campolieti (2015), who used data from the Canadian Labour Force Survey from 1997 to 2010 and suggested that spillover impacts in Canada are relatively modest compared to those in the U.S. However, there is notable heterogeneity among different subgroups and industries regarding the extent of this wage spillover. Significant spillover effects were found among teens (11.2%), individuals aged 20-25 (18.6%), individuals aged 15-25 (14.3%), non-permanent workers (23.3%), utilities (52.5%), arts (48.5%), and food services (11%) sectors. Overall, the share of spillovers in total wage increases among low-wage workers was small, with notable heterogeneity among different subgroups and industries.

Chapter 8

Conclusion

This thesis critically examines the employment and wage effects of minimum wage increases across various Canadian provinces, employing advanced econometric methodologies including bunching, Difference-in-Differences (DID), and event study analyses. The results provide nuanced insights into the impact of minimum wage adjustments on low-wage workers, challenging the traditional competitive model's predictions of significant employment reductions.

The main advantage of bunching is that it enables the evaluation of the overall impact of the minimum wage on low-wage workers, who are the primary focus of minimum wage policies. I implemented this method in two steps. First, I started by analyzing single minimum wage increases in Ontario, Alberta, and Ottawa vs Gatineau by using DID to construct the counter factual wage distribution. Then, combining this with an event study analysis of 56 minimum wage increases across all provinces of Canada from 1999 to 2019, I provided a robust and comprehensive assessment of how minimum wage increases affect the frequency distribution of wages.

Second, I determined the number of jobs that fall just below the minimum wage, the number of excess jobs at or slightly above the minimum wage, and the changes in jobs within the higher end of the wage distribution. My main estimates in all single minimum wage increases and also when pooling all 56 minimum wage increases indicate that the number of excess jobs at or slightly above the minimum wage closely matches the number of missing jobs just below the minimum wage. Additionally, I found no evidence of employment changes for jobs paying $4 or more above the minimum wage.

Tracking job changes throughout the wage distribution allows for a transparent identification of the sources of dis-employment effects, as suggested by Cengiz et al. (2019). This approach is crucial for detecting empirical specifications that suggest unrealistic impacts on the wage distribution's shape. More importantly, the relationship between minimum wages and wage distribution can be used to infer the structure of low-wage labor markets.

Contrary to the employment effects, the data consistently reveal substantial wage gains for affected workers. Specifically, the average wage increase was statistically significant across various demographic and regional subgroups. However, most of this increase in the average wage of affected workers comes from the direct effect of minimum wage increases, with the ripple or indirect effects being small and insignificant.

While Cengiz et al. (2019) found substantial ripple effects concentrated at the bottom of the wage distribution using CPS and administrative data from the U.S., my study did not identify significant ripple effects at the bottom of the wage distribution (jobs paying $4 or more above the minimum wage) using LFS data. Thus, the standard frictionless model of labor demand presented in Chapter 4 aligns better with my findings using Canadian data than with the findings of Cengiz et al. (2019) using US data. These small and insignificant spillovers are less likely to reflect labor market frictions, as suggested by Cengiz et al. (2019).

Overall, my empirical analysis of the wage distribution, labor-labor substitution across demographic groups, and sector-specific responses provides new insights for testing and differentiating various theories of the low-wage labor market. In summary, this thesis contributes to the ongoing debate on minimum wage policies by demonstrating that, contrary to traditional competitive models, increases in the minimum wage do not significantly reduce overall employment levels. Instead, they lead to substantial wage gains for low-wage workers. These findings are crucial for policymakers, suggesting that minimum wage adjustments can enhance labor market outcomes for low-wage earners without the adverse employment effects often predicted by conventional economic theories.

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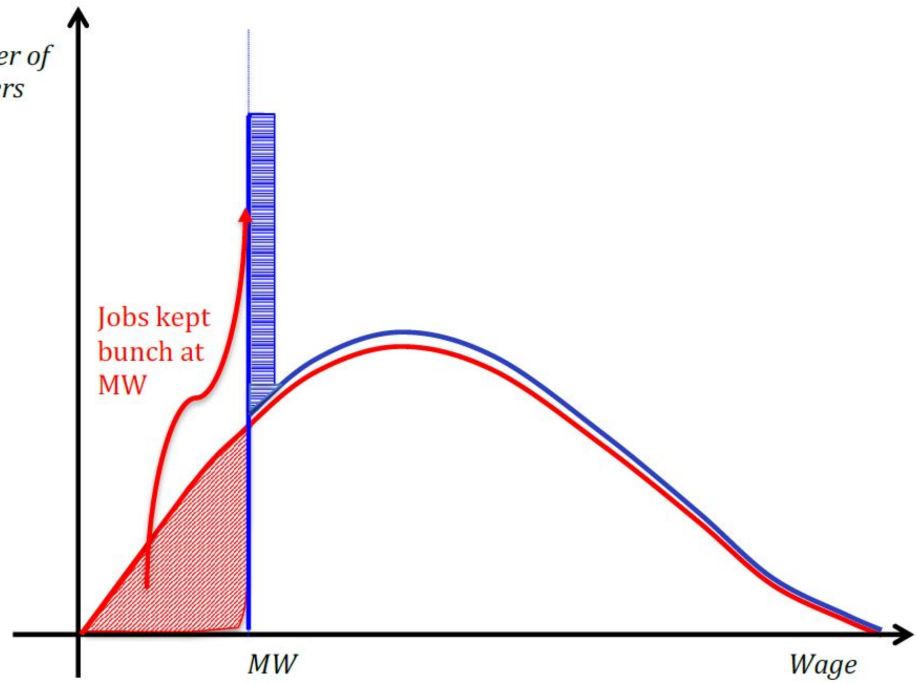
Appendices

Appendix A

Additional Figures and Tables

Figure A.1 illustrates the impact of the minimum wage within the frictionless standard labor demand model presented in Appendix B. The figure demonstrates that in the absence of any friction, the model generates a spike in the minimum wage. Additionally, the model predicts spillover effects throughout the wage distribution due to changes in the relative price of labor. However, the model does not predict spillover effects concentrated specifically at the bottom of the wage distribution.

Figure A.1: Effect of the Minimum Wage on the Wage Distribution in the Standard Labor Demand Model



Notes: The figure shows the effect of the minimum wage on the frequency distribution of hourly wages in the frictionless standard labor demand model presented in Chapter 2 and Appendix B. The red solid line represents the wage distribution in the absence of the minimum wage. Once the minimum wage is introduced (blue solid line), all jobs below it are either eliminated or pushed up to the new minimum wage, creating a spike. The difference between the missing jobs and the number of jobs at the spike estimates the disemployment effect of the minimum wage for low-wage workers. Additionally, the minimum wage has a modest impact on the upper tail of the wage distribution in this model, as the higher labor costs at the bottom of the wage distribution boost labor demand for workers higher up the wage distribution. Consequently, the post-treatment wage distribution (blue line) is elevated at wage levels above the minimum wage.(source:Cengiz et al. (2019))

Table A.1 examines the sensitivity of the results by using different thresholds, $\overline{W}$, to calculate the excess jobs at and above the minimum wage. In the baseline model, the excess jobs are computed by summing the impact within the range from MW to MW + \$4. The table presents results using thresholds for $\overline{W}$ ranging from \$1 to \$5 above the minimum wage. The findings indicate that the excess jobs estimate increases as the threshold is raised from \$1 (column 1) to \$3 (column 3), but remains somehow stable beyond that point. Regarding the employment effect, the data shows that up to $\overline{W} = MW + \$4$, the overall employment effect is approximately -2%. However, when $\overline{W}$ is set to MW + \$5, the effect becomes positive 1.4% but again it is statistically insignificant. In all specifications, the overall employment effects are statistically insignificant, except when $\overline{W}$ equals MW + \$2. Overall, while there is some minor sensitivity to the specific value of $\overline{W}$, this sensitivity does not significantly impact the statistical significance of the overall employment effect.

Table A.1: Impact of Minimum Wage Increase on the Average Wage and Employment of Affected Workers (Exploring Alternative Wage Windows in Calculating Excess Jobs)

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Missing jobs below new MW (Δb)	-0.032***	-0.032***	-0.032***	-0.032***	-0.032***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Excess jobs above new MW (Δa)	0.028***	0.030***	0.031***	0.030***	0.033***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
% Δ affected wages	0.058***	0.065***	0.070***	0.064***	0.087***
	(0.005)	(0.009)	(0.007)	(0.008)	(0.006)
% Δ affected employment	-0.043	-0.020**	-0.010	-0.020	0.014
	(0.025)	(0.007)	(0.017)	(0.025)	(0.016)
Employment elasticity w.r.t. MW	-0.05	-0.023**	-0.011	-0.023	-0.017
	(0.030)	(0.008)	(0.020)	(0.030)	(0.019)
Employment elasticity w.r.t. affected wage	-0.744	-0.304**	-0.141	-0.307	0.162
	(0.440)	(0.088)	(0.244)	(0.422)	(0.191)
Jobs below new MW ($\bar{b}_{-1}$)	0.095	0.095	0.095	0.095	0.095
$\%MW$	0.081	0.081	0.081	0.081	0.081
Number of event	56	56	56	56	56
Number of observations	287280	287280	287280	287280	287280
Number of workers in the sample	12998207	12998207	12998207	12998207	12998207
Upper endpoint of wage window ($\overline{W}$)	MW+$1	MW+$2	MW+$3	MW+$4	MW+$5

Note: The table reports the effects of a minimum wage increase based on the event study analysis (see equation 4) exploiting 56 province-level minimum wage changes between 1999-2019. The table reports 6-month averaged post-treatment estimates on missing jobs up to $4 below the new minimum wage, excess jobs, employment, and wages. The different columns explore the robustness of the results to alternative upper-end points, $\overline{W}$, for calculating excess jobs. The first column limits the range of the wage window by setting the upper limit for calculating the excess jobs to $\overline{W} = \$1$, and the last column expands it until $\overline{W} = \$5$. All specifications include wage bin-by-province and wage bin-by-period fixed effects. Regressions are weighted by province-month aggregated population. Robust standard errors in parentheses are clustered by province; significance levels are * 0.10, ** 0.05, *** 0.01.

Table A.2, I assess the robustness of my results by using alternative event windows. Column 6 repeats the baseline results, using a window from five months before to six months after the minimum wage increase (event date -5 to +5). Columns 1 through 5 present reduced post-treatment windows, from one month (column 1) to five months (column 5).

The results show a significant negative employment effect of -4.2% only in the month of the shock. For other months, the effect is around -2% and statistically insignificant. Specifically, in the month of the shock, the employment elasticity is -0.049 and statistically significant. For time windows from two to six months following the shock, the employment elasticity ranges between -0.023 and -0.029, with associated standard errors varying from 0.018 to 0.030.

These estimates indicate that the most significant employment effect occurs in the short term, specifically in the month of the shock. When considering more than one month after the shock, the employment effect is approximately -2% and statistically insignificant. Overall, these findings demonstrate that the results are not driven by the specific choice of the event window, except for the immediate month of the shock.

Table A.2: Impact of Minimum Wage Increase on the Average Wage and Employment of Affected Workers (Robustness to Alternative Time Windows)

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Missing jobs below new MW (Δb)	-0.017***	-0.020***	-0.025***	-0.028***	-0.031***	-0.032***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)
Excess jobs above new MW (Δa)	0.013***	0.018***	0.023***	0.026***	0.029***	0.030***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
% Δ affected wages	0.021***	0.040***	0.049***	0.054***	0.060***	0.064***
	(0.007)	(0.005)	(0.004)	(0.005)	(0.005)	(0.008)
% Δ affected employment	-0.042**	-0.025	-0.022	-0.025	-0.021	-0.020
	(0.018)	(0.015)	(0.016)	(0.023)	(0.024)	(0.025)
Employment elasticity w.r.t. MW	-0.049**	-0.029	-0.026	-0.029	-0.025	-0.023
	(0.022)	(0.018)	(0.019)	(0.028)	(0.028)	(0.030)
Employment elasticity w.r.t. affected wage	-1.971	-0.616	-0.453	-0.458	-0.351	-0.307
	(1.508)	(0.446)	(0.358)	(0.456)	(0.419)	(0.422)
Jobs below new MW ($\bar{b}_{-1}$)	0.095	0.095	0.095	0.095	0.095	0.095
$\%MW$	0.081	0.081	0.081	0.081	0.081	0.081
Number of event	56	56	56	56	56	56
Number of observations	287280	287280	287280	287280	287280	287280
Number of workers in the sample	12998207	12998207	12998207	12998207	12998207	12998207
Time window	[-5,0]	[-5,1]	[-5,2]	[-5,3]	[-5,4]	[-5,5]

Note: The table reports the effects of a minimum wage increase based on the event study analysis (see equation 4) exploiting 56 province-level minimum wage changes between 1999-2019. The table reports averaged post-treatment estimates on missing jobs up to $4 below the new minimum wage, excess jobs $4 above it, employment, and wages. The different columns explore the robustness of the results to alternative time windows. The sixth column reproduces my baseline estimate in Table 4.4 in column 1. column 1, column 2, column 3, column 4, column 5, change the post-treatment period from 1 to 5 months, respectively. All specifications include wage bin-by-province and wage bin-by-period fixed effects. Regressions are weighted by province-month aggregated population. Robust standard errors in parentheses are clustered by province; significance levels are * 0.10, ** 0.05, *** 0.01.

Table A.3 compares the point estimates and standard errors of the bunching estimator with an estimator that uses equation 4 at the province level, employing specified groups' aggregate employment as the outcome variable to calculate the elasticity of employment with respect to the minimum wage. The bunching method infers job losses from employment changes around the minimum wage. As noted by Cengiz et al. (2019), this approach has a potential advantage, even in the absence of significant upper-tail employment changes: filtering out random shocks to the upper part of the wage distribution can improve the precision of the estimates. This advantage is more apparent in the study by Cengiz et al. (2019). When they compared the employment elasticity with respect to the minimum wage using both bunching and aggregate approaches, they found that for almost all groups, the bunching estimator is at least as precise as the aggregate estimator, and sometimes substantially more so in the case of smaller demographic groups.

Additionally, in their study, both the bunching and aggregate approaches for all low-wage workers (bunching) and all workers (aggregate) showed the same trend of being slightly positive and insignificant. In my study, the bunching estimator is also as precise as the aggregate estimator, but the difference in precision between these two estimators does not significantly highlight the advantage of the bunching estimator over the aggregate approach.

For smaller groups, the bunching estimator sometimes provides slightly better precision than the aggregate approach. For example, the standard error for college or some post-secondary education is 0.026 with the bunching estimator compared to 0.030 with the aggregate approach; for a university certificate below a Bachelor's, it is 0.116 vs. 0.139; and for a Bachelor's degree, it is 0.028 vs. 0.035. In some categories, the precision is approximately the same, such as the Teen group (0.096 in bunching vs. 0.091 in aggregate). Even in some categories, the aggregate approach provides more precise estimates, such as for the Age [15, 25) group (0.065 in bunching vs. 0.047 in aggregate). However, the direction of employment elasticity with respect to the minimum wage varies: the bunching approach shows a slightly negative elasticity (-0.023), while the aggregate approach shows a slightly positive elasticity (0.032). Nonetheless, both estimates are statistically insignificant.

Table A.3: Impact of Minimum Wages on Employment Elasticity - Bunching and Aggregate Approach

Type of Sample	Bunching Approach	Aggregate Approach
All workers	-0.023	0.032
	0.030	0.023
Teens	0.022	-0.042
	0.096	0.091
Age $[20, 25)$	0.073	0.163***
	0.072	0.037
Age $[15, 25)$	0.056	0.092*
	0.065	0.047
Age 25+	-0.038	0.02
	0.026	0.025
High school dropout	-0.085	0.026
	0.101	0.072
High school and less	0.014	0.086*
	0.070	0.046
High school graduate	0.056	0.110**
	0.075	0.047
College or some post secondary education	-0.059**	0.040
	0.026	0.030
University certificate below Bachelor's	-0.127	-0.185
	0.116	0.139
Bachelor's degree	0.009	0.005
	0.028	0.035
Women	-0.058	-0.008
	0.038	0.025

Note: Columns 1-2 present the separately estimated employment elasticity with respect to the minimum wage for the bunching and aggregate approach, for different demographic groups. The bunching approach is the preferred specification in this paper, using wage-bin-specific employment per-capita changes as the outcome. The aggregate approach uses overall employment per-capita as the outcome. Robust standard errors in parentheses are clustered by province; significance levels are *0.10, **0.05, ***0.01.

Table A.4 presents the estimated wage and employment effects using two methods: the aggregate event-based approach in Panel A and the bunching approach in Panel B, focusing on predicted probability groups from Card and Krueger (1995).

The aggregate event-based approach considers wage and employment changes for the entire group, while the bunching approach specifically examines local changes among affected workers near the minimum wage. It's important to note that the percentage change in the overall average wage will be significantly smaller than the percentage change in wages at the lower end of the distribution.

For instance, if both employment and wages of affected workers fell by 5%, but affected workers only comprise half of the total employment, then aggregate employment would decrease by 2.5%. However, the average wage would rise by less, given that unaffected workers typically earn higher wages than affected workers.

This discrepancy highlights a potential bias when calculating employment elasticity using the aggregate approach. The conventional method, which computes the ratio of employment changes to wage changes, may be biased, particularly when the share of affected workers in the group is smaller. In such cases, where the average wage of the group significantly exceeds the wage of affected workers, the bias in the elasticity estimate tends to be larger.

As shown in column 1 of Table A.4, for the high probability group, both the bunching (7.6%) and aggregate approaches (2.5%) estimate substantial and statistically significant wage effects, with no signs of disemployment effects.

For the middle probability group, the bunching approach also shows a notable and statistically significant wage effect (5.9%) without any indication of significant negative employment effects. In contrast, the aggregate approach estimates a small, statistically significant wage effect of 0.4% but shows no signs of employment effects.

In the case of the low probability group, neither the bunching approach nor the aggregate approach shows significant changes in employment. The bunching approach indicates no significant wage effect, whereas the aggregate approach estimates very slight wage effect of 0.4%.

Table A.4: Impact of Minimum Wages on Employment and Wages for Card and Krueger Probability Group: Bunching and Aggregate Approaches

Panel A: Aggregate Approach

Variable	**(1)**	**(2)**	**(3)**
% Δ average wage	0.025***	0.004*	0.004*
	(0.003)	(0.002)	(0.002)
% Δ employment	0.003	0.001	0.003
	(0.006)	(0.003)	(0.002)
Emp elasticity wrt wage	0.124	0.277	0.837
	(0.237)	(0.678)	(0.602)

Panel B: Bunching Approach

Variable	**(1)**	**(2)**	**(3)**
% Δ average wage	0.076***	0.059**	0.038
	(0.007)	(0.011)	(0.035)
% Δ employment	0.006	-.034	-0.063
	(0.015)	(0.031)	(0.054)
Emp elasticity wrt wage	0.075	-0.565	-1.65
	(0.201)	(0.591)	(2.728)
Jobs below new MW	0.453	0.090	0.032
% Δ MW	0.084	0.084	0.086
Number of events	56	56	56
Number of observations	287280	287280	287280
Group	High.prob	Medium.prob	Low.prob

Table A.5 presents the estimated employment elasticities using the event-based approach. In column 1, I report the employment elasticities based on aggregate employment, while column 2 shows the employment elasticity of the minimum wage on jobs below $19. As observed, excluding employment variations in the upper tail and focusing solely on jobs under $19 reduces the employment elasticity from 0.032 to 0.017.

Column 3 presents my baseline estimate, where I calculate the effect of the minimum wage on job counts within each wage bin, accounting for missing and excess jobs. In this baseline estimate, shown in column 3, the employment elasticity turns negative (-0.023). However, across all specifications, none of the employment elasticities are statistically significant.

Table A.5: Employment Elasticities of Minimum Wage from Alternative Event-Based Approaches

	Event based		
Variable	**(1)**	**(2)**	**(3)**
Emp elasticity w.r.t MW	0.032	0.017	-0.023
	(0.023)	(0.026)	(0.030)
Aggregate	Y		
Under $19		Y	
$[MW - 4\$, MW + \$4]$			Y
Data aggregation	province-month	province-month	Wage-bin-province-month

Note: In column 1, I use province-by-month aggregated LFS Data. In column 2, I directly estimate the effect of the minimum wage on jobs below $19. I refer to this specification as a simpler method in Chapter 4.2., because it estimates the sum of missing and excess jobs (refer to table 4.4, column 4). Finally, column 3 presents an estimate from the bunching approach (see table 4.4, column 1). Robust standard errors in parentheses are clustered by province; significance levels are *0.10, **0.05, ***0.01.

Appendix B

Bunching in a Competitive Model

In this section, I follow the methodology of Cengiz et al. (2019) to relate the size of the bunching at the minimum wage to the key parameters of the standard labor demand model with heterogeneous workers. First, I solve the cost minimization problem assuming that labor supply is perfectly elastic, demonstrating that the size of bunching is directly related to the elasticity of substitution across various types of workers. Next, I relax the assumption of a perfectly elastic labor supply and derive a more general formula for the size of the bunching. The more general formula depends not only on the elasticity of substitution but also on the labor supply elasticity. This formula suggests that when minimum wage workers constitute a small share of the aggregate labor cost, as is the case in Canada, the labor supply elasticity plays only a minor role in determining the size of bunching at the minimum wage. Finally, I characterize the firms' responses under profit maximization, which also considers scale effects. In this scenario, the size of the bunching depends not only on the substitution elasticity and labor supply elasticity but also on the impact of the minimum wage on aggregate production. However, this impact will be negligible when minimum wage workers represent only a small fraction of the aggregate labor cost, as is the case in Canada. Overall, my bunching estimator for employment elasticity captures the classic Hicks-Marshall laws of derived demand.

B.1 Cost Minimization with Perfectly Elastic Labor Supply.

I start by addressing the cost minimization problem, disregarding any changes in the overall production level caused by the minimum wage. This assumption simplifies my analysis with minimal impact, as the scale effects related to the minimum wage changes I examine are likely negligible. Firms address the following problem:

$$\min_{l_j} \int_{\underline{w}}^{\overline{w}} l_j w_j d_j$$

$$\text{subject to } Y = \left(\int_{\underline{w}}^{\overline{w}} \eta_j l_j^{\frac{\sigma-1}{\sigma}} \, dj \right)^{\frac{\sigma}{\sigma-1}}$$

where l_j represents the quantity of labor employed from type j, η_j denotes the productivity of type j, and w_j signifies the wage cost associated with type j labor. We assume that at wage w_j, firms can hire an unlimited number of type l_j workers, implying that the supply of type l_j labor is perfectly elastic. This assumption can capture nominal wage rigidities, where wages remain unchanged despite short-term fluctuations in employment levels. It also parallels the implicit assumptions found in Saez (2010), who explores behavioral responses to tax kinks within a frictionless model of labor supply.[1] I should note that $\underline{w}$ is the lower wage limit and $\bar{w}$ is the upper wage limit. The lower limit in my model is \$4 below the new minimum wage and the upper wage limit is \$4 above the new minimum wage.

[1] In Saez (2010)'s benchmark model, workers are able to set their labor supply without affecting wages, implicitly assuming that labor demand is perfectly elastic at any given wage. Following Cengiz et al. (2019), I adopt a similar simplification focusing on labor demand, assuming a perfectly elastic labor supply for each type of worker. However, I later relax this assumption to consider the more realistic scenario with an inelastic labor supply.

The Lagrangian for this problem is given by:

$$\mathcal{L} = \int_{\underline{w}}^{\overline{w}} l_j w_j dj + \lambda \left[Y - \left(\int_{\underline{w}}^{\overline{w}} \eta_j l_j^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}} \right]$$

The first-order condition (FOC) for labor type j is as follows:

$$w_j = \lambda \left(\int_{\underline{w}}^{\overline{w}} \eta_j l_j^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma-1}{\sigma}-1} \eta_j l_j^{\frac{\sigma-1}{\sigma}-1}$$

Taking the ratio of the FOC for worker type j to that of worker type i yields the following expression:

$$\eta_j l_j^{\frac{\sigma-1}{\sigma}} = l_j w_j \frac{\eta_i}{w_i} l_i^{\frac{\sigma-1}{\sigma}-1}$$

I integrate this expression with respect to j from $\underline{w}$ to $\overline{w}$:

$$\int_{\underline{w}}^{\overline{w}} \eta_j l_j^{\frac{\sigma-1}{\sigma}} dj = \frac{\eta_i}{w_i} l_i^{\frac{\sigma-1}{\sigma}-1} \int_{\underline{w}}^{\overline{w}} l_j w_j dj$$

which can be reformulated as:

$$Y^{\frac{\sigma-1}{\sigma}} = \frac{\eta_i}{w_i} l_i^{\frac{\sigma-1}{\sigma}-1} C(Y, w)$$

where $C(Y,w) = \int_{\underline{w}}^{\overline{w}} l_j^* w_j dj$ is the cost function. The labor demand for each type of worker as a function of the total labor cost can be formulated as:

$$l_j = Y^{1-\sigma} C(Y,w)^{\sigma} \left(\frac{\eta_j}{w_j}\right)^{\sigma} \tag{7}$$

Multiplying both sides by w_j and integrating it between $\underline{w}$ and $\overline{w}$ leads to the following expression:

$$\int_{\underline{w}}^{\overline{w}} w_j l_j dj = C(Y,w)^{\sigma} \int_{\underline{w}}^{\overline{w}} \eta_j^{\sigma} w_j^{1-\sigma} dj$$

This can be used to derive the cost function as follows:

$$C(Y,w) = Y \left(\int_{\underline{w}}^{\overline{w}} \eta_j^{\sigma} w_j^{1-\sigma} dj\right)^{\frac{1}{1-\sigma}} \tag{8}$$

Substituting the cost function into equation (7) yields the conditional labor demand function:

$$l_i = Y c(w)^{\sigma} \left(\frac{\eta_i}{w_i}\right)^{\sigma}$$

where $c(w) = \left(\int_{\underline{w}}^{\overline{w}} \eta_j^{\sigma} w_j^{1-\sigma} dj\right)^{\frac{1}{1-\sigma}}$ is the unit cost of production.

Next, following Cengiz et al. (2019), I introduce a minimum wage $MW > \underline{w}$. The new labor demand for each type of worker can be expressed as:

$$l_j = \begin{cases} Y(\frac{\eta_j}{MW})^{\sigma} c(MW,w)^{\sigma} & \text{if } w_j \leq MW \\ Y(\frac{\eta_j}{w_j})^{\sigma} c(MW,w)^{\sigma} & \text{if } w_j > MW \end{cases}$$

where $c(MW, w) = \left(\int_{\underline{w}}^{MW} \eta_j^\sigma MW^{1-\sigma} dj + \int_{MW}^{\overline{w}} \eta_j^\sigma w_j^{1-\sigma} dj\right)^{\frac{1}{1-\sigma}}$ is the unit cost of production given a minimum wage MW.

The impact of the minimum wage on the wage distribution is illustrated in Figure A.1. With perfect compliance, all worker types earning below the minimum wage (MW) are elevated to the new level, resulting in a spike at the minimum wage. The size of this spike is determined by the following formula:

$$a = \int_{\underline{w}}^{MW} Y(\frac{\eta_j}{MW})^\sigma c(MW, w)^\sigma dj$$

When starting from an economy without a minimum wage, the number of workers who would earn below the minimum wage, denoted as $-b_{\text{no MW}}$, can be expressed as:

$$-b_{\text{no MW}} = \int_{\underline{w}}^{MW} Y(\frac{\eta_j}{w_j})^\sigma c(w)^\sigma dj$$

and the change in employment for all workers who would earn below $w_j \leq MW$ without a wage floor is as follows:

$$\Delta e = a + -b_{\text{no MW}} = \int_{\underline{w}}^{MW} [Y(\frac{\eta_j}{MW})^\sigma c(MW, w)^\sigma - Y(\frac{\eta_j}{w_j})^\sigma c(w)^\sigma] dj$$

The formula above demonstrates that the bunching estimator captures the employment change for the targeted group of "low-wage" workers. Simultaneously, it shows the increase in the unit cost of production from $c(w)$ to $c(MW, w)$,[2] indicates that labor demand for

[2]Here, $c(w)$ represents the unit cost function without any minimum wage, whereas $c(MW, w)$ represents the unit cost function with a binding minimum wage

workers earning above the minimum wage increases. This illustrates the classic labor-labor substitution effect: the cost increase in low-wage labor drives up the demand for high-wage labor. The bunching estimator proposed here provides an estimate of the overall impact of the minimum wage on the targeted low-wage population, focusing specifically on the wage compression effect without accounting for job gains at the upper tail of the wage distribution. So, if one is interested in understanding employment changes across the entire wage distribution, the estimates provided here may overestimate the employment reduction caused by the minimum wage.

It is important to note that while the standard labor demand model can account for the spike at the minimum wage, it does not capture ripple effects that often manifest just above the minimum wage (as illustrated in Figure 1.1). To address these spillover effects, Cengiz et al. (2019). introduce additional factors such as measurement errors in wages (as discussed by Autor et al. (2016)), distance-based substitution across different types of labor (as proposed by Teulings (2000), or certain frictions (as outlined by Flinn (2011)).[3]

This empirical approach identifies the employment effects by leveraging variations in the minimum wage. Now, consider an increase in the minimum wage from MW_0 to MW. The effect of the minimum wage change on the excess number of jobs is expressed by the following formula:

$$\frac{\partial a}{\partial MW} = Y\left(\frac{\eta(MW)}{MW}\right)^{\sigma} c(MW,w)^{\sigma} - \sigma \frac{1}{MW}(1-s_{MW})\left(\int_{\underline{w}}^{MW} Y(\frac{\eta_j}{MW})^{\sigma} c(MW,w)^{\sigma} dj\right) \tag{9}$$

Here,$s_(MW) = \frac{\int_{\underline{w}}^{MW} \eta_j^{\sigma} MW^{1-\sigma} dj}{\int_{\underline{w}}^{MW} \eta_j^{\sigma} MW^{1-\sigma} dj + \int_{MW}^{\overline{W}} \eta_j^{\sigma} w_j^{1-\sigma} dj}$ denotes the share of workers earning the minimum wage, while $\eta(MW)$ represents the productivity of the marginal worker type, whose wage would be $w_j = MW$ even without a minimum wage.

[3]If labor supply is inelastic, the model presented here predicts spillover effects on wages. However, these effects are not concentrated near the minimum wage but rather extend throughout the wage distribution.

The number of jobs below the new minimum wage, $-b$, is given by

$$-b = \int_{\underline{w}}^{MW} Y(\frac{\eta_j}{MW_0})^{\sigma} c(MW_0, w)^{\sigma} dj$$

which just sums up all the workers who would earn below the new minimum in the absence of any behavioral response. Note that the empirical measure of exposure to the minimum wage, -b, differs from the total number of workers who would earn below the minimum wage in the absence of it, denoted as $-b_{\text{no MW}}$, assuming the initial minimum wage level is $MW_0 > \underline{w}$. This distinction arises because the measure of directly affected workers excludes those who had already lost their jobs due to the presence of the minimum wage MW_0, even before considering the increase in the minimum wage.

The effect of the minimum wage change on the jobs earning below the minimum wage is:

$$\frac{\partial b}{\partial MW} = -Y\left(\frac{\eta(MW)}{MW_0}\right)^{\sigma} c(MW_0, w)^{\sigma}$$

Therefore, the elasticity of employment with respect to the minimum wage is expressed by the following formula:

$$\frac{\%\Delta e}{\%\Delta MW} = \frac{MW_0}{b}\frac{\partial a}{\partial MW}\bigg|_{MW=MW_0} + \frac{MW_0}{b}\frac{\partial b}{\partial MW}\bigg|_{MW=MW_0} = -\sigma(1 - s_{MW})$$

where $\frac{\partial a}{\partial MW}$ and $\frac{\partial b}{\partial MW}$ are evaluated at $MW = MW_0$.

B.2 Cost Minimization with Inelastic Labor Supply.

Until now, I have assumed that firms can hire an unlimited number of workers at a fixed wage. I will now consider the scenario of inelastic labor supply. In this context, the wage level is no longer determined externally, meaning there isn't a one-to-one relationship between workers' types and their wages. Consequently, following Cengiz et al. (2019) I introduce the following production function:

$$Y = \left(\int_{j \in \Theta} \eta_j l_j^{\frac{\sigma-1}{\sigma}} \, dj \right)^{\frac{\sigma-1}{\sigma}}$$

where Θ represents the set of worker types. For simplicity, I assume that the labor supply elasticity, γ, remains constant across all types of labor:

$$l_j^s = k_j w_j^{\gamma} \tag{10}$$

Firms minimize their costs based on the given wages, resulting in conditional labor demand.

$$l_j = Y c(w)^{\sigma} \left(\frac{\eta_j}{w_j} \right)^{\sigma}$$

where $c(w) = \left(\int_{j \in \Theta} \eta_j^{\sigma} w_j^{1-\sigma} dj \right)^{\frac{1}{1-\sigma}}$ is the unit product cost as previously defined. The wage is determined by balancing the supply and demand for each type of labor:

$$l_j = Yc(w)^{\sigma}\left(\frac{\eta_j}{w_j}\right)^{\sigma} = Yc(w)^{\sigma}\left(\frac{\eta_j}{\frac{1}{k_j}^{\frac{1}{\gamma}} l_j^{\frac{1}{\gamma}}}\right)^{\sigma}$$

This can be rearranged to illustrate labor demand and equilibrium wages:

$$l_j = Y^{\frac{\gamma}{\gamma+\sigma}} c(w)^{\frac{\gamma\sigma}{\gamma+\sigma}} \left(k_j^{\frac{1}{\gamma}} \eta_j\right)^{\frac{\gamma\sigma}{\gamma+\sigma}}$$

$$w_j = \left(\frac{1}{k_j}\right)^{\frac{1}{\gamma}} l_j^{\frac{1}{\gamma}} = Y^{\frac{1}{\gamma+\sigma}} c(w)^{\frac{\sigma}{\gamma+\sigma}} \eta_j^{\frac{\sigma}{\gamma+\sigma}} k_j^{-\frac{1}{\gamma+\sigma}}$$

The above equations demonstrate that employment increases with both η_j and k_j, while wages increase with η_j but decrease with k_j. Assuming, without loss of generality, that η_j increases with j, and for simplicity, that k_j is weakly decreasing with j, I see that equilibrium wages w_j will strictly increase with η_j. This ensures a one-to-one relationship between productivity and wages, allowing the cost function to be rewritten as $c(w) = \left(\int_{j\in\Theta} \eta_j^{\sigma} w_j^{1-\sigma} dj\right)^{\frac{1}{1-\sigma}} = \left(\int_{\underline{\eta}}^{\overline{\eta}} \eta_j^{\sigma} w_j^{1-\sigma} dj\right)^{\frac{1}{1-\sigma}}$ where, $\underline{\eta}$ is the productivity level with the lowest wage and $\overline{\eta}$ is the productivity level associated with the highest wage. Note that this assumption does not constrain the shape of the wage distribution, as the level of employment at a given wage depends on $k_j^{\frac{1}{\gamma}} \eta_j$, which can vary in either direction(increasing or decreasing).

Following Cengiz et al. (2019), I introduce a binding minimum wage, meaning that for some workers, the minimum wage is higher than their equilibrium wage. Under a binding minimum wage, workers can fall into three distinct categories: The first group consists of workers whose equilibrium wages are significantly below the minimum wage. Employers are now required to pay these workers the minimum wage, even if this results in labor supply exceeding demand at that wage level. All the workers in this group who manage to retain their jobs will cluster at the minimum wage, creating a spike. Whether a worker falls into this category depends on the unit cost of production and the size of $\eta_j^{\frac{\sigma}{\gamma+\sigma}} k_j^{-\frac{1}{e+\sigma}}$.Since w_j increases with j, there will be a threshold $\eta(MW)$ below which all workers will fall into this category. As a result, the number of workers at the minimum wage spike is:

$$a = \int_{\underline{\eta}}^{\eta(MW)} Y(\frac{\eta_j}{MW})^{\sigma} c(MW, w)^{\sigma} dj$$

where

$$\begin{aligned} c(MW, w) &= \left(\int_{\underline{\eta}}^{\overline{\eta}} \eta_j^{\sigma} w_j^{1-\sigma} \, dj \right)^{\frac{1}{1-\sigma}} \\ &= \left(\int_{\underline{\eta}}^{\eta(MW)} \eta_j^{\sigma} MW^{1-\sigma} \, dj \right. \\ &\quad \left. + \, Y^{\frac{1-\sigma}{\gamma+\sigma}} c(MW, w)^{\frac{(1-\sigma)\sigma}{\gamma+\sigma}} \int_{\eta(MW)}^{\overline{\eta}} \eta_j^{\sigma + \frac{(1-\sigma)\sigma}{\gamma+\sigma}} k_j^{-\frac{1-\sigma}{\gamma+\sigma}} \, dj \right)^{\frac{1}{1-\sigma}} \end{aligned} \tag{11}$$

The second group of workers includes those who earn slightly below or at the minimum wage. Following the minimum wage increase, the unit labor cost $c(MW, w)$ rises, boosting labor demand for this group of workers. When labor supply is inelastic, this results in an increase in wages. Consequently, some workers whose equilibrium wage was near the minimum wage will be pushed slightly above it, creating a spillover effect. Therefore, in the model with inelastic labor supply, setting $\overline{W}$ slightly above the minimum wage is beneficial when aiming to assess the impact of the minimum wage on those directly affected by it.

The third group of workers initially earn wages above the minimum wage. The rise in the unit labor cost $c(MW, w)$ makes these workers relatively more affordable, leading to an increase in demand for their labor.This results in higher wages when the labor supply is inelastic, causing a slight rightward shift in the entire wage distribution. In summary, labor demand is now represented by the following equation:

$$l_j = \begin{cases} Y(\frac{\eta_j}{MW})^\sigma c(MW,w)^\sigma & \text{if } \eta_j < \eta(MW) \\ Y(\frac{\eta_j}{w_j})^\sigma c(MW,w)^\sigma & \text{if } \eta_j \geq \eta(MW) \end{cases}$$

Given that this empirical approach identifies the employment effects by leveraging variations in the minimum wage, I now focus on understanding how changes in the minimum wage affect the number of excess and missing jobs. Now, consider an increase in the minimum wage from MW_0 to MW. The impact of this minimum wage change on the number of excess jobs is described by the following formula:

$$\begin{aligned} \frac{\partial a}{\partial MW} =& Y\left(\frac{\eta(MW)}{MW}\right)^\sigma c(MW,w)^\sigma \frac{\partial \eta(MW)}{\partial MW} + \\ & - \sigma\left(\frac{1}{MW} - \frac{1}{c(MW,w)}\frac{\partial c(MW,w)}{\partial MW}\right)\left(\int_{\underline{\eta}}^{\eta(MW)} Y\left(\frac{\eta_j}{MW}\right)^\sigma c(MW,w)^\sigma dj\right) \end{aligned} \tag{12}$$

Note that differentiating Equation 11 with respect to the minimum wage yields the following expression (using the Leibniz integral rule):

$$\frac{\partial c(MW,w)}{\partial MW} = s_{MW}\frac{c(MW,w)}{MW} + \frac{\partial c(MW,w)}{\partial MW}(1 - s_{MW})\frac{\sigma}{\gamma + \sigma}$$

where $s_{MW} = \frac{\int_{\underline{\eta}}^{\eta(MW)} \eta_j^\sigma MW^{1-\sigma} dj}{\int_{\underline{\eta}}^{\eta(MW)} \eta_j^\sigma MW^{1-\sigma} dj + \int_{\eta(MW)}^{\overline{\eta}} \eta_j^\sigma w_j^{1-\sigma} dj}$. By rearranging this equation, the derivative of the unit cost function with respect to the minimum wage can be expressed as follows:

$$\frac{\partial c(MW,w)}{\partial MW} = s_{MW}\frac{c(MW,w)}{MW}\frac{1}{1-(1-s_{MW})\frac{\sigma}{\sigma+\gamma}}$$

Substituting this back into Equation 12 results in the following expression:

$$\begin{aligned}\frac{\partial a}{\partial MW} =&Y\left(\frac{\eta(MW)}{MW}\right)^{\sigma} c(MW,w)^{\sigma}\frac{\partial \eta(MW)}{\partial MW}+\\ &-\sigma\frac{1}{MW}\left(1-s_{MW}\frac{1}{1-(1-s_{MW})\frac{\sigma}{\gamma+\sigma}}\right)\left(\int_{\underline{\eta}}^{\eta(MW)} Y\left(\frac{\eta_j}{MW}\right)^{\sigma} c(MW,w)^{\sigma} dj\right)\end{aligned} \tag{13}$$

The number of jobs below the new minimum wage is $-b = \int_{\underline{\eta}}^{\eta(MW)} Y\left(\frac{\eta_j}{MW_0}\right)^{\sigma} c(MW_0,w)^{\sigma} dj$. The change in the number of jobs below the minimum wage is:

$$\frac{\partial b}{\partial MW} = Y\left(\frac{\eta(MW)}{MW_0}\right)^{\sigma} c(MW_0,w)^{\sigma}\frac{\partial \eta(MW)}{\partial MW}$$

Therefore, the percentage change in employment can be calculated using the following formula:

$$\begin{aligned}\frac{\%\Delta e}{\%\Delta MW} &= \frac{MW_0}{b}\frac{\partial a}{\partial MW}\bigg|_{MW=MW_0} + \frac{MW_0}{b}\frac{\partial b}{\partial MW}\bigg|_{MW=MW_0}\\ &= -\sigma\left(1-s_{MW}\frac{1}{1-(1-s_{MW}\frac{\sigma}{\sigma+\gamma})}\right) = -\sigma\left(\frac{\gamma - s_{MW}\gamma}{\gamma + s_{MW}\gamma}\right)\end{aligned}$$

When s_{MW} is close to zero, which is a reasonable approximation in the Canadian context, the minimum wage bunching estimate closely approximates σ, the conditional substitution elasticity across various types of labor.

B.3 Profit Maximization with Inelastic Labor Supply.

To solve the profit maximization problem, I utilize the previously derived cost function, assuming that perfectly competitive firms aim to maximize their profits.

$$\max_{Y} PY - C(Y, w)$$

Where $C(Y, w)$ is defined by equation 1. To complete the model, following Cengiz et al. (2019), I assume that the aggregate output is inversely related to the price of the output good, P.

The first-order condition (FOC) from the firm's optimization problem is as follows:

$$P = \frac{\partial C(Y, w)}{\partial Y} = c(w) = \left(\int_{j \in \Theta} \eta_j^{\sigma} w_j^{1-\sigma} dj \right)^{\frac{1}{1-\sigma}}$$

With a binding minimum wage in place, the preceding formula can be rewritten as follows:

$$P = c(MW, w) = \Bigg(\int_{\underline{\eta}}^{\eta(MW)} \eta_j^{\sigma} MW^{1-\sigma} \, dj + Y^{\frac{1-\sigma}{\gamma+\sigma}} c(MW, w)^{\frac{(1-\sigma)\sigma}{\gamma+\sigma}} \int_{\eta(MW)}^{\overline{\eta}} \eta_j^{\sigma + \frac{(1-\sigma)\sigma}{\gamma+\sigma}} k_j^{\frac{(1-\sigma)\gamma}{\gamma+\sigma}} \, dj \Bigg)^{\frac{1}{1-\sigma}}$$

The price increase in response to the minimum wage is proportional to the share of total production costs that are attributed to minimum wage workers:

$$\frac{\partial P}{\partial MW} = \frac{\int_{\underline{\eta}}^{\eta(MW)} \eta_j^{\sigma} MW^{1-\sigma} dj}{\int_{\underline{\eta}}^{\overline{\eta}} \eta_j^{\sigma} w_j^{1-\sigma} dj} = s_{MW}$$

The change in the output price, P, will affect the output level; hence, I need to include an additional term in the formula for the number of excess jobs derived earlier (see equation 13):

$$\frac{\partial a}{\partial MW} = \underbrace{Y\left(\frac{\eta(MW)}{MW}\right)^{\sigma} c(MW,w)^{\sigma}\frac{\partial \eta(MW)}{\partial MW} = -\sigma\frac{1}{MW}\left(1 - s_{MW}\frac{1}{1-(1-s_{MW}\frac{\sigma}{\sigma+\gamma})}\right)a}_{\text{Substitution effect}}$$
$$= \underbrace{\frac{1}{Y}\frac{\partial Y}{\partial P}\frac{\partial P}{\partial MW}a}_{\text{Scale effect}}$$

The first part of the formula is identical to the one derived in the cost minimization problem, reflecting only the substitution effect. The second part represents the change in the scale of production. Assuming a constant product demand elasticity, $\frac{\partial \log Y}{\partial \log p} = -\varepsilon$, I get:

$$\frac{\%\Delta e}{\%\Delta MW} = \underbrace{-\sigma\left(\frac{\gamma - s_{MW}\gamma}{\gamma + s_{MW}\sigma}\right)}_{\text{Substitution effect}} - \underbrace{\varepsilon s_{MW}}_{\text{Scale effect}}$$

I want to emphasize two important points about the preceding formula, which represents a version of the classic Hicks-Marshall law of derived demand. First, observe that when the minimum wage is set sufficiently low, then

$$s_{MW} = \frac{\int_{\underline{w}}^{MW} \eta_j^{\sigma} MW^{1-\sigma} dj}{\int_{\underline{w}}^{MW} \eta_j^{\sigma} MW^{1-\sigma} dj + \int_{MW}^{\overline{w}} \eta_j^{\sigma} w_j^{1-\sigma} dj} \approx 0$$

and the size of the bunching is equal to $-\sigma$. In this scenario, my estimator directly identifies the uncompensated labor-labor substitution parameter across different worker types. A large spike indicates that the $\%\Delta e$ is small in magnitude, and so is the substitution elasticity, σ. Conversely, if there is no bunching at the minimum wage, then $\%\Delta e$ is large in magnitude, and so is σ. This result is similar to Saez (2010), who identifies the uncompensated labor supply-demand elasticity in the frictionless model based on the bunching at tax kink points.

Second, the cost share of minimum wage workers, s_{MW} in Canada is generally small. While certain industries may have a higher proportion of minimum-wage workers, the overall share across the economy tends to be relatively low. This is because many sectors have average wages above the minimum wage, thus reducing the overall cost share of minimum wage workers. Therefore, the bunching estimates on employment will be closely related to σ.