Effects of Age-Dependent Minimum Wage on Youth Employment Flows in the Netherlands

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October 29, 2015

Abstract

This paper investigates the effects of the age-dependent minimum wage on youth employment flows in the Netherlands. The Dutch minimum wage for workers aged 15-23 is defined as a step-wise increasing function of a worker’s calendar age. At the age of 23, workers become eligible for the “adult” minimum wage which does not increase further with age. This creates an incentive for firms to discriminate against employees on the basis of their age, substituting more expensive older workers by younger hires. In order to grasp the size of these effects, I analyze monthly flows in and out of employment using administrative records for the entire youth population of the Netherlands. I account for the time remaining until workers’ next birthdays, exploiting the fact that firms are facing a sharp discontinuity in labor costs in the month when a worker turns one year older. The results show a significant increase in job separation around the time of this discontinuity: the probability of job separation increases by 1-2% in the three calendar months which are closest to a worker’s next birthday. Job accession peaks just after workers’ birthdays, representing both entry of the workers with higher reservation wages and re-employment of the workers whose job was dissolved around the time of the discontinuity. I investigate characteristics of the latter group, showing that they do not face a penalty in terms of the length of their unemployment spells, but they are likely to earn lower wages in their prospective jobs.

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1 Introduction

Many countries use age-dependent minimum wage systems in order to facilitate the entry of young workers into the labor force. The age-dependency turns the minimum wage rate into a stepwise increasing function of workers’ calendar age, rendering young workers comparatively cheaper than older workers. Being subject to the reduced minimum wage, the youth job seekers become more desirable for firms, and therefore more likely to find a job which fits their level of skills and experience. Indeed, several empirical studies confirm the positive effects of age-dependent minimum wage on youth employment. However, what they fail to address is that apart from the effect on employment stocks, this policy design fundamentally changes the youth labor market flows, introducing new dynamics into the decision making of both employers and employees.

Firstly, the age-dependency motivates employers to discriminate against their own employees on the basis of their age. Since the costs of minimum wage labor increase with workers’ age, employers are facing the incentive to periodically replace their older, costlier employees with younger ones. Accordingly, we can expect more workers to get fired when they are close to reaching the eligibility threshold for the higher minimum wage rate. Secondly, the age-dependent systems also influence the supply side of labor markets, with some workers delaying their labor market entry in order to reap the higher minimum wage rates applicable to older workforce. In this case, we can expect that more people will decide to start a job after becoming eligible for the higher minimum wage. Both job separations and job accessions are therefore likely to reflect the variation of labor costs which is inherent in the age-dependent policy design.

In this paper, I investigate how pronounced these effects are among Dutch workers, who are subject to multiple age-dependent increases of the youth minimum wage rate. A convenient feature of the age-dependent system is that the increases of the minimum wage rate are discrete and fixed by a worker’s calendar age. This makes the resulting changes in labor market flows easy to analyze by focusing on the behavior of workers and firms around workers’ birthdays. This paper analyzes these sharp discontinuities in labor costs, and it is the first study to present the effects of age-dependent minimum wages on labor market flows.

The analysis rests on an administrative dataset covering the entire popula-

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1 These studies investigate the employment effects of the simplest form of age-dependency, that is, the single subminimum wage rate for youth workers. Neumark and Wascher (2004) use a cross-national analysis to show that the presence of a youth subminimum wage rate reduces the negative employment effects of a minimum wage among young workers. Yuen (2003) and Shannon (2011) study the effects of the abolition of the youth subminimum wage rate in several Canadian states, finding mixed evidence of the disemployment effects among their youth workforce.

2 Unlike most countries which use age-dependent minimum wage systems, the Dutch legislation does not impose a single youth rate for teenage workers. The system differentiates between 9 minimum wage rates for workers aged 15-23, with one rate applicable to workers of each calendar age. At the age of 23, workers become eligible for the adult minimum wage rate, which does not vary further with age. Similar, although less differentiated systems are used by Australia, Belgium, Ireland, Israel, and the United Kingdom.
tion of the Netherlands followed over the years 2006 to 2012. The data contain detailed information on individual labor market histories, including starting dates and (if available) end dates of every employment spell observed in this period. When linked with information on individual birth months, it can be quantified how far the workers were from their next birthdays at the time of their job accessions and job separations. In this way, I can assess whether the proximity to birthdays (and hence to the minimum wage discontinuities) is having an influence on employment flows in the Dutch labor market.

The employment duration analysis shows that for workers aged 16-23, the probability of job separation increases by 1-2% in the three months preceding their birthdays. This increase translates into 2275 youth employment spells terminated on an annual basis. The size of this effect varies with age, exhibiting a sawtooth pattern which peaks at workers 16th and 19th birthdays and falls in the following years. The second peak occurs in the year following the high school graduation, coinciding with the entry of many inexperienced workers into the labor force. The gradual attenuation of the effect is suggestive of better screening of older/more experienced workers and possibly also of changes in the job mix applicable to the older workforce (lower substitutability of personnel in “adult” jobs). The job accessions are shown to increase in the month immediately following the workers’ birthdays. This spike can be partially explained by re-employment of those workers who have lost their jobs due to the MW discontinuities, but it also accounts for the labor market entry of individuals with higher reservation wages.

Apart from the employment flows, this study also analyzes the characteristics of the workers whose employment was terminated close to their birthday (treatment group). Their labor market outcomes are compared with the control group of workers whose job spells ended during the other months of the year, finding that the two groups cannot be distinguished in terms of their unemployment spell duration. However when re-employed, the treatment group is found to earn significantly lower wages than the control group. This result suggests that employers cannot effectively screen for the ability of teenage applicants in the hiring process, but once hired, the employers will learn about workers’ abilities and they will dismiss those who are adding the least value. Such results are well-in-line with the search and matching models of Pissarides (2000). More recently, the model proposed by Brochu and Green (2013), which postulates that the true value of the worker is revealed to the employer after an initial probationary period, seems to fit well with the evidence presented here.

This paper contributes to the voluminous literature on the labor supply and demand effects of minimum wages by exploiting a policy variation which has been largely overlooked so far. Until now, the majority of minimum wage studies analyzed US state-level changes of minimum wage rates using either a difference-in-differences or panel designs. However, despite the amount of work done in this area, there is still little consensus on an estimation strategy which would

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3For a thorough overview, see Neumark and Wascher (2008) and the papers cited therein. Recent studies focusing on youth employment include Giuliano (2013), Brochu and Green (2013) and Dube, Lester, and Reich (forth.).
ensure consistent estimation of the minimum wage effects. Furthermore, since the minimum wage changes in the US tend to be rather small in magnitude, it is an open question whether the results derived using such sources of variation could prove informative for more pronounced changes of minimum wage rates (such as those considered by the current US administration).

Such identification problems contrast starkly with the identifying policy variation exploited here. The age-dependent minimum wages in the Netherlands induce substantial (up to 17%) year-on-year variation of individual labor costs for a sizable share of the youth workforce. These changes are dependent only on a worker’s age, and therefore they are not confounded by business cycles, political factors, spatial heterogeneity, spurious trends, or other issues commonly discussed in the minimum wage literature. Furthermore, since the Dutch system exhibits multiple increases of the minimum wage rate, it can be verified that the estimated effects are not driven by other age-dependent policy changes which are specific to certain ages, such as 15 or 18 years. The effects presented in this study however pertain to age-dependent minimum wages, and this should be borne in mind when interpreting the findings.

The literature focusing on the labor effects of age-dependent minimum wage rates is very scarce. Dickens, Riley, and Wilkinson (2014) evaluate the effects of age-dependent minimum wages on employment stocks in the UK, focusing on the minimum wage rate discontinuity which occurs on workers’ 22nd birthday. Using a regression discontinuity (RD) design they find a positive employment effect of the minimum wage rate increase among low-skilled individuals. However, the analysis of job separations and job initiations presented in this paper casts doubt on the validity of identifying assumptions underlying the RD design. The observed spike of job separations which precedes workers’ birthdays can be considered a clear violation of the no-anticipation assumption, and therefore the positive employment effect of minimum wage increase found by Dickens, Riley, and Wilkinson (2014) is likely to be an artifact of the applied estimation strategy.

This paper is organized as follows. The next section introduces the minimum wage system in the Netherlands. Section 4 presents the econometric specification that is taken to the data. Section 3 documents the data set used for the empirical analysis, and Section 4 discusses the results. Section 5 concludes.

4Recently, Dube, Lester, and Reich (forth.) advocate the use of the dif-in-dif design with bordering county pairs in order to attenuate the confounding effects of state-specific unobserved trends. In another recent study, Meer and West (2013) argue that the dif-in-dif design might be suboptimal if the minimum wage changes are affecting employment growth, rather than levels. They propose to study the effects using a dynamic panel specifications of Arellano and Bond (1991).

5The results cannot be directly applied to make a prediction about, e.g., the changes in labor flows induced by a universal increase of the minimum wage.

Recent working paper by Fidrmuc and Tena (2013) re-examines the UK data using an alternative RD design. The authors find mixed evidence of negative employment effects around the birthday discontinuities. The presence of anticipation effects (acknowledged by the authors) however poses the same problems for the interpretation of their results as in Dickens, Riley, and Wilkinson (2014).
2 Institutional Setting

2.1 Minimum Wage in the Netherlands

The minimum wage has been a central part of the Dutch labor legislation for more than 40 years. The minimum wage regulation (applicable for workers older than 23) was formally introduced in 1968 and the installment of youth minimum wages (applicable for workers aged 15-22) followed in 1974. The youth minimum wage has been defined as a stepwise increasing function of a worker’s calendar age, with age-specific wage rates expressed as fixed percentages of the adult minimum wage. This legislation remained largely unchanged - the youth rates were only slightly reduced in 1981 and 1983 in response to high levels of youth unemployment, and the same setup has been maintained up to the present time. The real values of minimum wages are stable - unlike in the United States, the Dutch system is indexed to inflation and the rates are updated twice a year.

![Figure 1: Minimum Hourly Wage Rates in the Netherlands, Expressed as Percentages of the Adult Minimum Wage, and in Actual Levels Applicable in 2010.](image)

Figure 1 illustrates the age-dependence of Dutch minimum wages. Workers become eligible for the minimum wage at the age of 15, and the applicable rate gradually rises up to the age of 23 when workers become eligible for the adult minimum wage. The discontinuities of minimum wage rates are sharp - the applicable rates are subject to change on the day of a youth worker’s birthday. We can see that the nominal increments get more pronounced each year, but when expressed in relative terms, the year-on-year changes prove to be fairly stable (raising the minimum wage rate by 15-17% of the level applicable for the preceding year). Given that the age dependence spans 8 consecutive years, the difference between the initial youth rate and the adult rate becomes very pronounced. In 2010, the hourly minimum wage rate for 15-year olds was €2.57, whereas the adult rate was more than threefold, €8.55.7

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7 As indicated in Figure 1, the 2010 levels of hourly wage rates are specific to the firms
The Dutch minimum wage legislation applies to almost all types of labor, with the sole exception being internships (which amount to approx. 7% of the youth employment spells). Compliance is very high (see descriptive statistics presented in the next section), and given the amount of time which has passed since the last change of the legislation, it can be safely assumed that the current minimum wage system is deeply embedded in the functioning of Dutch labor markets. Both workers’ and firms’ expectations should reflect the legislation in place, and the measured effects should not be confounded by learning or other policy introduction effects on either side of the labor markets.

It goes without saying that there are many other age-dependent changes in the lives of youth workers which are likely to influence their labor market decisions. Most importantly, the Dutch labor market legislation imposes heavy restrictions on the types of jobs that can be performed by very young workers. Most of these restrictions are alleviated on 15th and 16th birthdays, which should be borne in mind when interpreting the data corresponding to these age groups.\(^8\) Other age-dependent changes can be, for example, related to the completion of different levels of schooling. However these changes, albeit being dependent on age, are not directly related to the month of birth and so they do not distort the following analysis. The only potentially confounding effect of the proximity to birthday on labor market performance could manifest itself through the combination of worker’s relative seniority within his or her school grade (determined by school entry cutoff dates), and seasonality of youth employment (which peaks in the summer).\(^9\) In order to account for these confounding effects, the estimated models include controls for seasonality and relative seniority of youth workers within their school grade.

3 Data

3.1 Overview of the Dataset

The dataset is constructed from several administrative sources collected by Statistics Netherlands (CBS). It covers the entire population of the Netherlands (approx. 14 mil. individuals), which is observed over the period of seven which operate under the 38-hour definition of the full-time working week. The reason for this distinction is that the Dutch minimum wages are not defined in terms of hourly rates. Instead, the Dutch legislation uses weekly full-time equivalent (fte) rates, and since different firms operate under different definitions of the full-time working week (36- and 40-hour definitions are also common), the value of the applicable hourly MW rate will be specific to each of the definitions. To illustrate, the weekly fte adult rate in 2010 was set to be €325.08, which translates into three hourly rates of €9.03, €8.55, and €8.13 for the firms using the 36-, 38-, and 40-hour definitions of the working week.

\(^8\) A detailed description of the age-dependent labor restrictions is presented in Appendix A.1.

\(^9\) An illustration of such mechanism is as follows: the oldest children within the school grade (born in September-October) might be, ceteris paribus, more likely to work. If they plan to work only during the summer, their employment spells are bound to end in August. This would create a disproportionate number of spells ending 1-2 months prior to the workers’ birthdays, which would be falsely attributed to the minimum wage variation.
years, starting in January 2006 and ending in December 2012. The data are aggregated into yearly blocks and contain exhaustive information about each worker’s labor market history, specified at the level of individual employment spells observed within a given calendar year. This information includes dates of initiation and (if observed) termination of each employment spell, gross labor earnings, sector of employment, and work intensity. The data also contains various demographic characteristics such as gender, education (highest attained and highest followed), and immigration background (accounting for the 1st and 2nd generation immigrants).

The key data entries for the analysis are related to the date of birth. The exact date is not observable - in order to ensure personal privacy, the individual information is restricted to the year and month of birth. Nevertheless, this is enough to approximate a worker’s monthly age at any given point of time. Together with the information about individual labor market histories, this allows me to quantify how close were the Dutch youth workers to their next birthdays at the time of initiation and termination of their employment spells.

3.2 Descriptive Statistics

Summary statistics for the population of interest (15-23-year olds) are shown in Table 1. We can see that the dataset is reasonably balanced by age, which follows from having the information over the entire population. A substantial fraction of the Dutch youth population is shown to have immigrant background, with the 1st and 2nd generation immigrants representing approximately 33% of the observations. The average employment rate within the population of interest is 45%, but the actual employment rates are highly dependent on workers’ age. Figure 2 illustrates this dependence.

The employment rate starts rising sharply once teenagers reach the age of 15 (which coincides with the loosening of the most stringent work restrictions). The rapid growth continues throughout the teenage years, although it gradually becomes less pronounced. The positive trend is sustained further, reflecting the labor market entry of college-educated job seekers. Similar employment patterns are observed in other countries as well. Blundell, Bozio, and Laroque (2013) report the age-specific employment rates for France, the United Kingdom and the United States, showing that both the UK and the US exhibit relatively similar employment trends as the Netherlands. The French youth employment rates are shown to be consistently lower. In comparison to the UK and the US, the Dutch employment rates are higher for workers aged 15-17, and lower for workers older than 21. The former finding can be potentially

10 The data are available also for the period 1999-2005, but since there were changes in the CBS coding definitions between the waves 2005 and 2006, I restrict my analysis to the period 2006-12.
11 Here, the work intensity quantifies the observed work hours as a fraction of full-time equivalent hours. Since the fte hours are firm-specific, I cannot derive actual hours of work from the raw data. Observing the fte fractions is however much more useful for the analysis. The minimum wage rates are also defined in terms of the fte (see Footnote 7), and therefore knowing the fte fraction allows me to quantify exact minimum wage rate applicable for any given part-time worker. In order to do so, it suffices to multiply the statutory weekly fte minimum wage rate by his or her work intensity.
12 Similar employment patterns are observed in other countries as well. Blundell, Bozio, and Laroque (2013) report the age-specific employment rates for France, the United Kingdom and the United States, showing that both the UK and the US exhibit relatively similar employment trends as the Netherlands. The French youth employment rates are shown to be consistently lower. In comparison to the UK and the US, the Dutch employment rates are higher for workers aged 15-17, and lower for workers older than 21. The former finding can be potentially
Table 1: Summary Statistics, Ages 15-23, Years 2006-2012

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>18.64</td>
<td>2.33</td>
</tr>
<tr>
<td>1st gen. immigrant</td>
<td>0.18</td>
<td>0.38</td>
</tr>
<tr>
<td>2nd gen. immigrant</td>
<td>0.15</td>
<td>0.36</td>
</tr>
<tr>
<td>Employment rate</td>
<td>0.45</td>
<td></td>
</tr>
</tbody>
</table>

*Conditional on employment:*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual gross income</td>
<td>4321.29</td>
<td>6850.40</td>
</tr>
<tr>
<td>Gross hourly wage</td>
<td>7.83</td>
<td>41.77</td>
</tr>
<tr>
<td>Sector: Bars &amp; Restaurants</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>Sector: Wholesale</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>Sector: Retail</td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td>Work intensity (share of fte)</td>
<td>0.48</td>
<td>0.35</td>
</tr>
<tr>
<td>Employment spell length (months)</td>
<td>11.26</td>
<td>14.12</td>
</tr>
<tr>
<td>Observations</td>
<td>13,037,428</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2: Youth Employment Rate as a Function of Age, Dutch Population Aged 13-25, Years 2006-12
The mean annual income conditional on employment is 4321 Euro, which is approximately 25% of the annual income corresponding to a full-time adult minimum wage job. This finding is driven by the short duration and the low work intensity of youth employment spells.\textsuperscript{13}

Figure 3 shows the distribution of youth workers’ gross monthly wages standardized by the minimum wage rates applicable for the respective age groups. The density starts rising sharply above 1 which is the point of identity between the observed wages and the corresponding MW rates. We see that the majority of the workforce is earning wages well above the minimum levels. There are workers who are observed to earn wages below the legal minimum\textsuperscript{14}, but the general trend is consistent with the assumption that the minimum wage is indeed constituting a binding minimal amount of earnings which can be generated from formal employment.

![Figure 3: Empirical Distribution of Gross Monthly Wages, Normalized by the Applicable MW Rates, 15-22 Year Old Workers, Years 2006-12](image)

Figure 3 also shows that a sizable fraction of the workforce is likely to be affected by the age-dependent discontinuities of the minimum wage rates.\textsuperscript{15} This attributed to low minimum wage rates for 15-17 year-old workers in the Netherlands, while the latter finding is likely to be related to relatively generous allowances for Dutch students engaged in tertiary education.\textsuperscript{16} Young workers are more likely to engage in seasonal (holiday) work, and when employed during the school year, they are more constrained in terms of the time they can dedicate to their labor engagement. Both spell durations and work intensities are increasing with age, following the general dynamics of youth employment. Accordingly, the annual earnings are also observed to be higher among older workers.\textsuperscript{17} In the observed period, 2% of the employment spells are recorded to yield wages below the applicable minimum rate. This discrepancy is well-documented in the literature (Flinn, 2011), and its occurrence can be attributed to many causes, including firms’ failure to comply with the legislation, variability of earnings of the self-employed, employment spells with irregular working hours, etc.\textsuperscript{18} Recall that each age-specific increase of the youth minimum wage rate amounts to 15-17% of the preceding level.
category represents 33% of the youth workforce aged 15-22, and this share is fairly stable with respect to workers’ calendar age.

The average duration of a youth employment spell is 11 months and the average work intensity is 0.48 fte, which corresponds to approximately 19 hours of work per week. Similarly to the other labor-related indicators, both the spell duration and the work intensity are strongly dependent on the age of workers. The duration of the employment spells increases with age, and the intensity of work also rises from the minimal part-time allocations of the 15-year olds to the full-time work allocations which are prevalent among the adult workers.

3.3 Employment Dynamics

As documented in Figure 2, the month-to-month transitions of the employment rate are smooth, although minor disturbances of the general trend seem to occur around the workers’ birthdays (indicated by the grey vertical lines). These disturbances are suggestive of changes in the employment patterns induced by the discontinuities of youth minimum wage rates. To investigate the dependence further, I calculate age-specific job accession rates and job separation rates. These rates document how many employment spells start and end at a given (monthly) age relative to the total number of employment spells observed in the same age group. The age profiles of the population-wide job separation and job accession rates are shown in Figure 4.

![Figure 4: Job Accession and Job Separation Rates, 15-25 Year Old Workers, Years 2006-12](image)

The general trend of the job accession rate is dominated by two spikes following workers’ 15th and 16th birthdays. These spikes are however caused by institutional changes unrelated to the setting of minimum wage rates. As discussed in Section 2, the 15th and 16th birthdays mark the gradual alleviation of labor restrictions imposed on the types of work popular among teenagers.

\[16\] The exact definitions of the job accession and the job separation used in this paper are included in Appendix A.2.
Rather than the minimum wage effects, the two spikes therefore represent the expansion of work opportunities for workers of the respective ages. The trend corresponding to the job separation rate is shown to be highly non-monotonic: the rate is falling following worker’s 15th birthday, rebounds when workers turn 16 and gradually falls back. It starts increasing again prior to workers’ 18th birthday, peaks at the age of 19 and falls sharply in the following years.17

However, apart from the general trend, Figure 4 also reveals the dependence of job separation rate on the proximity to workers’ next birthdays: The rate is shown to increase one month prior to workers’ birthdays, which means that disproportionately more spells are being terminated among workers who are just about to turn one year older. The job accessions past the age of 16 also exhibit dependence on the birthdays which is of similar magnitude as in the case of the job separation rate. This dependence becomes clearer in Figure 5 where the job accession and separation rates are de-trended and pooled by age starting 6 months prior to the 18th birthday and ending 5 months past the 23rd birthday18.

Figure 5: Monthly Fluctuations of the De-trended Job Accession and Separation Rates, 17-23 Year Old Workers, Years 2006-12

The de-trended job accession rate is shown to fall in the months preceding workers’ birthdays, but once workers turn one year older, it immediately increases by 12 basis points. The job separation rate exhibits a wave-like pattern which peaks in the 3 months closest to workers’ next birthdays. A second, smaller peak is observed 3 months past the discontinuity.

The spike of job separations preceding workers’ birthdays is reinforcing the

17The increase of job separation rate at the age of 16 is also likely to be caused by the loosening of job restrictions, and the subsequent labor market entry of inexperienced workers. Similarly, the increase among 18 and 19-year olds is likely to be caused by high school graduates entering the labor market for the first time.

18This selection is imposed to avoid the job accession spikes at the ages 15 and 16. The figures corresponding to the full sample are presented in the appendix A.3.
evidence of employers discriminating against their workers on the basis of age.\textsuperscript{19} The observed changes of job accession rate are however more difficult to attribute to either the supply side or the demand side of labor markets.\textsuperscript{20}

The following econometric analysis is focused mainly on quantifying the effects of minimum wage discontinuities on the job separation. This is motivated by limitations of the data - an analysis of the job accession would require models of unemployment duration, however since young job seekers are rarely recognized as unemployed by the authorities, it would be very difficult to set up such models with the current administrative dataset. That being said, the analysis of job separation can still prove useful for disentangling the job accession effects. Its results can provide an indirect evidence of the relative importance of the supply side and demand side effects discussed above.

4 Econometric Analysis

4.1 Models of Job Separation

The figures in the previous section are highly suggestive of adverse effects of the minimum wage discontinuities on the job retention. However, the actual size of the MW effects cannot be directly derived from these descriptive plots. The MW effects can be obscured by various confounders, such as workers’ experience and general age effects. In order to control for these issues, I estimate a conditional log-log duration model with time-varying covariates. The model is specified as follows,

\[
\log[-\log(1 - \lambda_{it})] = \alpha + \beta_1 \log(dur_{it}) + \sum_{j=1}^{3} \beta_{2j} \text{age}_{it}^j \cdot (\text{age}_{it} \leq 210) \\
+ \sum_{j=1}^{3} \beta_{3j} \text{age}_{it}^j \cdot 1(\text{age}_{it} > 210) + \sum_{m=1}^{11} \gamma_m \cdot 1(mtb\_bd_{it} = m) \quad (1)
\]

\textsuperscript{19}An alternative explanation of the spikes of job separations uses reservation wages. The argument is that workers themselves decide to terminate their employment prior to the next birthday, because with the higher minimum wage they do not need to work as much to earn their reservation wage. Accordingly, they will attempt to switch to a less-intensive job (generating earnings still above their reservation wage). In Section 4.3, I look for empirical evidence supporting this theory, concluding that such strategic behavior is unlikely to be the cause of the observed fluctuations.

\textsuperscript{20}The standard supply-side argument advocated by Card and Krueger (1994) is also based on reservation wages. The youth workers whose reservation wages are above the applicable minimum wage rate will be more likely to engage in work past their next birthday, provided that the increased minimum wage rate will be higher than their reservation wages. An alternative, demand-driven argument stipulates that employers are going to hire workers who are further from their next birthdays, because their expected labor costs are lower. If the employers look for employees of specific age (e.g., due to the labor restrictions), then we should observe bunching of job accession rates after the birthdays. Furthermore, since a considerable amount of workers have their employment spells terminated prior to their birthday, the increase of job accessions in the following months could be also an evidence of them finding new jobs. This would render the post-birthday increase of job accession rate to be a mechanical consequence of the preceding spikes of the job separation rate.
where \((1 - \lambda_{it})\) represents the survival probability \((i.e., \text{the likelihood of keeping the same job})\) corresponding to the worker \(i\), who is observed to be employed at the time \(t\) \((a \text{ unit of time corresponds to one calendar month})\). The covariates include a constant, the logarithm of employment duration \((\text{accounting for job-specific tenure})\) and two third-order age polynomials, one for workers in the high school age range, and one for adult workers.\(^{21}\) The main variables of interest are eleven indicator functions / dummies which differentiate the workers by the proximity to their next birthday. The proximity is captured by the variable \(mtbd_{it}\), which quantifies the number of months remaining until the worker \(i\)'s next birthday at the time \(t\). Other controls include a set of calendar month dummies which account for seasonality, year dummies, and dummies for workers birth months. The latter set of dummies accounts for potential confounding effects of workers’ age relative to their peers in the school grade. In this setup, the \(mtbd\) dummies are identified through the interaction of calendar months and birth months. An inclusion of such interaction terms in the regression equation would render the \(mtbd\) dummies perfectly collinear.

The model is estimated using the employment histories of Dutch youth workers who were older than 15 years and 5 months, and younger than 23 years and 6 months within the period 2006-11. The employment spells observed in the last available year \((2012)\) are not analysed as it cannot be determined whether the observed job separations were permanent, or whether they correspond to jobs that were resumed later in 2013. The only maintained sample selection criterion is to drop those workers who are pursuing internships, as they are exempted from the minimum wage regulation. The results are presented in Table 2.

The parameter estimates are reported in the exponentiated form, so that the coefficients larger than one imply, \textit{ceteris paribus}, a higher relative risk of failure \((\text{job separation})\) compared to the baseline case. The coefficients smaller than one have the opposite interpretation. Accordingly, we see that the duration of employment is found to reduce the risk of failure, reflecting the higher job-specific experience and better screening of tenured workers.

The \(mtbd\) coefficients reveal a pattern which is reinforcing the evidence of employers acting on the minimum wage discontinuities. For ease of exposition, this is documented graphically in Figure 6.

The coefficients are expressed as percentage changes of the baseline job separation rate, which corresponds to the workers who are 7 months short of their next birthday. The dotted lines indicate the 95% confidence interval. The graph shows that after controlling for the job-specific experience, age, and other potential confounders, the wave-like pattern and the second peak of the job separation rate captured in Figure A.1 disappears. The job separation probabilities are shown to be indistinguishable from the baseline in all months except for the three which are the closest to workers’ next birthdays. Within this period, the job separation probability increases by 0.5-1.5%, and remains significantly

\(^{21}\) The cutoff for the high school age range is 210 months, which corresponds to 17 years and 6 months. Qualitatively similar results have been found with the cutoff at 222 months.
Table 2: Estimation Results of the Employment Duration Analysis, Workers Aged 15-23, Years 2006-11

<table>
<thead>
<tr>
<th>log(duration)</th>
<th>Age (at least 17.5 yrs)</th>
<th>Birth month = 2</th>
<th>(0.576^{***})</th>
<th>1.760^{***}</th>
<th>0.989^{***}</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0.0003)</td>
<td>(0.0223)</td>
<td>(0.0021)</td>
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<td>(0.0021)</td>
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<td>(0.0020)</td>
<td>(0.0021)</td>
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<td>(0.0021)</td>
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<tr>
<td>Age (below 17.5 yrs)</td>
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<td>(0.0016)</td>
<td>(0.0021)</td>
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<td>(mtd = 10)</td>
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<td>(mtd = 10)</td>
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<td>(mtd = 8)</td>
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</tbody>
</table>

Observations: 79.3 mil.
Likelihood: -1.91E+07

The coefficients are presented in the exponentiated form, standard errors in parentheses.

\(*** p < 0.01, ** p < 0.05, * p < 0.1\)
The stable profile of the job separation probabilities with a single peak preceding workers’ birthdays is well-aligned with the hypothesis that employers discriminate against their employees on the basis of their age. It confirms that cost-minimizing employers have little incentive to act upon the minimum wage discontinuities unless the workers are close to the eligibility threshold. The elimination of the second peak of the job separation rate (observed 3 months after workers birthdays) can be fully attributed to the inclusion of spell duration among the covariates. This finding has several important implications - the increase of the job separation rate following workers’ birthdays is caused by the workers who got employed very soon after their birthdays and who face higher risk of job separation due to their short tenure. The failure to account for spell duration in the analysis of job separation would therefore bias the effect of minimum wage discontinuities downwards, as the job accessions are peaking after workers’ birthdays.

Since the Dutch system employs multiple increases of the youth minimum wage rate, the employment duration can be analysed separately for workers observed in the twelve months around each of the birthday discontinuities. The duration model used for these birthday-specific analyses is a simplified version of the baseline model, specified as

\[
\log[- \log(1 - \lambda_{it})] = \alpha + \beta_1 \log(dur_{it}) + \beta_2 age_{it} + \beta_3 age_{it}^2 + \gamma \cdot 1(mtbd_{it} < 3) + \text{other controls}.
\]  

Here, the third-order age polynomial with splines has been replaced by a second-order polynomial (the age-specific job separation rates are well-behaved within the isolated 12-month intervals), and the set of \(mtbd\) dummies has been replaced by a single dummy variable representing the three months closest to
workers’ next birthday. The model is estimated for each birthday discontinuity included in the full sample, and also for workers aged 24-26 who are no longer subject to the changes of minimum wage. Figure 7 documents the effects for each of the age groups together with 95% confidence bands.

Figure 7: Predicted Changes of Job Separation Probability in the 3 Months Closest to Workers’ Next Birthdays, Workers Aged 15-23, Years 2006-11

The age profile of the birthday effects resembles a sawtooth pattern. The effect is high for the 16 year olds, which is to be expected as this group is the youngest (and therefore the least-skilled). The size of the effect falls in the two following years and rebounds when workers reach the age of 19. For a majority of Dutch students, the 19th birthday occurs in the year following the high school graduation, and therefore it represents the first minimum wage discontinuity for workers who decide to join the labor force after finishing the high school (and who are likely to lack prior work experience). The effect then starts to decline again and turns insignificant at the age of 22. The effects attributed to 23rd and 24th birthdays seem to be larger (23rd birthday follows college graduation) but neither of them proves significant. No dependence has been found in the following years.

We see that the minimum wage discontinuities have the strongest effect on the job separation of the youngest and least experienced workers. The effects are less pronounced for the older age groups, which is suggestive of better screening for older workers’ abilities. An alternative explanation is that the jobs performed by older MW workers require more job-specific skills and therefore the workers are less substitutable by younger and cheaper labor market entrants.
4.2 How Many Workers Are Losing Jobs Due to the MW Discontinuities?

The effects of the minimum wage discontinuities on the probability of job separation are sizable, but whether they are practically important depends on the actual job separation frequencies. For the sake of better exposition, I quantify how many workers are expected to lose their job due to the minimum wage discontinuities on an annual basis. I take a conservative position, assuming that the minimum wage discontinuities affect job separation only in the three months which are closest to workers’ birthdays. I quantify job separation frequencies within these three months and compare them to the MW separation frequencies in the remaining months of the year. Table 3 reports the findings.

Table 3: Quantification of MW Discontinuity Effects on Annual Job Separation Frequencies for MW workers aged 15-22, years 2006-12

<table>
<thead>
<tr>
<th>Age</th>
<th>#Separations per Year</th>
<th>Predicted Monthly Separations in the 3 Months Closest to Workers’ BD</th>
<th>Predicted Quarterly Separations in Other Months</th>
<th>#Separations Caused by MW Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>64878.2</td>
<td>16154.9</td>
<td>16413.4</td>
<td>258.5</td>
</tr>
<tr>
<td>17</td>
<td>95647.2</td>
<td>23857.5</td>
<td>24074.8</td>
<td>217.3</td>
</tr>
<tr>
<td>18</td>
<td>119515.3</td>
<td>29832.3</td>
<td>30018.4</td>
<td>186.2</td>
</tr>
<tr>
<td>19</td>
<td>133924.2</td>
<td>33322.4</td>
<td>33957.1</td>
<td>634.8</td>
</tr>
<tr>
<td>20</td>
<td>132544.7</td>
<td>33004.0</td>
<td>33532.7</td>
<td>528.7</td>
</tr>
<tr>
<td>21</td>
<td>126727.1</td>
<td>31615.3</td>
<td>31881.2</td>
<td>265.9</td>
</tr>
<tr>
<td>22</td>
<td>118280.0</td>
<td>29561.9</td>
<td>29594.4</td>
<td>32.5</td>
</tr>
<tr>
<td>23</td>
<td>109338.6</td>
<td>27296.7</td>
<td>27448.5</td>
<td>151.8</td>
</tr>
<tr>
<td>total</td>
<td>900855.3</td>
<td>224644.9</td>
<td>226920.6</td>
<td>2275.7</td>
</tr>
</tbody>
</table>

In the second column we see how many MW employment spells were terminated per year for each of the four age groups of interest. The frequencies rise with age, reflecting higher employment rates among older cohorts. The third column contains predicted number of job separations in the three months closest to workers’ birthdays, and the fourth column contains the predicted quarterly frequencies corresponding to the remaining months.

The fifth column then quantifies how many of the terminated spells can be attributed to increased job separation in the three months prior to MW workers’ birthday. The number of jobs lost per year due to the MW discontinuities is calculated to be 2275.7. This accounts for about 0.4% of the annual youth job separations. The workers who are contributing the most to this figure are aged 19, which stems from a combination of relatively large pool of 19 year old workers, and the highest effect of the MW discontinuity on the job separations within this age group.
Table 3 shows that the employment effects of MW discontinuities are not economically insignificant - every year, more than 2000 employees lose their jobs due to the changes of minimum wage rates. It should be also noted that the MW effects may seem small when expressed in terms of changes of the job separation rates, but this exposition is likely to be misleading. Job separations can occur for many reasons, and only a fraction of them will represent dismissals directly initiated by the employers. The measured MW effect is however attributable purely to the demand side, as the workers themselves have little incentive to base the decision to quit their job on proximity to their next birthday. Consequently, isolating the effect of MW discontinuities on firing rates rather than the job separation rates would render the MW effects much more prominent.

4.3 Who Is Losing Jobs Due to the MW Discontinuities?

It can be expected that the MW discontinuities will affect some workers more than others. In order to explore which workers are likely to lose their jobs due to the discontinuities, I estimate several additional models with focus on workers’ observable characteristics.

First, I investigate whether the MW effects are specific to certain sectors of the economy, or demographic groups within the workforce. I estimate a variant of the initial cloglog model where the set of covariates was augmented by dummies for the main sectors of youth employment, gender and immigration status, and by interactions of these dummies with the mtbd dummy.

The results presented in Figure 10 (and Table ??) reveal substantial sectoral dependence of the MW effects. The effect is very large for supermarkets,
which constitute the sector that is dominating the youth labor markets. The MW effects are smaller for the other two largest sectors: restaurants and bars, and retail, but they prove to be higher than the effects for all the other sectors combined. This finding goes in line with the intuition that the effects are likely to be stronger for sectors with job opportunities which do not require extensive training, thereby making the individual workers easily replaceable.\footnote{More detailed analysis of sectoral MW effects confirms this line of reasoning - further sectors with large MW effects are agriculture, bakeries, and butchers. In contrast, sectors which do not show sizable MW effects include science & education, logistics, postal services and healthcare. Detailed results are available upon request.}

Interestingly, the regression results show no significant difference between the MW effects for men and women. There is also no change of the MW effects for immigrants, although both immigrants and women are shown to have higher baseline probability of job separation.

Second analysis focuses on labor market prospects of those workers who lost their job due to the MW discontinuities. Having identified that the probability of job separation peaks in the two months prior to the MW workers’ birthdays, we can compare the characteristics of MW workers whose employment spell was terminated in this particular period with the MW workers whose spell ended at different points of time. Under the assumption that the characteristics of dismissed MW workers depend on the proximity to birthday only through the general age effects and MW discontinuities, we can estimate the following models,

\[ y_i = \alpha + \beta_1 \text{age}_i + \beta_2 \text{age}_i^2 + \gamma \cdot 1(\text{mtbd}_i < 3) + \text{other controls} + \epsilon_i, \]  

where \( y_i \) represents the outcome of interest and \( 1(\text{mtbd}_i < 3) \) denotes the workers whose job spell ended 0-2 months prior to their next birthday. The models are estimated using a sub-population of workers aged 15-22 whose job spells ended within the observed period. I consider several model specifications with dependent variables being:

1. Time spent without an employment (proxy for unemployment duration).
2. Work intensity (weekly hours) in the next employment spell.

In order to estimate the first two models, two sample selection criteria are applied. First, the sample is restricted to workers who lost their job in the period 2006-07, so that we would have sufficiently long span of years following the initial event. Second, I have excluded workers who are observed to have multiple jobs. This is to ensure that the worker’s next employment spell has been initiated after the observed separation.\footnote{This adjustment reduced the sample by 22%. The share of workers with multiple jobs shows no dependence on the proximity to birthday at the time of the initial separation.}

\[ 22 \]
The first model is specified as a duration model similar to the baseline model presented in Section 4.1. The jobless spell can be thought of as a proxy for unemployment duration in the population which is unlikely to be tracked by unemployment agencies. The results show that the workers whose job was terminated around their birthday experience neither shorter nor longer spells without active employment. The histograms of spell lengths in Figure 9 also confirm that there is no obvious difference between the ‘treatment’ group represented by the mtbd dummy, and the ‘control’ group.

Figure 9: Duration of Jobless Spells, 15-23 Year Old Workers Whose MW Job Spell Ended in Years 2006-07

The second model is a standard regression model where the dependent variable is work intensity in the first employment spell observed after the initial job separation. Here we see that the MW workers who lost their job around the birthday are likely to work significantly longer hours. On the other hand, the same workers are also found to work longer hours prior to their job loss - effectively, they are keeping the same work intensity as before. The dependent variable of the third model is hourly wage of the same workers 5-6 years from the point of failure. This time the results show significantly negative effect for the ‘treatment’ group. The workers whose job ended due to the MW discontinuities are shown to earn $\sim 50$ cents less per hour than the workers whose job ended in the other months. This differential is in stark contrast with their daily wages at the point of their job loss, which are as high as the wages in the control group.

These results have several important implications for interpretation of the MW effects found through the initial analysis. The first model shows that the workers dismissed due to the MW discontinuities are likely to remain jobless for as long as the other workers. From the supply side perspective, this finding suggests that the workers either cannot foresee their upcoming dismissal, or they can but they fail to secure a job in a comparatively shorter time due to their lower abilities. The second model shows that these workers are re-employed

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Table A.1 listing coefficients for each of the models is presented in the Appendix
in more intensive jobs.\textsuperscript{25} The third model provides evidence that the workers whose job ended due to the MW discontinuities are likely to be those with lower abilities.

This creates an interesting exposition of the dynamics present in the Dutch youth labor markets. As shown above, the probability of re-employment is the same for affected workers, irrespective of their potentially lower abilities. This suggests that the employers cannot effectively screen for abilities of youth MW workers when making hiring decisions (which is intuitive as the youth workers’ prior experience and other signals of ability are likely to be limited at best). On the other hand, the employers do learn about the abilities of workers who got hired, and use this knowledge in making the subsequent job retention decisions.

4.4 Effects on Employment Stocks

The analysis of jobless duration reveals another important finding - the post-birthday spikes in job accession rates documented in Figure 4 cannot be fully attributed to re-employment of those workers who lost their job due to the MW discontinuities. These workers will certainly contribute to the spikes\textsuperscript{26}, but their re-employment flows are not strong enough to fully explain the observed spikes of job accession. This means that other channels are likely to contribute to the observed patterns. These channels include increased inflow of new labor market entrants (whose reservation wages fall above the pre-birthday MW rate but below the post-birthday MW rate), and also selective hiring of employers who aim to hire workers that are far from their next birthday.\textsuperscript{27} Assessing the relative importance of the two alternative channels is however infeasible due to the current data limitations.

Capturing general employment effects induced by the MW changes is also rather cumbersome. In Section 3 we saw that the employment rates grow as the youth population ages, but these growth rates are unlikely to be related to the changes of minimum wages (similar sustained growth paths are observed in other countries as well, irrespective of their use of age-dependent minimum wages Blundell, Bozio, and Laroque, 2013). The approach pursued by Dickens, Riley, and Wilkinson (2014) is to study the employment effects of age-dependent MW changes using regression discontinuity (RD) design. In their study, the authors evaluate the employment effects of age-dependent minimum wages in the UK, focusing on the MW rate discontinuity which occurs on workers’ 22nd birthday. Using sharp RD design with polynomial age trends, the authors find that the

\textsuperscript{25}This result goes against the reservation wage argument presented in Footnote 19. The workers whose job ended due to the MW discontinuities get re-employed in more intensive jobs (raising the work hours by approximately 2.8 hours per week) which bolsters the claim that the job separation effects of MW discontinuities are driven by the firms rather than the strategic considerations of MW workers themselves.

\textsuperscript{26}As shown in Figure 9, \textasciitilde43\% of workers will find a new occupation within first two months of their jobless spells. Since the job separation peaks prior to the birthdays, we can expect job accession to peak past the birthdays as a direct consequence.

\textsuperscript{27}The second channel is likely to be particularly important for workers aged 15 & 16, due to the age-dependent institutional restrictions on the types of jobs they can perform.
MW increase has a positive effect on aggregate employment rate, but this finding is restricted only to certain demographic groups within their population sample.

A similar exercise could be performed in the Dutch context as well, but the findings presented above suggest that there may be a fundamental problem with this approach. The RD design uses the no-anticipation assumption to justify that comparing the employment trends before and after the discontinuity can capture the true effect of the MW rate change. This assumption is however likely to be violated, since employers are shown to anticipate the increased labor costs by terminating many MW contracts already before workers’ next birthdays. The positive employment effect found by Dickens, Riley, and Wilkinson (2014) may be therefore an artifact of increased job separation prior to the discontinuity, and consecutive re-employment of those workers who have lost their job due to the MW change.

For that reason, the commentary of employment effects is restricted to descriptive analysis. Figure 10 shows the evolution of Dutch employment rate around the 22nd birthday.

![Figure 10: Youth Employment Rate as a Function of Age, Dutch Population Aged 21-23, Years 2006-12](image)

In line with the results presented so far, we see that the growth of employment slows down prior to the birthday, and rebounds after the birthday. The figure does not indicate positive employment effects occurring at the very point of discontinuity. Rather than that, the general growth rate appears to be staggered by the MW changes.
4.5 Further Discussion

The econometric analysis presented above documents the adverse effects of changes in age-dependent minimum wages on job separation of MW workers. The effects are both statistically and economically significant, and as such they should be of considerable interest to the ongoing debate regarding the merits of minimum wages. Bearing that in mind, it is important to interpret the results in an appropriate context.

The measured effects imply that a 1% increase of a single age-dependent MW rate translates into approximately 0.08% increase in the probability of job separation in the three months closest to the corresponding MW discontinuity. However, this does not mean that if we raise minimum wages for the entire youth population, we would expect job separation effects of similar magnitude. A crucial feature of the age-dependent system is that the employers can always substitute their current workers by younger and cheaper hires. Such substitution is however not feasible in the case of universal MW increase, since the labor costs change for the entire workforce. Therefore, the effects of universal MW change on job separation can be expected to be lower.

On the other hand, even in the universal case the adverse effects are unlikely to disappear completely - as shown above, the employers do respond to changes in the labor costs, and the aggregate increase of (youth) minimum wages may therefore facilitate implementation of new technologies which are less labor-intensive. An example of this could be introduction of self-service checkout terminals in the supermarkets, or automation of the wholesale warehouses. Since the minimum wage jobs are less intensive in human capital, introduction of such technology constitutes indeed a viable, albeit costly alternative to the youth labor force.

5 Conclusions

This paper provided an evidence of adverse effects of the age-dependent minimum wages on job retention of Dutch youth workers aged. The age-dependency is an important part of the Dutch variant of minimum wage legislation, increasing the youth minimum wage by more than 300% in the span of 8 years, starting at the age of 15 and ending at the age of 23, when workers become entitled to the adult minimum wage. The empirical analysis exploits the fact that the firms are facing sharp discontinuity in labor costs in the month when worker turns one year older. Accordingly, the workers earning minimum wages are shown to face higher risks of losing their job in the two months closest to their next birthday.

Using administrative records for the entire population of the Netherlands, I analyze monthly flows in and out of the labor force, accounting for the time

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28 This follows from the fact that the aggregate effect amounts to approx. 1.15% change of the baseline job separation probability, and corresponds to 15-17% year-on-year changes of age-dependent minimum wages.
remaining until workers’ next birthday. The results show a sizable increase in probability of job separation around the time of discontinuity: the job separation probability increases by 1-2% in the 3 months closest to workers’ birthdays. There is a substantial heterogeneity in the MW effects, with their size being heavily dependent on the sector of employment and age of the workers. The supermarkets, representing the sector which employs the most youth workers, are shown to exploit this discontinuity the most, with the job separation probability increasing by 2%, compared to the 0.9% increase applicable for the other sectors. The effect is shown to be the highest at ages which correspond to the influx of inexperienced workers into the labor force. Otherwise, the effect is decreasing with age, which is suggestive of human capital accumulation and better screening of older workers’ abilities.

I also investigate the characteristics of workers whose job ended around the time of the MW discontinuity, showing that they do not face a penalty in terms of the length of their unemployment spells, but they are likely to earn lower wages in their prospective jobs. Furthermore, they are not observed to sort themselves into less-intensive jobs after the MW change, which supports the hypothesis that the measured MW effects are driven by the demand side, rather than the workers themselves.

The analysis presented here remains agnostic about the overall employment effects of the age-dependent minimum wages. This is due to current data limitations and potential confounding effects, such as the interplay between work and schooling decisions. The administrative dataset does not contain information on whether the youth workers are actively looking for an employment, which makes the analysis of employment decisions difficult. More information is therefore needed in order to explore this domain of interest.

The results derived from the econometric analysis confirm that the employers respond to age-dependent minimum wages, and they are likely to replace a sizable number of minimum wage workers due to their rising labor costs. However, it remains an open question whether the changes of similar magnitude could be expected in the case of minimum wage reform increasing the MW rates across the board. The lack of cheaper ‘substitute’ workforce would likely moderate the adverse effects on job separation, but it might motivate firms to switch to the less labor-intensive modes of operation. The analysis of such a change would be further complicated by the supply side effects of MW changes, which would require explicit structural modeling of individual decision making with respect to work and schooling decisions. These efforts are left for the follow-up analyses.

References


A Appendix

A.1 Other Age-Dependent Labor Market Policies in the Netherlands

Apart from minimum wage, the Dutch labor legislation makes use of other policies which are dependent on the calendar age of youth workers. These policies are regulatory measures which impose restrictions on the hours of work and the types of jobs that can be pursued by teenagers.

The institutional restrictions are most stringent for workers aged 13 & 14, who are allowed to be employed only by family businesses, and whose work engagement should not exceed 12 hours per week during the school year and 35 hours per week during the school holidays. These restrictions are partially loosened when workers turn 15. For this group, the total work & schooling engagement should not surpass 40 hours per week. The 15-year olds are however still heavily limited in the types of work they are allowed to do. The occupational restrictions include factory work, handling hazardous substances, heavy manual labor, but also working behind the counter and working in bars and restaurants (since alcohol is served). The major change comes with the 16th birthday, which marks the end of compulsory schooling in the Netherlands. Past this point, workers are allowed to engage in most types of work (the restrictions are maintained only for work involving hazardous substances and work in extremely noisy environments), and their maximal work engagement is increased up to 45 hours per week. The remaining restrictions are dropped at the age of 18.

Just like the minimum wage discontinuities, these institutional changes are sharp and therefore they should be borne in mind when analyzing the employment flows around workers’ 15th & 16th birthdays. Some workers may indeed decide to change their current labor market status around the 16th birthday for reasons unrelated to the coinciding minimum wage change (especially if there are better work opportunities in the age-restricted occupations). On the other hand, the effects of minimum wage discontinuities occurring at the other birthdays should not be confounded by institutional changes. The alleviation of work restrictions at the 18th birthday applies only to a very specialized subset of the workforce, and the remaining six birthdays are not subject to any age-dependent variation in the labor market policies.

A.2 Definitions

Job Accession - The job accession is recorded in the calendar month when a worker starts working for a new employer. The job accession is not recorded when a worker resumes the work for the same employer after a period of absence (she is observed to work for the same employer earlier in the same calendar year or the year before). This coding prevents misclassification of jobs with variable work days, job spells interrupted by school holidays, or promotions within the same firm.
**Job Separation** - The job separation is recorded in the calendar month when a worker is observed to stop working for a given employer, and she is not observed to resume the work for the same employer in the same calendar year or the following year.

**Employment Duration** - The employment duration in the month of observation is recorded as the number of months passed from a worker’s job accession, accounting for any interruptions of her employment spell.

### A.3 Figures and Tables

![Figure A.1: Monthly Fluctuations of the Detrended Job Separation Rate, 15-23 Year Old Workers, Years 2006-11](image1)

![Figure A.2: Monthly Fluctuations of the Detrended Job Accession Rate, 15-23 Year Old Workers, Years 2007-12](image2)
Table A.1: Labor Market Prospects of MW Workers Whose Employment Spell Ended in Years 2006-07

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) Jobless Spell Duration</th>
<th>(2) Daily (fte) Wages in 2012</th>
<th>(3) Job Intensity (share of fte)</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>mtbd &lt; 3</code></td>
<td>1.004</td>
<td>-0.491***</td>
<td>0.007***</td>
</tr>
<tr>
<td></td>
<td>(0.00519)</td>
<td>(0.24578)</td>
<td>(0.00134)</td>
</tr>
<tr>
<td><code>log(dur)</code></td>
<td>0.643***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.00115)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><code>age(in months)</code></td>
<td>1.290***</td>
<td>12.33***</td>
<td>0.057***</td>
</tr>
<tr>
<td></td>
<td>(0.01369)</td>
<td>(0.49550)</td>
<td>(0.0158)</td>
</tr>
<tr>
<td><code>age2</code></td>
<td>0.994***</td>
<td>-0.162***</td>
<td>-0.001***</td>
</tr>
<tr>
<td></td>
<td>(0.00025)</td>
<td>(0.01327)</td>
<td>(0.00083)</td>
</tr>
<tr>
<td><code>Constant</code></td>
<td>0.0236***</td>
<td>-65.88***</td>
<td>-0.384***</td>
</tr>
<tr>
<td></td>
<td>(0.00249)</td>
<td>(4.576)</td>
<td>(0.01591)</td>
</tr>
</tbody>
</table>

Observations: 2,342,864, 458,321, 377,096
R-squared: 0.110, 0.130, 0.100
ll: -841026, -1.349e+06, -1.07985

Standard errors in parentheses, *** \( p < 0.01 \), ** \( p < 0.05 \), * \( p < 0.1 \)