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The Young Bunch: Youth Minimum Wages and Labor Market Outcomes

The 2017 Dutch youth minimum wage increase has improved labor market outcomes for young workers, raising their average wage incomes by 4% without adverse employment effects. This wage increase is not only experienced by workers paid exactly the minimum wage: 75% of the total effect is due to salary increases for young low-wage workers paid more than the minimum.

We do not find evidence of adverse outcomes for any subgroups of affected workers, nor of worsening worker outcomes along other margins, such as contract type.

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The Young Bunch: Youth Minimum Wages and Labor Market Outcomes*

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Abstract

We estimate the effects of an increase in the minimum wage for 20- to 22-year-olds in the Netherlands on their employment and earnings, using a difference-in-differences approach with detailed administrative data. We find that the increase does not have a negative effect on the number of jobs and somewhat increases hours worked, hence raising overall earnings for affected workers. Further, the minimum wage increase has substantial spillover effects, accounting for more than 75% of the average wage increase experienced by workers. Lastly, while employment grows in fixed-term and temporary help agency contracts, we do not find evidence of declines in employment in other types of work arrangements, nor of labor-labor substitution. Importantly, labor market outcomes evolve most favorably for full-time workers who are not enrolled in education and thus less likely to be transient occupants of minimum-wage jobs.

Keywords: Youth minimum wage, Labor demand, Spillovers

JEL: J23, J38, J88

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1 Introduction

The past decades have witnessed increasing inequality in many developed countries (OECD, 2015). Minimum wage increases are an important policy instrument to counteract inequality at the bottom of the labor market, as real minimum wages are known to have important consequences for the evolution of lower-tail inequality (Autor et al., 2016; Engbom and Moser, 2018; Lee, 1999). A large literature has assessed the potential downside of this instrument predicted by perfectly competitive labor market models: decreased employment for low-wage workers. The empirical evidence suggests that for the economy as a whole, such disemployment effects are absent or negligibly small, at least at present minimum wage levels (for overviews, see Belman and Wolfson, 2014; Dube, 2019). The absence of disemployment effects for moderate minimum wage increases can be understood as resulting from efficiency wages (e.g. Rebitzer and Taylor, 1995), inelastic labor demand, or employers' monopsony power (e.g. see Burdett and Mortensen, 1998; Manning, 2003).[1]

However, this does not rule out bigger effects for the most strongly affected groups: a prime example are young workers, who are strongly over-represented among minimum wage workers. While some recent studies for the US also find small or near-zero employment effects of the minimum wage for these groups (e.g. Allegretto et al., 2017; Dube et al., 2016), others report adverse effects on youth labor market outcomes (e.g. Neumark et al., 2014a,b).

This paper contributes new evidence to this literature by studying the impact of the minimum wage on youth labor market outcomes. We examine the impact of a recent increase in the age-specific minimum wage for 20–22-year-olds in the Netherlands on the employment outcomes of these age-groups at the extensive and intensive margins (i.e. the number of jobs and hours worked), as well as on their overall earnings. This 2017 reform increased age-specific minimum wages by around 15 to 19% for workers aged 20 to 22, with virtually no change for older minimum-wage workers. Hence, the reform offers a quasi-experimental setting in which the age-specific variation in the minimum wage increase can be exploited to estimate the impact of the

[1] Increased minimum wages could for example lower worker turnover and monitoring costs, as well as raise worker productivity, offsetting any direct increase in firms' wage costs. It could also be the case that labor demand is relatively inelastic because minimum wage workers are not a large share of firms' labor costs; minimum-wage workers are not easily substitutable for other factors of production; and/or product demand is inelastic in the (often non-tradable) sectors where minimum-wage workers are employed. Further, in imperfect labor markets, rising minimum wages increase labor supply, making the employment effects theoretically ambiguous. See Manning (2021) for a recent overview of the literature's findings and theories consistent with absent disemployment effects.

minimum wage on labor market outcomes of young workers.

The context we study is of interest for several reasons. First, the increase in the minimum wage is directly aimed at specific age-groups. While the majority of the empirical literature focuses on the impact of a change in the general minimum wage, relatively few studies have examined the impact of a minimum wage increase that is only legally binding for workers of specific ages (e.g. Hyslop and Stillman, 2007; Pereira, 2003; Portugal and Cardoso, 2006; Shannon, 2011), even though such age-specific minimum wages are very common.[2][3] A clear consensus has not yet emerged, with some finding zero or positive impacts on youth labor market outcomes (Hyslop and Stillman, 2007; Portugal and Cardoso, 2006) while others find negative effects or have mixed results (Pereira, 2003; Shannon, 2011).

Second, the increase in the age-specific minimum wage is relatively large compared to previous studies and it has a large bite, because, as in many other countries, Dutch youth employment is concentrated in low-wage jobs. In contrast to many other countries, however, Dutch youth employment is relatively high. In 2019, the Dutch employment rate of 15–24-year-olds was 65.3%, compared to 51.2% in the US and 54.1% in the UK (OECD, 2021). This allows us to study the impact of the minimum wage in a context where firms have a strong incentive to adjust their workforce and production process, particularly in sectors where youth workers account for a large share of the labor force such as retail, and bars and restaurants. In addition, due to flexible and part-time work arrangements among youth workers, firms also have the ability to adjust their workforce quickly and firms in the Netherlands have been shown to act on increases in labor costs for young workers (Kabátek, 2020).

Third, while most studies examining the employment effect of the minimum wage exploit variation in the nominal minimum wage, we exploit an increase in the minimum wage that is adjusted every six months in line with average wages. Therefore, the minimum wage increase we study is more persistent than a nominal increase. Lastly, our analysis is based on detailed administrative employer-employee records rather than the much more common survey data.

[2]Many countries have minimum wage systems with age-based minimum wage differentiation or have had youth minimum wage provisions in the past. Implementation differs across countries, with variation in the number of age-gradients, the youth-adult minimum wage ratio, and the age threshold which separates youth and adult minimum wages (see Grimshaw et al., 2014; Marimpi and Koning, 2018).

[3]Some studies use age-discontinuities in the minimum wage to study the impact of youth minimum wages on youth labor market outcomes. For example, Dickens et al. (2014); Kabátek (2020); Kreiner et al. (2020) study the impact of individual labor market outcomes when individual workers cross an age threshold, resulting in a higher applicable minimum wage. While these studies focus on minimum wage variation embedded in the prevailing youth minimum wage system, we focus minimum wage changes resulting from a change in the age-dependent minimum system.

This allows us to obtain very precise estimates and be confident that our results are not driven by misreported hours or wages (Autor et al., 2016).

We use a difference-in-differences design exploiting the fact that somewhat older workers are not directly affected by the minimum wage increase. In particular, we show that workers aged 23–25 are on parallel trends to 20–22-year-olds prior to the reform and can serve as a control group. In order to inform on the localized impacts for these specific groups, we follow Cengiz et al. (2019) by examining changes in the frequency distribution of wages at the bottom of the wage distribution around the new minimum wage. We exploit our detailed administrative data on all youth workers in the Netherlands to estimate the impact of the reform on the total number of jobs and hours worked in consecutive €0.50 wage bins defined relative to the new age-specific minimum wage. This also allows us to estimate potential spillover effects further up the wage distribution. We focus our main estimates on the short-term impact of the reform because other policies aimed at youth workers introduced in later years could bias estimates of the medium-term impact, although we show that the medium-term impacts are very similar to the short-term ones.

We find that the increase in the age-specific minimum wage has resulted in a reallocation of employment around the new minimum wage. Specifically, the number of jobs and hours worked in wage bins below the new minimum wage is reduced, but this is fully compensated by an increase in the number of jobs and hours worked in wage bins at or slightly above the new minimum wage. The gains in hours worked in wage bins above the minimum wage even exceeds the reduction in hours worked below the new minimum wage for 20–22-year-olds, such that total hours worked modestly increased for affected workers. Further, there are spillover effects of the minimum wage, with around 90% of these occurring within €2.50 above the new minimum wage. These spillovers are quantitatively important, accounting for around 75% of the increase in the average wage for 20–22-year-olds. While we focus our analysis on the 2017 minimum-wage increase to avoid confounding effects from other policies, we find similar results from a second minimum wage increase which was implemented in 2019.[4]

[4]Overall, our results are consistent with findings from two policy reports produced at the request of the Ministry of Social Affairs and Employment (ter Weel et al., 2018, 2020). Relative to these reports, we contribute in the following ways. First, rather than using a conventional two-way fixed effects specification over the full population of young workers, we examine the impact of the reform along the wage distribution. We find that this matters for identifying the impacts on hours worked. As pointed out by Cengiz et al. (2019), this empirical approach further allows for a falsification check on impacts of wages at the top of the distribution. Importantly, it also allows us to examine spillovers of the minimum wage, which we find are substantial for young workers.

Lastly, we study heterogeneity in these effects by considering the most affected industries, as well as effects across different types of labor contracts and worker demographics. Although there is some heterogeneity across these margins, we find the average effects do not hide adverse outcomes in some sectors or for some groups of workers. We also do not find evidence of 'offsets' in terms of contract quality– impacts are in fact more favorable for full-time minimum-wage workers who are not enrolled in education, and therefore less likely to be transient occupants of minimum-wage jobs.

2 Data

2.1 Youth minimum wages in the Netherlands

The adult minimum wage in the Netherlands covers all workers aged 23 and older. For younger workers, from ages 15 to 22, the youth minimum wage is defined as a stepwise increasing fraction of the adult minimum wage. In January 2017, right before the reforms we study, the minimum wage ranged from 35% of the adult minimum wage for 15-year-olds to 85% of the adult minimum wage for 22-year-olds (column 1 in Table 1). In the month of a worker's birthday, they become eligible for the next step in the minimum wage. The minimum wage is biannually adjusted to keep pace with average wage growth.

The Netherlands has no hourly minimum wage. Instead, minimum wages are defined per day, week and month. The hourly minimum wage depends on what constitutes a full-time workweek. This is agreed upon in collective bargaining agreements, which often cover a whole sector, but large firms frequently also have their own collective bargaining agreement. Full-time workweeks always range between 36 and 40 hours per week.

The minimum wage reform. In July 2017 and July 2019 the youth minimum wage for workers aged 18 and older was increased in two steps. The minimum wage for workers aged 15–17 remained unaltered. Table 1 shows the change in both the rate of the age-specific minimum wage relative to the adult minimum wage and the implied increase in the real weekly minimum wage by age-group for both steps of the reform. The first column reports the youth minimum wage as a share of the adult minimum wage before each step of the reform. The third column reports the youth minimum wage in real euros per week before the reform. For example, prior to the 2017 reform 20-year-olds had a minimum wage that was 61.5% of the adult minimum wage, or 217 euros per week compared to 352 euros per week for those aged 23 or older.

On July 1, 2017, the minimum wage increased overnight by 18.7% for 22-year-olds, 18.3% for 21-year-olds, and 14.9% for 20-year-olds. At the same time, the minimum wage for adults was only raised by 0.9%, reflecting the biannual real wage indexation. On July 1, 2019, the minimum wage was raised by another 19.1% for 21-year-olds, and 15.7% for 20-year-olds. The minimum wage for adults, this time also including 22-year-olds, was raised by 1.2%. The table also shows relatively small increases in the minimum wage for 18–19-year-olds which we will not study here, instead focusing on the sizable minimum wage increases for 20–22-year-olds.[5]

Table 1: The two-step youth minimum wage reform

	MW as a percentage of adult MW		(Real) Weekly minimum wage		
Age	Before reform	After reform	Before reform	After reform	Change (%)
	Step 1: July 2017 reform				
23 and older	100	100	352	355	0.9
22	85	100	299	355	18.7
21	72.5	85	255	302	18.3
20	61.5	70	217	249	14.9
19	52.5	55	185	195	5.7
18	45.5	47.5	160	169	5.3
	Step 2: July 2019 reform				
22 and older	100	100	351	355	1.2
21	85	100	298	355	19.1
20	70	80	246	284	15.7
19	55	60	193	213	10.4
18	47.5	50	167	178	6.6

Additional policies. As part of a compensation scheme for the minimum wage increase, the Dutch government introduced a wage subsidy for youth minimum wage workers aged 18–21 that started in January 2018 (the so-called JLIV subsidy).[6] The subsidy compensates firms for hours worked by young workers at the minimum wage from 2018 onwards. There is no compensation in 2017, nor is there compensation for hours worked in 2017. The first compensation was paid out automatically to firms at the end of 2019, covering hours worked in 2018.

While the subsidy weakens the link between labor costs and the minimum wage increase, we believe our results are unlikely to be biased by the introduction in 2018. The most important reasons are the following. First, we limit our main analysis to the six months immediately following the reform in July 2017 for which there was no compensation. Second, we find very similar results for workers aged 22, who were not eligible for the subsidy, as for workers aged 20 and 21. Third, we find that most of our results are driven by spillovers to workers earning

[5] Estimates show that the employment impacts of these small increases for 18 and 19-year-olds are around zero. Estimates available upon request.

[6] The subsidy was announced at the same time as the minimum wage increase, but implemented later.

somewhat more than the new minimum wage: these workers are not covered by the subsidy. Fourth, the volatility of employment in low-wage sectors and the lag in payout of the subsidy means the subsidy is not always targeted towards the firms that were hit by the minimum wage increase. We present more extensive evidence on this in Appendix A.1, along with more detail on the subsidy and several other reasons for why our results are unlikely to be biased by the subsidy.

2.2 Data construction

Data sources. We construct a panel of monthly employment records of the universe of 20–27-year-olds with residency in the Netherlands in 2007–2017. We merge several high-quality administrative sources collected by Statistics Netherlands, covering the entire population of the Netherlands. The employment data is based on income statements from employers to the Dutch Tax Authority and Employee Insurance Agency (UWV). Individuals in the employment data are matched to municipal register data containing information on individual demographic characteristics such as gender, date of birth, residency spells, and country of birth of both the individual and their parents. Because many young workers are still in education, we match education enrollment data, which include information on the date of enrollment and graduation, as well as the level and type of education.

The employment data contain information on hours worked and gross monthly earnings for each individual worker's employment spell, separately by firm. In addition, the data contain several job characteristics, such as the type of contract (e.g. intern, on-call-employee, temporary work agency, and fixed term or open-ended contract) and sector (but not occupation) of employment.

We define a job as a single employer-employee relationship during a given month. Since individuals can have multiple employment relationships with the same firm in a given month, we sum the gross monthly earnings and hours worked for each individual at the firm-level.[7] We compute the average hourly wage for each job-month by dividing gross earnings by hours worked. The hourly wage measure is an approximation of the contracted hourly wage. We

[7] Monthly earnings are defined as gross basic income, which excludes premiums and special payments. Income for overtime hours worked are included in gross basic income as long as compensation for these hours worked is the same as the contractual wage. Hours worked are defined as basic hours worked, i.e. the total hours over which an employee received a wage during an employment spell, including any overtime hours for which employees receive the same hourly compensation. Employers are obliged to pay the minimum wage over all hours worked, including any overtime: that is, they cannot increase overtime hours as a way to avoid minimum wage compliance.

deflate hourly wages to 2015 euros using the annual consumer price index.

Determining the applicable minimum wage. As outlined above, we need the full-time workweek for each worker to determine the applicable minimum wage. However, We do not observe the actual full-time workweek, so instead we approximate it as follows. For each job we do observe the number of full-time equivalent days worked. We divide this by the number of working days in a month to obtain the part-time share of each job. We then divide the actual hours worked observed in the data by the calculated part-time share to obtain the implied full-time hours for each job. We take the average implied full-time hours over the months worked in a calendar year, and then assign each job to the closest category out of either 36, 38, or 40 hours per week.[8]

Sample restrictions. We restrict the sample in the following ways. First, we exclude jobs of individuals without a registered address in the Netherlands in a month. This removes around 2.5% of the jobs in the raw employment data. Second, we exclude jobs that are internships, sheltered employment arrangements, or directors / major shareholderships, since the minimum wage does not apply to these job types. This removes an additional 4.3% of jobs.

2.3 Descriptives

Table 2 shows summary statistics on our sample, averaged over 2007–2017. The table highlights a number of characteristics of the Dutch youth labor market. First, a non-negligible share of young workers earn the minimum wage: around 11% of workers aged 20–22 and 10% of workers aged 23–25. On average in the Netherlands, around 6% of workers earn the minimum wage (CBS, 2021). Second, many young workers are working while enrolled in education: 67 to 53% of 20 to 22-year-olds, 39% of 23–25-year-olds, and still around 12% for 26–27-year-olds. This also explains the high incidence of part-time work, as seen from low average weekly hours and the low share of full-time jobs. Minimum wage workers are more likely to be enrolled in education and hold part-time jobs than those who earn more than the minimum wage. Third, the majority of young workers are employed in temporary contracts, and temporary contract incidence is higher among minimum wage workers compared to non-minimum wage workers.[9] On-call and temp

[8]See Appendix A.6 for details. Our results remain qualitatively the same if we instead assign each worker a 36 or a 40 hour work week (the lower and upper bound, respectively).

[9]A temporary contract is defined as a contract with a fixed end date or a fixed duration (e.g. six months).

work are also relatively common, with the former more frequent for the youngest age-groups.

Minimum wage employment of 20–22-year-olds is concentrated in wholesale and retail trade, food and beverage services, and the employment placement industry (including temporary help agencies). Together these account for around 60% of all minimum wage jobs held by 20–22-year-olds. Retail trade accounts for the largest share of minimum wage employment, accounting for 30% of minimum wage jobs held by 20-year-olds and 27% to 23% of minimum wage jobs held by 21–22-year-olds. While men and women are about equally represented, first- or second-generation migrants are over-represented among minimum wage workers, particularly among 23–27-year-olds. Lastly, while between 26% and 29% of minimum wage jobs among 20–22-year-olds are held by individuals not enrolled in education who live with their parents, a non-negligible share of minimum wage jobs are held by individuals in single- or two person households. In particular, among 20–22-year-olds, between 7% and 12% of minimum wage jobs are held by individuals in one- or two-person households who are not enrolled in education. In our analyses, we will study impacts on minimum-wage workers not enrolled in education (33 to 47% for the treated age-groups) separately because students are more likely to be transient occupants of minimum-wage jobs.

Table 2: Summary statistics on the Dutch youth labor market by age-group

	20		21		22		23-25		26–27	
	MW	> *MW*	*MW*	> *MW*	*MW*	> *MW*	*MW*	> *MW*	*MW*	> *MW*
Job characteristics										
Full-time	0.20	0.21	0.23	0.27	0.26	0.34	0.30	0.49	0.35	0.60
Hours worked per week	17.22	17.40	18.43	19.85	19.59	22.41	21.08	27.43	23.58	31.18
Hourly wage (2015 euro's)	4.74	9.48	5.54	10.83	6.54	12.06	7.78	13.70	7.68	15.18
Temporary contract	0.69	0.64	0.68	0.63	0.66	0.61	0.66	0.54	0.64	0.45
On-call	0.16	0.23	0.15	0.19	0.15	0.16	0.12	0.10	0.09	0.05
Temp work	0.09	0.13	0.11	0.13	0.12	0.13	0.17	0.11	0.19	0.08
Worker characteristics										
Female	0.53	0.50	0.52	0.50	0.51	0.51	0.51	0.51	0.50	0.50
Migration background	0.21	0.19	0.22	0.19	0.23	0.20	0.28	0.21	0.35	0.23
Sector of employment										
Wholesale trade	0.04	0.04	0.05	0.04	0.05	0.04	0.05	0.05	0.05	0.06
Retail trade	0.30	0.22	0.27	0.18	0.23	0.15	0.16	0.11	0.14	0.08
Food & beverage service	0.16	0.12	0.14	0.10	0.13	0.08	0.11	0.05	0.09	0.04
Employment placement	0.14	0.17	0.16	0.17	0.18	0.17	0.23	0.14	0.25	0.11
Other	0.35	0.46	0.38	0.52	0.42	0.56	0.45	0.65	0.47	0.71
Educational enrollment										
Student	0.67	0.63	0.60	0.52	0.53	0.42	0.39	0.24	0.21	0.11
Non-student household types										
Living with parents	0.26	0.29	0.29	0.34	0.29	0.35	0.25	0.27	0.18	0.15
Not living with parents	0.07	0.08	0.12	0.14	0.18	0.23	0.35	0.49	0.61	0.75
Unique individuals	14,197	116,762	14,654	121,125	15,510	124,575	45,627	396,931	16,812	291,466
Total population	205,717		207,370		208,355		624,939		413,483	

Notes: We report the means over monthly jobs observations in the sample period 2007-2017 (N=164,236,969). For each age-group, the odd column reports the means for jobs with real hourly wage at or below the real minimum wage. The even column reports the means for jobs with real hourly wage above the real minimum wage.

Table 3 summarizes the real wage distributions of the number of jobs and total hours worked, expressed as the distance from the real minimum wage in €1 increments, for 20–27-year-olds over the six-month period leading up to the first step of the minimum wage reform (January to June 2017). The table highlights that youth employment is strongly concentrated in low-wage jobs. In particular, around 10% of jobs held by 20–22-year-olds as well as 23–25-year-olds pay no more than the minimum wage, and more than 50% pay no more than €2.00 above the minimum wage. In contrast, employment of 26–27-year olds is less concentrated in low-wage jobs. The share of total hours worked for low-wages is slightly lower compared to the share of the total number of jobs, reflecting that lower-wage jobs have lower weekly hours on average. This concentration of young workers in jobs paying close to the minimum wage underscores the importance of this policy instrument for this labor market segment.

Table 3: Wage distributions in the Dutch youth labor market

	20		21		22		23-25		26–27	
	Jobs	Hours	Jobs	Hours	Jobs	Hours	Jobs	Hours	Jobs	Hours
Distance to MW										
≤€0	0.10	0.11	0.10	0.10	0.11	0.10	0.10	0.08	0.06	0.04
€0 – €1	0.21	0.19	0.17	0.15	0.15	0.13	0.17	0.14	0.10	0.08
€1 – €2	0.19	0.18	0.17	0.15	0.17	0.15	0.15	0.14	0.10	0.09
€2 – €3	0.14	0.15	0.14	0.14	0.15	0.15	0.13	0.13	0.10	0.10
€3 – €4	0.11	0.11	0.13	0.13	0.12	0.13	0.11	0.12	0.10	0.11
€4 – €5	0.08	0.08	0.09	0.10	0.10	0.11	0.09	0.10	0.10	0.11
€5 – €6	0.05	0.06	0.07	0.08	0.07	0.08	0.07	0.08	0.09	0.10
≥€6	0.12	0.12	0.13	0.14	0.14	0.15	0.18	0.20	0.34	0.37

Notes: We report the means over monthly jobs observations between January 2017 – June 2017. (N=15,099,912). Each row reports the fraction of total employment in each €1 increment distance from the applicable real hourly minimum wage. For each age-group, the odd column reports the means for jobs. The even column reports the means for hours worked.

3 Empirical approach

3.1 Identifying the impact of the minimum wage

To identify the impact of the youth minimum wage on young workers' employment and earnings, we exploit the increase in the youth minimum wage on July 1, 2017. We use a difference-in-differences design to estimate the impact of the minimum wage on the number of jobs and total hours worked by 20–22-year-olds. We follow the bunching approach outlined in Cengiz et al. (2019). This approach breaks down the aggregate employment effect of the minimum wage by constituent wage bins throughout the hourly wage distribution. The impact of the minimum wage is subsequently inferred by examining changes in employment in wage bins locally around the minimum wage.

The intuition behind this approach is that an increase in the minimum wage induces a change in the wage distribution of affected groups, in our case 20–22-year-olds. The distribution is altered in three ways. First, if firms comply with the higher legislated minimum wage, we will observe a reduction in the number of jobs that were paying below the minimum wage before the reform. Second, not all jobs below the new minimum wage need disappear. Jobs that are preserved and experience a mandated wage increase could appear at the new minimum wage, creating a spike or 'bunch' at the new minimum wage. Third, the minimum wage change may induce 'spillover' effects – changes in employment further up the wage distribution. Such spillovers could be driven by various factors, such as labor-labor substitution (Clemens et al., 2021; Fairris and Bujanda, 2008), hedonic-based labor supply substitution (Phelan, 2019), maintaining within-firm wage-hierarchies and fairness concerns (Dube et al., 2019; Giuliano, 2013), reallocation of employment toward higher paying firms (Dustmann et al., 2020), and increased job-search because the new minimum wage exceeds the reservation wage for more workers (Flinn, 2006). However, these spillover effects are likely to fade out further up the wage distribution. This implies the employment effect of the minimum wage should be inferred by examining employment changes locally around the new minimum wage.

To estimate the impact of the increase in the minimum wage on the number of jobs and hours worked, we first compute monthly distributions of hourly wages at the age-group level. Each job in our sample is assigned to a bin relative to the age-specific new real hourly minimum wage effective July 2017 (defined as MW_a), henceforth referred to as a wage bin. The width of the bins in our baseline specification is €0.50.[10] For example, jobs with a hourly wage between the post-reform age-specific minimum wage MW_a and $MW_a + 0.49$ are assigned to $bin_a = 0$ and jobs with a real hourly wage between $MW_a - 0.01$ and $MW_a - 0.50$ are assigned to $bin_a = -1$. The distance to the minimum wage is winsorized at $-€3$ and $+€12$ of MW_a, yielding a total of 30 bins. Next, we collapse the data to the number of jobs and total hours worked by age, wage-bin, and month.

Workers aged 23–25, who are not affected by the minimum wage reform, serve as our control group. For these workers, we calculate the same age-specific bins relative to their (the adult)

[10]Both the minimum wage and the wages in each job are rounded down to the nearest 50 cents, following Cengiz et al. (2019) to address potential measurement error in wages. However, our results are unaffected when we do not round hourly wages before assigning them to wage bins relative to the unrounded new minimum wage.

minimum wage.[11]

Estimating equation. We use the following regression specification to estimate the impact of the minimum wage on employment outcomes and earnings of 20–22-year-olds:

$$Y_{bat} = \sum_{b=-6}^{23} \sum_{\substack{\tau \notin \{-6,...,-1\}; \\ \tau=-30}}^{5} \beta_{b\tau} \times I_{treat} + \gamma_{ba} + \delta_{bt} + \eta_{bam} + \varepsilon_{bat}, \tag{1}$$

where b indexes wage bins relative to the new minimum wage (such that $b = 0$ includes the new minimum wage); a age-groups; t time in months; and τ month relative to treatment (such that $\tau = 0$ during the month of the reform). As such, Y_{bat} is the outcome variable for age-group a in bin b at time t. Further, m denotes calendar months. We estimate this equation separately for 20-, 21-, and 22-year-olds, each time using 23–25-year-olds as our control group. The main coefficients of interest are $\beta_{b\tau}$ for $\tau \geq 0$. These bin-specific coefficients are obtained from the treatment dummy I_{treat}, which equals 1 if the minimum wage was raised for age-group a, τ months from time t. We include up to 30 months before treatment to estimate pre-trends. Conditional on our controls, these coefficients capture the difference-in-differences estimates of the minimum wage increase on our outcome variables for each age group a in each wage bin b at each period τ, relative to the average of the six-month pre-treatment period ($\tau \in \{-6, ..., -1\}$). In our main analysis, we restrict the estimation window to the six months immediately following the reform. The reason is the wage subsidy scheme that we discussed above.

Outcome variables. We estimate the impact of the minimum wage increase on two outcome variables. The first, E_{bat}, is the monthly number of jobs in each wage bin by age-group, relative to the age-specific population. In other words, it is the age and wage-bin specific number of jobs per capita. This captures employment adjustments at the extensive margin. The second outcome variable, H_{bat}, is the age and wage-bin specific total hours worked per capita. This is defined as the monthly total hours worked in each wage bin by age-group, relative to the age-specific population.[12] This measure aims to capture potential employment adjustments both at the extensive and intensive margins. Employment and hours worked are both normalized by the age-specific population to account for possible changes in population by age that could drive

[11] In Tables A.5-A.4 in Appendix A.3 we also show results using workers aged 26–27 as a control group: results have the same sign but are larger in magnitude. We present the more conservative estimates as a baseline.

[12] The age-specific population is defined as the number of individuals of a specific age with a registered address in the Netherlands in a specific month.

changes in their number of jobs and total hours worked.

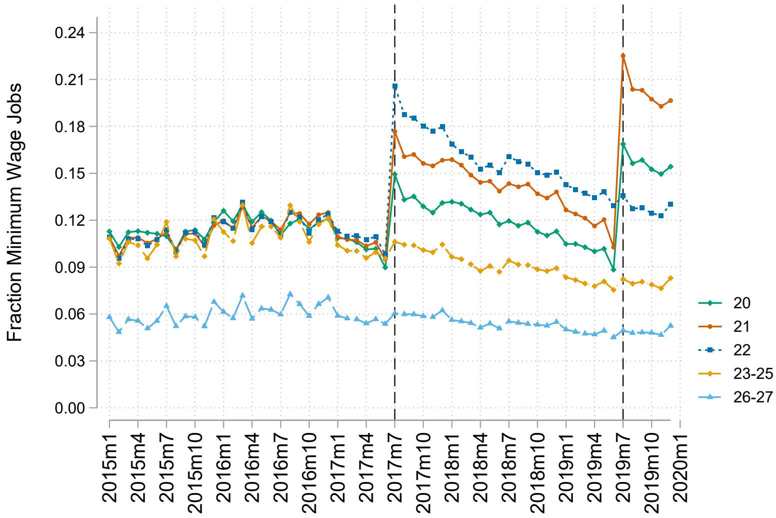
Control variables. We include a full set of wage bin by age-group fixed effects, γ_{ba}, to capture time-invariant differences in the shape of the wage distribution by age-group. Hence, we only retain changes in employment by age-group and/or wage bin over time. The specification additionally controls for any differential employment trends between treated and control groups. Specifically, we include wage bin by month fixed effects, δ_{bt}, that capture the evolution in the wage distribution shared across age-groups. To account for age and bin-specific seasonality, we also include age-group by wage bin by calendar month fixed effects η_{bam}.[13]

Main assumptions for causal identification. Causal interpretation of our estimates relies on two assumptions. First, we require the parallel trends assumption. In our case, this means that absent the reform, the change in each constituent wage bin relative to the new minimum wage should be the same for the treated and control groups. As a first check, Figure 1 shows the share of minimum wage jobs per age-group from January 2015 to December 2019. We find that prior to the first step of the reform (indicated by the first dashed line), the share of minimum wage jobs for 23–25-year-olds follows a very similar trend to the share of minimum wage jobs for 20–22-year-olds. There is a large increase in the share of minimum wage jobs following the first step of the reform, and a gradual convergence to the initial share. At the second step of the reform (indicated by the second dashed line), the share of minimum wage jobs increases again for 20–21-year-olds. As a further check on the parallel trends assumption, we estimate leading terms up to 30 months before the treatment and find no evidence of pre-trends (shown below). This strengthens our confidence in using 23–25-year-olds as a control group.

Second, we require the absence of spillover effects to our control group (i.e. the Stable Unit Treatment Value Assumption, SUTVA). Under this assumption, changes in the number of jobs and total hours worked for each age-group depend on the treatment status of that age-group alone. Violation of SUTVA would bias the estimated employment effects of the minimum wage. If, for example, firms substitute employees aged 20 with employees aged 23, because 20-year-olds are becoming more expensive due to the minimum wage increase, using 23-year-olds as a control group overestimates the job loss experienced by 20-year-olds. While choosing older age-groups as a control group may limit the threat of cross-age spillover effects, it is also less likely that the parallel trends assumption is satisfied, as shown in Figure 1 for 26–27-year olds. For this

[13] Because we estimate treatment effects up to 30 months before the treatment (i.e. January 2015), the seasonal effects are identified using variation from January 2007 up to December 2014.

Figure 1: Fraction of minimum wage jobs around the first and second step of the reform



Notes: The vertical dashed lines indicate the dates of the first and second step of the minimum wage reform.

reason, we choose 23–25-year-olds as our primary control group. As a robustness check we use 26–27-year-olds and find similar effects.[14]

4 The impact of youth minimum wages on labor market outcomes

4.1 Impact of the 2017 minimum wage increase on hours worked and number of jobs

We begin our analysis by estimating the effect of the 2017 increase in the minimum wage on the number of jobs and hours worked in each €0.50 wage bin, separately for 20-, 21-, and -22-year-olds. Figure 2 shows per wage bin the estimated impact of the minimum wage increase on hours worked. The figure presents averages of bin-specific parameters from equation 1 over the first six months following the reform. Changes are normalized by the average age-specific number of hours worked per capita over the six months prior to the reform. Hence, they should be interpreted as the change in each wage bin as a percentage of the average six-month pre-reform period total number of hours worked. For example, an increase of 5% in a given bin means that, in that bin, hours worked increased by 5% relative to total hours worked by this age group

[14] See Tables A.5-A.4 in Appendix A.3.

in the six months prior to the reform. The orange line presents running cumulative estimated effects.[15] Standard errors are calculated using the delta method.

The figure shows three main findings. First, we find no impact of the increase in the applicable minimum wage on the total hours worked by 20–22-year-olds. The cumulative impact of the minimum wage becomes statistically indistinguishable from zero beyond the wage bin €1.00 above the new minimum wage for 20-year-olds and €1.50 for 21–22-year-olds. These points correspond approximately to the 40^{th} percentile of the six-month post-treatment hourly wage distribution for 20-year-olds and the 47–50^{th} percentile for 21–22-year-olds. At the same time, we observe a clear and precisely estimated reduction in the number of hours worked in wage bins below the new minimum wage for each age-group, which shows that the minimum wage increase had a substantial bite. For all three age groups there is a decline in hours worked below the new minimum wage of about 15% of total pre-reform employment. When moving further up the wage distribution, the cumulative impact of the minimum wage turns slightly positive for all treated age-groups. However, these positive effects are small and fade out as we move further along the wage distribution.

Second, the total hours worked in wage bins at the new minimum wage increases, creating a spike at the bin containing the minimum wage. This evidence is consistent with some jobs being preserved and experiencing a wage increase in accordance with the higher legislated minimum wage.

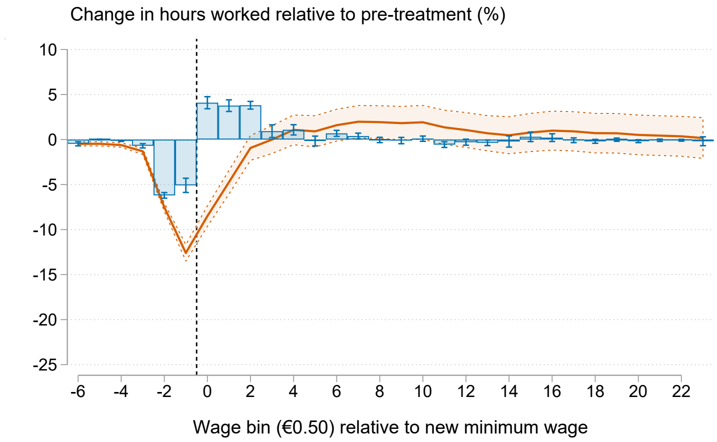
Third, we find evidence of substantial spillover effects to jobs above the minimum wage: the number of hours worked does not just increase right above the minimum wage, but also in bins somewhat further up the distribution. These spillovers fade out when moving further up the wage distribution. For each treated age-group, the impact of the minimum wages has largely faded out beyond €4 above the minimum wage. The largest adjustment occurs up to €2.50 above the new minimum wage. Over 90% of the spillover effects occur within wage bins up to €2.50 above the new minimum. This point corresponds to approximately the 64^{th} percentile of the six-month post-treatment hourly wage distribution. These findings are in line with previous studies finding spillover effects up to €2 – €3 above the minimum wage (e.g. Brochu et al., 2018; Cengiz et al., 2019; Gopalan et al., 2020; Harasztosi and Lindner, 2019).

[15] The line is constructed by calculating the running sum of the estimated effects up to each bin. For example, at 2 euros above the new minimum wage, the orange line shows the total change in hours worked (relative to total hours worked in the six months prior to the reform) following the reform for bins up to 2 euros above the new minimum wage.

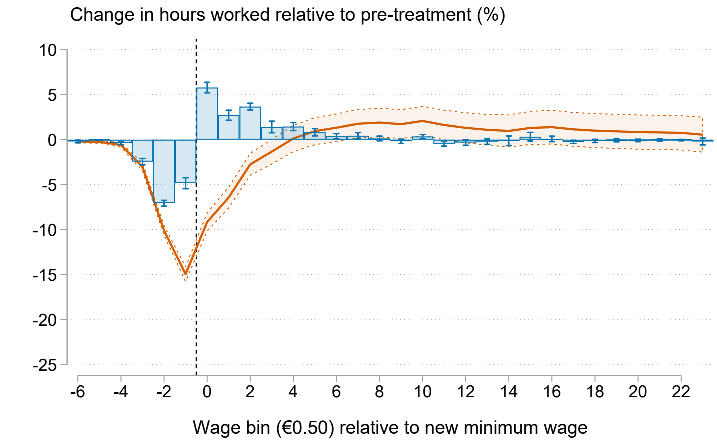
We perform a corresponding analysis for the number of jobs, shown in Figure 3. We find that the reallocation of jobs around the new minimum wage broadly mirrors the results for the total hours worked. However, for each treated age-group, the cumulative impact of the minimum wage on the number of jobs held by 20–22-year-olds becomes statistically indistinguishable from zero beyond the wage bin €2 above the new minimum wage and remains statistically insignificant beyond this point in the hourly wage distribution. As with total hours worked, the minimum wage had a substantial bite. The reduction in jobs below the new minimum wage is slightly larger compared to the reduction in total hours, reflecting that low-wage youth workers work relatively fewer hours. As with hours worked we find substantial spillover effects, with the vast majority occurring within wage bins up to €2.50 above the new minimum wage.

Figure 2: Impact of 2017 minimum wage increase on number of hours worked by wage bin

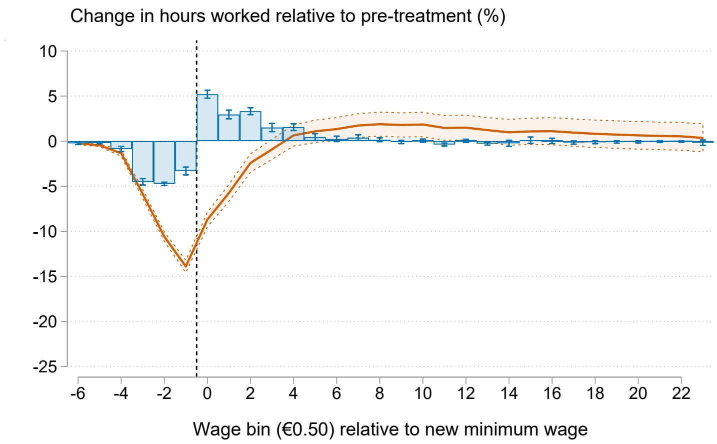
(a) 20-year-olds



(b) 21-year-olds



(c) 22-year-olds



Notes: The solid vertical line is positioned at the new age-specific minimum wage. The bars show the estimated average change in total hours worked in each €0.50 wage-bin over the 6-month post-treatment period relative to average the total hours worked over the six-months before treatment. The error bars show the 95% confidence interval using robust standard errors. The horizontal line shows the running sum of estimated changes up to the wage bin it corresponds to. The shaded area shows the 95% confidence interval of the running sum.

4.2 Dynamic impacts

We continue our analysis by tracing the impact of the minimum wage increase resulting from the July 2017 reform month-by-month from January 2015 to right before the start of the second step of the reform, June 2019. This exercise serves a dual purpose. First, we can assess the presence of preexisting trends by examining leading terms. Second, by tracing the impact of the minimum wage over the months following the reform, we can document potential dynamic treatment effects. While we find no short-term impact of the reform, the mid- and long-term impact may differ if firms face adjustment costs (Aaronson et al., 2018; Sorkin, 2015). Therefore, we may underestimate potential employment losses when focusing on the six-month post-reform period.

For this analysis we extend our primary sample to June 2019 and estimate a model similar to equation 1, but now including terms up to $\tau = 23$. We subsequently sum the estimated $\beta_{b\tau}$ over the wage bins below the new minimum wage ($-6 \leq b \leq -1$), and over the wage bins including the new minimum wage up to €4.00 above the new minimum wage ($0 \leq b \leq 8$). We choose €4.00, because we found that there are no spillovers beyond this point. Changes are normalized by age-specific employment per capita in the month prior to the reform.

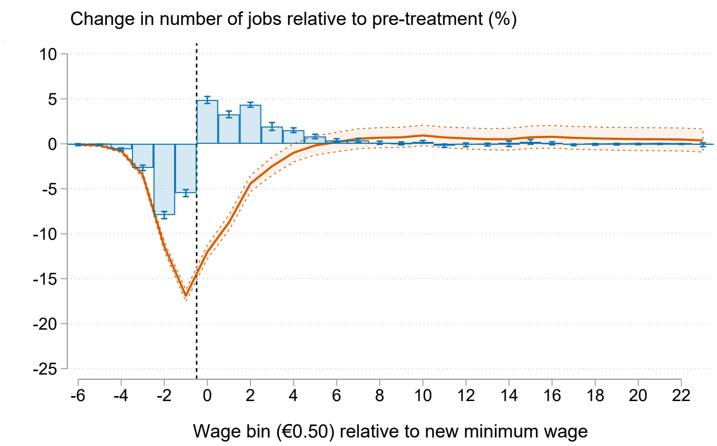
Figure 4 shows the month-by-month changes in missing- and excess total hours worked by the treated age-groups.[16] First, we find no evidence of pre-trends up to 30 months before the reform, indicating that low-wage workers aged 20–22 are on parallel trends with low-wage workers aged 23–25, conditional on our controls. Moreover, the absence of pre-trends indicates that there are no anticipatory effects. Second, there is a sharp decline in missing hours worked and a sharp increase in excess hours worked at the time of treatment. The employment response remains relatively stable over the entire period of the reform. This suggests that the adjustment occurs immediately, and our 'short-term' baseline results discussed in the previous section are informative in the longer run, as well.

[16]See Figure A.1 in Appendix A.2.1 for the corresponding figures for the total number of jobs.

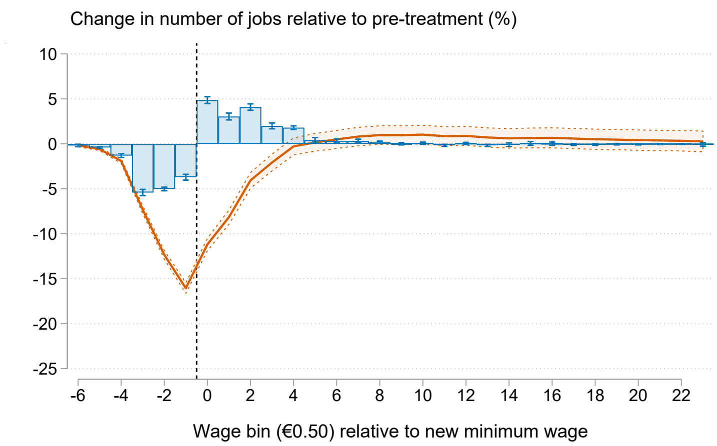
Figure 3: Impact of 2017 minimum wage increase on number of jobs by wage bin

(a) 20-year-olds

(b) 21-year-olds



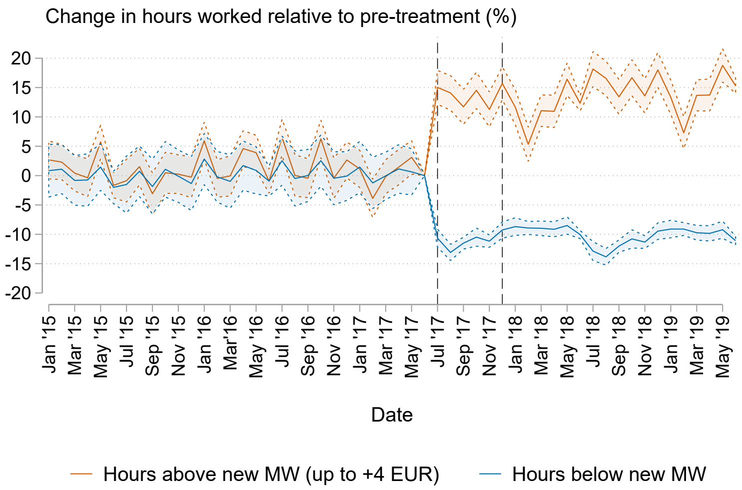
(c) 22-year-olds



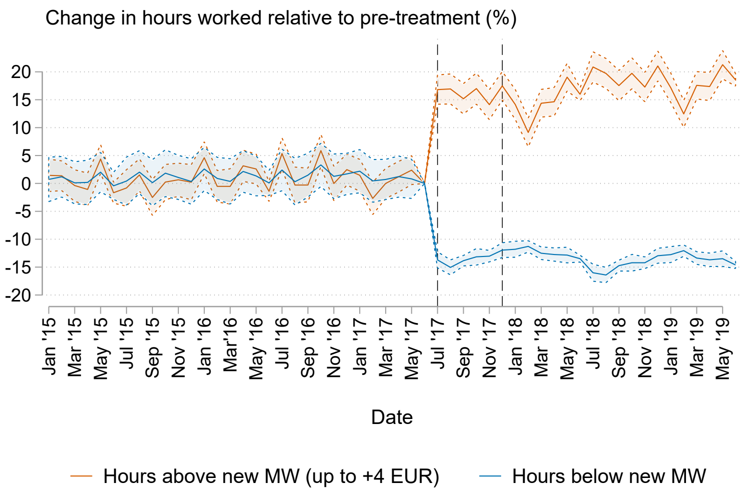
Notes: The solid vertical line is positioned at the new age-specific minimum wage. The bars show the estimated average change in the total number of jobs in each €0.50 wage-bin over the 6-month post-treatment period relative to average the total number of jobs over the six-months before treatment. The error bars show the 95% confidence interval using robust standard errors. The gray line shows the running sum of estimated changes up to the wage bin it corresponds to. The shaded area shows the 95% confidence interval of the running sum.

Figure 4: Impact of the 2017 minimum wage increase on number of hours worked over time

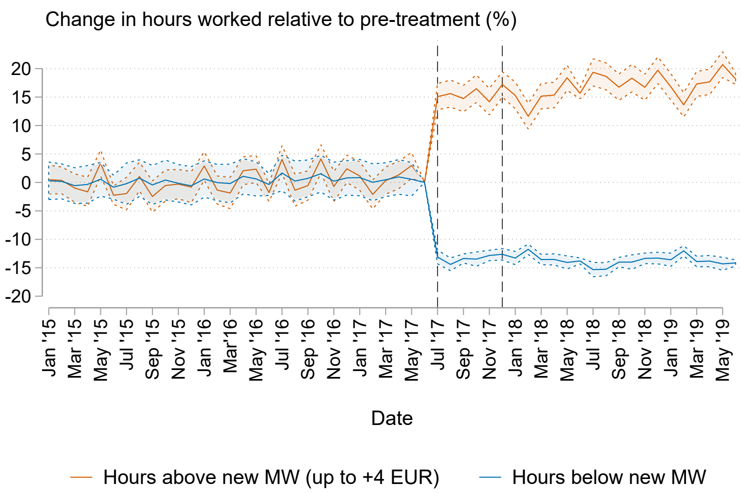
(a) 20-year-olds



(b) 21-year-olds



(c) 22-year-olds



Notes: The graph plots estimates of the change in hours worked above the new MW and hours worked below the new MW in a month, relative to June 2017, the month before the first minimum wage increase. The shaded areas show the 95% confidence interval. Vertical dashed lines show the 6-month period used to infer the short-term impact of the minimum wage increase.

4.3 Quantifying employment elasticities and spillover shares

As is common in the literature, we can use our results to calculate the overall short-term impact of the minimum wage increase on age-specific employment and the elasticities with respect to the minimum wage and the own wage. We use the estimated six-month average changes in the number of jobs and hours worked up to a point in the post-reform age-specific wage distributions where the impact of the minimum wage fades out, which we call $\overline{W}$. Since we found no evidence of spillovers beyond €4.00 above the minimum wage, we will choose $\overline{W} = 4$ at baseline.[17] The results are reported in Table 4 for hours worked and Table 5 for jobs. For each estimate the standard errors are calculated using the delta method.

We find that the increase in the minimum wage increased total hours worked by 2% for 20-year-olds and by 1.8–1.9% for 21–22-year-olds when considering changes up to €4.00 above the new minimum wage (first row of Table 4). In line with this, the elasticity of total hours worked to the minimum wage (Minimum Wage Elasticity or MWE) is positive, ranging between 0.142 and 0.097. The 95% confidence interval rules out MWEs below 0.013, 0.012, and 0.024 for 20-, 21-, and 22-year-olds. For jobs we can rule out MWEs below below -0.032, -0.031 and -0.012 for 20-, 21-, and 22-year-olds (second row in Table 5). Note that this is a short-term elasticity and hence may understate the long-term responsiveness of overall low-wage employment if firms face adjustment costs. However, we find no substantial decline in low-wage employment in the 24 months following the reform (cf. Figure 4), suggesting that any such adjustments have already been made.

A disadvantage of the MWE is that it is difficult to compare across studies because the minimum wage may have a different bite in different settings. To facilitate direct comparisons of our findings to those reported in the literature, we therefore calculate the implied own-wage elasticity (OWE), which measures the responsiveness of employment to a change in the average wage. The OWE effectively normalizes the MWE by the change in the average wage due to the minimum wage increase. This recognizes that a more binding minimum wage increase tends to have a larger impact on the average wage.

The fourth rows in Tables 4 and 5 show that the increase in the minimum wage had a significant impact on average wages, with elasticities between 0.288 and 0.217 for the estimates based on hours and between 0.253 and 0.308 for the estimates based on jobs. We obtain the

[17] Tables A.5–A.4 in Appendix A.3 report the results for different threshold values $\overline{W}$.

own-wage elasticity of low-wage hours worked by dividing the estimated change in low-wage employment up to €4.00 above the new minimum wage by the change in the average wages up to this point in the distribution. Results are reported in the third rows in Tables 4 and 5, showing estimated OWEs of total hours worked between 0.519 and 0.626 and of jobs between 0.144 and 0.225. Note that although the estimates are imprecise, the 95% confidence interval clearly rules out OWEs below -1 for both hours and jobs. This implies that total earnings increased for each affected age-group.

Our findings are most directly comparable to studies that also examine the impact of changes in youth minimum wages. Here, the lack of any adverse employment effects and small increase in hours worked are in line with Hyslop and Stillman (2007), who study the impact of an age-specific minimum wage reform in New Zealand on workers aged 16–19 over 2001–2002. Their implied MWEs of weekly hours worked are 0.49 for 16–17-year-olds and 0.09 for 18–19-year-olds.[18] On the other hand, Pereira (2003) finds that the 1987 repeal of a lower minimum wage for 18–19-year-olds in Portugal had a negative impact on the relative employment and hours worked of this age-group. The reported MWEs between -0.4 and -0.2 are well outside the 95% confidence interval of MWEs for 20–22-year-olds found in our setting. However, the Portuguese reform resulted in a 35.5% increase in the real minimum wage, reflecting an increase almost twice the size of the one we study.

Looking beyond studies considering age-specific minimum wages, our results are consistent with recent studies on the impact of changes in the general minimum wage on teenage employment which generally find no or modest effects (e.g. Allegretto et al., 2017, 2011; Cengiz et al., 2019; Dube et al., 2016; Gittings and Schmutte, 2016). On the other hand, our estimated MWEs are well outside the range of those reported in some recent studies that find a negative impact of general minimum wage increases on teenage employment (e.g. Neumark et al., 2014a,b; Sabia et al., 2012, 2016; Thompson, 2009).[19]

Lastly, we quantify the relative importance of the spillover effects we found in the total wage impact, following the approach of Cengiz et al. (2019). First, we compute a counterfactual change that would occur if there were no spillover effects. This is the wage increase that results

[18] Implied elasticities are not reported by Hyslop and Stillman (2007) but computed by Belman and Wolfson (2014).

[19] For an extensive overview of this literature see Belman and Wolfson (2014); Dube (2019); Neumark and Wascher (2008). For recent meta-studies see Belman and Wolfson (2014); Doucouliagos and Stanley (2009); Wolfson and Belman (2019).

from moving the jobs that were initially below the new minimum wage to right at the new minimum wage.[20] Next, we infer the spillover share of the total wage impact by taking the difference between the actual and 'no spillover' wage increase. We find that in the absence of spillovers, wages would increase by 0.9%, 1.1% and 1.2% for 20-, 21-, and 22-year-olds, respectively. Results for employment rather than hours worked are very similar, as seen in Table 5. This implies spillovers are quantitatively important, constituting between 68 and 77 percent of the total found wage gains resulting from the 2017 minimum wage increase.

Table 4: Quantifying effects of the 2017 minimum wage increase on hours worked

	Workers Aged 20	Workers Aged 21	Workers Aged 22
Δ Total Hours	0.020**	0.018**	0.017***
	(0.009)	(0.008)	(0.007)
Minimum-Wage Elasticity (MWE)	0.142**	0.102**	0.097***
	(0.066)	(0.046)	(0.038)
Own-Wage Elasticity (OWE)	0.626**	0.519**	0.578***
	(0.283)	(0.229)	(0.218)
Wage Elasticity wrt MW	0.288***	0.253***	0.217***
	(0.015)	(0.010)	(0.008)
Δ Average Wage	0.040***	0.044***	0.039***
	(0.002)	(0.002)	(0.001)
Spillover Share	0.773***	0.754***	0.683***
	(0.015)	(0.011)	(0.012)

Notes: Robust standard errors in parentheses. For rows 3–6 the standard errors are obtained using the delta method. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Columns 2–4 report the estimated effects of the increase in the age-specific minimum wage based on a $\overline{W}$ threshold level of €4.00 above the new minimum wage. Estimates are obtained using January-June 2017 as reference period and using 23–25-year-olds as control group, Elasticities with respect to the minimum wage are based on increase in the real minimum wage of 14.9%, 18.3% and 18.7% for 20–22-year-olds, respectively, minus the increase in the real minimum wage for adults of 0.9%. All estimates are based on around 82 million monthly job spells collapsed to 15,840 *age* × *wage-bin* × *month* cells.

[20]For more details, see Appendix A.5

Table 5: Quantifying effects of the 2017 minimum wage increase on jobs

	Workers Aged 20	Workers Aged 21	Workers Aged 22
Δ Total Jobs	0.006	0.006	0.008
	(0.006)	(0.006)	(0.005)
Minimum-Wage Elasticity (MWE)	0.047	0.032	0.045
	(0.040)	(0.032)	(0.029)
Own-Wage Elasticity (OWE)	0.188	0.144	0.225
	(0.160)	(0.144)	(0.144)
Wage Elasticity wrt MW	0.308***	0.282***	0.253***
	(0.010)	(0.007)	(0.006)
Δ Average Wage	0.043***	0.049***	0.045***
	(0.001)	(0.001)	(0.001)
Spillover Share	0.777***	0.755***	0.676***
	(0.008)	(0.007)	(0.008)

Notes: Robust standard errors in parentheses. For rows 3–6 the standard errors are obtained using the delta method. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Columns 2–4 report the estimated effects of the increase in the age-specific minimum wage based on a $\overline{W}$ threshold level of €4.00 above the new minimum wage. Estimates are obtained using January-June 2017 as reference period and using 23–25-year-olds as control group, Elasticities with respect to the minimum wage are based on increase in the real minimum wage of 14.9%, 18.3% and 18.7% for 20–22-year-olds, respectively, minus the increase in the real minimum wage for adults of 0.9%. All estimates are based on around 82 million monthly job spells collapsed to 15,840 *age* × *wage-bin* × *month* cells.

4.4 Comparison to the 2019 minimum wage increase

We repeat the analysis using variation in the minimum wage for 20–21-year-olds induced by the July 2019 reform (recall that 22-year-olds were already at the adult minimum wage, so that nothing changed for them in 2019). For this analysis we extend our primary sample to December 2019. We assign jobs to €0.50 wage bins based on the difference between the hourly wage and the age-specific minimum wage effective July 2019, and estimate equation (1) separately for 20–21-year-olds.[21]

Figure 5 shows the impact of the minimum wage increase for 20–21-year-olds as the six-month averaged change in the number of hours worked in each wage bin, normalized by the average age-specific number of hours worked per capita over the six months prior to the reform (January–June 2019). Similar to the 2017 reform, the increase in the minimum wage for 20–21-year-olds did not result in a decline in employment for the treated age-groups. The cumulative impact of the minimum wage is positive beyond €2.50 above the new minimum, but converges to zero again after around €7 above the new minimum wage. For both treated age-groups,

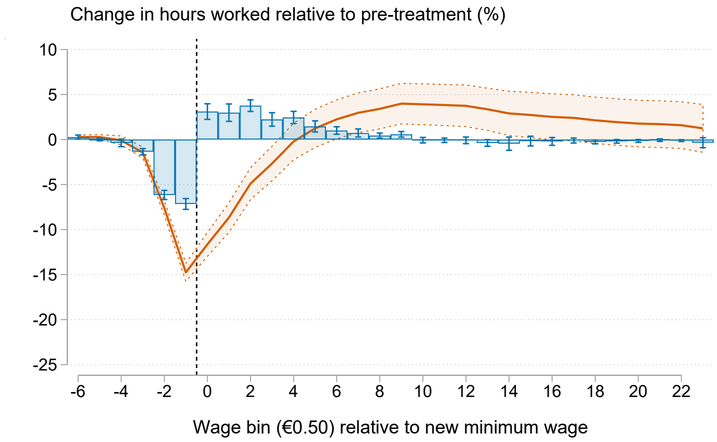
[21] We continue to estimate leading terms starting in January 2015, such that the included leading terms now start at $\tau = -54$ instead of $\tau = -30$

there is a clear reduction in hours worked in wage bins below the new minimum wage, which shows that the additional increase in the minimum wage for 20–21-year-olds had a substantial bite. In line with our findings for the 2017 reform, we observe a spike in hours worked at the minimum wage and additional increases in hours worked in wage bins above the new minimum wage for both treated age-groups. Just as with the 2017 reform, the cumulative impact of the minimum wage on the number of low-wage jobs is statistically indistinguishable from zero for both treated age-groups.[22] Overall, we conclude that employment effects for treated age groups from both of these minimum wage reforms were very similar.

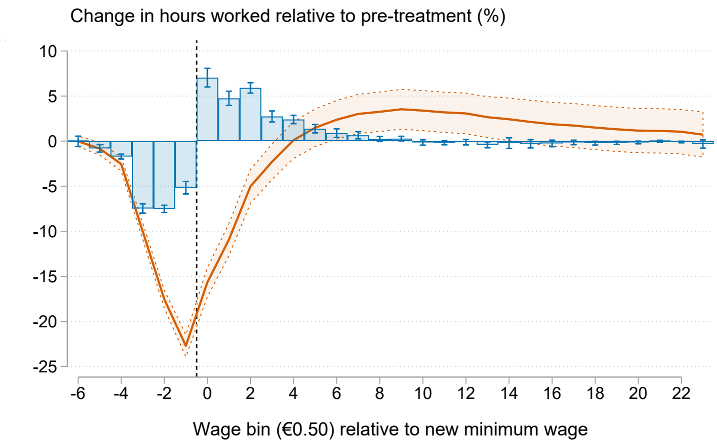
[22] See Figure A.2 in Appendix A.2.2

Figure 5: Impact of 2019 minimum wage increase on number of hours worked by wage bin

(a) 20-year-olds



(b) 21-year-olds



Notes: The solid vertical line is positioned at the new age-specific minimum wage. The bars show the estimated average change in the total hours worked in each €0.50 wage-bin over the 6-month post-treatment period relative to average the total hours worked over the six-months before treatment. The error bars show the 95% confidence interval using robust standard errors. The vertical line shows the running sum of estimated changes up to the wage bin it corresponds to. The shaded area shows the 95% confidence interval of the running sum.

5 Effect heterogeneity

Although we find zero or even slightly positive employment effects of the minimum wage reform, there may be underlying heterogeneity which potentially hides adverse outcomes for some groups of workers. Of particular concern would be a rising incidence of flexible work arrangements; potentially more adverse effects in specific industries with a high incidence of low-wage employment; and any adverse impacts concentrated among workers who are not transitory occupants of minimum-wage jobs. We study these in turn.

5.1 Heterogeneity by contract type

Even absent negative employment impacts, employment could shift towards more flexible arrangements in response to minimum wage increases, which could still leave some workers worse off.[23] This is of particular concern in the Netherlands, where flexible work arrangement have become very common over the past twenty years (CBS, 2020).

We therefore continue our analysis by dissecting the impact of the minimum wage on employment changes across different contract types. Specifically, we distinguish between fixed-term and permanent contracts, part-time and full-time contracts, and on-call, temp agency or regular contracts. These contracts can overlap in different ways: e.g. one worker could be on a fixed-term, part-time, regular contract and another could be on a permanent, part-time, on-call contract.[24] Using our primary sample, we collapse the number of jobs and total hours worked in each contract type to the age-wage-bin-month level. For each age by wage bin pair, employment in each contract type sums to total age-bin employment. We estimate equation (1), using age-specific employment in a contract type in bin b at time t, relative to the age-specific population, as our outcome variable.

First, we find some evidence of a rise in flexible employment arrangements for workers subject to the minimum wage increase relative to the control group, as shown in Table 6. In particular, we find an increase in hours worked in fixed-term and temp agency work contracts. At the same time, however, we also find an increase in full-time contracts. This suggests that the small number of additional hours worked up to €4.00 above the new minimum wage are in temp agency, fixed-term, and full-time contracts. Most importantly, we do not find a corresponding decline in other types of contracts, implying the expansion in these contract types is not coming at the expense of others. Second, the increase in total hours worked in full-time and temp agency work is partially driven by an increase along the extensive margin as well.[25]

5.2 Heterogeneity by industry

We continue exploring effect heterogeneity by zooming in on several industries that together account for the largest share of low-wage employment for 20–22-year-olds. These are Wholesale;

[23] See Datta et al. (2020) for evidence that the minimum wage can lead to a shift to alternative work arrangements.

[24] Specifically, the mutually exclusive contract types we distinguish are: part-time vs. full-time; fixed-term vs. permanent; and on-call vs. temp agency vs. regular contracts.

[25] Results for employment in number of jobs are reported in Table A.2.3 in the Appendix.

Table 6: Effects on hours worked by job characteristic

	Workers Aged 20	Workers Aged 21	Workers Aged 22
Fixed-term contract	0.024***	0.018**	0.017***
	(0.008)	(0.007)	(0.006)
Permanent contract	0.010	0.016	0.018
	(0.019)	(0.014)	(0.011)
Full-time	0.041**	0.035**	0.023**
	(0.018)	(0.013)	(0.010)
Part-time	0.007	0.004	0.011**
	(0.007)	(0.006)	(0.006)
On-call	0.016	0.011	0.011
	(0.010)	(0.009)	(0.009)
Temp agency work	0.052***	0.037***	0.038***
	(0.012)	(0.010)	(0.009)
Regular	0.016	0.016	0.015**
	(0.012)	(0.010)	(0.008)

Notes: The table groups the rows by mutually exclusive contract types (i.e. fixed-term and permanent; full-time and part-time; on-call, temp agency and regular). Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Columns 2-4 report the estimated effects of the increase in the age-specific minimum wage based on a $\overline{W}$ threshold level of €4.00 above the new minimum wage. Estimates are obtained using January-June 2017 as reference period and using 23–25-year-olds as control group. Estimates are based on around 82 million job spells. All monthly job spells collapsed to 15,840 *age* × *wage-bin* × *month* cells.

Retail; Food and Beverage Services; and Employment Placement, Temporary Employment Provision and Payrolling (labeled 'Temp' in Table 7). We include all other industries as a separate category, labeled 'Other' in Table 7. We estimate equation (1) separately for these industries.

The minimum wage reform had a heterogeneous impact across industries, as seen from Table 7. Most prominently, and in line with the results on contract types, across all age groups we find an increase in hours worked in temp agency work. For 20-year-olds we also find an increase in wholesale and for 22-year-olds we find a small increase in hours worked in food and beverage services. However, importantly, we do not find negative effects on hours worked for any of these most-exposed industries: any negative point estimates are very small and never statistically significant. The minimum wage reform had the largest bite in the food and beverages industry, where average wages increased by 6 to 7%. It had the smallest bite in temp agency work, where average wages increased by around 4%. For each industry we can confidently rule out own-wage elasticities below −1, with the most negative point estimate being for retail for 22-year-olds at −0.212, but with a standard error of 0.289. We find that the number of jobs declined somewhat in food and beverage services for 20-year-olds, with a statistically significant implied own-wage elasticity of −0.359, but an increase in jobs in temp agency work for the same age group. We find no other impacts on the number of jobs.[26]

Table 7: Effect heterogeneity across industries

	Wholesale	Retail	Food	Temp	Other
Panel A: 20-year-olds					
Δ Total Hours	0.040**	−0.002	−0.012	0.026***	0.034***
	(0.019)	(0.016)	(0.012)	(0.010)	(0.012)
Minimum-Wage Elasticity (MWE)	0.290**	−0.014	−0.088	0.187***	0.242***
	(0.135)	(0.112)	(0.086)	(0.073)	(0.088)
Own-Wage Elasticity (OWE)	1.514**	−0.087	−0.254	0.939***	1.812***
	(0.697)	(0.424)	(0.220)	(0.382)	(0.636)
Wage elasticity wrt MW	0.233***	0.274***	0.400***	0.263***	0.188***
	(0.030)	(0.021)	(0.013)	(0.020)	(0.028)
Δ Average Wage	0.032***	0.038***	0.056***	0.037***	0.026***
	(0.004)	(0.003)	(0.002)	(0.003)	(0.004)
Panel B: 21-year-olds					
Δ Total Hours	0.004	0.004	0.003	0.021**	0.025***
	(0.016)	(0.015)	(0.012)	(0.009)	(0.010)
Minimum-Wage Elasticity (MWE)	0.022	0.023	0.018	0.123**	0.145***
	(0.090)	(0.088)	(0.070)	(0.054)	(0.056)
Own-Wage Elasticity (OWE)	0.105	0.117	0.056	0.704**	1.301***
	(0.385)	(0.284)	(0.178)	(0.295)	(0.460)
Wage elasticity wrt MW	0.269***	0.339***	0.402***	0.228***	0.169***
	(0.018)	(0.015)	(0.009)	(0.012)	(0.015)
Δ Average Wage	0.047***	0.059***	0.070***	0.040***	0.029***
	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)
Panel C: 22-year-olds					
Δ Total Hours	0.017	−0.012	0.022**	0.030***	0.021***
	(0.013)	(0.014)	(0.011)	(0.008)	(0.008)
Minimum-Wage Elasticity (MWE)	0.095	−0.070	0.122**	0.170***	0.115***
	(0.071)	(0.080)	(0.062)	(0.045)	(0.043)
Own-Wage Elasticity (OWE)	0.425	−0.212	0.312**	1.016***	1.250***
	(0.383)	(0.289)	(0.172)	(0.235)	(0.416)
Wage elasticity wrt MW	0.222***	0.321***	0.378***	0.220***	0.142***
	(0.014)	(0.014)	(0.008)	(0.008)	(0.011)
Δ Average Wage	0.040***	0.057***	0.067***	0.039***	0.025***
	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)

Notes: Robust standard errors in parentheses. For rows 3–5 the standard errors are obtained using the delta method. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Columns 2-6 report the estimated effects of the increase in the age-specific minimum wage based on a $\overline{W}$ threshold level of €4.00 above the new minimum wage. Estimates are obtained using January-June 2017 as reference period and using 23–25-year-olds as control group. Elasticities with respect to the minimum wage are based on increase in the real minimum wage of 14.9%, 18.3% and 18.7% for 20–22-year-olds, respectively, minus the increase in the real minimum wage for adults of 0.9%. Wholesale is wholesale trade, Retail is retail trade, Food is food and beverage service activities (not hotels), Temp is employment placement, temporary employment provision and payrolling. Estimates for wholesale trade are based on around 3.8 million job spells. Estimates for retail trade are based on around 10.5 million job spells. Estimates for food and beverages are based on around 5.5 million job spells. Estimates for employment placement, temporary employment provision and payrolling are based on around 12.8 million job spells. Estimates for remaining industries are based on around 48 million job spells. All monthly job spells collapsed to 15,840 *age* × *wage-bin* × *month* cells.

[26] Table A.2 in the Appendix A.2.4 reports the estimated employment effects in jobs, as well as the implied MWEs and OWEs, for each age-group per industry.

5.3 Heterogeneity by demographics

Lastly, we study the extent of labor-labor substitution within age-groups by looking at different demographic groups.[27] Specifically, we estimate our baseline model separately for students and non-students; females and males; and workers with and without a migration background.[28] Results are shown in Table 8.[29]

We find no evidence of labor-labor substitution in hours worked between groups: none of the groups we study experience a decline in working hours following the minimum wage reform. However, we do find that most of the additional hours worked following the reform are worked by non-students, males, and people without a migration background. The minimum wage had the largest bite for students, whose hourly wages increase by around 4 to 5% on average. For jobs, we do uncover some evidence of labor-labor substitution between students and non-students for 20-year-olds, with a decline of about 1.3% for students and an increase of 4.1% for non-students. For 21- and 22-year-olds we find small increases in the number of jobs for non-students, but no corresponding declines for students. Overall, these results suggest little labor-labor substitution, and more favorable employment outcomes for workers who are not enrolled in education and therefore likely less transient occupants of minimum-wage jobs.

[27] Recent studies uncover mixed evidence of labor-labor substitution in the US, with Cengiz et al. (2019) finding no such effects, but Giuliano (2013) showing an increase in teenage employment relative to older workers following an overall minimum wage increase and Horton (2018) showing an increase in hours worked of more productive workers on online platforms.

[28] An individual with a migration background was either born in a foreign country, or one of their parents was born in a foreign country.

[29] Result for jobs are reported in Table A.3 in Appendix A.2.5.

Table 8: Effect heterogeneity across demographic groups

	Student	Non-student	Female	Male	Migration background	No migration background
Panel A: 20-year-olds						
Δ Total Hours	−0.009	0.046***	0.016	0.023**	−0.004	0.026***
	(0.007)	(0.015)	(0.011)	(0.009)	(0.009)	(0.010)
Minimum-Wage Elasticity (MWE)	−0.065	0.331***	0.116	0.161**	−0.030	0.184***
	(0.047)	(0.107)	(0.078)	(0.064)	(0.066)	(0.069)
Own-Wage Elasticity (OWE)	−0.274	1.606***	0.528	0.694***	−0.144	0.800***
	(0.198)	(0.515)	(0.347)	(0.264)	(0.319)	(0.291)
Wage elasticity wrt MW	0.289***	0.274***	0.280***	0.293***	0.264***	0.293***
	(0.013)	(0.023)	(0.020)	(0.015)	(0.016)	(0.017)
Δ Average Wage	0.040***	0.038***	0.039***	0.041***	0.037***	0.041***
	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
Panel B: 21-year-olds						
Δ Total Hours	0.010	0.022**	0.012	0.022***	0.006	0.020**
	(0.006)	(0.010)	(0.009)	(0.008)	(0.008)	(0.008)
Minimum-Wage Elasticity (MWE)	0.057	0.128**	0.070	0.127***	0.037	0.118**
	(0.037)	(0.060)	(0.051)	(0.047)	(0.048)	(0.048)
Own-Wage Elasticity (OWE)	0.224	0.775**	0.350	0.656***	0.188	0.599**
	(0.147)	(0.353)	(0.250)	(0.235)	(0.247)	(0.237)
Wage elasticity wrt MW	0.304***	0.221***	0.265***	0.245***	0.244***	0.255***
	(0.009)	(0.013)	(0.012)	(0.011)	(0.010)	(0.011)
Δ Average Wage	0.053***	0.038***	0.046***	0.043***	0.042***	0.044***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Panel C: 22-year-olds						
Δ Total Hours	0.008	0.021***	0.018***	0.017**	0.008	0.020***
	(0.006)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
Minimum-Wage Elasticity (MWE)	0.046	0.116***	0.102***	0.093**	0.045	0.110***
	(0.034)	(0.044)	(0.038)	(0.041)	(0.039)	(0.039)
Own-Wage Elasticity (OWE)	0.189	0.827***	0.589***	0.567**	0.241	0.672***
	(0.140)	(0.301)	(0.215)	(0.243)	(0.209)	(0.232)
Wage elasticity wrt MW	0.294***	0.186***	0.225***	0.210***	0.228***	0.213***
	(0.007)	(0.009)	(0.008)	(0.009)	(0.007)	(0.008)
Δ Average Wage	0.052***	0.033***	0.040***	0.037***	0.041***	0.038***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)

Notes: Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Columns 2-7 report the estimated effects of the increase in the age-specific minimum wage based on a $\overline{W}$ threshold level of €4.00 above the new minimum wage. Estimates are obtained using January-June 2017 as reference period and using 23–25-year-olds as control group. Estimates for students are based on around 25 million job spells. Estimates for non-students are based on around 56 million job spells. Estimates for female are based on about 41 million job spells. Estimates for men are based on around 40 million job spells. Estimates for individuals with a migration background are based on about 17 million job spells. Estimates for individuals without a migration background are based on about 65 million job spells. All monthly job spells collapsed to 15,840 *age* × *wage-bin* × *month* cells.

6 Conclusion

We study the employment impacts of a sizable minimum wage increase for young workers, using a differences-in-differences approach combined with detailed administrative data from the Netherlands. We find no evidence that the minimum wage has reduced the number of jobs held or total hours worked by affected workers. In fact, we find small positive effects on hours worked for some subgroups. The robust absence of negative effects is in part due to substantial spillover effects from the minimum wage further up the wage distribution, accounting for more than 75% of the total wage increase. Our results clearly rule out own-wage elasticities below -1, indicating that the minimum wage increase led to a rise in overall earnings for affected workers. We find that most of the hours increase occurs in full-time jobs and for non-student workers, which suggests that workers who rely on low-wage jobs for a living are more positively impacted by the policy.

The absence of negative employment effects of the minimum wage is consistent with a low demand elasticity for young workers, for example because demand for goods and services produced by minimum wage workers is inelastic (such that consumers effectively pay for the minimum wage increase), because firms' profit margins decrease, or because minimum wage workers are a small share of firms' total costs. It could also be explained by models of imperfect labor market competition, which predict such effects if the minimum wage is not set too high. These models include efficiency wages (e.g. Rebitzer and Taylor, 1995) and models incorporating various sources of monopsony power through frictions (e.g. see Burdett and Mortensen, 1998; Manning, 2003). While we do not distinguish specific mechanisms, our finding that in particular non-student, full-time workers are seeing increases in hours worked is consistent with firms focusing on more stable and productive employment relationships following the minimum wage increase, as would be predicted by some variants of these models.

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A Appendices

A.1 The 2018 wage subsidy for young workers

We have restricted our main analysis to six months after the 2017 reform. The primary reason is that effective January 2018, firms receive a wage subsidy as a temporary compensation for the increase in labor costs induced by the increase in the minimum wage for 18–21-year-olds. The subsidy (called *jeugd lageinkomensvoordeel*, or JLIV) gives firms a lump-sum payment based on the hours worked by youth workers around the minimum wage in the previous year. This means that firms received the first payment in 2019 which compensated for hours worked in 2018. There is no direct compensation for 2017. However, in 2018 the subsidy was increased by 50% and this was stated to compensate for the minimum wage increase in 2017. Hence, firms receive the compensation *ex post* 18 months after their wage payments in 2017, but only if they keep the same number of hours worked around the minimum wage in 2018 as they did in 2017. In 2018, because of the increase in the subsidy amount, the subsidy was around 120% of the increase in the minimum wage for 18–21-year-olds. Subsidy amounts were lowered in 2019 and 2020 and the subsidy will be abolished in 2024.

If firms took into account the subsidy they would receive in 2019 when making employment decisions in early 2017, this would mean we would underestimate any potential negative effects of the minimum wage increase. There are however several reasons we believe our results are unlikely to be biased by the subsidy.

First, more than 75% of the increase in the average wage for 20–21-year-olds is driven by spillover effects, rather than by workers precisely at the minimum wage. Firms are not eligible for subsidies for these workers. This means that most of the increase in labor costs is borne by firms themselves. Second, we find that the impacts of the minimum wage increase are very similar between 22-year-olds and 20- and 21-year-olds, but 22-year-olds were ineligible for the subsidy.[30] Third, the subsidy only compensates firms for the increase in gross wages for 20–21-year-old minimum wage workers and not for other wages components (e.g. holiday allowance and contributions to the employee insurance). This lowers the effective compensation in labor costs. Fourth, we obtain our results in a setting where firms can easily adjust their employment due to the high share of temporary and flexible contracts for young workers. There is also evidence that Dutch firms do in fact adjust their employment quickly to increased labor costs: Kabátek (2020) shows that firms are more likely to lay off workers in the month of their birthday when they become eligible for a higher tier of the minimum wage. Fifth, we find that our results remain stable over time even when the subsidy was effectively introduced in 2018 and paid out in 2019. We also find similar results for the second step of the reform in 2019, when the subsidy was already lower, and when 21-year-olds were no longer eligible for the subsidy.

Finally, employment in these low-wage sectors is quite volatile and hence so is receipt of the wage subsidy. Due to the lag in the receipt of the subsidy, it is not always targeted towards firms that were affected by the minimum wage increase: data on receipt of the JLIV subsidy supports this. First, 6.3% of firms that receive JLIV in 2018 were started after the minimum wage increase in 2017. Second, 33% of firms that existed before July 2017 and that receive JLIV in 2018, would not have received JLIV in 2017 based on their workforce and wages. Third, 35% of firms that would have received JLIV in 2017 based on their workers and wages if it would have compensated in 2017, did not receive JLIV in 2018.

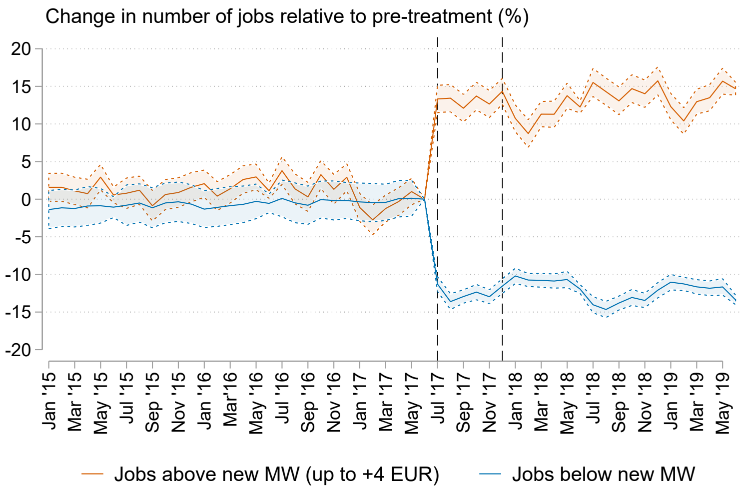
[30] Some 22-year-olds may be eligible for another wage subsidy for low-wage workers that already started in January 2017. However, due to the much more stringent eligibility requirements for this subsidy, only 7.8% of workers aged 22 at the time of the reform with pre-reform wages below the new minimum wage meet these requirements. Hence, this subsidy (LIV) played a negligible role in compensating for the minimum wage increase.

A.2 Additional results on the impact of the minimum wage on the number of jobs

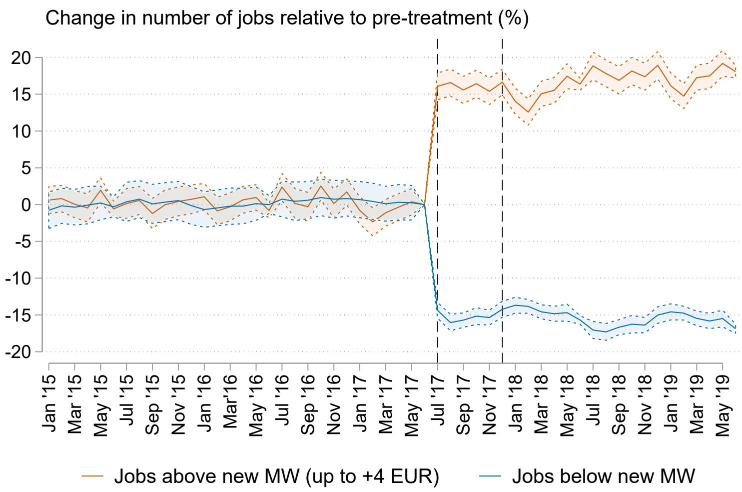
A.2.1 Dynamic impacts on the number of jobs

Figure A.1: Impact of minimum wage increase on number of jobs over time

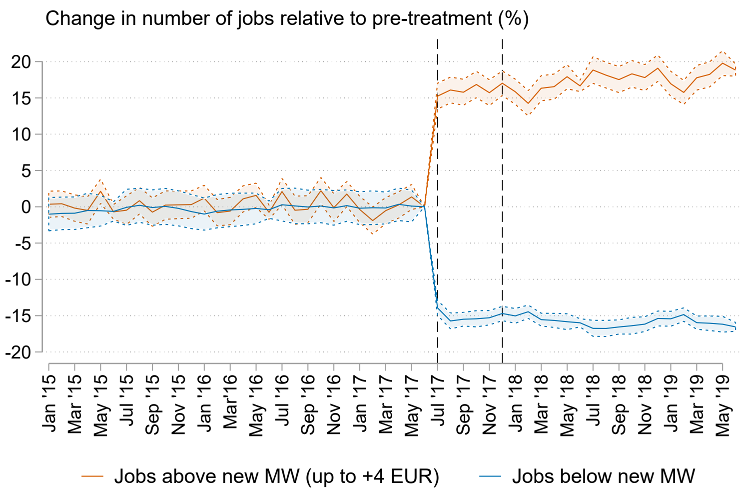
(a) 20-year-olds



(b) 21-year-olds



(c) 22-year-olds

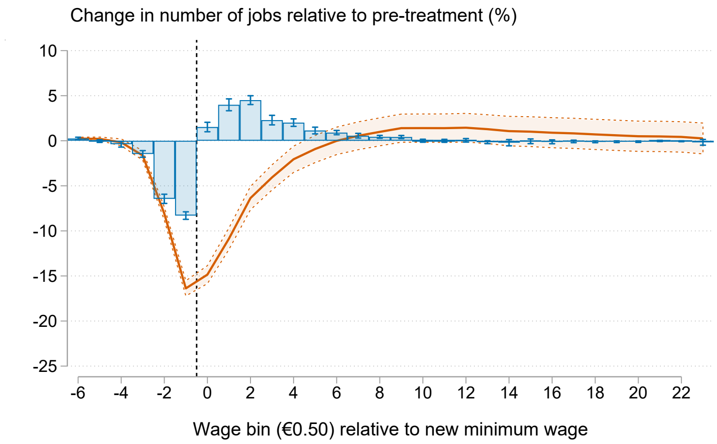


Notes: The graph plots estimates of the change in jobs above the new MW and jobs below the new MW in a month, relative to June 2017, the month before the first minimum wage increase. The shaded areas show the 95% confidence interval. Vertical dashed lines show the 6-month period used to infer the short-term impact of the minimum wage increase.

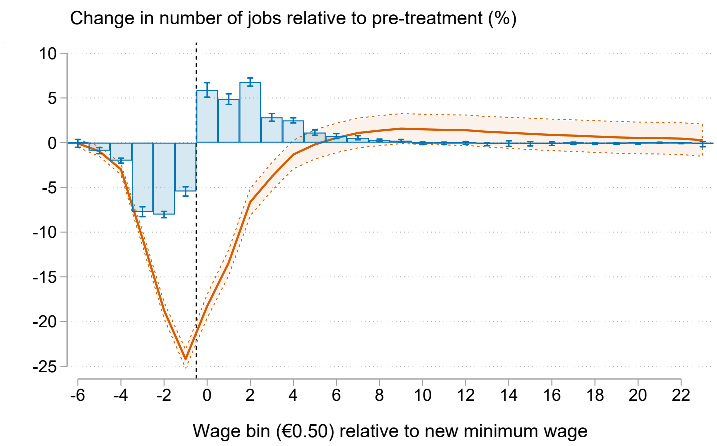
A.2.2 Comparison to the 2019 minimum wage increase

Figure A.2: Impact of 2019 minimum wage increase on number of jobs by wage bin

(a) 20-year-olds



(b) 21-year-olds



Notes: The solid vertical line is positioned at the new age-specific minimum wage. The bars show the estimated average change in the total number of jobs in each €0.50 wage-bin over the 6-month post-treatment period relative to average the total number of jobs over the six-months before treatment. The error bars show the 95% confidence interval using robust standard errors. The gray line shows the running sum of estimated changes up to the wage bin it corresponds to. The shaded area shows the 95% confidence interval of the running sum.

A.2.3 Employment effects across job and contract types

Table A.1: Effects of the MW increase on employment in jobs: job characteristics and contract types

	Workers Aged 20	Workers Aged 21	Workers Aged 22
Fixed-term contract	0.008	0.007	0.009
	(0.006)	(0.006)	(0.005)
Permanent contract	0.004	0.003	0.006
	(0.011)	(0.009)	(0.008)
Full-time	0.041**	0.036***	0.023**
	(0.017)	(0.013)	(0.010)
Part-time	−0.001	−0.003	0.002
	(0.005)	(0.005)	(0.005)
On-call	−0.007	−0.007	−0.004
	(0.009)	(0.009)	(0.009)
Temp agency work	0.037***	0.024**	0.019**
	(0.010)	(0.010)	(0.009)
Regular	0.006	0.007	0.010
	(0.008)	(0.007)	(0.006)

Notes: The table groups the rows by mutually exclusive contract types (i.e. fixed-term and permanent; full-time and part-time; on-call, temp agency and regular). Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Columns 2-4 report the estimated effects of the increase in the age-specific minimum wage based on a $\overline{W}$ threshold level of €4.00 above the new minimum wage. Estimates are obtained using January-June 2017 as reference period and using 23–25-year-olds as control group. Estimates are based on around 82 million job spells. All monthly job spells collapsed to 15,840 *age* × *wage-bin* × *month* cells.

A.2.4 Employment effects across industries

Table A.2: Effect heterogeneity across industries

	Wholesale	Retail	Food	Temp	Other
Panel A: 20-year-olds					
Δ Total Jobs	0.016	−0.010	−0.022**	0.017**	0.021***
	(0.011)	(0.012)	(0.011)	(0.008)	(0.008)
Minimum-Wage Elasticity (MWE)	0.116	−0.074	−0.156**	0.124**	0.152***
	(0.078)	(0.085)	(0.077)	(0.059)	(0.059)
Own-Wage Elasticity (OWE)	0.579	−0.329	−0.359**	0.573**	1.064***
	(0.387)	(0.356)	(0.168)	(0.249)	(0.401)
Wage elasticity wrt MW	0.252***	0.264***	0.453***	0.307***	0.208***
	(0.018)	(0.019)	(0.011)	(0.017)	(0.019)
Δ Average Wage	0.035***	0.037***	0.063***	0.043***	0.029***
	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)
Panel B: 21-year-olds					
Δ Total Jobs	−0.015	−0.004	−0.018	0.012	0.015**
	(0.010)	(0.011)	(0.011)	(0.009)	(0.007)
Minimum-Wage Elasticity (MWE)	−0.085	−0.024	−0.102	0.069	0.089**
	(0.06)	(0.063)	(0.063)	(0.053)	(0.041)
Own-Wage Elasticity (OWE)	−0.323	−0.049	−0.216	0.344	0.674**
	(0.246)	(0.219)	(0.142)	(0.222)	(0.307)
Wage elasticity wrt MW	0.289***	0.326***	0.457***	0.272***	0.189***
	(0.013)	(0.013)	(0.009)	(0.011)	(0.011)
Δ Average Wage	0.050***	0.057***	0.079***	0.047***	0.033***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Panel C: 22-year-olds					
Δ Total Jobs	0.001	−0.015	0.005	0.012	0.015***
	(0.010)	(0.010)	(0.011)	(0.008)	(0.006)
Minimum-Wage Elasticity (MWE)	0.005	−0.083	0.030	0.067	0.085***
	(0.054)	(0.058)	(0.062)	(0.045)	(0.033)
Own-Wage Elasticity (OWE)	−0.033	−0.254	0.067	0.359	0.764***
	(0.266)	(0.219)	(0.148)	(0.185)	(0.277)
Wage elasticity wrt MW	0.248***	0.321***	0.438***	0.264***	0.165***
	(0.011)	(0.012)	(0.008)	(0.007)	(0.008)
Δ Average Wage	0.044***	0.057***	0.078***	0.047***	0.029***
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)

Notes: Robust standard errors in parentheses. For rows 3–5 the standard errors are obtained using the delta method. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Columns 2-6 report the estimated effects of the increase in the age-specific minimum wage based on a $\overline{W}$ threshold level of €4.00 above the new minimum wage. Estimates are obtained using January-June 2017 as reference period and using 23–25-year-olds as control group. Elasticities with respect to the minimum wage are based on increase in the real minimum wage of 14.9%, 18.3% and 18.7% for 20–22-year-olds, respectively, minus the increase in the real minimum wage for adults of 0.9%. Wholesale is wholesale trade, Retail is retail trade, Food is food and beverage service activities (not hotels), Temp is employment placement, temporary employment provision and payrolling. Estimates for wholesale trade are based on around 3.8 million job spells. Estimates for retail trade are based on around 10.5 million job spells. Estimates for food and beverages are based on around 5.5 million job spells. Estimates for employment placement, temporary employment provision and payrolling are based on around 12.8 million job spells. Estimates for remaining industries are based on around 48 million job spells. All monthly job spells collapsed to 15,840 *age* × *wage-bin* × *month* cells.

A.2.5 Employment effects across demographic groups

Table A.3: Effect heterogeneity across demographic groups

	Student	Non-student	Female	Male	Migration background	No migration background
Panel A: 20-year-olds						
Δ Total Jobs	−0.013**	0.041***	0.006	0.007	0.007	0.003
	(0.005)	(0.011)	(0.006)	(0.006)	(0.006)	(0.006)
Minimum-Wage Elasticity (MWE)	−0.094**	0.296***	0.040	0.053	0.053	0.022
	(0.038)	(0.079)	(0.044)	(0.041)	(0.042)	(0.040)
Own-Wage Elasticity (OWE)	−0.381**	1.211***	0.163	0.213	0.215	0.088
	(0.157)	(0.319)	(0.179)	(0.160)	(0.170)	(0.158)
Wage elasticity wrt MW	0.300***	0.316***	0.310***	0.307***	0.307***	0.313***
	(0.009)	(0.016)	(0.011)	(0.010)	(0.011)	(0.009)
Δ Average Wage	0.042***	0.044***	0.043***	0.043***	0.043***	0.044***
	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Panel B: 21-year-olds						
Δ Total Jobs	−0.004	0.016**	0.001	0.010*	0.005	0.006
	(0.005)	(0.008)	(0.006)	(0.006)	(0.006)	(0.006)
Minimum-Wage Elasticity (MWE)	−0.021	0.094**	0.008	0.058*	0.031	0.035
	(0.031)	(0.048)	(0.034)	(0.034)	(0.033)	(0.034)
Own-Wage Elasticity (OWE)	−0.082	0.488**	0.034	0.256*	0.142	0.151
	(0.125)	(0.244)	(0.151)	(0.152)	(0.150)	(0.147)
Wage elasticity wrt MW	0.305***	0.253***	0.287***	0.277***	0.280***	0.288***
	(0.006)	(0.010)	(0.007)	(0.008)	(0.007)	(0.007)
Δ Average Wage	0.053***	0.044***	0.050***	0.048***	0.049***	0.050***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Panel C: 22-year-olds						
Δ Total Jobs	−0.001	0.015**	0.007	0.009	0.008	0.009
	(0.006)	(0.007)	(0.005)	(0.006)	(0.005)	(0.006)
Minimum-Wage Elasticity (MWE)	−0.007	0.086**	0.038	0.053	0.044	0.048
	(0.032)	(0.037)	(0.029)	(0.032)	(0.030)	(0.032)
Own-Wage Elasticity (OWE)	−0.030	0.515**	0.186	0.266	0.226	0.219
	(0.129)	(0.215)	(0.144)	(0.161)	(0.152)	(0.143)
Wage elasticity wrt MW	0.297***	0.216***	0.258***	0.248***	0.248***	0.270***
	(0.005)	(0.007)	(0.006)	(0.007)	(0.006)	(0.006)
Δ Average Wage	0.053***	0.038***	0.046***	0.044***	0.044***	0.048***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

Notes: Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Columns 2-7 report the estimated effects of the increase in the age-specific minimum wage based on a $\overline{W}$ threshold level of €4.00 above the new minimum wage. Estimates are obtained using January-June 2017 as reference period and using 23–25-year-olds as control group. Estimates for students are based on around 25 million job spells. Estimates for non-students are based on around 56 million job spells. Estimates for female are based on about 41 million job spells. Estimates for men ae based on around 40 million job spells. Estimates for individuals with a migration background are based on about 17 million job spells. Estimates for individuals without a migration background are based on about 65 million job spells. All monthly job spells collapsed to 15,840 *age* × *wage-bin* × *month* cells.

A.3 Robustness checks: employment impacts using different cutoffs

Table A.4: Robustness of the employment impacts and elasticities of the minimum wage on hours worked to choosing the cutoff point of the wage distribution ($\overline{W}$).

	Up to MW+Wage Bin					
	+3		+4		+5	
	Control group					
	23-25	26-27	23-25	26-27	23-25	26-27
Panel A: 20-year-olds						
Δ Total Hours	0.009	0.016**	0.020**	0.035***	0.018**	0.040***
	(0.009)	(0.009)	(0.009)	(0.010)	(0.009)	(0.011)
Minimum-Wage Elasticity (MWE)	0.065	0.112**	0.142**	0.247***	0.130**	0.283***
	(0.063)	(0.066)	(0.066)	(0.072)	(0.068)	(0.076)
Own-Wage Elasticity (OWE)	0.309	0.471**	0.626**	0.913***	0.627**	1.056***
	(0.294)	(0.262)	(0.283)	(0.242)	(0.319)	(0.256)
Wage elasticity wrt MW	0.306***	0.344***	0.288***	0.344***	0.244***	0.314***
	(0.017)	(0.020)	(0.015)	(0.020)	(0.016)	(0.020)
Δ Average Wage	0.043***	0.048***	0.040***	0.048***	0.034***	0.044***
	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)
Spillover Share	0.743***	0.748***	0.773***	0.790***	0.762***	0.796***
	(0.017)	(0.018)	(0.015)	(0.015)	(0.017)	(0.015)
Panel B: 21-year-olds						
Δ Total Hours	0.010	0.015**	0.018**	0.030***	0.017**	0.035***
	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)	(0.009)
Minimum-Wage Elasticity (MWE)	0.055	0.087**	0.102**	0.174***	0.099**	0.204***
	(0.044)	(0.046)	(0.046)	(0.051)	(0.047)	(0.055)
Own-Wage Elasticity (OWE)	0.286	0.417**	0.519**	0.779***	0.540**	0.929***
	(0.226)	(0.213)	(0.229)	(0.213)	(0.254)	(0.228)
Wage elasticity wrt MW	0.284***	0.308***	0.253***	0.288***	0.215***	0.258***
	(0.011)	(0.013)	(0.010)	(0.013)	(0.01)	(0.014)
Δ Average Wage	0.049***	0.054***	0.044***	0.050***	0.037***	0.045***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Spillover Share	0.735***	0.740***	0.754***	0.770***	0.747***	0.775***
	(0.012)	(0.013)	(0.011)	(0.012)	(0.012)	(0.013)
Panel C: 22-year-olds						
Δ Total Hours	0.011**	0.016**	0.017**	0.028***	0.018***	0.033***
	(0.006)	(0.007)	(0.007)	(0.008)	(0.007)	(0.008)
Minimum-wage Elasticity (MWE)	0.061**	0.088**	0.097**	0.158***	0.100***	0.188***
	(0.035)	(0.039)	(0.038)	(0.044)	(0.038)	(0.048)
Own-Wage Elasticity (OWE)	0.365**	0.491**	0.578***	0.837***	0.626***	1.005***
	(0.208)	(0.210)	(0.218)	(0.218)	(0.236)	(0.232)
Wage elasticity wrt MW	0.249***	0.267***	0.217***	0.242***	0.187***	0.219***
	(0.008)	(0.010)	(0.008)	(0.011)	(0.007)	(0.011)
Δ Average Wage	0.044***	0.047***	0.039***	0.043***	0.033***	0.039***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)
Spillover Share	0.665***	0.674***	0.683***	0.705***	0.679***	0.713***
	(0.012)	(0.014)	(0.012)	(0.014)	(0.012)	(0.015)

Notes: Robust standard errors in parentheses. For each panel, rows 3–6 the standard errors are obtained using the delta method. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Columns 2-7 report the estimated effects of the increase in the age-specific minimum wage based on different $\overline{W}$ threshold levels based on the distance to the new minimum wage. For each $\overline{W}$, the first column reports estimates obtained using 23–25-year-olds as control group. The second column reports estimates obtained using 26–27-year-olds as control group. All estimates are obtained using January-June 2017 as reference period. Elasticities with respect to the minimum wage are based on increase in the real minimum wage of 14.9%, 18.3% and 18.7% for 20–22-year-olds, respectively, minus the increase in the real minimum wage for adults of 0.9%. For each $\overline{W}$, estimates in the first column are based on around 82 million monthly job spells collapsed to 15,840 *age×wage-bin×month* cells. Estimates in the second column are based on around 62 million monthly job spell collapsed to 11,880 *age×wage-bin×month* cells.

Table A.5: Robustness of the employment impacts and elasticities of the minimum wage on jobs to choosing the cutoff point of the wage distribution ($\overline{W}$).

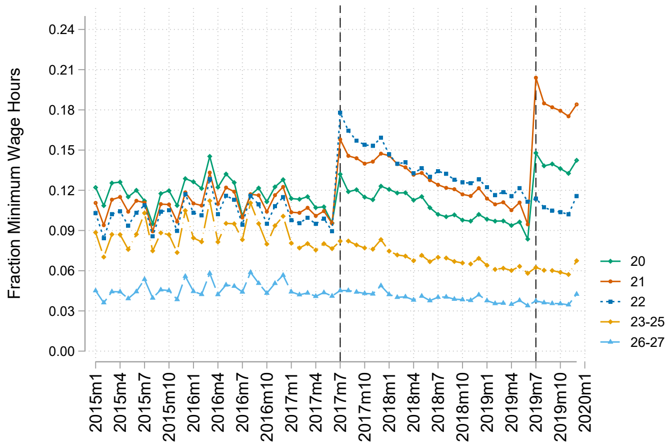
	Up to MW+Wage Bin					
	+3		+4		+5	
	Control group					
	23-25	26-27	23-25	26-27	23-25	26-27
Panel A: 20-year-olds						
Δ Total Jobs	−0.001	−0.002	0.006	0.009	0.008	0.014**
	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
Minimum-Wage Elasticity (MWE)	−0.008	−0.012	0.047	0.065	0.059	0.098**
	(0.038)	(0.039)	(0.040)	(0.042)	(0.041)	(0.044)
Own-Wage Elasticity (OWE)	−0.033	−0.050	0.188	0.245	0.243	0.361**
	(0.163)	(0.157)	(0.160)	(0.155)	(0.167)	(0.158)
Wage elasticity wrt MW	0.331***	0.346***	0.308***	0.332***	0.284***	0.315***
	(0.010)	(0.011)	(0.010)	(0.012)	(0.010)	(0.013)
Δ Average Wage	0.046***	0.048***	0.043***	0.046***	0.040***	0.044***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)
Spillover Share	0.756***	0.759***	0.777***	0.787***	0.781***	0.797***
	(0.009)	(0.009)	(0.008)	(0.009)	(0.009)	(0.009)
Panel B: 21-year-olds						
Δ Total Jobs	−0.002	−0.002	0.006	0.008	0.007	0.012**
	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
Minimum-Wage Elasticity (MWE)	−0.011	−0.014	0.032	0.047	0.041	0.071**
	(0.031)	(0.031)	(0.032)	(0.033)	(0.033)	(0.035)
Own-Wage Elasticity (OWE)	−0.050	−0.064	0.144	0.198	0.188	0.300**
	(0.143)	(0.137)	(0.144)	(0.138)	(0.151)	(0.144)
Wage elasticity wrt MW	0.308***	0.318***	0.282***	0.298***	0.253***	0.274***
	(0.007)	(0.008)	(0.007)	(0.008)	(0.007)	(0.009)
Δ Average Wage	0.054***	0.055***	0.049***	0.052***	0.044***	0.048***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Spillover Share	0.737***	0.740***	0.755***	0.764***	0.758***	0.772***
	(0.007)	(0.008)	(0.007)	(0.007)	(0.007)	(0.008)
Panel C: 22-year-olds						
Δ Total Jobs	0.002	0.001	0.008	0.011**	0.010**	0.015**
	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.006)
Minimum-Wage Elasticity (MWE)	0.009	0.005	0.045	0.059**	0.054**	0.082**
	(0.028)	(0.029)	(0.029)	(0.031)	(0.030)	(0.033)
Own-Wage Elasticity (OWE)	0.044	0.027	0.225	0.279**	0.274**	0.388**
	(0.141)	(0.140)	(0.144)	(0.144)	(0.151)	(0.151)
Wage elasticity wrt MW	0.281***	0.289***	0.253***	0.266***	0.227***	0.245***
	(0.006)	(0.007)	(0.006)	(0.007)	(0.006)	(0.008)
Δ Average Wage	0.050***	0.051***	0.045***	0.047***	0.040***	0.044***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Spillover Share	0.656***	0.661***	0.676***	0.688***	0.679***	0.698***
	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)

Notes: Robust standard errors in parentheses. For each panel, rows 3–6 the standard errors are obtained using the delta method. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Columns 2-7 report the estimated effects of the increase in the age-specific minimum wage based on different $\overline{W}$ threshold levels based on the distance to the new minimum wage. For each $\overline{W}$, the first column reports estimates obtained using 23–25-year-olds as control group. The second column reports estimates obtained using 26–27-year-olds as control group. All estimates are obtained using January-June 2017 as reference period. Elasticities with respect to the minimum wage are based on increase in the real minimum wage of 14.9%, 18.3% and 18.7% for 20–22-year-olds, respectively, minus the increase in the real minimum wage for adults of 0.9%. For each $\overline{W}$, estimates in the first column are based on around 82 million monthly job spells collapsed to 15,840 *age × wage-bin × month* cells. Estimates in the second column are based on around 62 million monthly job spell collapsed to 11,880 *age × wage-bin × month* cells.

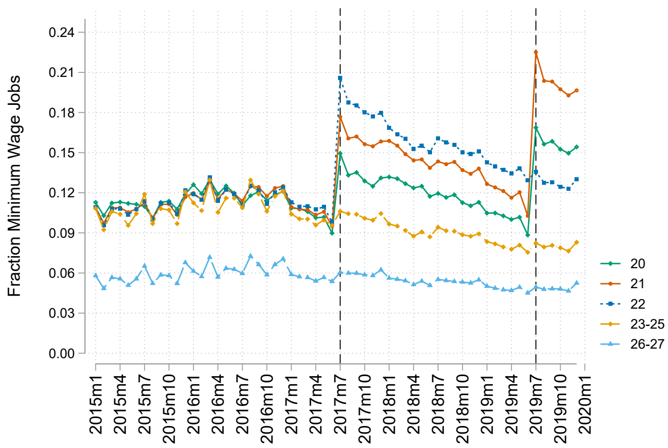
A.4 Youth labor market trends

Figure A.3: Youth labor market trends

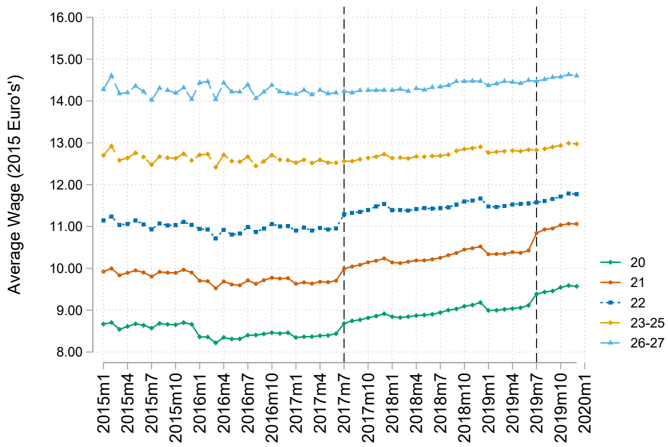
(a) Share of MW hours worked



(b) Share of MW Jobs



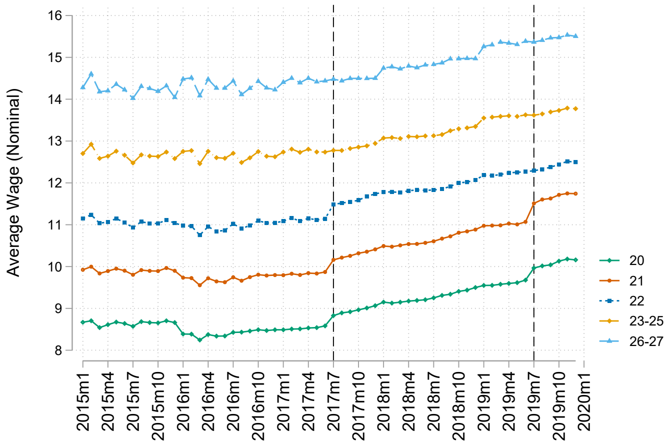
(c) (Real) average wage



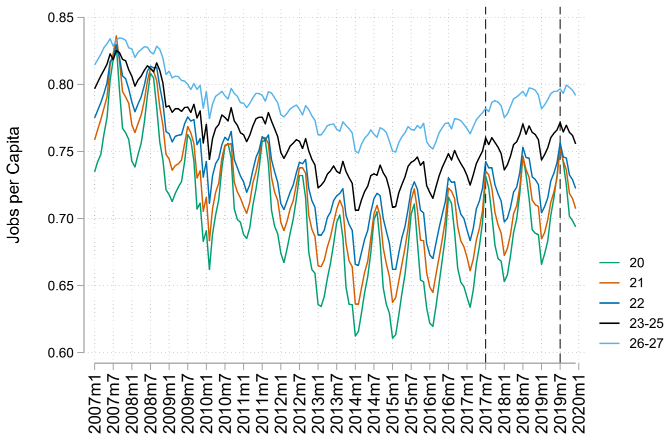
The dashed vertical dashed line indicates the months of the Dutch youth minimum wage reform.

Figure A.4: Youth labor market trends

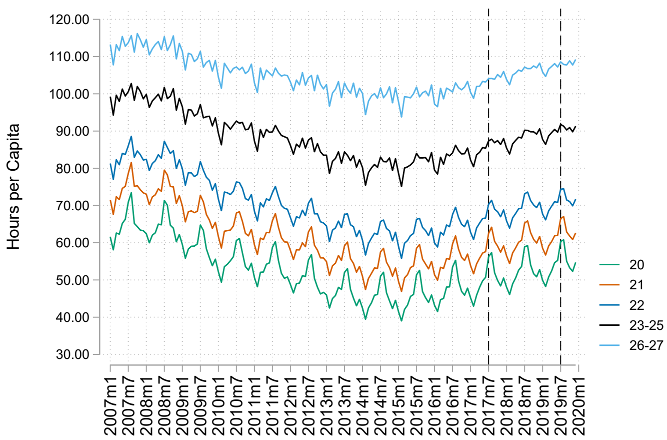
(a) (Nominal) average wage



(b) Jobs per capita



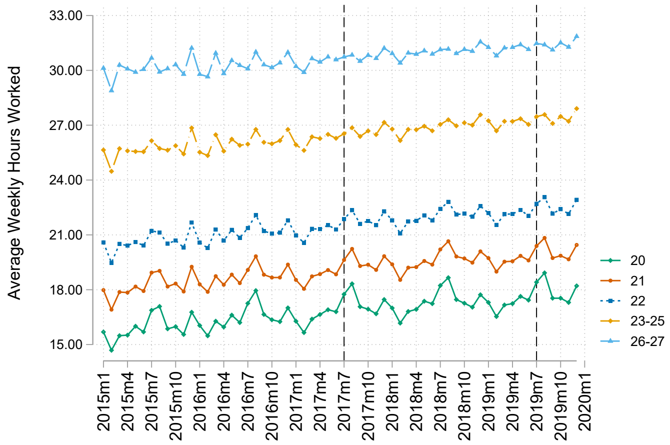
(c) Hours per capita



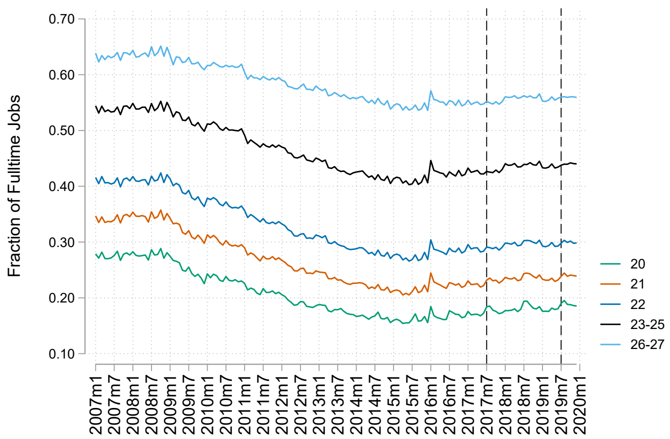
The dashed vertical dashed line indicates the months of the Dutch youth minimum wage reform.

Figure A.5: Youth labor market trends

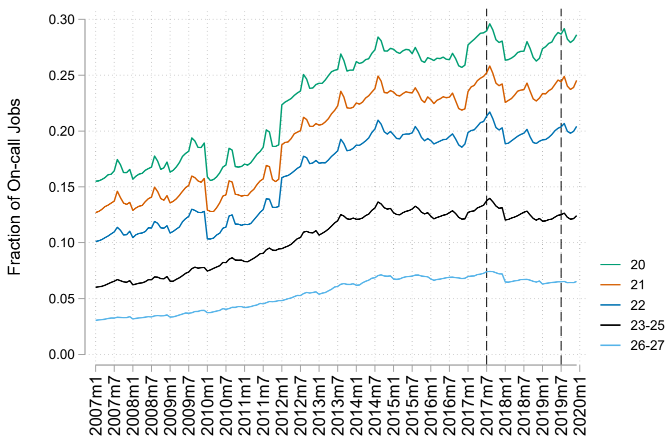
(a) Average weekly hours worked



(b) Share Fulltime Jobs



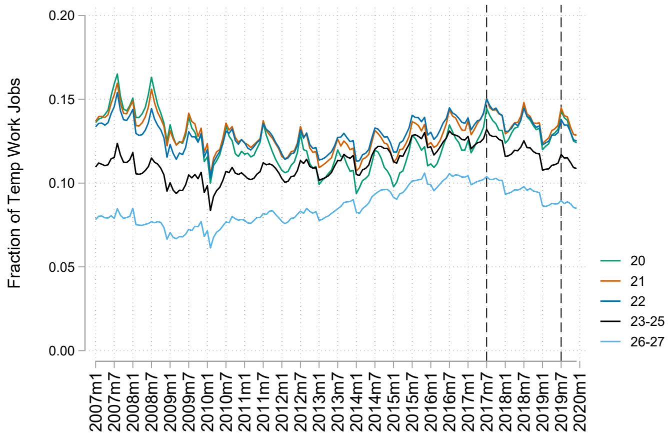
(c) Share On Call Jobs



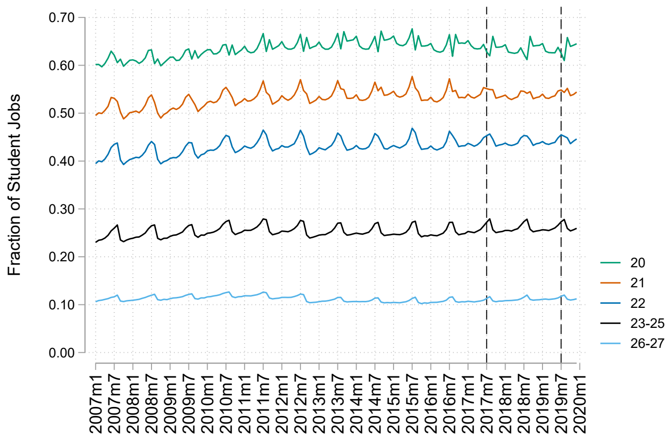
The dashed vertical dashed line indicates the months of the Dutch youth minimum wage reform.

Figure A.6: Youth labor market trends (continued)

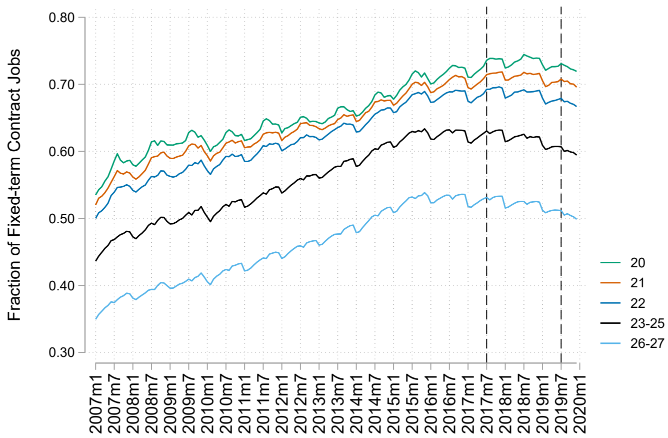
(a) Share Temp Work Jobs



(b) Share Student Jobs



(c) Share Fixed Term Contract Jobs



The dashed vertical dashed lines indicate the months of the Dutch youth minimum wage reform.

A.5 Employment effect computations

A.5.1 Overall employment effects and minimum wage elasticity

We compute the employment effects and employment elasticities with respect to the minimum wage (MWE) as follows. First, for each treated age-group we estimate the change in the number of jobs and the total hours worked per capita in each €0.50 wage bin b in period τ, relative to the average of the six-month pre-treatment period ($\tau \in \{-6, ..., -1\}$) using regression equation (1). These are captured by the coefficients $\beta_{b\tau}$. Second, we sum the estimated changes in each wage bin up to the wage bin where the impact of the minimum wage is assumed to be negligible, represented by $\overline{W}$. Third, we normalize the estimated change in each wage bin by the average age-specific number of jobs (hours worked) per capita over the six months before treatment, $EP_{\tau\in\{-6,...,-1\},a}$.

This yields the estimated change in the number of jobs (hours worked) in period τ and the average of the six-month pre-reform period, $\tau \in \{-6, ..., -1\}$, expressed as a percentage of total pre-treatment employment:

$$\Delta E_{a,\tau} = \frac{\sum_{b=-6}^{\overline{W}} \beta_{b\tau}}{EP_{\tau\in\{-6,...,-1\},a}}$$

We subsequently average $\Delta E_{a,\tau}$ for $\tau \geq 0$ to obtain the short-run impact of the increase of the minimum wage on overall low-wage employment, ΔE_a. Next, we compute the MWEs of the number of jobs (total hours worked) by dividing ΔE_a by the change in the real applicable minimum wage, minus the increase in the real minimum wage for adults.

A.5.2 Own-wage elasticity

In order to obtain the own-wage elasticity (OWE) of the number of jobs and the total hours worked for each treated age-group, we first use the estimates coefficient from (1), $\beta_{b\tau}$, to compute the change in the average hourly wage of low-wage workers. For this purpose, we first compute the change in wage bill up to threshold wage bin $\overline{W}$:

$$\Delta WB_{a,\overline{W}} = \frac{\frac{1}{6}\sum_{\tau=0}^{5}\sum_{b=-6}^{\overline{W}} \beta_{b\tau} \times (MW_a + 0.50b)}{\sum_{b=-6}^{\overline{W}} \overline{w}_{b,a} \times EP_{\tau\in\{-6,...,-1\},a,b}},$$

here $\overline{w}_{b,a}$ is the average wage in wage bin b for treated age-group a between $\tau = -6$ and $\tau = -1$ (i.e. the six months prior to treatment). $EP_{\tau\in\{-6,...,-1\},a,b}$ is the average total employment (i.e. jobs or hours) per capita in wage bin b for treated age-group a between $\tau = -6$ and $\tau = -1$. The denominator is the average cumulative wage bill to the age-specific population over the bins up to wage bin $\overline{W}$ in the six months before treatment. The numerator is the change in the total wage bill to population, averaged over the 6 month following the reform.

Next we compute the change in employment up to threshold $\overline{W}$ as follows:

$$\Delta E_{a,\overline{W}} = \frac{\frac{1}{6}\sum_{\tau=0}^{5}\sum_{b=-6}^{\overline{W}} \beta_{b\tau}}{\sum_{b=-6}^{\overline{W}} EP_{\tau\in\{-6,...,-1\},a,b}}$$

Finally, we compute the change in the average wage up to threshold $\overline{W}$ as follows:

$$\Delta W_{a,\overline{W}} = \frac{\Delta WB_{a,\overline{W}} - \Delta E_{a,\overline{W}}}{1 + \Delta E_{a,\overline{W}}}$$

The own-wage elasticities are computed by dividing $\Delta E_{a,\overline{W}}$ by $\Delta W_{a,\overline{W}}$, using the delta method to compute the standard errors.

A.5.3 Spillover share

To obtain the spillover share of the increase in the average wage, we first obtain the change in the average wage up to threshold $\overline{W}$ in the absence of spillover. This is done by moving each missing job/hours worked under the new minimum wage exactly to the new minimum wage:

$$\Delta W_{A,\overline{W},nsp} = \frac{\frac{1}{6}\sum_{\tau=0}^{5}\sum_{b=-6}^{-1}\beta_{b\tau} \times 0.50b}{\sum_{b=-6}^{\overline{W}} \overline{w}_{b,a} \times EP_{\tau\in\{-6,\ldots,-1\},a,b}},$$

Finally, we compute the spillover share as follows:

$$1 - \frac{\Delta W_{A,\overline{W},nsp}}{\Delta W_{A,\overline{W}}}$$

A.6 Hourly minimum wage computation

As discussed in the main text, the hourly minimum wage depends on the number of hours that constitute a full-time workweek, which can differ across sectors, firms and individual labor contracts. We therefore calculate the applicable minimum wage for each job separately, using the following procedure:

1. For each job, we observe the full-time-equivalent days worked. We divide this by the working days in a month to calculate the part-time share of each job.

2. We then divide the observed hours worked per month for each job by the part-time share to obtain the implied full-time hours worked.

3. We drop outliers in implied full-time hours per month: all observations above the 99th percentile or below the 1st percentile of the distribution.

4. We then compute the average hours worked for each job over the calendar year and divide this by 4.33 to obtain the average hours worked per week (or 4.35 if it is a leap year).

5. Finally, we assign each job to one of three hours categories that minimizes the distance between the category and the hours calculated in step 4: 36, 38 or 40.
   - If we cannot assign a category, we assign the mode within the firm.
   - If an individual works in primary or secondary education, we assign 36.86 hours, which are the full-time hours worked according to the collective labor agreement.

A.7 Data Sources

Table A.6: Data Sources (CBS)

Data	Source	Year	
Employment	(S)POLISBUS	2007-2019	Primary employment data
Demographics	GBAPERSOONSTAB	2019	Date of birth, gender, migration background
Residency	GBAADRESOBJECTBUS	2019	Residency in the Netherlands
Education	ONDERWIJSINSCHRTAB	2006-2019	Education enrollment, level of education