Cardiff Economics Working Papers



Working Paper No. E2026/8

Gendered Effects of the Minimum Wage

Alessandro Di Nola, Haomin Wang

July 2026

ISSN 1749-6010

Cardiff Business School
Cardiff University
Colum Drive
Cardiff CF10 3EU
United Kingdom
t: +44 (0)29 2087 4000
f: +44 (0)29 2087 4419
business.cardiff.ac.uk

This working paper is produced for discussion purpose. These working papers are expected to be published in due course, in revised form.
Cardiff Economics Working Papers are available online from:
http://econpapers.repec.org/paper/cdfwpaper/ and
https://carbsecon.com/wp/index_abstracts.html
Enquiries: EconWP@cardiff.ac.uk

Gendered Effects of the Minimum Wage*

Alessandro Di Nola† Haomin Wang‡

July 3, 2026

Abstract

Women are more likely than men to work in low-hours jobs, which are associated with lower hourly wages and are disproportionately impacted by minimum wage policies. To quantify the gendered effects, we build and estimate an equilibrium search model that incorporates demographic and firm productivity heterogeneity, as well as jobs differing in both wages and hours requirements. The model replicates observed gender gaps in employment, hours worked, and wages, as well as the positive relationship between hours and hourly wages. We implement the minimum wage in our model with a penalty to address non-compliance. Using this framework, we find that Germany's initial 8.5 € minimum wage reallocates women toward higher-hours jobs, reducing non-employment. Firm adjustments, however, dampen this effect by raising wages for low-hours jobs, making them relatively more attractive. Enhanced enforcement of the minimum wage amplifies the upward reallocation for women. Finally, we examine the effects of higher minimum wages, finding that increases up to 14 € reduce both the gender wage and hours-worked gaps. At 11 €, 44.8% of the reduction in the gender income gap is attributable to changes in hours worked.

JEL Classifications: J08, J31, J16, E24, E64

Keywords: Minimum wage, gender gaps, equilibrium job posting, hours requirement.

*We are grateful to Effrosyni Adamopoulou, Naoki Aizawa, Lutz Bellmann, Javier Fernández-Blanco, Leonard Bocquet, Sebastian Findeisen, Peter Haan, Leo Kaas, John Kennan, Chiara Lacava, Rasmus Lentz, Alexander Ludwig, Christian Moser, Josep Pijoan-Mas, Andrew Shephard, Hitoshi Tsujiyama and Emircan Yurdagul and seminar participants at the University of Konstanz, Goethe University of Frankfurt, Universitat de Barcelona, Universitat Autònoma de Barcelona, Universitat de les Illes Balears, University of Birmingham, Lisbon Macro Workshop, the 2nd UB Macro Workshop, VfS Social Policy Workshop at the IAB, Labor and Finance Group Conference at the Chicago Fed, the 5th Dale T. Mortensen Center Conference, Konstanz Workshop "Determinants and Consequences of Labor Market Mobility," and Money, Macro and Finance workshop for their discussion and useful feedback. We thank Luke Haywood for his early input and discussion.

†University of Birmingham. Email: a.dinola@bham.ac.uk.

‡Cardiff University. Email: wangh142@cardiff.ac.uk.

1 Introduction

The minimum wage is a key policy tool for reducing income inequality, with the potential to address the persistent gender income gap. This gap reflects disparities in both wages and hours worked between men and women, and minimum wage policies have the potential to influence both dimensions. Women, who are more likely to work in low-hours jobs due to caregiving responsibilities, are particularly affected by minimum wage policies that establish a floor on hourly wages. These low-hours jobs are often associated with lower hourly pay, a phenomenon known as the part-time penalty (Aaronson and French, 2004).

While previous research has primarily examined the effect of the minimum wage on the gender wage gap (DiNardo et al., 1996; Caliendo and Wittbrodt, 2022), a comprehensive understanding of its impact on the gender income gap requires consideration of how the policy influences employment and hours worked. The minimum wage may lead to job losses for women in low-wage, low-hours jobs or, conversely, encourage women to transition to higher-hours jobs with better compensation and job security. In addition to workers' responses, the overall impact of the minimum wage critically depends on firms' adjustments. Firms may adjust their wage-setting policies and modify the types of jobs they offer in terms of hours requirements.

In this paper, we employ an equilibrium job search model with heterogeneous workers and firms to address the following questions: How does the minimum wage influence the equilibrium labor market outcomes of men and women? What mechanisms drive these equilibrium effects? To what extent can the minimum wage serve as a policy tool to combat gender inequality in the labor market, and how does it affect gender gaps in wages and hours worked?

To quantify the equilibrium effects of the minimum wage on the gender income gap, we use a job-posting model based on Burdett and Mortensen (1998) and Bontemps et al. (2000). This model allows us to examine the underlying mechanisms of the minimum wage's impact on the decisions of both workers and firms. It is particularly well-suited to studying minimum wage policies, as it can generate plausible spillover effects on higher wage percentiles (Engbom and Moser, 2022; Blömer et al., 2024).

We incorporate an hours margin in our model, an underexplored dimension of minimum wage effects. The empirical literature on the German minimum wage highlights the importance of considering the hours margin: while the minimum wage has little effect on part-time and full-time employment, it is shown to negatively impact marginal employment (Caliendo et al., 2018; Bonin et al., 2020). Marginal employment refers to Germany's "minijobs," a contractual form characterized by low hours and low hourly wages, combined with preferential tax and social-security treatment. These jobs are especially common among women.

In our model, firms are heterogeneous in productivity and choose both an hours requirement, corresponding to marginal, part-time, and full-time employment, and a posted wage to maximize expected profits net of job-posting costs. Firms can also choose to stay inactive and not post a job. These choices depend on the expected measure of labor the firm can attract at each hours-wage combination as well as the profit per unit of labor.[1]

Our model incorporates rich demographic heterogeneity, including gender, marital status, and a stochastic child state process, factors empirically shown to influence employment and hours outcomes. Men and women differ in several dimensions, including labor efficiency, preferences for non-working time, and, for married workers, the distribution of spousal income.[2] Although we do not explicitly model joint family decision making, we account for the effects of spousal income and joint taxation on labor supply. These gender based differences shape equilibrium outcomes in employment, hours, and wages.

To estimate the model, we use data from the German Socio-Economic Panel (SOEP), a longitudinal dataset that provides detailed demographic characteristics and employment outcomes, including working hours, for a representative sample of German households. The unit of observation is the household, enabling us to observe marital status and children's ages. Our estimated model is calibrated to match key features of the labor market before the introduction of the minimum wage (2013-2014). It successfully replicates observed patterns, including that women are less likely to be employed, more likely to work in marginal or part-time employment, and receive lower hourly wages in full-time jobs. While gender differences in preferences for working hours and spousal incomes primarily drive the gender gaps in employment and hours, gender differences in productivity are the main factor underlying the gender wage gap, conditional on hours worked.

The model also captures variations in employment and hours worked by the age of children and replicates the positive correlation between hourly wages and hours of employment. Two key features of the model explain this correlation. First, offering a full-time job is associated with higher hourly productivity compared to marginal or part-time jobs within a given firm. This can be rationalized by the presence of sunk management costs, which are incurred per position regardless of weekly hours. Second, there is production complementarity between firm productivity and working hours, leading higher-productivity firms to set higher hours requirements.

Unlike previous studies, we account for the widespread non-compliance with minimum wage policies

[1] We model the hours choice as a "sector choice," where each type of hours is treated as a distinct "sector" of the labor market. Previous job-posting models with sector choices have been studied in contexts such as labor market formality (Meghir et al., 2015), and employer healthcare provision (Ginja et al., 2025; Fang and Shephard, 2019; Aizawa and Fang, 2020). Shephard (2017) also considers a job-posting model with full-time and part-time jobs, though in that case, hours is exogenous rather than a firm decision.

[2] Gender differences in labor efficiency may reflect genuine productivity differences or discriminatory behavior by firms. See Sec. 3.4.1 for further discussion.

documented in Germany (Burauel et al., 2017, 2020; Bossler et al., 2022). We introduce a penalty mechanism that reduces the job contact rate for jobs with hourly wages below the minimum wage. Firms can still post non-compliant jobs, but workers are less likely to contact these positions due to the penalty. This reflects the practical challenges firms face in openly recruiting for non-compliant jobs through standard advertising channels. We calibrate the magnitude of the penalty to match the non-compliance rate observed in the SOEP data.

We analyze the equilibrium effects of the minimum wage policy in two steps. First, we study Germany's initial federal minimum wage of 8.5 € per hour. Using the equilibrium model, we examine how firms respond to the minimum wage and how these responses shape labor market outcomes for men and women. We also explore the role of minimum wage enforcement and the policy's heterogeneous effects across different groups of workers. In the second step, we investigate how higher minimum wage levels influence equilibrium gender gaps.

In equilibrium, the 8.5 € minimum wage leads to an upward reallocation in hours for both genders, with this effect being more pronounced for women. As women transition from marginal employment to part-time or full-time employment, they benefit from a lower job separation rate, which contributes to a modest reduction in female non-employment.

Turning to firms' job-posting decisions, we examine how their adjustments to the minimum wage affect gendered labor market outcomes. The implementation of the minimum wage shifts the offer distribution toward higher-hours jobs. This shift is primarily driven by the response of low-productivity firms, which are more likely than higher-productivity firms to offer low-hours jobs in the benchmark model. Following the introduction of the minimum wage, low-productivity firms are the most likely to either become inactive or increase their hours requirements. These firms also raise wages, with 78% of marginal-employment job offers at the lower end of the wage distribution seeing wage hikes, compared to 26% of full-time jobs.

To quantify the role of firm adjustments in shaping equilibrium outcomes, we compare the equilibrium minimum-wage economy with a counterfactual scenario where firms do not adjust their job-posting decisions. Our findings shows that firm adjustments dampen the reallocation effect; this is particularly true for women, as they are more likely to work in low-hours and low-wage jobs. By increasing wages in low-hours jobs, firms make these positions relatively more attractive.

We then analyze a counterfactual scenario with increased enforcement of the minimum wage and observe stronger shifts in the offer distribution toward higher-hours jobs, accompanied by a more pronounced upward reallocation of women in hours. These findings suggest that policymakers should consider not only the level of the minimum wage but also the degree of enforcement when using the policy to combat gender inequality. They also underscore the importance of accounting

for non-compliance, a factor that has been insufficiently addressed in previous structural analyses of minimum wage policies.

Regarding the heterogeneity of the minimum wage's effects, we observe differences not only by gender and child state but also by marital and spousal income status. For example, among women with young children, the minimum wage increases employment for single women and those married to low-income spouses. Despite the negative impact of the minimum wage on the job contact rate, these women become more likely to accept jobs, including part-time and full-time jobs, due to higher offered wages. In contrast, women married to high-income spouses set higher reservation wages for jobs with high hours, and the wage increases in the lower part of the offer distribution do not affect their job acceptance, leading to a negative employment effect. Beyond employment and hours, the minimum wage also generates heterogeneous effects on welfare and employer productivity. The prominent influence of marital status and spousal income highlights the significance of intrahousehold income pooling and joint taxation as key factors shaping the impact of minimum wage policies.

Lastly, we examine the effects of varying the minimum wage up to 14 € per hour on different dimensions of gender inequality. We find that minimum wages up to this level positively impact wage, hours worked and income for both genders, with stronger effects for women than for men. Our findings confirm the wage gap as the primary channel through which the minimum wage affects gender inequality. However, the gender gap in hours worked is larger than the gender wage gap in Germany, and our analysis shows that the minimum wage also reduces this gap. At 11 €, 44.8% of the minimum wage's impact on the gender income gap is attributable to the hours-worked margin. Nonetheless, the minimum wage has a non-monotonic effect on the gender hours-worked gap, with the effects beginning to diminish at a minimum wage of 11 €. These findings underscore the importance of considering both wage and hours-worked margins in designing effective minimum wage policies.

Related literature Our research contributes to the existing literature on the impact of minimum wages on gender inequality. Previous studies, such as DiNardo et al. (1996) and Autor et al. (2016), demonstrate that minimum wage policies have a stronger effect on reducing wage inequality for women than for men in the United States. Similarly, Bargain et al. (2019) find that minimum wages significantly reduce the gender wage gap in Ireland, while Caliendo and Wittbrodt (2022) report analogous findings for Germany. However, these studies primarily focus on the short-run effects of minimum wages on the gender wage gap. In contrast, our research provides an equilibrium analysis of minimum wage policies, examining their impact on the broader gender income gap by incorporating employment and hours worked alongside wage differentials. Our findings emphasize

that minimum wages can reduce gender gaps not only in wages but also in hours worked, thereby contributing to a more comprehensive understanding of the policy's impact on gender inequality.

There is a growing body of literature examining firm responses to minimum wage policies. Empirical studies have estimated various effects on businesses, including price pass-through, substitution between capital and labor, and business entry and exit (see, for example, Aaronson et al., 2008; Harasztosi and Lindner, 2019; Jardim and Inwegen, 2019; Adamopoulou et al., 2022). In addition, several recent studies have employed quantitative equilibrium models to analyze firm behavior under minimum wage policies. For instance, Berger et al. (2022) consider oligopsonistic labor markets and study the welfare effects of minimum wage policies. Hurst et al. (2022) develop a general equilibrium model with monopsonistic labor market competition and firms facing putty-clay frictions in adjusting production technology. Our research contributes to this literature by analyzing the responses of heterogeneous firms to minimum wages in a frictional labor market. Specifically, we highlight the role of hours requirements as an additional margin for firm adjustment, alongside wages and job-posting participation. This focus on hours requirements provides new insights into how firms adapt to minimum wage policies and their implications for labor market outcomes.

This paper is closely related to the literature that examines the effects of minimum wage policies using equilibrium job search models. Flinn (2006) provides seminal work demonstrating how minimum wages can increase both employment and welfare within a search model with Nash bargaining. Engbom and Moser (2022) extend this line of research by employing an equilibrium job-posting model to study the spillover effects of the Brazilian minimum wage.

Two studies particularly relevant to our work focus on the German minimum wage: Blömer et al. (2024) and Drechsel-Grau (2023). Blömer et al. (2024) analyze the minimum wage's impact on full-time employment, emphasizing the heterogeneous effects across labor market segments driven by firm productivity. Our study extends this analysis by considering the effects of the minimum wage not only on wage but also hours. We show that accounting for marginal and part-time employment is crucial for capturing gender inequality and the gendered effects of the minimum wage policy (see Appendix H.2). Drechsel-Grau (2023) investigates the short- and long-run effects of the minimum wage using a search-and-matching model that incorporates different hours of employment. Unlike our approach, which derives an equilibrium wage and hours distribution, their model assumes that wages are determined by either a fixed share of match output or the minimum wage, whichever is higher. In addition to our gendered focus, our contribution lies in modeling endogenous wage posting. By comparing to a version of the model with a fixed wage rule, we show that firms' endogenous wage responses to the minimum wage through endogenous non-compliance are central for evaluating the quantitative impact of minimum wage policy (see Appendix H.1).

This paper also contributes to the literature that examines gender gaps using dynamic equilibrium models. Morchio and Moser (2023) study the role of amenities in gender gaps in an equilibrium

search model. Their paper is particularly relevant as low working hours can be considered an amenity costly for firms to provide, and workers of different genders and family situations value it differently. Amano-Patino et al. (2020) examine gender differences in career interruptions due to fertility and their implications for human capital accumulation, while Bartolucci (2013) investigates a search model with wage bargaining and finds that gender differences in productivity, rather than bargaining power, are the primary drivers of the gender wage gap. Our paper contributes to this literature by emphasizing the significant gender gap in hours worked, in addition to wages, and by analyzing how the minimum wage affects equilibrium gender gaps across these dimensions.

Organization The remainder of the paper is organized as follows. Section 2 documents the gender gaps in employment and hours in Germany, explores the factors driving these disparities, and provides a brief overview of the minimum wage policy in Germany. Section 3 describes the equilibrium job search model used to analyze the effects of minimum wages on the gender income gap. In Section 4, we outline our estimation strategy and present the results. Section 5 examines the equilibrium effects of Germany's first federal minimum wage of 8.5 €, while Section 6 analyzes the impact of higher minimum wages on gender inequality. Finally, Section 7 concludes the paper.

2 Empirical Motivation

2.1 Gender asymmetry in hours of work

In Germany, despite a relatively small gender gap in employment, there is a substantial gender difference in hours of work. Women are less than half as likely than men to hold a full-time job, but six times more likely to be part-time employed and over three times more likely to be marginally employed (Table 1).

Regular employment in Germany comprises full-time and part-time jobs, whereas marginal employment refers to so-called "minijobs." Minijobs are characterized by a monthly income below a specified income cap, allowing their income to be exempt from income tax and part of social security contributions. At the time of the introduction of Germany's first federal minimum wage in 2015, the income cap for minijobs was 450 € per month. According to data from the German Socio-Economic Panel (SOEP), the median weekly hours for marginal employment is 11 hours, compared to 25 hours for part-time employment and 40 hours for full-time employment.

To better understand the forces behind the gender asymmetry in hours, we estimate how key demographic variables correlate with the probability of working in different hours types or being

non-employed (Table 2). Higher education is associated with a lower probability of non-employment for both men and women, and the positive effect on employment is strongest for full-time work. Marriage is linked to lower non-employment for both genders, but the patterns diverge thereafter: marriage increases men's likelihood of full-time employment, while for women it raises the probability of both marginal and part-time work. Spousal income contributes to these patterns for women. Married women with higher-income partners are more likely to sort into lower-hours jobs than those with lower-income partners, whereas spousal income plays a much smaller role for men. The most pronounced difference, however, concerns children. For men, employment outcomes vary only modestly with the presence of children. For women, having children, especially young children, is associated with substantially lower employment rates and a markedly reduced likelihood of full-time work.[3]

Table 1: Employment Distribution By Gender

	Men	Women
Full-time	0.811	0.393
Part-time	0.052	0.302
Marginal emp.	0.026	0.085
Non-emp.	0.112	0.220

Data source: SOEP. *Notes*: The sample is an unbalanced panel of yearly observations and contains 25-54 year old individuals between 2006 and 2017.

2.2 Minimum wage in Germany

Germany introduced its first federal minimum wage in 2015 at 8.50 € per hour, with near-universal coverage.[4] At the time of its introduction, a substantial share of employment paid wages below this threshold: approximately 9% of full-time jobs, 15% of part-time jobs, and 62% of marginal-employment jobs (Burauel et al., 2017).

To provide empirical context for our analysis, we examine the short-run employment effects of the 2015 reform. Following Caliendo et al. (2018), we exploit regional variation in the bite of

[3] Parental leave policies likely help shape parents' employment outcomes (for evidence from the US, see Baker and Milligan, 2008; Han et al., 2009; Rossin-Slater et al., 2013; Timpe, 2024). In Germany, these policies are relatively generous and formally grant equal rights to both mothers and fathers. During our sample period, the key rules were as follows: each parent could take up to three years of parental leave until the child reached age eight, with job protection guaranteeing the right to return to the pre-leave position once leave ends. Parents shared 12-14 months of parental allowance, amounting to roughly 67% of previous earnings, subject to a floor and a cap. Individuals on parental leave are permitted to work up to an hours limit. In the SOEP, their employment status reflects their actual labor market activity.

[4] Before 2015, minimum wages existed only in industries covered by collective bargaining agreements. Appendix A provides additional institutional details on the German minimum wage.

Table 2: Marginal effects on employment probability

A. Male

	FT	PT	ME	NE
Marital / Spousal Income (ref: Single)				
Married, high-earning spouse	0.162***	-0.001	-0.016**	-0.145***
	(0.020)	(0.006)	(0.006)	(0.017)
Married, low-earning spouse	0.176***	-0.015**	-0.021***	-0.140***
	(0.018)	(0.006)	(0.005)	(0.015)
Children				
No. children under 6	-0.025***	0.008**	-0.001	0.018**
	(0.009)	(0.003)	(0.003)	(0.008)
No. children	-0.009	-0.001	0.001	0.010**
	(0.006)	(0.002)	(0.002)	(0.005)
Education (ref: ≤9 years)				
10-12 years	0.206***	-0.031***	-0.015**	-0.161***
	(0.022)	(0.007)	(0.006)	(0.018)
Observations		43,764		
Clusters		11,725		
Pseudo R^2		0.093		

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

B. Female

	FT	PT	ME	NE
Marital / Spousal Income (ref: Single)				
Married, high-earning spouse	-0.207***	0.163***	0.079***	-0.035**
	(0.018)	(0.016)	(0.009)	(0.016)
Married, low-earning spouse	-0.112***	0.092***	0.045***	-0.025*
	(0.017)	(0.014)	(0.008)	(0.014)
Children				
No. children under 6	-0.193***	-0.000	-0.004	0.197***
	(0.016)	(0.013)	(0.006)	(0.010)
No. children	-0.087***	0.018***	0.023***	0.046***
	(0.007)	(0.006)	(0.003)	(0.005)
Education (ref: ≤9 years)				
10-12 years	0.095***	0.088***	0.015	-0.198***
	(0.021)	(0.017)	(0.009)	(0.021)
Observations		51,371		
Clusters		12,792		
Pseudo R^2		0.106		

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: SOEP. *Notes*: The sample is an unbalanced panel of yearly observations and contains 25-54 year old individuals between 2006 and 2017. We exclude those in cohabitation or with over 12 years of education. High-earning (low-earning) spouse refers to having a spouse whose income is above (below) the median labor earnings in the sample. The marginal effects are estimated in a multinomial logit regression model. Additional controls include age, age squared, and year and federal-state fixed effects. Clustered standard errors at the individual level.

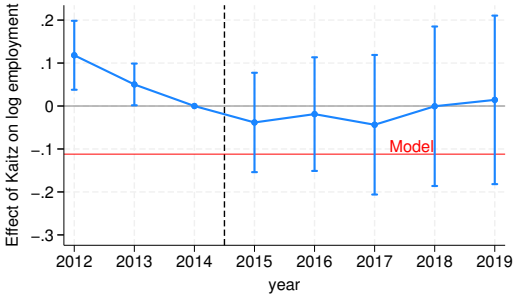
the minimum wage, measured by the Kaitz index, the ratio of the minimum wage to the regional median wage before the reform. We estimate the relationship between this index and log employment outcomes across 257 German labor market regions, controlling for region and year fixed effects as well as regional population. Details on the regression analysis are provided in Appendix B.

Figure 1 presents the estimated effects of the minimum wage bite on employment by gender and job type (marginal, part-time, and full-time). The results indicate that the minimum wage primarily affects women by reducing marginal employment and increasing part-time work, while effects on men and on full-time employment for both genders are small or statistically insignificant. In addition to the empirical estimates, the figure displays horizontal lines corresponding to effects predicted by our structural model (Section 3). We discuss the comparison between empirical and model-based results in Section 4.5.

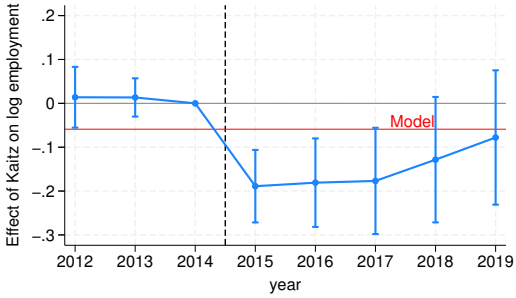
Our findings are consistent with previous evidence in the empirical literature. Vom Berge and Weber (2017) document that the minimum wage led to a doubling in the number of marginal-employment jobs converted into regular employment, including part-time or full-time jobs subject to social security contributions. Similarly, Caliendo et al. (2018) and Bonin et al. (2020) find that, in the short run, the minimum wage had only moderate effects on regular employment but reduced marginal employment. Bossler et al. (2026) report a significantly positive effect on transitions out of marginal employment, with roughly 2% of those in marginal employment moving to another labor market status between 2014 and 2015. Compared with men, women were more likely to transition from marginal employment to regular employment.

While the empirical estimates provide valuable insights into the short-run effects of the minimum wage, we provide an equilibrium analysis to understand firm responses and the long-run effects on the distribution of employment, hours, and wages, with particular attention to gender differences.

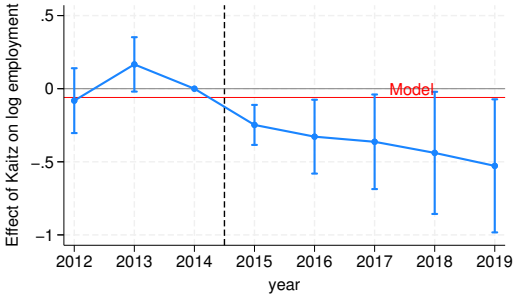
Figure 1: Estimated effects of the bite of minimum wage on labor market outcomes (γ_τ)



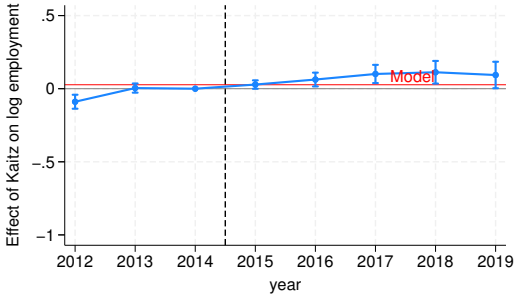
(a) Male - ME



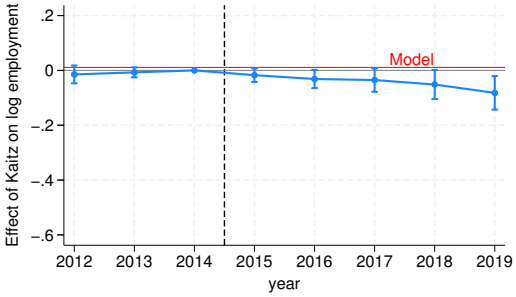
(b) Female - ME



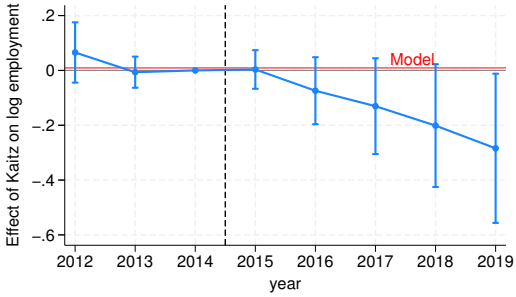
(c) Male - PT



(d) Female - PT



(e) Male - FT



(f) Female - FT

Source: Regional data accessed from INKAR.de. *Note:* Vertical bars indicate 95% confidence intervals. The vertical dashed line separates the pre- and post-introduction periods of the minimum wage. Regions are defined as labor market regions ("Arbeitsmarktregion"). Marginal employment excludes individuals who hold such contracts as secondary jobs. Regressions are estimated with robust standard errors clustered at the regional level and include regional population (in logs) as a control. See Appendix B for further details on the regression specification. The red horizontal line labeled "Model" shows the estimated effect from the structural model presented in Section 3, which should be interpreted as a medium- to long-run effect.

3 Model

In this section, we present an equilibrium job-posting model designed to capture key features of the German labor market that are relevant for understanding the gendered effects of minimum wage reforms. The model builds on the wage-posting framework of Burdett and Mortensen (1998) and Bontemps et al. (2000), where workers search randomly for job offers and decide whether to accept them, while firms take the labor supply function as given and choose which jobs to post.

We begin this section by describing the model in the absence of a minimum wage policy. In the model, workers differ by gender, marital status, and child state, which allows us to replicate the employment patterns documented in Section 2.1. Firms are heterogeneous in productivity and choose both an hours requirement and a posted wage to maximize expected profits net of job-posting costs. Firms may also choose to remain inactive and not post a job. These decisions depend on the expected measure of labor the firm can attract at each hoursâ€“wage combination (the labor supply function), as well as on the profit per unit of labor.

We describe the model environment in Sec. 3.1. In Sec. 3.2, we lay out workers' value functions and decisions, including job acceptance and quitting, taking the job offer distribution as given. Given workers' decisions, we can compute the equilibrium distribution of workers across jobs, which is used to obtain the labor supply function; this is described in Sec. 3.3. The labor supply function is a key input into firms' decisions, which we describe in Sec. 3.4. In Sec. 3.5, we characterize the equilibrium of the model.

To evaluate the gendered impact of minimum wage policy, the model must capture two key empirical features observed prior to its introduction: (i) women are disproportionately concentrated in low-hours jobs, and (ii) hourly wages increase with hours, a relationship commonly referred to as the part-time penalty.[5] Gender differences in preferences for non-working time, labor efficiency, and the distribution of spousal income allow the model to replicate the first fact. The second fact may arise endogenously in the model, as heterogeneous firms choose both hours requirements and posted wages when making job-posting decisions.

In Sec. 3.6, we describe how the minimum wage policy is implemented in the model. The minimum wage is introduced through a non-compliance penalty that reduces the rate at which workers contact job offers with wages below the statutory minimum. This formulation is motivated by empirical evidence of substantial non-compliance (Appendix A). At one extreme, a zero penalty

[5] The part-time penalty, documented by Aaronson and French (2004) and Calvo et al. (2024), refers to the empirical finding that longer work hours are associated with higher hourly wages. Erosa et al. (2016) impose a positive relationship between hourly wages and hours in the offer distribution of their labor supply model. Devicienti et al. (2017) show that firms with a higher share of part-time workers tend to have lower productivity.

renders the minimum wage completely ineffective; at the other, an infinite penalty prevents workers from contacting such jobs altogether, implying perfect compliance. Non-compliance therefore arises endogenously in equilibrium, as some firms may still find it optimal to post wages below the statutory minimum.

3.1 Environment

There is a continuum of workers that differs in gender j, where $j = 1$ if the worker is male and $j = 2$ if female. Workers also differ in the time-invariant demographic type $x \in \mathcal{X}$, which includes being single or married with various levels of spousal income. Men and women potentially draw x from different distributions.[6] Marital status and spousal income are important determinants of employment and hours outcomes (Sec. 2.1). In the model, married workers pool their incomes with their spouses and are subject to joint income taxation. As a result, workers with different marital statuses and spousal incomes make different labor market decisions.[7] Workers differ in the child state (k) that evolves stochastically. There are three child states: childless ($k = 1$), having at least one young child ($k = 2$), and having only grown children ($k = 3$). The transition matrix across child states is exogenous and specified separately for married individuals, single men, and single women. The transition rate from any state $k \in \{1, 2\}$ to $k + 1$ is $\phi_{j,x}(k)$.[8] There is no transition from k to $k' < k$ or $k' > k + 1$.

Workers derive utility from consumption and leisure and face a discount rate ρ. Table 2 in Sec. 2.1 shows that a lower spousal income is associated with more hours of work, which may be driven by an insurance motive.[9] To capture the influence of spousal income, we allow workers to be risk-averse. Workers can be either employed (e) or non-employed (n). At rate ρ_d, a worker in any child and employment state exits the model exogenously. Upon exiting, the worker is replaced by a newborn worker with the same gender and demographic type but is non-employed and childless.

There is a continuum of firms that differ in productivity level p. Firms operate a production technology with constant returns to scale in the measure of workers. There are three types of jobs by the hours requirement: marginal, part-time, and full-time. That is, $h \in \{h_{ME}, h_{PT}, h_{FT}\} \equiv \mathcal{H}$ with $h_{ME} < h_{PT} < h_{FT}$. Firms choose whether to post a job and, conditional on doing so, make

[6] The demographic type does not include education. As we explain in Sec. 4.1, we restrict our sample to only individuals without tertiary education when estimating the model.

[7] We abstract from the joint decision of couples for model tractability. In this way, we implicitly assume that the spousal income distribution is invariant to minimum wage changes. Compared to the direct effect of the minimum wage, we believe that the indirect effect of the minimum wage due to changes in spousal income is quantitatively less significant.

[8] We assume fertility is exogenous. The potential for the minimum wage policy to affect fertility outcomes is beyond the scope of the paper; we leave it for future research.

[9] Guler et al. (2012) show that couples make different job search decisions than singles when they are risk-averse.

the job-posting decision by choosing an hours requirement and an hourly wage per unit of labor efficiency. Δ^h denotes the measure of job offers with on hours requirement h, with $\sum_{h\in\mathcal{H}}\Delta^h \leq 1$. $F_h(w)$ denotes the hourly wage distribution of job offers with hours requirement h. Together, Δ^h and $F_h(w)$ constitute the offer distribution, which is determined in equilibrium. Let $\Delta^{act} \equiv \sum_{h\in\mathcal{H}}\Delta^h$ be the share of active firms. Workers contact job offers at rate $\Delta^{act}\lambda$.[10]

We allow men and women to have different levels of labor efficiency, and the difference can vary in the hours requirement of the job. This feature is important to replicate the observed gender wage gaps conditional on working hours.[11] Specifically, an employed worker in job (w,h) receives gross labor income $wa_j(h)h$, where $a_j(h)$ is the labor efficiency of a worker of gender j given hours requirement h. Without loss of generality, we normalize the labor efficiency for men to one (i.e., $a_1(h)=1$ for $h\in\mathcal{H}$) and allow that for women to take on any positive value (i.e., $a_2(h)\geq 0$ for $h\in\mathcal{H}$).

Employed workers may leave their jobs for three reasons. First, workers lose their jobs at an exogenous rate $\delta(h)$, which can be different for different hours to capture potential differences in job security. Second, workers may leave for a new job if they accept a job offer while employed. Lastly, workers can quit their jobs, which may happen if the child state changes. We assume a one-time disutility $\mu(j,k,h)$ that incurs when a worker accepts a job offer or decides to remain employed upon a child state change. The disutility captures adjustment costs associated with starting a new job or accommodating the arrival of children as working parents.[12]

The flow utility of gender j can be written as

$$u^j(c,h,k) = \ln c + \psi_k^j \frac{\left(\bar{h}-h\right)^{1-\gamma_k^j}}{1-\gamma_k^j}, \tag{1}$$

where ψ_k^j and γ_k^j are parameters specific to gender and the child state. Preferences for non-working time capture a combination of factors such as personal preferences, productivity in home production, and societal norms regarding gender roles. Parental leave policies, discussed in Footnote

[10] Although we assume that the contact rate is the same regardless of gender or employment status, different workers make different job-acceptance decisions, resulting in different job-finding rates. Moreover, we assume employed and non-employed workers search with the same efficiency. This is consistent with Drechsel-Grau (2023)'s estimation result that that search efficiency of employed workers in any hours type is similar to that of short-term unemployed workers.

[11] The gender difference in labor efficiency can be due to genuine productivity difference or perceived differences which result from employer discrimination. We do not take a stance on the underlying mechanism. Although men and women can potentially sort into different firms as they self-select into jobs with different working hours, this is not enough to replicate the observed gender wage gap conditional on hours.

[12] We acknowledge that accepting a job offer and remaining employed when a worker's child state changes are different life events, and they could, in principle, involve different types or magnitudes of disutility. Allowing separate parameters, however, would require identifying employment transitions exactly at the moment of a child-state change by gender, hours-type, and current child state. In our estimation sample, such transitions occur for only a very small number of individuals, making the corresponding parameters difficult to estimate with sufficient precision.

3, also likely shape parents' hours choices in practice. In our model, mothers' higher rates of non-employment and lower hours while children are young are reflected through the preference parameters for women with young children.[13] We assume no saving or borrowing technology. If the worker is employed, consumption is $c = \mathcal{N}^e(y, h; j, k, x)$, where $\mathcal{N}^e$ gives the disposable income for the employed worker given gross labor income y and hours h. For non-employed workers, the consumption is $c = \mathcal{N}^n(j, k, x)$. Since consumption depends on x, so do all endogenous objects, including workers' value functions, decisions, and distribution.

3.2 Worker value functions

In this subsection, we omit the dependence on x for brevity. The Bellman equation for a non-employed worker of gender j is as follows

$$\begin{aligned} \mathcal{D}_j^n V_j^n(k) &= u^j\left(\mathcal{N}^n(j,k), 0, k\right) + \phi_j(k) V_j^n(k') \\ &\quad + \lambda \sum_{h \in \mathcal{H}} \int \Delta^h \max\left\{V_j^e\left(\{w,h\}, k\right) - \mu(j,k,h), V_j^n(k)\right\} dF_h(w), \end{aligned} \tag{2}$$

where $k' = \min\{k+1, 3\}$ and $\mathcal{D}_j^n = \rho + \rho_d + \phi_j(k) + \Delta^{act}\lambda$. A non-employed worker with child state k experiences a child state transition at rate $\phi_j(k)$, where the child state becomes k'. The worker receives a job offer with hours requirement h at rate $\lambda\Delta^h$, and the wage is drawn from the wage offer distribution $F_h(\cdot)$. Upon receiving an offer, the worker decides whether to accept it. The optimal job acceptance decision of a non-employed worker is denoted by $\Omega_j^n(\{w,h\}; k)$ as follows:

$$\Omega_j^n(\{w,h\}; k) = \begin{cases} 1 & \text{if } V_j^e(\{w,h\}, k) - \mu(j,k,h) > V_j^n(k), \\ 0 & \text{else.} \end{cases} \tag{3}$$

The Bellman equation for an employed worker of gender j is as follows:

$$\begin{aligned} \mathcal{D}_j^e V_j^e(\{w,h\}, k) &= u^j\left(\mathcal{N}^e(wa_j(h)h, h; j, k), h, k\right) + \delta(h) V_j^n(k) \\ &\quad + \phi_j(k) \max\left\{V_j^e\left(\{w,h\}, k'\right) - \mu(j,k',h), V_j^n(k')\right\} \\ &\quad + \lambda \sum_{h' \in \mathcal{H}} \int \Delta^{h'} \max\left\{V_j^e\left(\{w,h\}, k\right), V_j^e\left(\{w',h'\}, k\right) - \mu(j,k,h')\right\} dF_{h'}(w'), \end{aligned} \tag{4}$$

where $k' = \min\{k+1, 3\}$ and $\mathcal{D}_j^e = \rho + \rho_d + \delta(h) + \phi_j(k) + \Delta^{act}\lambda$. The employed worker becomes non-employed exogenously at rate $\delta(h)$. At rate $\phi_j(k)$, the worker experiences a child state transition

[13] We do not explicitly model the parental leave decision or parental leave policies, as they are not the focus of this paper. In ongoing work, Di Nola et al. (2026) study parental leave policies and their implications for gender inequality in an equilibrium household search framework.

and decides to remain employed or quit. Eq. 3 also describes the optimal decision for remaining employed upon a child state transition. Finally, at rate $\lambda\Delta^{h'}$, the worker draws a new job offer with hours requirement h', with the wage w' drawn from the distribution $F_{h'}(\cdot)$. The worker then decides whether to accept the offer or remain with the incumbent employer.

The optimal job acceptance decision of a worker employed in job (w,h) who receives an offer (w',h') is

$$\Omega_j^e\left(\{w',h'\},\{w,h\};k\right)=\begin{cases}1 & \text{if } V_j^e\left(\{w',h'\},k\right)-\mu(j,k,h')>V_j^e\left(\{w,h\},k\right),\\ 0 & \text{else.}\end{cases} \tag{5}$$

In solving the model, we assume a small preference shock with zero mean associated with the decisions of job acceptance and remaining employed in the case of a change in the child state. The shock helps smooth the labor supply function (see Appendix C.4 for details).

3.3 Stationary distribution and labor supply

In steady-state equilibrium, the distribution of workers is stationary. Let $g^{j,e}(w,h,k,x)$ denote the measure of gender j workers employed with job (w,h), child state k and demographic type x, and let $g^{j,n}(k,x)$ denote the measure of gender j non-employed workers with child state k and demographic type x. We solve for the stationary distribution by equating inflows to outflows in and out of each worker state. Details are relegated to Appendix C.2.

The stationary distribution allows us to compute the labor supply function $l(w,h)$, which is the expected firm size in terms of efficiency units of labor for a firm that posts job (w,h). The labor supply is the ratio between the efficiency units of labor employed in job (w,h) and the measure of firms posting the job. Specifically, the labor supply is computed as follows:

$$l(w,h) \;=\; \sum_{j=1}^{2}\sum_{k=1}^{3}\sum_{x\in\mathcal{X}}\frac{a_j(h)g^{j,e}(w,h,k,x)}{\Delta^h f_h(w)}. \tag{6}$$

3.4 Firms

Firms are risk neutral and differ in permanent productivity p, which is drawn from the distribution $\Gamma(\cdot)$ with the corresponding PDF $\gamma(\cdot)$ on the support $\left[\underline{p},\bar{p}\right]\subset(0,\infty)$. The flow output per unit of labor efficiency is given by the following production function

$$y(p,h)=\theta_h p h, \tag{7}$$

where θ_h is the hourly productivity shifter. We allow hourly labor productivity to differ between jobs with different hours requirements to reflect potential sunk management costs for each position.[14]

3.4.1 Firm strategy

Firms first choose whether to be active. Conditional on being active, they then make their optimal job-posting decisions. We begin with the latter.

Job-Posting Decisions Active firms choose the hours requirement and the hourly wage. We assume that firms do not make job offers contingent on gender, even though they may have an incentive to discriminate. Note that the gender specific labor efficiency term $a_j(h)$ can be interpreted as a reduced form way of capturing potential gender discrimination, since the hourly wage a worker receives is the product of the posted wage and labor efficiency.[15] In the following, we first consider the wage decision and then the hours decision. Given productivity p and hours requirement h, the expected flow profit from posting wage w is

$$\pi_h(w;p) = \big[y(p,h) - wh\big]\, l(w,h). \tag{8}$$

For each (p,h), the optimal posted wage $w_h(p)$ solves the firm's problem of maximizing (8) with respect to w. The maximized expected flow profit is

$$\pi_h(p) = \big[y(p,h) - w_h(p)\, h\big]\, l\big(w_h(p),h\big). \tag{9}$$

Next, firms choose the hours requirement. Let $h(p,\boldsymbol{\varepsilon}) \in \mathcal{H}$ denote the optimal choice for a firm with productivity p. Firms draw idiosyncratic job-posting costs $\boldsymbol{\varepsilon} = \{\varepsilon_{h_{ME}}, \varepsilon_{h_{PT}}, \varepsilon_{h_{FT}}\}$ from a Type-I Extreme Value distribution with scale parameter $\sigma_\varepsilon > 0$ and mean zero. In addition, we assume that posting a job with hours $h \in \mathcal{H}$ incurs a fixed flow cost of $\bar{\epsilon}_h$, which is common to all firms. The choice rule is

$$h(p,\boldsymbol{\varepsilon}) = \arg\max_{h\in\mathcal{H}} \left\{\pi_h(p) + \varepsilon_h - \bar{\epsilon}_h\right\}. \tag{10}$$

Given $\sigma_\varepsilon > 0$, firms with the same p may choose different hours requirements. The resulting share of productivity-p firms choosing hours requirement h is given by $\Delta(h;p)/\Delta^{act}(p)$:

$$\Delta(h;p)/\Delta^{act}(p) = \frac{\exp[\,(\pi_h(p) - \bar{\epsilon}_h)/\sigma_\varepsilon]}{\sum_{h'\in\mathcal{H}} \exp[\,(\pi_{h'}(p) - \bar{\epsilon}_{h'})/\sigma_\varepsilon]}. \tag{11}$$

[14] That is, the management cost *per hour of work* may be higher when a firm hires multiple workers under marginal or part-time contracts rather than employing a single full-time worker to perform the same total amount of work.

[15] By not allowing firms to post gender specific wages, our model does not capture potential changes in gender based discrimination induced by the minimum wage.

where $\Delta^{act}(p)$ is the share of active firms given productivity p, defined later.

Finally, we can define $\bar{\pi}(p)$, the unconditional expected profit net of job-posting costs:

$$\bar{\pi}(p) \equiv \mathbb{E}_{\boldsymbol{\varepsilon}} \left[\max_{h \in \mathcal{H}} \{\pi_h(p) + \varepsilon_h - \bar{\epsilon}_h\} \right], \tag{12}$$

where $\mathbb{E}_{\boldsymbol{\varepsilon}}$ denotes the expectation over $\boldsymbol{\varepsilon}$.

Activity Decision Given $\bar{\pi}(p)$, the firm decides either to be inactive or active by comparing the values corresponding to the two alternatives, $\{\varepsilon_{\text{inact}},\ \bar{\pi}(p) + \varepsilon_{\text{act}}\}$, where the expected profit from inactivity is zero, and $\{\varepsilon_{inact}, \varepsilon_{act}\}$ are the idiosyncratic shocks corresponding to the two alternatives. We assume they are drawn from Type-I Extreme Value distribution with scale parameter σ_{ε^a}. The share of firms with productivity p that choose to be active is

$$\Delta^{act}(p) = \frac{\exp[\bar{\pi}(p)/\sigma_{\varepsilon^a}]}{1 + \exp[\bar{\pi}(p)/\sigma_{\varepsilon^a}]}. \tag{13}$$

We can then pin down $\Delta(h;p)$ from Eq. 11 and 13.

Offer Distribution We can construct the offer distribution $\{F_h(w), \Delta^h\}_{h \in \mathcal{H}}$ using the optimal wage strategy $w_h(p)$ and the hours-requirement function $\Delta(h;p)$. For each $h \in \mathcal{H}$, we have

$$F_h(w) = \frac{\int_{\underline{p}}^{w_h^{-1}(w)} \Delta(h;p)\, d\Gamma(p)}{\Delta^h}, \tag{14}$$

$$\Delta^h = \int_{\underline{p}}^{\bar{p}} \Delta(h;p)\, d\Gamma(p), \tag{15}$$

where $w_h^{-1}(\cdot)$ denotes the inverse of the optimal wage function $w_h(p)$. Since $\sum_{h \in \mathcal{H}} \Delta(h;p) \leq 1$ for all p, it follows directly that $\Delta^{act} = \sum_{h \in \mathcal{H}} \Delta^h \leq 1$.

Correlation between Posted Wages and Hours Our model captures the observed part-time penalty through two mechanisms that generate a positive correlation between hours requirements and posted wages. First, if the estimated hourly productivity shifter θ_h is higher for full-time jobs than for part-time or marginal jobs, then firms tend to post higher wages when offering full-time hours. Second, Eq. 7 implies a production complementarity between productivity p and hours requirements h: hourly productivity rises more steeply with hours for high-p firms than for low-p firms. This complementarity induces positive sorting between p and h, meaning that more productive firms are more likely to post jobs requiring longer hours. Since more productive firms also

tend to post higher hourly wages (Burdett and Mortensen, 1998), this sorting further reinforces the positive correlation between posted wages and hours.

3.5 Steady state equilibrium

Definition 1. A steady-state equilibrium is defined by the offer distribution $\{F_h(\cdot), \Delta^h\}_{h\in\mathcal{H}}$ such that

i. Given the offer distribution, workers make optimal job acceptance and quitting decisions as described by Eq. 3 and 5.

ii. The distribution of workers is stationary (Sec. 3.3).

iii. Given the labor supply function (Eq. 6), firms choose optimal activity and hours requirements $(\Delta^{act}, \Delta(h;p))$ and wages $(w_h(p))$, as described in Sec. 3.4.1.

iv. The wage distribution over job offers with hours requirement h is given by Eq. 14 and the measure of offers with hours requirement h is given by Eq. 15.

The equilibrium can be solved numerically by iterating on $\{F_h(\cdot), \Delta^h\}_{h\in\mathcal{H}}$. Details of the numerical solution are given in Appendix C.3.

3.6 Implementing Minimum Wages

Widespread non-compliance with the minimum wage is a well-documented phenomenon in Germany. It has been attributed to the lack of enforcement and awareness (for details, see Appendix A). Since low-hours jobs have lower hourly wages, these jobs are more susceptible to non-compliance issues following the introduction of the minimum wage in 2015. Burauel et al. (2017) find that in 2016, over 40% of marginal-employment jobs were non-compliant with the minimum wage, whereas less than 10% of full-time jobs were non-compliant.

To account for the prevalence of non-compliance, we incorporate the minimum wage into our model with a penalty. We assume that firms can post job offers with hourly wages below the minimum wage. However, workers encounter such offers at a reduced contact rate, reflecting that firms may be unable to recruit openly for non-compliant positions through standard advertising channels. Specifically, we assume that the job contact rate is multiplied by a factor $\max\{0, 1-\kappa(wa_j(h); w_{min})\} \leq 1$ where

$$\kappa(wa_j(h); w_{min}) = \begin{cases} \kappa_0 \left(w_{min} - wa_j(h)\right)^2 & \text{if } wa_j(h) < w_{min}, \\ 0 & \text{else.} \end{cases} \tag{16}$$

We calibrate the penalty parameter κ_0 to match the observed change in the share of full-time jobs paying less than 8.5 € after the introduction of the minimum wage. Given minimum wage w_{min}, the rate that workers contact a job offer (w, h) becomes

$$\lambda \max\{0, 1 - \kappa(wa_j(h); w_{min})\}\Delta^h_{w_{min}} f_h(w; w_{min})$$

where $\Delta^h_{w_{min}}$ and $f_h(w; w_{min})$ are offer distribution given w_{min}.

The minimum wage can also affect firms' inactivity decisions. A greater fraction of low-productivity firms are likely to choose to be inactive once the minimum wage is imposed, reducing labor demand. Although we do not impose a free-entry condition as in Blömer et al. (2024), the endogenous inactivity margin allows us to capture the negative effect of the minimum wage on labor demand in a frictional labor market.[16]

4 Estimation strategy and model fit

We estimate the model to match the German labor market before the introduction of the first federal minimum wage in 2015. Some model parameters can be externally calibrated to values computed directly from the data, while others are internally estimated via a two-step method. In our continuous-time model, one unit of time corresponds to a year.

4.1 Data

Our data source is the Core Study of the German Socio-Economic Panel (SOEP). SOEP is a representative household survey conducted annually with topics including household composition, education, employment biographies, and earnings. We estimate the model based on the 2013-2014 period and a sample of civilians between ages 25 and 54 who are not in school or retirement. We acknowledge that younger workers (under age 25) and older workers (above age 54) are disproportionately represented in low-hours, low-wage jobs and are therefore likely to be affected by minimum wage policies. However, these groups face life-cycle considerations such as schooling decisions for the young and retirement choices for older workers, and these are outside the scope of our equilibrium labor-market model. Our age restriction is well aligned with the focus on gendered impacts of the

[16] With the inactivity margin, we implicitly assume an elasticity of job matches with respect to posted vacancies of 1. A potential concern is that this specification may understate congestion on the worker side and overstate it on the firm side. However, these effects are likely of secondary importance for our quantitative results. On the worker side, all individuals search regardless of their employment state, so policy-induced changes in employment do not change aggregate search intensity. On the firm side, Section 5.1 shows that the inactivity response is small.

minimum wage, as the he gender difference in marginal employment is most pronounced among individuals aged 25-54, making this group particularly relevant for our analysis.[17]

Since the minimum wage mainly affects workers without a tertiary education, we consider only those with up to 12 years of education. We further exclude individuals who have never worked from our sample because our model concerns only individuals who are active or potential labor market participants. In the SOEP data, we observe not only the type of employment (e.g., full-time, part-time, or marginal employment) but also the weekly hours of work. We focus on dependent employment in the private sector (i.e., we exclude civil service and self-employment) and use contractual hours to compute hourly wages following Caliendo et al. (2018). In Appendix G.1, we examine how the choice between contractual and actual hours affects the hourly wage distribution and non-compliance calibration.

Individuals in our data can be classified into three relationship states: married, single, and cohabiting, where cohabiting households are defined as unmarried individuals living with a partner. We reclassify individuals who are cohabiting with children and subsequently marry as married.[18] We exclude other cohabiting individuals from our main sample for two reasons. First, cohabitation is an unstable relationship status, with frequent transitions into either marriage or singlehood, while our model assumes permanent relationship states. Second, although cohabiting couples share some risks within the household, they are not eligible for joint taxation. As a result, they differ in important ways from both singles and married couples, making it difficult to map them consistently into either group within our model framework.

4.2 External calibration

Table 3 reports the values of the externally calibrated parameters. We set the annual discount rate ρ to 4%, a standard value in the literature. The parameter ρ_d denotes the rate at which workers exit the model. Since we focus on individuals aged 25 to 54, we calibrate the exit rate to 1/30. The utility of leisure in Eq. 1 is expressed in terms of weekly hours. We assume that $\bar{h}$, the maximum number of weekly hours, is 80, corresponding to the number of weekday hours excluding 8 hours of sleep per day. The hours associated with each employment type correspond to the median contractual hours observed in our SOEP sample. The median weekly hours of a full-time job are 40, while those of part-time and marginal employment are 25 and 11, respectively.

[17] Using SOEP data, we estimate that among marginally employed individuals aged 25-54, 77% are women. In contrast, among those aged 15-24 or 55+, 56% of marginally employed workers are women.

[18] In our sample, the average age of children in cohabiting households is substantially lower than in married households, suggesting that many cohabiting couples transition into marriage soon after the birth of their first child.

Child state transition rates The state $k = 2$ (young children) is defined as having at least one child aged six or younger. We use this age cutoff because mothers' labor supply is most affected during the first six years after childbirth (Keller and Kahle, 2018; Turon, 2022). The child-state transition rates, $\phi_{j,x}(k)$, are calibrated to match annual transition probabilities computed from the SOEP; details are provided in Appendix C.1. We allow single men, single women, and married couples to follow different transition processes. Married couples exhibit the highest transition rate into the young-children state and the lowest transition rate out of it, reflecting the fact that they have more children on average than singles.

Marital and spousal income distribution We assume six demographic types. Type $x = 1$ corresponds to singles, and types $x \in \{2, 3, \ldots, 6\}$ correspond to married individuals differentiated by their spouse's income level. We assume that the share of singles is the same across genders, set to the observed fraction of singles in our SOEP sample. For the spousal income distribution, a higher value of x corresponds to a higher spousal income. We assume that the support of the spousal income distribution is the same for both genders, with the five income levels $\{\mathcal{X}(x)\}_{x=2}^{6}$ defined by the 10th, 30th, 50th, 70th, and 90th percentiles of the empirical distribution of labor income (including zeros) among married individuals in our sample (pooling men and women). We approximate the spousal income distribution with a discrete distribution over this common support, and we allow the distribution to differ by gender. Married individuals are assigned to the closest income bin based on their spouse's income. Figure 2 shows the resulting gender-specific distributions. Since men earn more on average, women are more likely to have high-income spouses (higher probability in the upper bins), whereas men are more likely to have low-income spouses (higher probability in the lower bins).

Tax and benefits Single workers consume their own after-tax income, whereas married workers pool their income with their spouse and consume half of the household after-tax income. In practice, marginal employment benefits from tax exemptions only if monthly earnings remain below the statutory income cap, as discussed in Sec. 2.1. Figure 12 in Appendix A documents the nominal and real adjustments in the minijob income cap alongside the statutory minimum wage: while the income cap was increased in 2022, it was not always jointly adjusted with the minimum wage. In the model, however, we abstract from this income cap and assume that all marginal-employment income is tax-exempt for technical reasons.[19] Thus, in the model, marginal-employment income

[19] The technical issue is that the income cap introduces a discontinuity in firms' profit function, which our solution method cannot accommodate. Let $\bar{E}_{ME}$ denote the income cap below which a marginal-employment job is tax-exempt. Since marginal-employment hours are fixed at h_{ME}, the corresponding hourly wage associated with the income cap is $\bar{w}_{ME} = \bar{E}_{ME}/h_{ME}$. The tax exemption creates a notch at this threshold. A marginal-employment job paying a gross wage slightly above $\bar{w}_{ME}$ loses the tax exemption and may therefore deliver a discretely lower net wage, and hence lower worker utility, than a job paying exactly $\bar{w}_{ME}$. Such offers are dominated: they are more

enters net income one-for-one, whereas income from part-time and full-time jobs is included in taxable income. As a consequence, we cannot capture the interaction between the income cap and minimum wage policies. Bossler et al. (2026) show that the income cap can induce reductions in hours within marginal employment: while the minimum wage raises hourly wages monotonically across the distribution, its effect on monthly earnings is non-monotonic because of the binding income cap. In addition, the income cap may discourage those in marginal employment from seeking higher income. This effect is likely to be particularly strong for those with a higher-earning spouse because of the high marginal tax rate they may face once their income exceeds the cap. By omitting this cap from our model, we cannot capture this effect. Nevertheless, our model does capture the differential tax treatment of regular employment (part-time and full-time) and marginal employment, and how this differential treatment can discourage workers, especially those with a higher-earning spouse, from transitioning toward regular employment.

Let y be the gross labor income of a worker. For married workers ($x > 1$), $\mathcal{X}(x)$ is the taxable income of the spouse.[20] The net-of-tax functions for employed ($\mathcal{N}^e$) and non-employed workers ($\mathcal{N}^n$) are as follows.

$$\mathcal{N}^e(y,h;j,k,x) = \begin{cases} \mathbf{1}_{\{h\in\{h_{PT},h_{FT}\}\}}\left(y - T_k^s(y)\right) + \mathbf{1}_{\{h=h_{ME}\}}y & \text{if single } (x=1), \\ \frac{1}{2}\left[\mathbf{1}_{\{h\in\{h_{PT},h_{FT}\}\}}y + \mathcal{X}(x) - T_k^c(\mathbf{1}_{\{h\in\{h_{PT},h_{FT}\}\}}y + \mathcal{X}(x)) + \mathbf{1}_{\{h=h_{ME}\}}y\right] & \\ & \text{else,} \end{cases}$$

$$\mathcal{N}^n(j,k,x) = \begin{cases} b_{j,s} + b_j^k & \text{if single } (x=1), \\ \frac{1}{2}\left[b_{j,c} + b_j^k + \mathcal{X}(x) - T_k^c(\mathcal{X}(x))\right] & \text{else,} \end{cases}$$

costly for firms but less attractive to workers. As a result, firms may bunch at $\bar{w}_{ME}$, generating a mass point, while no firm posts marginal-employment wages just above the threshold, generating a hole in the offer distribution. This feature is difficult to reconcile with the standard Burdett–Mortensen wage-posting framework, where the equilibrium offer distribution is atomless and has connected support (Burdett and Mortensen, 1998).

Imposing an upper bound on marginal-employment wages at $\bar{w}_{ME}$ avoids having taxable marginal-employment wages, but it does not remove the difficulty. It turns $\bar{w}_{ME}$ into a boundary mass point within the ME sector, while the same point need not be a boundary in the overall distribution of job values. This is because firms choose among ME, PT, and FT jobs, and workers rank these jobs by the utility they deliver rather than by sector-specific hourly wages. To see this, consider the PT wage $\hat{w}_{PT}$ that delivers the same worker value as an ME job paying $\bar{w}_{ME}$, abstracting from idiosyncratic preference shocks. A PT wage slightly below $\hat{w}_{PT}$ does not attract workers away from those ME jobs, while a PT wage slightly above $\hat{w}_{PT}$ jumps above the ME mass point and generates a discrete increase in labor supply. Hence the region just below $\hat{w}_{PT}$ may be left empty. The same logic applies to FT offers. Hence, a boundary mass point in the ME sector can generate holes and additional mass points in the PT and FT offer distributions. These objects are not covered by the usual atomless, connected-support Burdett-Mortensen equilibrium characterization. A potential avenue for future work, especially for studying the interaction between income caps and minimum-wage policies, is to consider a framework in which hours in marginal-employment jobs are allowed to vary more flexibly.

[20] We assume that all of the spousal income is taxable for numerical tractability. In practice, spousal income may include tax-free incomes such as incomes from marginal employment. Keeping track of the share of tax-free spousal income requires a much larger state space and greater computation time.

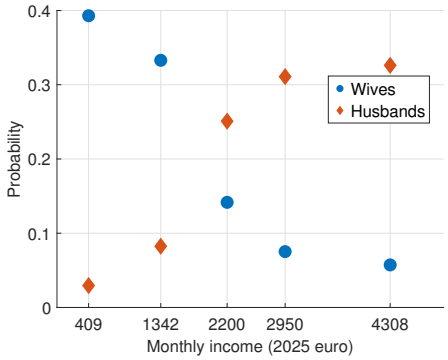
where $T_k^s(\cdot)$ and $T_k^c(\cdot)$ are tax functions for singles and couples, $b_{j,s}$ and $b_{j,c}$ are non-employment benefits for singles and married workers, and b_j^k is parental benefit. The tax function may differ between singles and couples, as married couples in Germany file joint tax returns. We include transfers in the tax function, except for non-employment and parental benefits. Since some government transfer programs are contingent on the presence and age of children, we allow the tax function to depend on the child state k. Note that non-employment and parental benefits are not subject to the income tax.

The parameters $b_{j,s}$ and $b_{j,c}$ are calibrated to the average unemployment benefit for each gender and marital status per period of non-employment. We assume that only workers with young children receive parental benefit b_j^k, which we calibrate to the corresponding average values in the data for each gender. We parametrize the tax functions $T_k^m(Y)$ for $m = s$ (singles), c (couples) following Heathcote et al. (2017) as follows

$$T_k^m(Y) = Y - \tau_{0,k}^m Y^{1-\tau_{1,k}^m}.$$

Under this specification, net household income is given by $\tau_{0,k}^m Y^{1-\tau_{1,k}^m}$, which is log-linear in gross household income Y. We estimate the tax function parameters $\tau_{0,k}^m$ and $\tau_{1,k}^m$ using SOEP data by running an OLS regression of the log of net annual household income on the log of gross annual household income. Calibration details are provided in Appendix C.1.

Figure 2: Distribution of spousal income for married men and women)



Note: The figure shows the probability distribution over the five spousal income bins for married men and women based on SOEP. The income levels on the horizontal axis correspond to the 10th, 30th, 50th, 70th, and 90th percentiles (i.e., $\{\mathcal{X}(x)\}_{x=2}^{6}$) of the empirical distribution of annual income among married individuals in our sample. A higher income level indicates a higher spousal income. Please see Sec. 4.2 for details.

Table 3: External parameters

Parameter	Value	Source
Discount rate, ρ	0.040	Standard value
"Death' rate, ρ_d	0.033	Number of years in model
Child transition rate, $\phi_{j,x}(k)$:		
No children to young children, single men	0.012	SOEP
No children to young children, single women	0.044	SOEP
No children to young children, married	0.069	SOEP
Young children to grown children, single men	0.224	SOEP
Young children to grown children, single men	0.198	SOEP
Young children to grown children, married	0.149	SOEP
Share single	0.428	SOEP
Hours grid, $\mathcal{H}$:		
Weekly hours of ME	11	SOEP
Weekly hours of PT	25	SOEP
Weekly hours of FT	40	SOEP
Spousal income grid (monthly), $\mathcal{X}$:		
$x = 2$ (married, lowest spousal income)	409.2	SOEP
$x = 3$	1341.7	SOEP
$x = 4$	2200.0	SOEP
$x = 5$	2950.0	SOEP
$x = 6$ (married, highest spousal income)	4308.3	
Tax function parameters, τ_0, τ_1 :		
Single, no children	3.8, 0.86	SOEP
Single, young children	156.0, 0.50	SOEP
Single, grown children	133.0, 0.52	SOEP
Married, no children	4.8, 0.84	SOEP
Married, young children	101.5, 0.56	SOEP
Married, grown children	59.1, 0.61	SOEP
Non-employment benefit (monthly), $b_{j,x}$:		
Men, single	849.5	SOEP
Women, single	772.1	SOEP
Men, married	697.1	SOEP
Women, married	209.9	SOEP
Parental benefit (monthly), b_j^k :		
Men	13.9	SOEP
Women	102.0	SOEP

Note: See Sec. 4.2 for details on the computation of these values. All monetary figures are expressed in 2015 €.

4.3 Two-step estimation

The remaining parameters are estimated jointly via a two-step estimation procedure. The two-step procedure has the advantage of avoiding solving the model equilibrium repeatedly, which is highly costly computationally.[21] We call the first step "supply-side" estimation, where we parametrize the offer distribution and estimate its parameters alongside parameters governing preferences, labor efficiency, and labor market transitions. The second step is "demand-side" estimation, where we estimate the parameters of the production function and the job-posting costs distribution. We also recover the firm productivity distribution in this step. Below we explain the two steps in detail.

4.3.1 Step 1: Estimation of supply-side parameters

We estimate the supply-side parameters using the Method of Moments, targeting statistics from the observed distribution of wages and hours as well as labor force transition rates. Solving the worker's optimization problem requires knowledge of the offer distribution $\{F_h(\cdot), \Delta^h\}_{h\in\mathcal{H}}$, which is an equilibrium object of the model (Definition 1). To make the estimation feasible, we parameterize the conditional wage offer distributions $\{F_h(\cdot)\}_{h\in\mathcal{H}}$ and jointly estimate their parameters together with the remaining supply-side parameters.

Specifically, we assume that each conditional wage offer distribution follows a Generalized Beta distribution with parameters $\{\alpha_{F_h}, \beta_{F_h}\}$ and support $[\underline{w}_h, \overline{w}_h]$. The support for each h is chosen to be sufficiently wide so that the model can replicate the empirical hourly wage distribution.

The supply-side parameters to be estimated are $\tilde{\lambda}$, $\{\alpha_{F_h}, \beta_{F_h}, \Delta^h/\Delta^{act}, \delta(h), a_2(h)\}_{h\in\mathcal{H}}$, $\{\psi_k^j, \gamma_k^j\}_{j\in\{1,2\},k\in\{1,2,3\}}$, and $\{\mu(j,k,h)\}_{j\in\{1,2\},k\in\{1,2,3\},h\in\mathcal{H}}$. Here $\tilde{\lambda} \equiv \Delta^{act}\lambda$ is the job contact rate. The share of active firms Δ^{act} will be recovered in the demand-side estimation (Sec. 4.3.2, which in turn allows us to back out the underlying parameter λ.

While the supply-side parameters are jointly estimated, we outline below how each set of parameters is identified. The offer distribution parameters $\{\alpha_{F_h}, \beta_{F_h}\}_{h\in\mathcal{H}}$ and the female labor efficiency parameters $\{a_2(h)\}_{h\in\mathcal{H}}$ shape the observed hourly wage distributions conditional on hours. Recall that we normalize men's labor efficiency to $a_1(h) = 1$ for all $h \in \mathcal{H}$. Thus, $a_2(h)$ determines the within-firm gender difference in hourly labor productivity for jobs with hours requirement h, and therefore influences the gender wage gap conditional on h. In the estimation, we target the 25th, 50th, and 75th percentiles of the hourly wage distribution for each hours type and for each gender.

The hours-distribution parameters $\{\Delta^h/\Delta^{act}\}_{h\in\mathcal{H}}$ are disciplined by the observed distribution of hours across jobs. Note that these probabilities must sum to one as $\Delta^{act} = \sum_{h\in\mathcal{H}} \Delta^h$ by definition.

[21] See Bontemps et al. (2000), Meghir et al. (2015), Aizawa and Fang (2020) and Fang and Shephard (2019).

The exogenous job separation rates $\{\delta(h)\}_{h\in\mathcal{H}}$ are identified from the observed transition rates from each employment type into non-employment.[22]

The remaining supply-side parameters include the preference parameters ψ_k^j and γ_k^j, as well as the job contact rate $\tilde{\lambda}$. The parameter $\tilde{\lambda}$ governs the rate at which workers receive job offers, while the ψ_k^j parameters determine the probability that such workers accept those offers. In our data, we cannot separately identify the job-offer arrival rate from the job-acceptance probability. Moreover, given an observed job separation rate, the steady-state condition implies a one-to-one relationship between the job-finding rate and the employment rate. We therefore use the employment rate to pin down $\tilde{\lambda}$, and normalize $\psi_{k=1}^{j=1} = 1$. We then estimate only the variation in ψ_k^j across gender and child-status groups to match the corresponding variation in employment rates. This normalization implies that the model cannot decompose cross-group differences in employment into components attributable to search-related factors versus preference heterogeneity.

Moreover, we set $\gamma_{k=1}^{j=1} = 2$, corresponding to an intertemporal elasticity of labor supply of 0.5 when working full-time.[23] We identify γ_k^j for men with $k = 2, 3$ and women with $k = 1, 2, 3$ by targeting the hours distribution by gender and child state. In the data, women with young and grown children have a non-monotone employment pattern over hours, with the part-time rate being substantially higher than both marginal employment and full-time rates. To replicate this feature, we allow the disutility $\mu(j, k, h = h_{FT})$ to be positive for women with young or grown children. We set the distaste to zero in all other cases since allowing the parameter to vary does not significantly improve the fit of the model.

4.3.2 Step 2: Estimation of demand-side parameters

Demand-side parameters to be estimated include the hourly productivity shifters $\{\theta_h\}_{h\in\mathcal{H}}$ and the scale parameter of the job-posting shocks $\{\sigma_\varepsilon, \sigma_{\varepsilon^a}\}$ and job-posting cost parameters $\{\bar{\epsilon}_h\}_{h\in\mathcal{H}}$. Additionally, we determine the firm productivity distribution $\Gamma(\cdot)$ non-parametrically based on the estimated parameters. To address the observational equivalence between average firm productivity p and the average value of the θ-parameters, we normalize $\theta_{FT} = 1$ without loss of generality. Moreover, we normalize the average job-posting cost of full-time jobs, $\bar{\epsilon}_{FT}$, to zero and estimate only $\bar{\epsilon}_{ME}$ and $\bar{\epsilon}_{PT}$, which capture the difference in job-posting cost between different hours-types.[24]

[22] The exogenous separation rates $\{\delta(h)\}_{h\in\mathcal{H}}$ cannot be externally calibrated from observed separation rates because, in our model, workers may quit their jobs following a child state transition.

[23] We borrow the value from Erosa et al. (2016), who have a similar utility function specification as ours. Chetty et al. (2011) find the Frisch labor supply elasticity to be 0.54 in their meta-study. We do not estimate γ_1^1 internally because we cannot separately identify it from $\{\Delta^h/\Delta^{act}, h \in \mathcal{H}\}$ without exogenous variations that affect their labor supply.

[24] In our model, the job-posting cost represents a flow cost for each job opening. The empirical counterpart is the recruitment cost divided by the expected duration of the filled position. Using the 2014 and 2015 German Job

For this estimation step, we identify demand-side parameters by ensuring that firms' optimal job-posting decisions yield an offer distribution consistent with the one uncovered in Step 1 (Sec/ 4.3.1). Following Fang and Shephard (2019), we construct a theoretical hours requirement choice function $\Delta(h;p)$, and compare it to the observed counterpart, $\widehat{\Delta}(h;p)$. Demand-side parameters are estimated by minimizing the distance between these two functions. The theoretical choice is derived from firms' optimal job-posting decisions, given the estimated labor supply from Step 1, while the observed choice is the one that is consistent with the estimated offer distribution from Step 1. The details of demand estimation are provided in Appendix D. Below, we present a heuristic argument for identification.

The parameters $\bar{\epsilon}_{h_{ME}}$ and $\bar{\epsilon}_{h_{PT}}$ are identified from the shares of job offers that are marginal-employment and part-time, respectively ($\Delta^{h_{ME}}/\Delta^{act}$ and $\Delta^{h_{PT}}/\Delta^{act}$). A higher value of $\bar{\epsilon}_h$ corresponds to a higher average job-posting cost for type-h jobs, which reduces the fraction of firms choosing to post such jobs and therefore leads to a smaller Δ^h. Tazhitdinova (2020) documents that workers in marginal employment receive fewer fringe benefits such as vacation days and sickness pay because of higher non-compliance with mandated benefits. Although our model does not explicitly incorporate non-wage benefits, differences in benefit provision across hours types are captured implicitly through differences in job-posting costs. All else equal, a lower level of fringe benefits for jobs with hours requirement h corresponds to a lower job-posting cost $\bar{\epsilon}_h$ and thus a larger share of posted jobs with hours h.

As we do not observe the share of inactive firms by firm productivity, we cannot identify σ_{ε^a}. We, thus, assume that $\sigma_{\varepsilon^a} = \sigma_\varepsilon$. The parameter σ_ε governs the variance in offered wages within each hours type relative to the wage variance across different hours types. All else equal, a larger σ_ε implies that firms' decisions on hours requirements are less influenced by profit differences ($\pi_h(p)$) but more by the idiosyncratic job-posting cost. Since all firms draw the idiosyncratic job-posting costs from the same distribution, at the extreme, as σ_ε goes to infinity, they make the same hours-posting decisions. In this case, wage differences between hours-types are relatively small compared to wage variations within each hours type. Finally, the parameters $\theta_{h_{ME}}$ and $\theta_{h_{PT}}$ influence the difference in both the mean and dispersion of offered wages across hours types. A higher θ_h indicates that the offered wages for hours type h are, on average, higher and exhibit greater dispersion relative to other hours types.

Vacancy Survey, Carbonero and Gartner (2022) estimate the average cost of recruitment per job opening (full-time or part-time) to be 1576 €. Given an average job tenure of 10.5 years in Germany in 2014 (OECD.stat), the flow recruitment cost is approximately 150 € per year of job tenure, which is negligible compared to the expected wage or profit of a position.

4.4 Parameters and model fit

Supply side parameters Table 4 shows the parameter estimates. On the labor supply side, the estimated offer distribution indicates that 84% of job offers are full-time while only 3% are marginal employment. The exogenous job separation rate of marginal employment is 14 times as high as a full-time job and 5 times as high as a part-time job. The estimated γ_k^j for women is significantly higher than for men, indicating a substantial distaste for working full-time. Among women, those with children have a higher ψ_k^j, the scale parameter on the utility from leisure.

Table 5 shows the fit of targeted moments. The heterogeneity in preferences allows us to match several key employment patterns across demographic groups. Women, especially those with young children, have a lower employment rate than men, where the employment rate is the sum of marginal, part-time, and full-time employment rates. Among women, those with children are more likely to hold a marginal or part-time job and less likely to hold a full-time job than those without children.

Our model also performs well in matching the observed hourly wage distribution and the pattern in job separation probabilities. Figure 3 shows the fit of the observed hourly wages at various percentiles. Note that only the 25th, the 50th and the 75th wage percentiles are targeted moments. We replicate the gender hourly wage gap in each type of job: while the female hourly wage distribution in full-time jobs is first-order dominated by the male distribution, but not in marginal and part-time jobs. The gender differences in the estimated labor efficiency ($a_j(h)$) are crucial for matching the gender hourly wage gaps. Our estimation reveals that women are more efficient in marginal-employment and part-time jobs than men, but less efficient in full-time jobs. Without the gender differences in labor efficiency, women, who have a stronger dislike for working full-time compared to men, would set higher reservation wages, resulting in counterfactually higher hourly wages than men. The estimated $a_j(h)$ for women in full-time jobs is less than 1 (the value for men). As a result, women make lower hourly wages in full-time jobs despite their preferences.

Demand side parameters We find that the hourly productivity in marginal employment ($\theta_{h_{ME}}$) is about 68% of that in full-time jobs ($\theta_{h_{FT}}$). Notably, there is non-monotonicity in the hourly productivity shifters: the hourly productivity in part-time jobs is lower than that in marginal jobs. If the part-time productivity shifter $\theta_{h_{PT}}$ were higher, each firm p would post a higher part-time wage, as determined by the first-order condition of the wage-posting problem. Additionally, the likelihood of firms posting part-time jobs would increase for each p, as the expected profit of offering part-time jobs would be higher. These firm decisions would result in an offer distribution with a larger share of part-time offers and higher posted part-time wages than those observed in the estimated offer distribution from Step 1.

The average job-posting cost $\bar{\epsilon}_h$ decreases with hours. While the total recruitment cost for each marginal employment or part-time position may be lower than that for a full-time position, the expected job tenure increases in hours. Our estimate of the job posting cost indicates that the average recruitment cost per year of job tenure is the lowest for full-time jobs.

The bottom panel of Table 5 and Figure 4 compare the offered hours and wage distributions derived from the supply-side estimation and those constructed from firms' optimal job-posting decisions using the estimated demand-side parameters. Despite the parsimonious parametrization, the demand-side version of the offer distribution closely replicates key features of the supply-side version. These include the shares of job offers by hours, differences in the mean and dispersion of wages across hours types, as well as the variation in wage dispersion between and within hours types.

Non-compliance penalty As described in Sec. 3.6, we implement the minimum wage in the model through a penalty that reduces the rate at which workers contact non-compliant job offers. We calibrate the penalty parameter κ_0 (Eq. 16) to match the observed drop in the share of full-time jobs with hourly wages below 8.5 € (bottom panel, Table 4). Using our SOEP sample, we estimate a decline of 3.72 percentage points between the baseline period (2013-2014) and 2016. In the model, an 8.5 € minimum wage produces a comparable decline of 3.55 percentage points.[25]

In Appendix G.2, Figure 15 shows the equilibrium hourly wage distribution in our model without a minimum wage and with the â,¬8.50 minimum wage. The introduction of the minimum wage shifts mass upward at the lower end of all three wage distributions. Because firms are allowed to post non-compliant wages, the model does not generate bunching at the minimum wage. Figure 16 presents the corresponding wage distribution in the SOEP before and after minimum wage introduction. The data exhibit only a modest degree of bunching, and the overall shift in the distribution closely mirrors the model's prediction.

4.5 Minimum wage effects and comparison with empirical estimates

In this subsection, we compare the equilibrium employment and wage effects of the introduction of the German minimum wage implied by our model with empirical estimates of the short-run effects reported in recent literature and our empirical analysis. Ideally, we would compare the model-implied short-run effects directly with the empirical estimates. However, given the complexity of the model, solving for transitional dynamics is not computationally feasible without making additional simplifying assumptions. We therefore acknowledge that our analysis is based on comparative statics

[25] We compute hourly wages using contractual hours in the data. Appendix G.1 shows that using actual hours to construct the data target for calibrating κ_0 yields a statistically indistinguishable estimate.

Table 4: Estimated parameters

Parameter		value
Supply side:		
Offer distrib. parameter, α_{F_h}	ME	1.440
	PT	1.650
	FT	2.129
Offer distrib. parameter, β_{F_h}	ME	3.812
	PT	3.449
	FT	3.299
Offer distrib. parameter, Δ^h/Δ^{act}	ME	0.033
	PT	0.123
	FT	0.844
Contact rate, λ		2.590
Exog. separation rate, $\delta(h)$	ME	0.256
	PT	0.029
	FT	0.018
Preference parameters,ψ_k^j	male, young children	0.037
	male, grown children	0.314
	female, no children	0.862
	female, young children	1.873
	female, grown children	1.656
Preference parameters,γ_k^j	male, young children	2.669
	male, grown children	1.165
	female, no children	4.877
	female, young children	5.045
	female, grown children	4.443
Distrib. of disutility $\mu_\alpha(j,k,FT)$	female, young children	0.851
	female, grown children	0.703
Labor efficiency, $a_j(h)$	female, ME	1.266
	female, PT	1.341
	female, FT	0.851
Demand side:		
Production function param., θ_h	ME	0.682
	PT	0.383
Job-posting cost (monthly), $\bar{\epsilon}_h$	ME	1958.7
	PT	539.2
Job-posting cost (monthly), σ_ε		1054.5
Minimum wage implementation:		
Non-compliance penalty, κ_0		0.008

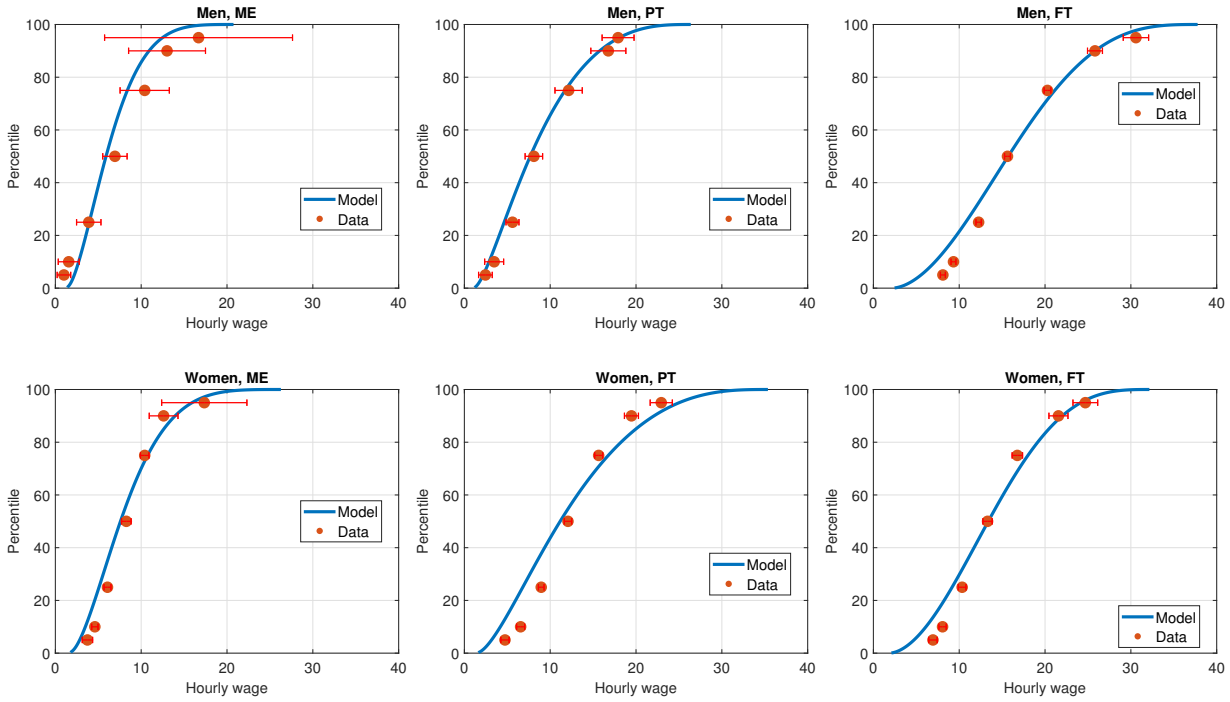
Note: See Sec. 4.3 for details of the estimated parameters.

Table 5: Model fit

Moment	**Men**				**Women**			
	Data (se)		Model	95% C.I. diff.	Data (se)		Model	95% C.I. diff.
Employment distribution:								
No children								
ME	0.032	(0.008)	0.023	(-0.01, 0.02)	0.065	(0.015)	0.043	(-0.01, 0.02)
PT	0.078	(0.014)	0.096	(-0.05, 0.01)	0.238	(0.025)	0.164	(-0.05, 0.01)
FT	0.728	(0.021)	0.721	(-0.03, 0.05)	0.573	(0.029)	0.558	(-0.03, 0.05)
Young children								
ME	0.025	(0.006)	0.023	(-0.01, 0.01)	0.156	(0.013)	0.124	(-0.01, 0.01)
PT	0.056	(0.010)	0.103	(-0.07,-0.03)	0.312	(0.019)	0.318	(-0.07,-0.03)
FT	0.823	(0.019)	0.846	(-0.06, 0.02)	0.117	(0.019)	0.086	(-0.06, 0.02)
Grown children								
ME	0.022	(0.004)	0.024	(-0.01, 0.00)	0.132	(0.009)	0.121	(-0.01, 0.00)
PT	0.027	(0.004)	0.104	(-0.09,-0.07)	0.422	(0.013)	0.337	(-0.09,-0.07)
FT	0.857	(0.012)	0.854	(-0.02, 0.03)	0.277	(0.012)	0.281	(-0.02, 0.03)
Hourly wage:								
ME								
P25	3.893	(0.710)	3.952	(-1.45, 1.33)	6.074	(0.202)	5.086	(0.59, 1.38)
P50	6.941	(0.710)	5.905	(-0.36, 2.43)	8.267	(0.278)	7.587	(0.13, 1.23)
P75	10.411	(1.435)	8.387	(-0.79, 4.84)	10.411	(0.246)	10.745	(-0.82, 0.15)
PT								
P25	5.606	(0.377)	4.638	(0.23, 1.71)	8.955	(0.164)	6.803	(1.83, 2.47)
P50	8.098	(0.509)	7.675	(-0.57, 1.42)	12.071	(0.213)	11.161	(0.49, 1.33)
P75	12.147	(0.795)	11.740	(-1.15, 1.96)	15.647	(0.232)	16.768	(-1.58,-0.67)
FT								
P25	12.264	(0.155)	10.756	(1.20, 1.81)	10.344	(0.222)	9.168	(0.74, 1.61)
P50	15.624	(0.170)	15.707	(-0.42, 0.25)	13.303	(0.269)	13.387	(-0.61, 0.44)
P75	20.286	(0.195)	21.130	(-1.23,-0.46)	16.774	(0.304)	18.006	(-1.83,-0.64)
Job separation prob. (monthly, both genders):								
ME-to-NE	0.022	(0.003)	0.020	(-.003,0.008)				
PT-to-NE	0.007	(0.001)	0.004	(0.002,0.005)				
FT-to-NE	0.006	(0.000)	0.003	(0.002,0.004)				
Share of job offers with hours h (Δ^h/Δ^{act})*:*								
ME	0.033		0.036					
PT	0.123		0.120					
FT	0.844		0.845					

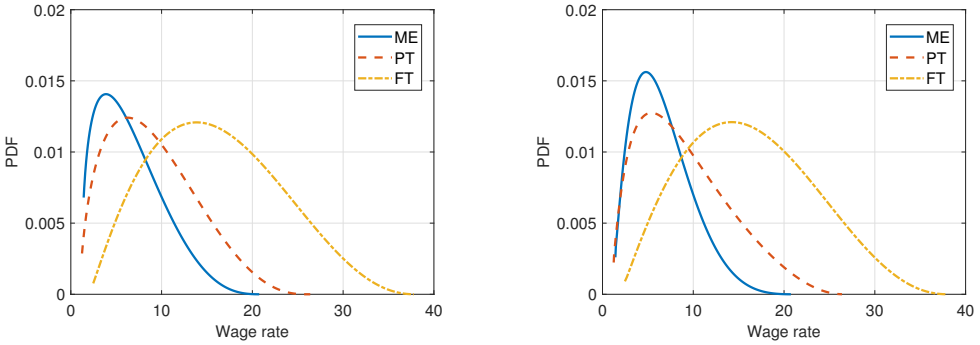
Notes: Data moments (except "Share of job offers with hours h") are computed using the SOEP. Standard errors are reported in parentheses. "se" refers to standard error. For the hourly wage percentiles (p25, p50, and p70), standard errors are obtained via bootstrap. Model moments are generated from the calibrated equilibrium model. "95% C.I. diff" is the 95% confidence interval for the difference between data and model moments. For the moment "Share of job offers with hours h," Data refers to the results from the supply side estimation. ME, PT, and FT refer to marginal employment, part-time, and full-time work, respectively.

Figure 3: Model fit of the equilibrium hourly wage distributions



Note: Red circles denote the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentiles of the empirical hourly wage distribution based on SOEP data. The 25th, 50th, and 75th percentiles are targeted in the estimation. Horizontal red bars indicate 95% confidence intervals obtained via bootstrap. The solid blue line shows the hourly wage distribution implied by the estimated model. ME, PT, and FT refer to marginal employment, part-time, and full-time work, respectively.

Figure 4: Model fit: wage offer distributions



(a) Offer distribution from supply-side estimation

(b) Offer distribution given demand-side estimation

Notes: The figure compares the wage offer distribution ($f_h(\cdot)$) from the step 1, supply-side estimation (Panel a) and that constructed from the optimal firm decisions using Eq. 14 and 15 given parameter estimates from step 2, demand-side estimation. ME, PT, and FT are, respectively, marginal-employment, part-time and full-time.

and, accordingly, that the effects implied by the model should be interpreted as mid- to long-run effects.

Employment Effects As shown in Table 6, the model predicts a small but positive effect of the minimum wage on overall employment and on regular employment. By contrast, it predicts a strong negative effect on marginal employment of about 4%. These results are broadly consistent with Caliendo et al. (2018), who find that the minimum wage reduces marginal employment by roughly 3%, while its effect on overall and regular employment is small and negative.

We further compare the model's predictions for gender-specific employment outcomes with our empirical estimates in Section 2.2, where the model-based results are shown as horizontal lines labeled "Model" in Figure 1. To construct these model-based lines, we compute the model analogue of the effect of the Kaitz index on log employment using the benchmark and minimum-wage equilibria. Let E^0_{jh} denote employment for gender j and job type h in the benchmark economy without a minimum wage, and let E^{MW}_{jh} denote the corresponding employment level after introducing the 8.5 € minimum wage. We define the model change in the Kaitz index as $\Delta K^M = 8.5/w^0_{50} - 0$, where w^0_{50} is the median hourly wage in the benchmark model. The second term is zero because the benchmark economy has no minimum wage, equivalently a minimum wage of zero. The horizontal line in Figure 1 is therefore

$$\widehat{\gamma}^M_{jh} = \frac{(E^{MW}_{jh} - E^0_{jh})/E^0_{jh}}{\Delta K^M},$$

where the numerator is the model-implied relative employment change, used as the approximation to the change in log employment. Thus, the comparison scales the model's equilibrium response to the 8.5 € reform by the change in the minimum-wage bite between the benchmark and minimum-wage economies.

According to the model, the minimum wage leads to a decline in female marginal employment and an increase in female part-time employment, in line with the empirical evidence. The model also predicts negative effects on male marginal and part-time employment. The regression analysis provides inconclusive evidence for male marginal employment but does indicate a negative effect on male part-time employment, which is broadly consistent with the model. For full-time employment, the model predicts small positive effects for both men and women, whereas the regression analysis finds generally insignificant effects, with the exception of 2019, the final year of the analysis. Overall, both the model and the data point to limited full-time employment effects.

Evidence from Bossler et al. (2026) shows that the minimum wage increased exits from minijobs and that women who exit minijobs are more likely than men to transition into regular employment. As we do not consider the short-run transition dynamics following the introduction of the minimum wage,

we cannot validate this mechanism directly. Nevertheless, while the percentage decline in marginal employment is larger for men (6.8%) than for women (3.6%), the decline in the marginal-employment rate is larger for women (0.40 percentage points) than for men (0.16 percentage points). The model also predicts a small increase in female part-time employment. These patterns are consistent with the gender differences documented by Bossler et al. (2026).

Wage Effects Our model predicts positive wage effects at the lower end of the distribution and modest average gains. On average, the minimum wage increases monthly wages by 2.4% (monthly wage equals hourly wage times monthly hours in the model) and hourly wages by 3.0%. These magnitudes are close to the estimated effects reported in the empirical literature: Dustmann et al. (2022) estimate an average hourly wage increase of about 1.3%, while Bossler et al. (2026) report 5.3%; for monthly wages, Bossler and Schank (2023) find 4.4% and Bossler et al. (2026) find 5.8%.

The model generates sizable gains at the lower percentiles. At the 20th percentile, monthly wages rise by 25% and hourly wages by 16%, closely matching empirical estimates: Bossler and Schank (2023) report a 22% increase in the P20 monthly wage, and Bossler et al. (2026) report 16%; for P20 hourly wages, Bossler et al. (2026) find a 9.1% increase. Our results also show that, at the 20th percentile, the effect on monthly wages is about 9 percentage points larger than the effect on hourly wages. This is comparable to the 7 percentage point difference reported by Bossler et al. (2026). The gap reflects the fact that part of the increase in monthly wages comes from higher hours of work. At the median (P50), the model implies a small negative effect on both monthly and hourly wages, whereas Bossler and Schank (2023) (monthly only) and Bossler et al. (2026) (monthly and hourly) find small positive effects.

Table 6: Effects of the First German Minimum Wage

	Model	Data	Source
		Employment	
Overall	0.14	-0.42	Caliendo et al. (2018, Table 4, col. 3)
Marginal	-4.14	-2.97	Caliendo et al. (2018, Table 4, col. 3)
Regular (part-time and full-time)	0.55	-0.19	Caliendo et al. (2018, Table 4, col. 3)
		Monthly Wage	
Mean	2.43	4.4	Bossler et al. (2023, Table 2, col. 1)*
		5.1	Bossler et al. (2026, Table 2, col. 3)**
P20	24.88	12.1	Bossler et al. (2026, Table 3.B, col. 5)**
		21.8	Bossler et al. (2023, Table 2, col. 4)*
P50	-0.60	1.9	Bossler et al. (2023, Table 2, col. 7)*
		3.2	Bossler et al. (2026, Table 3.B, col. 7)**
		Hourly Wage	
Mean	3.03	1.2	Dustmann et al. (2022, Table VII.A, col. 2)***
		5.0	Bossler et al. (2026, Table 2, col. 1)**
P20	16.13	8.6	Bossler et al. (2026, Table 3.A, col. 5)**
P50	-0.31	2.1	Bossler et al. (2026, Table 3.A, col. 7)**

Note: The table shows the effect of the first German minimum wage (8.5 €) on employment rates and monthly wages. "Data" refers to empirical estimates in the literature. "Model" refers to the equilibrium effects generated by our model. Employment and wage effects are reported as percentage changes. Overall employment refers to the employment rate including marginal, part-time, and full-time employment. Regular employment refers to part-time and full-time employment. P20 and P50 refer to the 20th and 50th percentiles of the overall monthly wage distribution, including all employment types. Entries marked with * use the coefficient from Bossler and Schank (2023) multiplied by the average bite of 12.4%; entries marked with ** use the coefficient from Bossler et al. (2026) multiplied by the average bite of 11.8%; entries marked with *** use the coefficient from Dustmann et al. (2022) multiplied by the average GAP measure of 0.017.

5 Equilibrium Effects

In this section, we examine the equilibrium effects of the initial minimum wage of 8.5 € per hour using our model.

5.1 Firm response to the minimum wage

The introduction of a minimum wage prompts firms to adjust across three dimensions: wage levels, hours requirements, and the decision to post jobs or become inactive. We begin by analyzing wage adjustments. The penalty imposed on the contact rate for non-compliant jobs reduces the available labor supply for such positions. It adds an additional consideration to the tradeoff firms face when setting posted wages: while a higher wage reduces profit per unit of efficient labor, it increases labor supply not only because more workers are willing to accept the job offer, but also because it lowers the non-compliance penalty. As a result, firms posting low wages have an incentive to raise their posted wages toward the minimum wage.

Figure 5 compares the equilibrium distributions of offered wages in the benchmark economy (without a minimum wage) and the economy with an 8.5 € minimum wage. Marginal-employment job offers experience the largest wage increases because they initially have the lowest wages. Specifically, 76% of marginal-employment job offers at the lower end of the wage distribution see wage hikes, compared to 60% of part-time and 24% of full-time job offers.[26] Despite the wage increases, not all jobs become compliant. Because the posted wage is monotonically increasing in firm productivity, non-compliance concentrates among low-productivity firms.

Next, we examine firm inactivity. Figure 6a shows that low-productivity firms are the most likely to be inactive in the benchmark economy without a minimum wage. This pattern reflects the fact that expected profit $\bar{\pi}(p)$ increases with firm productivity (p). The minimum wage leads to only a moderate increase in inactivity among low-p firms. This limited effect arises from two mitigating mechanisms: (1) firms can post non-compliant jobs to preserve profitability, and (2) they can adjust the required hours. Since full-time jobs have higher hourly labor productivity than marginal or part-time jobs, firms may find it more profitable to increase hours requirements rather than become inactive.

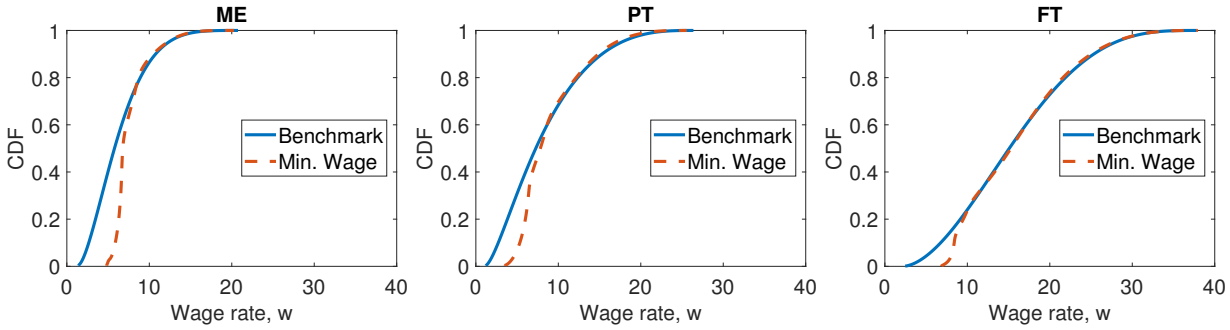
Regarding hours requirements, Figures 6b to 6d present the conditional distribution of hours by firm productivity and activity status. More productive firms are more likely to offer full-time jobs,

[26] Empirical studies have documented the spillover effects of the German minimum wage. See Gregory and Zierahn (2022), Bossler and Schank (2023) and Bossler et al. (2026).

consistent with empirical evidence.[27] In response to the minimum wage, low-productivity firms post fewer marginal or part-time jobs and more full-time jobs.

Driven by changes in the activity and job-posting decisions of low-p firms, the 8.5 € minimum wage results in a notable reduction in the measure of firms posting marginal-employment and part-time jobs (Column 1 in Panel A, Table 7), shifting the job-offer distribution toward higher hours.

Figure 5: Wage offer distributions



Note: The figure shows the offer distribution $F_h(w)$ in the benchmark equilibrium without any minimum wage (solid line) and that in the equilibrium with a minimum wage set at 8.5 € (dashed line). ME, PT, and FT are, respectively, marginal-employment, part-time and full-time.

5.2 Equilibrium Employment and Hours

The minimum wage can have either a positive or negative effect on the equilibrium employment rate due to opposing mechanisms. Column 1 of Table 7, Panel B, presents the impact of the minimum wage on job contact, job finding, and separation rates for men and women in equilibrium. On the one hand, the minimum wage reduces the job contact rate. As discussed in Section 5.1, it decreases the overall measure of active firms, lowering the job contact rate for workers. Additionally, the non-compliance penalty further reduces the rate at which workers contact non-compliant jobs. Together, these factors result in an effective job contact rate reduction of 0.6% for men and a reduction of 1.4% for women.

On the other hand, the minimum wage can increase employment through several mechanisms. First, as shown in Section 5.1, the minimum wage prompts firms offer higher wages, making a larger share of job offers acceptable to workers. This increase in the job acceptance probability helps mitigate the reduction in the effective job contact rate. As a result, the decline in the job finding rate is much smaller than the drop in the contact rate. Second, as lower-hours jobs become relatively

[27] Dustmann et al. (2022) document a positive correlation between firm productivity and the share of full-time workers.

harder to find due to the minimum wage, workers become more inclined to accept jobs with longer hours. According to our estimation results, jobs with longer hours are associated with lower job-separation rates. This shift toward higher hours leads to a decrease in the average job separation rate, particularly for women.

Figure 7a shows the equilibrium effect of the minimum wage on employment and non-employment rates for men and women. The policy reallocates both genders toward jobs with longer hours, albeit in different ways. For men, it mainly decreases the part-time employment rate while increasing the full-time employment rate. Since both part-time and full-time employment are associated with relatively low separation rates, this reallocation does not lead to higher overall employment. For women, it reduces the marginal employment rate while predominantly increasing the part-time employment rate. The reduction in non-employment among women is primarily driven by a decrease in the average job-separation rate, as women reallocate from marginal-employment to more stable part-time employment. Notably, marginal employment is associated with a significantly higher job separation rate compared to both part-time and full-time employment in our estimated model.

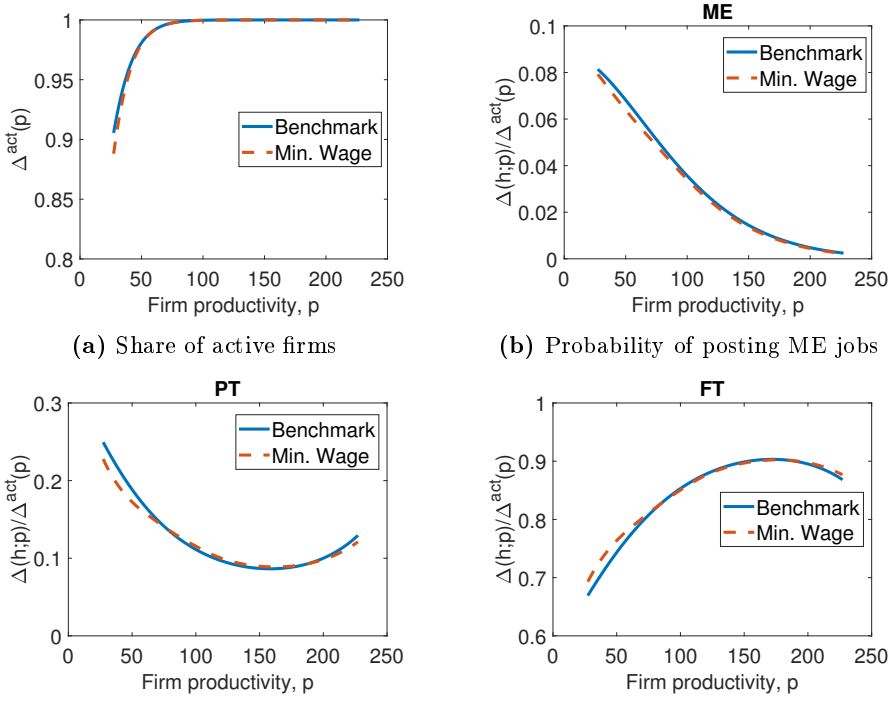
The gender asymmetry in the effect of the minimum wage arises from women's greater likelihood of working in low-hours and low-wages jobs prior to its introduction, making them more susceptible to the impact of the policy. This initial gender gap is driven by gender differences in productivity and, more importantly, preferences for working hours. For women with children, the distaste for full-time employment further shapes the reallocation effect, limiting the impact to mainly reallocating from marginal to part-time jobs. In Section 5.4, we explore the heterogeneity in child state and demographic type, while Section 6 examines how higher minimum wages affect gender inequality.

5.3 Inspecting the Roles of Firm Decisions and Minimum Wage Enforcement

Equilibrium labor market outcomes are crucially influenced by firm responses to the minimum wage and the degree of enforcement of the policy. To examine these factors, we consider two counterfactual scenarios: a partial equilibrium (PE) economy where firms do not adjust to the implementation of the minimum wage, and a high-penalty economy where the non-compliance penalty is doubled compared to the benchmark level. In both scenarios, the minimum wage remains at 8.5 € per hour.

Role of firms As discussed in Section 5.1, the minimum wage disproportionately increases wages for low-hours job offers, making marginal-employment and part-time job-offers more attractive to workers, raising their acceptance probabilities. At the same time, the minimum wage induces a shift in the offer distribution towards high-hours jobs, which can lead to a higher full-time employment rate relative to other hours types. To understand how firm responses influence the reallocation

Figure 6: Effects on the share of active firms and hours requirement distribution



(a) Share of active firms

(b) Probability of posting ME jobs

(c) Probability of posting PT jobs

(d) Probability of posting FT jobs

Notes: "Benchmark" refers to the benchmark economy (no minimum wage), and "Min. Wage" refers the equilibrium with 8.5 € minimum wage. The share of active firm given firm productivity p is $\Delta^{act}(p) \equiv \sum_{h \in \mathcal{H}} \Delta(h;p)$, and the probability of posting jobs with hours h given firm productivity p is $\frac{\Delta(h;p)}{\Delta^{act}(p)}$. ME, PT, and FT are, respectively, marginal-employment, part-time and full-time.

of workers towards higher-hours jobs, we compare the counterfactual PE economy (Column 2 in Table 7 and Figure 7b) to the equilibrium minimum wage economy (Column 1 in Table 7 and Figure 7a).

In the PE economy, without increases in offered wages, a larger share of job offers are non-compliant compared to the benchmark minimum-wage economy. This is evident in Panel C of Table 7: the minimum wage results in only a moderate reduction in the share of jobs paying below 8.5 € and the reduction is solely due to the non-compliance penalty. The greater share of non-compliant job offers leads to a larger reduction in the effective job contact rates, with low-hours jobs being disproportionately affected due to their lower wages. In response, workers-particularly women-become more inclined to accept jobs with longer hours, resulting in greater upward reallocation in terms of hours (Figure 7b) and lower job separation rates. Overall, in the absence of firm adjustments, the minimum wage produces amplified effects on employment and hours. There is a stronger shift toward jobs with longer hours, and for women, the reduction in their non-employment rate is even more pronounced. Firm responses to the minimum wage dampen this upward reallocation in hours

Table 7: Minimum Wage Effects in Benchmark and Counterfactual Economies

	(1) Baseline	(2) CF 1	(3) CF 2
A: Effects on firm decisions			
Share of active firms Δ^h (% change)	-0.2	0.0	-0.1
Firms posting hours requirement h, Δ^h (% change):			
ME	-6.2	0.0	-9.8
PT	-2.8	0.0	2.3
FT	0.4	0.0	0.0
B: Effects on employment transitions			
Men:			
Effective contact rate (% change)	-0.6	-2.1	-0.6
Job-finding rate (% change)	0.6	-2.5	1.2
Ave. separation rate (% change)	-0.9	-1.1	-1.3
Women:			
Effective contact rate (% change)	-1.4	-2.1	-0.4
Job-finding rate (% change)	-0.5	0.0	8.6
Ave. separation rate (% change)	-3.7	-5.5	-12.0
C: Effects on wages			
Share with wage below 8.5 € (p.p. change):			
ME	-11.3	-2.5	-16.6
PT	-7.8	-2.7	-11.4
FT	-3.5	-0.8	-6.1

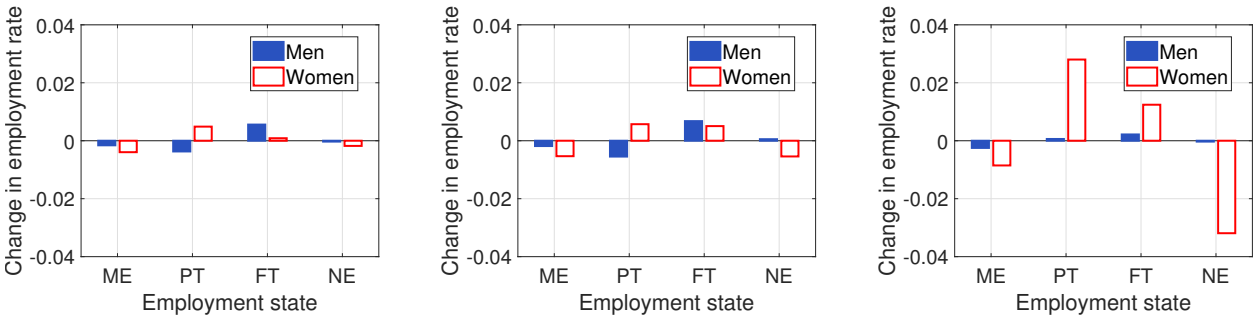
Note: The table shows changes from the benchmark economy (no minimum wage) in % or percentage points (p.p.). "Benchmark" refers to the equilibrium minimum-wage economy; "CF1" refers to the counterfactual partial-equilibrium economy; "CF2" refers to the counterfactual high-penalty economy. In all three scenarios, the minimum wage is 8.5 €. ME, PT, and FT are, respectively, marginal-employment, part-time and full-time. Effective contact rate is the rate at which a worker contacts any job offer, $\lambda \sum_h \int \max\{0, 1-\kappa(wa_j(h); w_{min})\}\Delta^h dF_h(w)$. Job-finding rate is the rate at which a non-employed worker becomes employed. The average separation rate is the average rate at which an employed worker loses their job exogenously.

as firms disproportionately increase offered wages for low-hours jobs.

Role of enforcement Despite empirical evidence of widespread non-compliance (Burauel et al., 2017, 2020; Bossler et al., 2022), structural analyses of the minimum wage often assume perfect enforcement (Engbom and Moser, 2022; Drechsel-Grau, 2023; Blömer et al., 2024). In our model, the parameter κ_0 in Eq. 16 governs the degree of compliance with the minimum wage. When κ_0 is set to zero, the minimum wage has no effect on the economy. Conversely, if κ_0 is set to infinity, perfect compliance is achieved, as no worker would be able to contact a job with wages below the minimum wage. To demonstrate the importance of capturing observed levels of non-compliance, we analyze a counterfactual economy where the non-compliance penalty (κ_0) is doubled.

Column 3 of Table 7 shows that a higher penalty leads to higher wages and greater compliance, as

Figure 7: Effects of the minimum wage on employment distribution



(a) Benchmark **(b)** CF1 **(c)** CF2

Note: The figure shows changes from the benchmark economy (no minimum wage). "Benchmark" refers to the equilibrium minimum-wage economy; "CF1" refers to the counterfactual partial-equilibrium economy; "CF2" refers to the counterfactual high-penalty economy. In all three scenarios, the minimum wage is 8.5 €. ME, PT, FT and NE are, respectively, marginal-employment, part-time employment, full-time employment and non-employment.

evidenced by a more significant decline in the share of jobs paying below 8.5 € in the high-penalty economy. Despite the higher penalty, the minimum wage leads to an increase in the job finding rate for women driven by a higher job acceptance probability. On the hours margin, Figure 7c shows that a higher penalty induces a significant shift away from marginal-employment jobs. This shift is driven by workers'-particularly womens'-greater willingness to accept part-time and full-time jobs that now offer higher wages, along with firms' adjustments to post jobs with higher hours. The reallocation toward high-hours jobs results in a substantial reduction in the separation rate for women, leading to a marked decrease in the female non-employment rate. These findings suggest that better enforcement of the minimum wage could make the policy a more effective tool in reducing gender inequality. They underscore the importance of considering non-compliance and its influence on workers' and firms' decision regarding hours of employment.

Discussion The counterfactual models above underscore that firms' wage responses to the minimum wage through endogenous non-compliance are central for evaluating the quantitative impact of minimum wage reforms on female employment and gender inequality. This highlights the importance of modeling an endogenous wage-posting decision: if wages were determined exogenously, then compliance with the minimum wage would also have to be imposed exogenously. Drechsel-Grau (2023), for example, assume a wage rule in which wages are a fixed share of labor productivity; once a minimum wage is introduced, the wage simply becomes the maximum of this fixed share and the statutory minimum, implying full compliance by construction. In Appendix H.1, we analyze a version of our model that replaces endogenous wage posting with a similar fixed-wage rule. We show that this rule mechanically raises wages in low-hours jobs where women are disproportionately concentrated, thereby understating its effect on the gender gap in hours worked.

Our results also show that the hours margin is crucial for understanding the minimum wage's impact on women, a margin not considered in Blömer et al. (2024). We demonstrate this in Appendix H.2, where we consider a version of our model with only full-time jobs. In that environment, the minimum wage has virtually no effect on the gender income gap: without part-time and marginal-employment jobs, women cannot move into higher-hours jobs, and the pre-reform gender wage gap is already small once low-hours jobs are excluded. As a result, the minimum wage raises women's wages no more than men's.

5.4 Heterogeneous effects

Employment and hours Figure 8 shows the employment and hours effects of the 8.5 € minimum wage across different demographic groups and child states. The minimum wage has a qualitatively similar reallocation effect for all male groups, shifting employment from part-time and marginal jobs to full-time, with negligible effects on overall employment. In contrast, its effects on women vary depending on demographic group and child status.

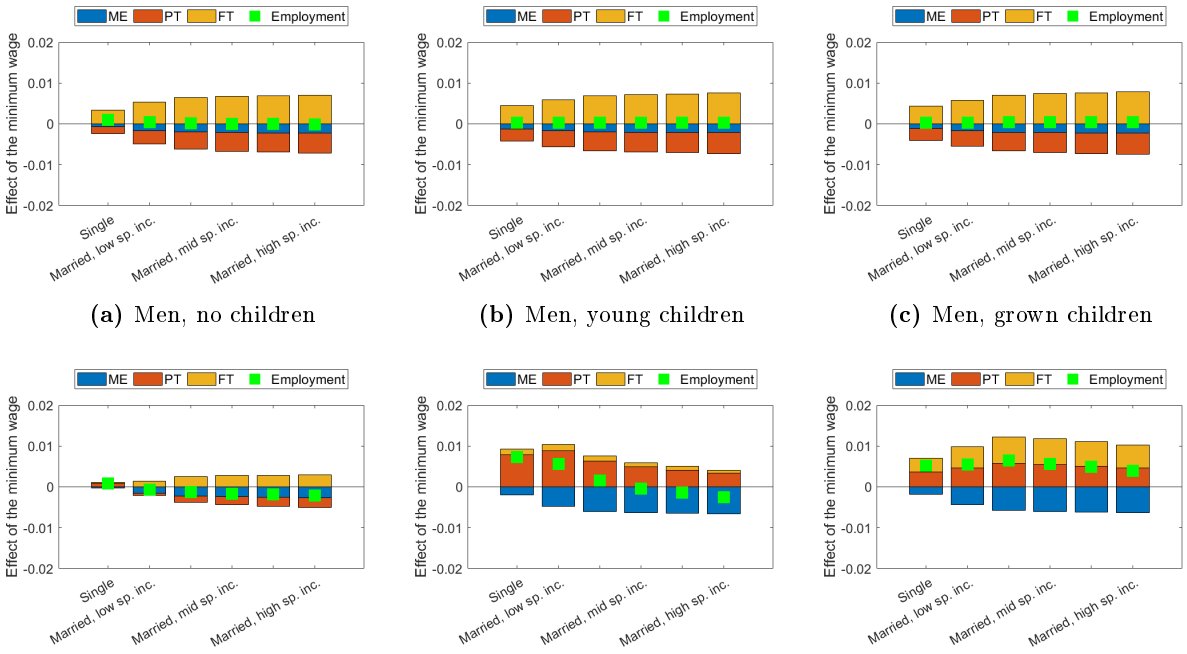
For childless women, the minimum wage has relatively small effects. Compared to other groups, they experience less disutility from working and are more likely to be employed and work full-time in the no-minimum-wage economy (Figure 17b).

For women with young children and high spousal income, the minimum wage reduces marginal employment, accompanied by a modest increase in part-time employment. For other groups of women with children, the increase in part-time and full-time employment outweighs the decline in marginal employment, resulting in a positive employment effect. This occurs because the minimum wage raises posted wages, thus increasing job acceptance rates for these women. However, for women with young children and high spousal income, their high reservation wages mean that the wage increases at the lower end of the wage distribution do not affect their job acceptance behavior. These findings suggest that intrahousehold income pooling and joint taxation play important roles in determining the effects of minimum wage policy.

The analysis above indicates that accounting for demographic heterogeneity is important for understanding the overall effect of minimum wage policy on gender inequality. In Appendix H.3, we examine a version of our model without heterogeneity in x, in which all individuals are assumed to be single. In this alternative model, minimum wages have stronger positive effects on women's employment and hours, leading to a larger reduction in the gender hours gap than in the benchmark model, while their impact on the gender wage gap is weaker.

Welfare We calculate the welfare effect of the minimum wage on different demographic groups using consumption equivalent variations (CEV). Our analysis focuses on the welfare impact of the minimum wage on model entrants in steady state, who are all childless ($k = 1$) and non-employed at entry. The results are presented in Figure 9.[28] The welfare effect varies more significantly across demographic groups than between genders. Single workers of both genders benefit from the minimum wage policy, while married workers-particularly those with a high-income spouse-are worse off. Singles gain from the higher posted wages at the lower end of the wage-offer distribution. In contrast, married individuals with a high-income spouse set higher reservation wages and are more adversely affected by the reduced job-contact rates of low-hours jobs.

Figure 8: Heterogeneous employment effects of the minimum wage.



(a) Men, no children **(b)** Men, young children **(c)** Men, grown children

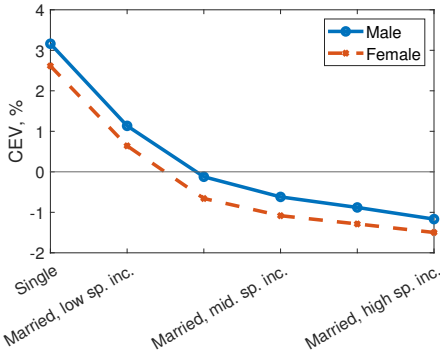
(d) Women, no children **(e)** Women, young children **(f)** Women, grown children

Note: The figure shows changes from the benchmark economy (no minimum wage). ME, PT and FT are, respectively, marginal-employment, part-time employment and full-time employment. Green square represents the employment rate (considering all three hours types). See Table 3 for spousal income levels.

Employer productivity The minimum wage can potentially "cleanse" the labor market by displacing low-productivity employers and improving the average job quality for workers. Dustmann

[28] Details of the CEV calculation are provided in Appendix E. This analysis aims to capture the heterogeneity in welfare effects. Determining the welfare-maximizing minimum wage is beyond the scope of the paper, as it would require incorporating the distribution of firm profit and government revenue to workers, modeling transitional dynamics, and evaluating the joint welfare effects for married couples. For an analysis of the optimal minimum wage in Germany, see Drechsel-Grau (2023).

Figure 9: Welfare effects

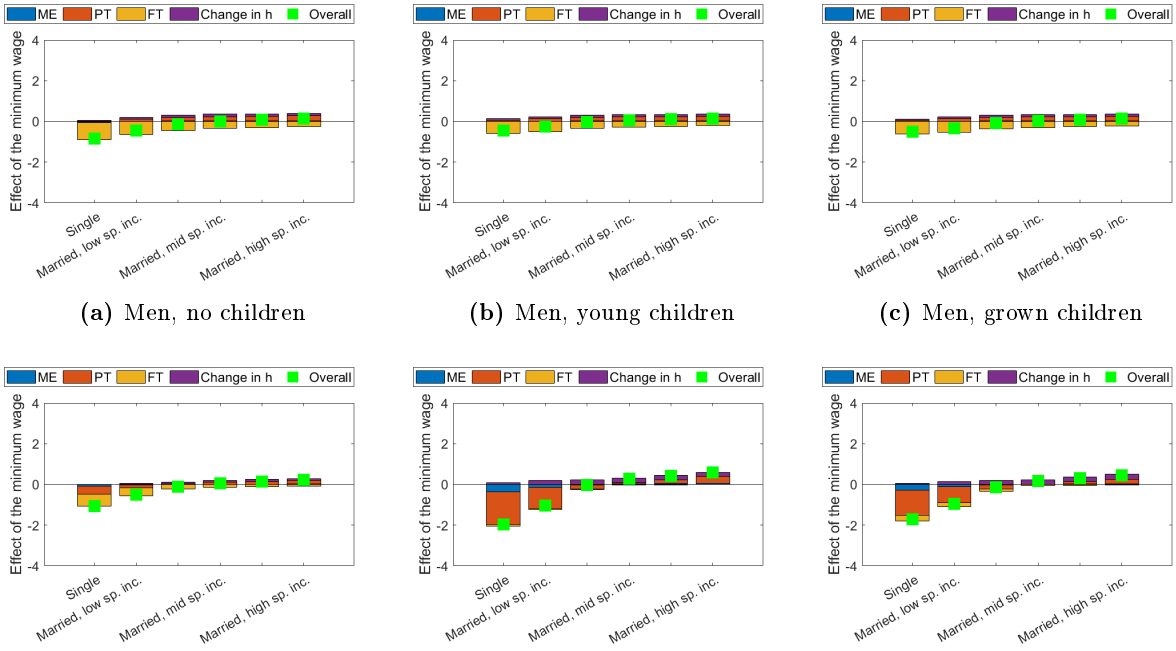


Note: The figure shows changes in consumption equivalent variations (CEV) from the benchmark economy (no minimum wage). CEV measures the welfare effect. See Table 3 for spousal income levels and Appendix E for details of the CEV calculation.

et al. (2022) provide empirical evidence that the introduction of the German minimum wage led to the reallocation of minimum-wage workers to "better" establishments in terms of average pay and firm size. Using our model, we examine the effect of the 8.5 € minimum wage on employer productivity by gender, child state and demographic group. We decompose the overall impact on employer productivity into two components: changes in average productivity conditional on hours and shifts in the distribution of hours. Details of this decomposition are provided in Appendix F.2, with results shown in Figure 10.

The effects of the minimum wage on employer productivity vary significantly across demographic groups, particularly by marital status and spousal income. Individuals without a high spousal income, including single workers and married individuals with low-income spouses, are more likely to accept jobs from less productive firms after the implementation of the minimum wage. This shift occurs as these firms raise their posted wages in response to the policy. Among them, women with children experience the largest decline, driven primarily by their increased likelihood of accepting part-time jobs from low-productivity firms. In contrast, employer productivity increases the most among those with a high spousal income. After the minimum wage is introduced, they are more likely to transition to jobs offered by more productive employers, as less productive firms are more likely to offer non-compliant jobs that become harder to find. Furthermore, an upward reallocation in hours modestly contributes to this increase in employer productivity. More productive firms tend to offer jobs with longer hours, so shifts to longer-hours jobs are often accompanied by an improvement in employer productivity.

Figure 10: Effect on average employer productivity and decomposition.



(a) Men, no children **(b)** Men, young children **(c)** Men, grown children

(d) Women, no children **(e)** Women, young children **(f)** Women, grown children

Note: The minimum wage is 8.5 € per hour. Green squares represent the overall average effect of the minimum age on employer productivity (considering all three hours types). The overall effect is decomposed into the effect due to changes in average productivity conditional on hours ("ME", "PT", or "FT") and the effect due to changes in the distribution of hours ("Change in h"). Red lines represent the average hourly wage in the benchmark (no minimum wage) economy. See Table 3 for spousal income levels.

6 Gendered Effects of the Minimum Wage

To what extent can the minimum wage serve as a policy instrument to combat gender inequality in the labor market? The gender income gap, which captures disparities in gross labor earnings between men and women, arises from differences in wages and hours worked.[29] Using our model as a laboratory, we examine the effects of varying the minimum wage up to 14 € per hour and compare the resulting equilibrium gendered outcomes.Figures 11a and 11b show that minimum wages up to this level have positive effects on all three outcomes-wage, hours worked, and income-for both genders. Notably, the effects are stronger for women than for men.

As expected, wages increase monotonically with the minimum wage for both men and women. However, the effects on hours worked are comparatively smaller. Men's hours worked are largely unaffected by the minimum wage, as they predominantly work full-time and earn higher hourly

[29]Wages are conditional on employment, while hours worked and incomes are not. Income, or gross labor earning, excludes non-labor incomes such as non-employment benefits.

wages even in the absence of a minimum wage. For women, hours worked peak at a 11 € minimum wage, representing a 4.2% increase compared to the benchmark no-minimum-wage economy. As explained in Section 5, the minimum wage reduces the effective job contact rate but reallocates workers-particularly women-toward jobs with longer hours and lower separation rates. At modest levels of the minimum wage, this reallocation effect dominates, leading to higher female hours worked. However, when the minimum wage increases above 11 €, the reduction in the job contact rate due to greater non-compliance penalty and firm inactivity begins to outweigh the reallocation effect, resulting in a decline in women's hours worked.

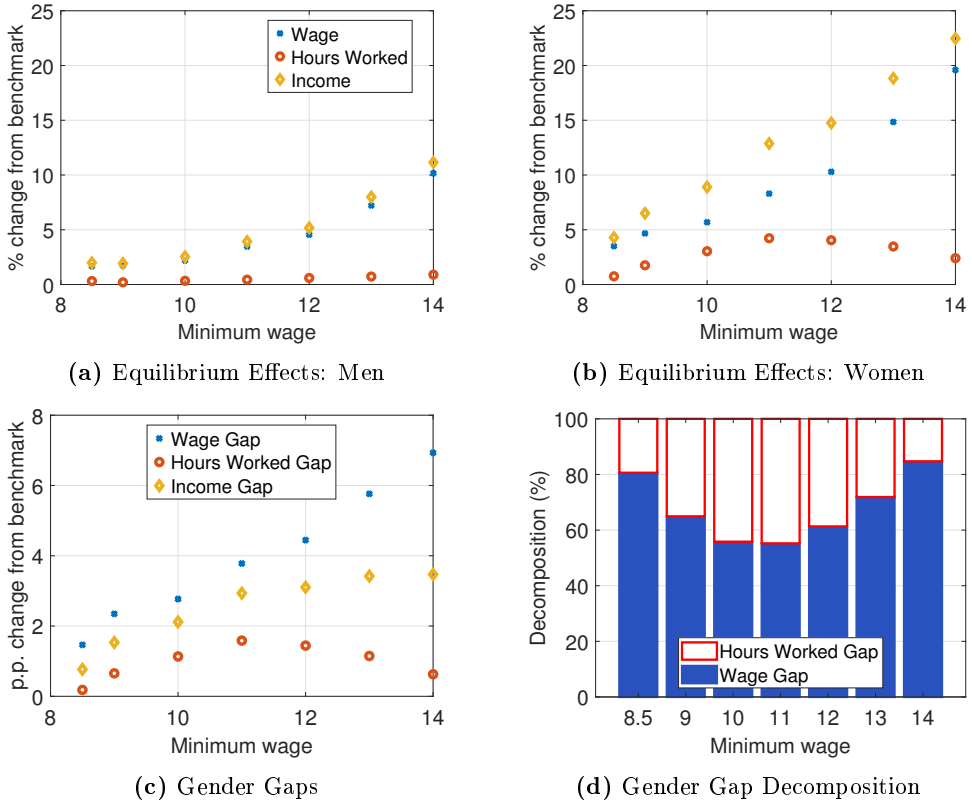
The gender-asymmetric effects of the minimum wage policy suggest its potential to reduce gender gaps across all dimensions. We define the gender gap in a specific variable as the ratio between the corresponding value for women to that for men, with a value of one indicating gender equity. In the absence of a minimum wage, our model indicates that women earn, on average, 34.1% of men's gross labor income. This disparity is driven by a gender wage gap of 81.0% and a gender hours-worked gap of 42.1%. Figure 11c shows the impact of minimum wages on gender gaps, where a positive effect corresponds to a reduction in the gap. Figure 11d presents a decomposition of the effect on the gender income gap, separating the contributions of wage and hours effects.[30]

The initial German minimum wage of 8.5 € reduces the gender income gap by 0.8 percentage points, with the majority of this reduction (80.6%) attributed to the narrowing of the gender wage gap. As the minimum wage increases to 14 €, the gender income gap continues to narrow. At 14 €, the minimum wage reduces the gender income gap by 3.5 percentage points, with 84.7% of the effect driven by the narrowing of the wage gap.

Previous literature has primarily focused on the minimum wage's role in reducing the gender wage gap (DiNardo et al., 1996; Autor et al., 2016; Bargain et al., 2019; Caliendo and Wittbrodt, 2022). While this focus is warranted-our findings confirm the gender wage gap as the primary channel through which the minimum wage affects gender inequality, our analysis reveals that the hours-worked margin also plays a significant role, with the minimum wage exerting a non-monotonic effect on this gap due to the policy's non-monotonic effect on the female hours worked. The gender hours-worked gap is minimized at 11 €, where 44.8% of the minimum wage's impact on the gender income gap is attributable to changes in hours worked. Overall, our findings indicate that the minimum wage is not only an effective tool for reducing the gender wage gap but, when set appropriately, also helps to narrow the gender gap in hours worked.

[30] Details of the decomposition are provided in Appendix F.1.

Figure 11: Effects of Higher Minimum Wages



(a) Equilibrium Effects: Men

(b) Equilibrium Effects: Women

(c) Gender Gaps

(d) Gender Gap Decomposition

Note: Figures (a) to (c) show changes from the benchmark economy (no minimum wage). Figure (d) shows the decomposition of effects on the income gap into effects on the hours-worked and wage gaps.

7 Conclusion

Women are disproportionately affected by the minimum wage due to their higher likelihood of working in low-hours jobs with low hourly wages compared to men. In this paper, we examine how the minimum wage influences equilibrium labor market outcomes for men and women, the mechanisms driving these effects, and its potential as a policy tool to reduce gender gaps in wages and hours worked. To quantify the effects of the minimum wage, we develop an equilibrium job-posting model that incorporates household demographic heterogeneity and firm productivity heterogeneity. A key feature of our model is that firms' job-posting decision includes not only the wage, but also the hours requirement, which can be marginal, part-time, or full-time. The model successfully matches important features in the data, such as gender gaps in employment, hours and wage, and the correlation between hours and hourly wages observed in the German data. We introduce the minimum wage through a non-compliance penalty that lowers the job contact rate for offers below the minimum. This generates non-compliance endogenously in equilibrium, and we calibrate the

penalty to match the observed reduction in the share of low-wage jobs.

We first analyze the introduction of Germany's initial federal minimum wage of 8.5 € per hour. Our findings reveal that the minimum wage leads to an upward reallocation in hours for both men and women, with this effect being more pronounced for women. As women transition from marginal employment to part-time or full-time positions, they experience not only higher wages and longer hours but also a reduction in job separation rates, contributing to modest reductions in female non-employment.

We find that the minimum wage shifts the job-offer distribution toward higher-hours jobs. This shift is largely driven by low-productivity firms, which are more likely to exit the market or increase their hours requirements in response to the minimum wage. Additionally, these firms raise wages, particularly for marginal-employment jobs. Overall, firm adjustments dampen the reallocation effect by increasing wages in low-hours jobs, making these positions relatively more attractive. Our findings highlight the critical role of firm behavior in shaping gendered labor market outcomes under minimum wage policies.

Increased enforcement of the minimum wage strengthens its effects, leading to more pronounced upward reallocation in hours, particularly for women. These results underscore the importance of accounting for non-compliance, a factor that has been insufficiently addressed in prior structural analyses of minimum wage policies. Furthermore, our analysis shows that the effects of the minimum wage vary not only across gender and child state but also by demographic type. This highlights the role of income pooling and joint taxation in shaping the policy's impact.

Finally, we explore how varying the minimum wage up to 14 € per hour affects gender inequality. Our results confirm that the wage gap is the primary channel through which the minimum wage influences gender inequality. However, we also find that the gender gap in hours worked, which is larger than the wage gap in Germany, is significantly reduced by the minimum wage. At a moderate level of 11 €, 44.8% of the reduction in the gender income gap is attributable to changes in the hours-worked margin. Nonetheless, the minimum wage's effect on hours worked is non-monotonic, with diminishing effects at higher wage levels.

A limitation of our analysis is that the model abstracts from the statutory income cap for marginal employment. In the tax schedule, we treat all marginal-employment income as tax-exempt, whereas in practice this exemption applies only below the monthly income cap. As discussed in Sec. 4.2, this restriction may interact with the introduction of the minimum wage: at the initial 8.5 € reform, some marginal-employment jobs would have exceeded the income cap unless hours were reduced. This mechanism may have contributed to the decline in marginal employment, especially for women, and is therefore a potential complementary explanation to the equilibrium reallocation

channel emphasized by the model. A direction for future work is to explore this interaction in a framework that incorporates the income cap and allows richer hours adjustments within marginal employment.

Our benchmark model assumes a uniform penalty across all job types, yet some policy discussions advocate for concentrating enforcement resources on the lowest-wage sectors. This could be incorporated into our framework by imposing a higher non-compliance penalty for marginal-employment jobs and a lower penalty for part-time and full-time jobs. Such a pattern would likely lead to a stronger shift of job offers toward longer hours. However, with weaker enforcement in part-time and full-time jobs, it remains unclear whether women would be more or less likely to be reallocated to jobs with higher hours. We leave this question for future work.

Additionally, our analysis focuses solely on labor market outcomes for the working-age population. The minimum wage policy may have broader effects on other age groups and outcomes, including education, fertility, and retirement. The gendered implications of these outcomes warrant further exploration in future research.

References

Aaronson, D. and French, E. (2004). The effect of part-time work on wages: Evidence from the social security rules. *Journal of Labor Economics*, 22(2):329–252.

Aaronson, D., French, E., and MacDonald, J. (2008). The minimum wage, restaurant prices, and labor market structure. *The Journal of Human Resources*, 43(3):688–720.

Adamopoulou, E., Manaresi, F., Rachedi, O., and Yurdagul, E. (2022). Minimum wages and insurance within the firm. Technical report, University of Bonn and University of Mannheim, Germany.

Addison, J. T., Teixeira, P., Stephani, J., and Bellmann, L. (2015). Declining unions and the coverage wage gap: Can german unions still cut it? *Journal of Labor Research*, 36:301–317.

Aizawa, N. and Fang, H. (2020). Equilibrium labor market search and health insurance reform. *Journal of Political Economy*, 128(11):4258–4336.

Amano-Patino, N., Baron, T., and Xiao, P. (2020). Human Capital Accumulation, Equilibrium Wage-Setting and the Life-Cycle Gender Pay Gap. Cambridge Working Papers in Economics 2010, Faculty of Economics, University of Cambridge.

Autor, D. H., Manning, A., and Smith, C. L. (2016). The contribution of the minimum wage to us wage inequality over three decades: A reassessment. *American Economic Journal: Applied Economics*, 8(1):58–99.

Baker, M. and Milligan, K. (2008). How does job-protected maternity leave affect mothers' employment? *Journal of Labor Economics*, 26(4):655–691.

Bargain, O., Doorley, K., and Van Kerm, P. (2019). Minimum wages and the gender gap in pay: New evidence from the united kingdom and ireland. *Review of Income and Wealth*, 65(3):514–539.

Bartolucci, C. (2013). Gender wage gaps reconsidered: A structural approach using matched employer-employee data. *Journal of Human Resources*, 48(4):998–1034.

Bellmann, L., Bossler, M., Gerner, H.-D., and Hübler, O. (2021). Collective bargaining coverage, works councils and the new german minimum wage. *Economic and Industrial Democracy*, 42(2):269–288.

Berger, D. W., Herkenhoff, K. F., and Mongey, S. (2022). Minimum Wages, Efficiency and Welfare. Opportunity and Inclusive Growth Institute Working Papers 058, Federal Reserve Bank of Minneapolis.

Blömer, M. J., Guertzgen, N., Pohlan, L., Stichnoth, H., and van den Berg, G. J. (2024). Unemployment effects of the german minimum wage in an equilibrium job search model. *Labour Economics*, 91:102626.

Bonin, H., Isphording, I. E., Krause-Pilatus, A., Lichter, A., Pestel, N., and Rinne, U. (2020). The german statutory minimum wage and its effects on regional employment and unemployment. *Jahrbuecher fuer Nationaloekonomie und Statistik*, 240(2-3):295–319.

Bontemps, C., Robin, J.-M., and Van Den Berg, G. J. (2000). Equilibrium search with continuous productivity dispersion: Theory and nonparametric estimation. *International Economic Review*, 41(2):305–358.

Bossler, M., Jaenichen, U., and Schächtele, S. (2022). How effective are enforcement measures for compliance with the minimum wage? evidence from germany. *Economic and Industrial Democracy*, 43(2):943–971.

Bossler, M., Liang, Y., and Schank, T. (2026). The devil is in the details: Heterogeneous effects of the german minimum wage on working hours and minijobs. *Journal of Public Economics*, 253:105540.

Bossler, M. and Schank, T. (2023). Wage inequality in germany after the minimum wage introduction. *Journal of Labor Economics*, 41(3):813–857.

Burauel, P., Caliendo, M., Fedorets, A., Grabka, M. M., Schröder, C., Schupp, J., and Wittbrodt, L. (2017). Minimum Wage Not yet for Everyone: On the Compensation of Eligible Workers before and after the Minimum Wage Reform from the Perspective of Employees. *DIW Economic Bulletin*, 7(49):509–522.

Burauel, P., Caliendo, M., Grabka, M. M., Obst, C., Preuss, M., Schröder, C., and Shupe, C. (2020). The impact of the german minimum wage on individual wages and monthly earnings. *Jahrbücher für Nationalökonomie und Statistik*, 240(2-3):201–231.

Burdett, K. and Mortensen, D. T. (1998). Wage differentials, employer size, and unemployment. *International Economic Review*, pages 257–273.

Caliendo, M., Fedorets, A., Preuss, M., Schroeder, C., and Wittbrodt, L. (2018). The short-run employment effects of the german minimum wage reform. *Labour Economics*, 53:46 – 62. European Association of Labour Economists 29th annual conference, St.Gallen, Switzerland, 21-23 September 2017.

Caliendo, M. and Wittbrodt, L. (2022). Did the minimum wage reduce the gender wage gap in Germany? *Labour Economics*, 78(C).

Calvo, P., Lindenlaub, I., and Reynoso, A. (2024). Marriage Market and Labour Market Sorting. *The Review of Economic Studies*.

Carbonero, F. and Gartner, H. (2022). A Note On The Relation Between Search Costs And Search Duration For New Hires. *Macroeconomic Dynamics*, 26(1):263–276.

Chetty, R., Guren, A., Manoli, D., and Weber, A. (2011). Are micro and macro labor supply elasticities consistent? a review of evidence on the intensive and extensive margins. *American Economic Review*, 101(3):471–75.

Devicienti, F., Grinza, E., and Vannoni, D. (2017). The impact of part-time work on firm productivity: evidence from Italy. *Industrial and Corporate Change*, 27(2):321–347.

Di Nola, A., Kaas, L., Lacava, C., and Wang, H. (2026). Household search and the equilibrium gender pay gap. Mimeo.

DiNardo, J., Fortin, N. M., and Lemieux, T. (1996). Labor market institutions and the distribution of wages, 1973-1992: A semiparametric approach. *Econometrica*, 64(5):1001–1044.

Drechsel-Grau, M. (2023). Employment and reallocation effects of higher minimum wages. CESifo Working Paper Series 10412, CESifo.

Dustmann, C., Lindner, A., Schönberg, U., Umkehrer, M., and vom Berge, P. (2022). Reallocation Effects of the Minimum Wage*. *The Quarterly Journal of Economics*, 137(1):267–328.

Dütsch, M. and Bruttel, O. (2021). Are workers aware of the minimum wage level. baua: Fokus, Bundesanstalt für Arbeitsschutz und Arbeitsmedizin.

Engbom, N. and Moser, C. (2022). Earnings inequality and the minimum wage: Evidence from brazil. *American Economic Review*, 112(12):3803–47.

Erosa, A., Fuster, L., and Kambourov, G. (2016). Towards a Micro-Founded Theory of Aggregate Labour Supply. *Review of Economic Studies*, 83(3):1001–1039.

Fang, H. and Shephard, A. J. (2019). Household Labor Search, Spousal Insurance, and Health Care Reform. NBER Working Papers 26350, National Bureau of Economic Research, Inc.

Flinn, C. J. (2006). Minimum wage effects on labor market outcomes under search, matching, and endogenous contact rates. *Econometrica*, 74(4):1013–1062.

Ginja, R., Conti, G., and Narita, R. (2025). The value of health insurance: A household job search approach. *Journal of Labor Economics*.

Gregory, T. and Zierahn, U. (2022). When the minimum wage really bites hard: The negative spillover effect on high-skilled workers. *Journal of Public Economics*, 206:104582.

Guler, B., Guvenen, F., and Violante, G. L. (2012). Joint-search theory: New opportunities and new frictions. *Journal of Monetary Economics*, 59(4):352–369.

Han, W.-J., Ruhm, C., and Waldfogel, J. (2009). Parental leave policies and parents' employment and leave-taking. *Journal of Policy Analysis and Management*, 28(1):29–54.

Harasztosi, P. and Lindner, A. (2019). Who pays for the minimum wage? *American Economic Review*, 109(8):2693–2727.

Heathcote, J., Storesletten, K., and Violante, G. L. (2017). Optimal Tax Progressivity: An Analytical Framework. *The Quarterly Journal of Economics*, 132(4):1693–1754.

Hurst, E., Kehoe, P. J., Pastorino, E., and Winberry, T. (2022). The Distributional Impact of the Minimum Wage in the Short and Long Run. Staff Report 640, Federal Reserve Bank of Minneapolis.

Jardim, E. and Inwegen, E. V. (2019). Payroll, revenue, and labor demand effects of the minimum wage. Upjohn Institute Working Paper 19-298, Kalamazoo, MI.

Keller, M. and Kahle, I. (2018). Realisierte erwerbstätigkeit von müttern und vätern zur vereinbarkeit von familie und beruf. *WISTA–Wirtschaft und Statistik*, 3:54–71.

Meghir, C., Narita, R., and Robin, J.-M. (2015). Wages and informality in developing countries. *American Economic Review*, 105(4):1509–46.

Morchio, I. and Moser, C. (2023). The Gender Pay Gap: Micro Sources and Macro Consequences. Institute working paper 078, Federal Reserve Bank of Minneapolis Opportunity and Inclusive Growth Institute.

Müller, K.-U. and Steiner, V. (2010). Labor Market and Income Effects of a Legal Minimum Wage in Germany. Discussion papers, DIW Berlin.

Rossin-Slater, M., Ruhm, C. J., and Waldfogel, J. (2013). The effects of california's paid family leave program on mothers' leave-taking and subsequent labor market outcomes. *Journal of Policy Analysis and Management*, 32(2):224–245.

Shephard, A. (2017). Equilibrium Search And Tax Credit Reform. *International Economic Review*, 58(4):1047–1088.

Tazhitdinova, A. (2020). Do only tax incentives matter? labor supply and demand responses to an unusually large and salient tax break. *Journal of Public Economics*, 184:104162.

Timpe, B. (2024). The labor market impacts of america's first paid maternity leave policy. *Journal of Public Economics*, 231:105067.

Turon, H. (2022). The Labour Supply of Mothers. IZA Discussion Papers 15312, Institute of Labor Economics (IZA).

Vom Berge, P. and Weber, E. (2017). Beschäftigungsanpassung nach mindestlohneinführung: Minijobs wurden teilweise umgewandelt, aber auch zulasten anderer stellen. *IAB-Kurzbericht*, 11.

Appendix

A German Minimum Wage and Non-Compliance Issues

In the early 2000s, minimum wages existed only for industries covered by collective bargaining contracts in Germany, ranging from 6.5 to 12 € per hour (Müller and Steiner, 2010).[31] There had been a secular decline in the coverage of industry-level collective bargaining agreements, with coverage falling from over 60% in 1996 to 40% in 2014 and increasing flexibility for covered firms to deviate from the wage floor (Addison et al., 2015; Bellmann et al., 2021). Concerns about increasing income inequality and in-work poverty led to calls for a uniform federal minimum wage in Germany.

After the passage of the Minimum Wage Act (Mindestlohngesetz) in July 2014, the first German federal minimum wage came into effect on January 1, 2015, at 8.5 € per hour. Coverage is almost universal, including workers in part-time and marginal employment (minijobs). Exceptions include minors, apprentices, interns, and volunteer workers. The minimum wage is regularly adjusted based on the recommendation of the Minimum Wage Commission (Mindestlohnkommission), comprising representatives from employers, employees, and academia. The minimum wage was raised to 12 € per hour on October 1, 2022, and to 12.82 € on January 1, 2025. Both correspond to about 10 € in 2015 prices. Figure 12 plots the nominal and real evolution of the statutory minimum wage together with the minijob income cap.

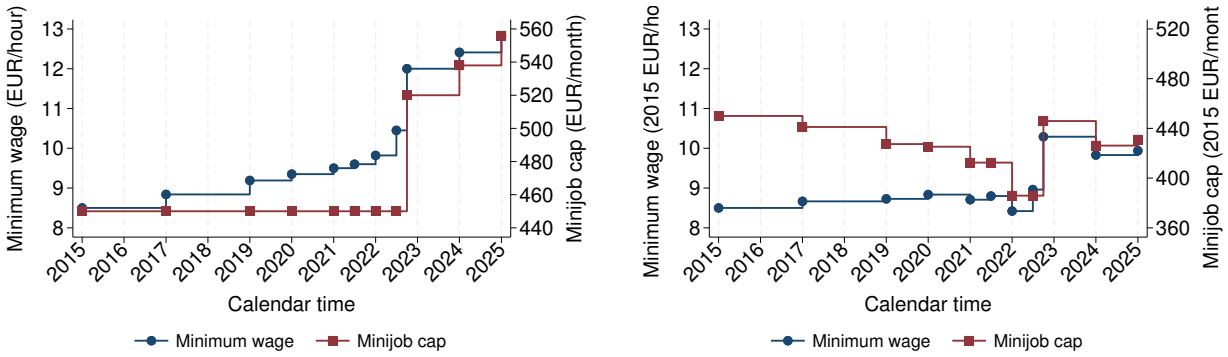
The Federal Customs Administration (Zoll) is in charge of enforcing the minimum wage. The Minimum Wage Act requires specific industries to record hours of work, and the Federal Customs Administration is tasked with inspecting compliance with the minimum wage. Employees can also sue employers who violate the minimum wage at a labor court and claim damages.

Widespread non-compliance has been documented in the literature. Using data from the German Socio-Economic Panel (SOEP), Burauel et al. (2017) and Burauel et al. (2020) document the prevalence of non-compliance with the German minimum wage legislation. Their findings reveal that in 2016, one year after the introduction of the federal minimum wage, approximately 1.8 million eligible employees were still receiving hourly wages below the 8.5 € threshold. Even after accounting for potential measurement errors, the level of non-compliance remains significant (Burauel et al., 2017). Based on administrative data, Bossler et al. (2022) confirm the existence of widespread non-compliance.

[31] Industries covered by collectively bargained minimum wages were construction, waste management, roofing, electrical trades, industrial laundries, painting and varnishing, and care services.

Non-compliance has been attributed to a lack of resources to enforce the minimum wage and a lack of awareness among workers. Bossler et al. (2022) explain that, for political reasons, the German government did not allocate additional personnel or resources to the Federal Customs Administration when the federal minimum wage was introduced in 2015. Furthermore, in 660 out of 733 industries, employers are not legally obliged to record the working hours of their employees, making it challenging for the enforcement agency to provide evidence of non-compliance. The enforcement of the minimum wage relies on random audits; however, the actual audit rate is reported to be less than 5% even in low-wage industries where the obligation to record hours exists. Regarding awareness of the minimum wage, Dütsch and Bruttel (2021) find that less than one-fifth of workers are aware of the exact minimum wage level from a survey of a representative sample of employees in 2020.

Figure 12: German minimum wage and minijob income cap



(a) Nominal values

(b) Real values

Note: Policy schedules come from official BMAS, Mindestlohn-Kommission, and Minijob-Zentrale. The minimum wage is measured in euros per hour and the minijob income cap in euros per month. Real values are expressed in 2015 euros using the CPI index.

B Short-Run Effects of the Minimum Wage on Gender-Specific Employment Outcomes

We examine the short-run employment effects of the introduction of the German statutory minimum wage, exploiting regional variation in its "bite" across local labor market regions. The empirical strategy, including the model specification and data, closely follows Caliendo et al. (2018). We use the Kaitz index, defined as the ratio of the minimum wage to the median wage in a region, to capture the intensity of the minimum wage.

Formally, we estimate the following regression model:

$$Y_{j,t} = \gamma_t \, Bite_j + \alpha_j + \theta_t + \beta^{Pop} X_{j,t}^{Pop} + v_{j,t}, \tag{17}$$

where $Y_{j,t}$ denotes the log of employment by gender and hours type (marginal employment, part-time, or full-time) in region j and year t. The key explanatory variable $Bite_j$ is the regional Kaitz index, constructed from the 2014 Structure of Earnings Survey (SES) aggregated to the German labor market regions (Arbeitsmarktregionen).[32] The regression includes region fixed effects α_j and year fixed effects θ_t, and controls for the log of gender-specific regional population, $X_{j,t}^{Pop}$.

The coefficients of interest, γ_t, capture the time-varying impact of the minimum wage bite on employment. We normalize $\gamma_{2014} = 0$ and interpret deviations of γ_t from zero in post-reform years as the causal effect of the minimum wage, provided that pre-reform coefficients are statistically indistinguishable from zero (parallel trends assumption). We estimate Eq. 17 using regional panel data provided by the INKAR database.[33]

Results. Table 8 reports the regression results, and Figure 1 plots the estimated marginal effects of the minimum wage bite on log employment levels. The most striking finding is that a one-percentage-point increase in the minimum wage bite leads to a statistically significant decline of about 0.2% in female marginal employment during the first three years after the reform. This effect becomes statistically insignificant in later years. For men, the evidence is inconclusive as the parallel-trends assumption is not satisfied.

For part-time employment, the results indicate a negative effect for men and a positive effect for women. The positive effect for female part-time employment should be interpreted with caution, since the parallel-trends assumption is satisfied only in 2013 and 2014.

Finally, the effects on full-time employment for both men and women are generally not statistically significant at the 95% confidence level, with the exception of 2019. Overall, the minimum wage primarily affects women by reducing marginal employment and increasing part-time work, while effects on men and on full-time employment for both genders are small or statistically insignificant.

[32] See Caliendo et al. (2018) for more details.

[33] INKAR stands for Indikatoren und Karten zur Raum- und Stadtentwicklung (Indicators and Maps for Spatial and Urban Development), a database of the BBSR, the Federal Institute for Research on Building, Urban Affairs and Spatial Development. The data were retrieved from https://www.inkar.de/ in October 2020, covering Arbeitsmarktregionen (labor market regions) from 2012 to 2019.

Table 8: Estimated effects

	(1) ME Male	(2) ME Female	(3) PT Male	(4) PT Female	(5) FT Male	(6) FT Female
year=2012 × kaitz	0.118***	0.014	-0.082	-0.089***	-0.015	0.065
	(0.041)	(0.035)	(0.113)	(0.024)	(0.017)	(0.056)
year=2013 × kaitz	0.050**	0.013	0.166*	0.004	-0.007	-0.007
	(0.025)	(0.022)	(0.095)	(0.016)	(0.009)	(0.029)
year=2015 × kaitz	-0.038	-0.189***	-0.248***	0.028*	-0.017	0.003
	(0.059)	(0.042)	(0.070)	(0.015)	(0.013)	(0.036)
year=2016 × kaitz	-0.019	-0.181***	-0.328**	0.063***	-0.031*	-0.074
	(0.067)	(0.051)	(0.129)	(0.024)	(0.017)	(0.062)
year=2017 × kaitz	-0.044	-0.177***	-0.363**	0.101***	-0.035	-0.130
	(0.083)	(0.062)	(0.165)	(0.032)	(0.022)	(0.089)
year=2018 × kaitz	-0.001	-0.128*	-0.439**	0.112***	-0.051*	-0.201*
	(0.095)	(0.073)	(0.213)	(0.039)	(0.027)	(0.114)
year=2019 × kaitz	0.014	-0.078	-0.528**	0.094**	-0.082***	-0.284**
	(0.100)	(0.078)	(0.232)	(0.046)	(0.031)	(0.139)
lwapop_male	0.683***		0.615*		0.910***	
	(0.162)		(0.367)		(0.051)	
lwapop_female		0.826***		0.682***		1.440***
		(0.139)		(0.082)		(0.233)
Observations	1784	1784	1768	1784	1768	1784
Clusters	223	223	221	223	221	223
R^2 (within)	0.435	0.778	0.827	0.964	0.905	0.696
R^2 (between)	0.972	0.939	0.822	0.991	0.985	0.917
R^2 (overall)	0.970	0.938	0.811	0.990	0.984	0.916

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Regional data accessed from INKAR.de. *Note:* Values in parentheses represent standard errors. Regions are defined as labor market regions ("Arbeitsmarktregion"). Marginal employment excludes individuals who hold such contracts as secondary jobs. The regressions are weighted by regional population and estimated with robust standard errors clustered at the regional level. "lwapop_male" and "lwapop_female" represent the log of working-age male and female population at the regional level.

C Technical Appendix

C.1 External Calibration Details

Child state transition rates To calibrate $\phi_{j,x}(k)$, we compute annual child-state transition probabilities by gender and marital status. We consider two transitions: from $k = 1$ to $k = 2$ and from $k = 2$ to $k = 3$. In constructing these probabilities, we use individuals observed in two consecutive years and exclude those who experience transitions outside these two cases, as such transitions are not permitted in the model. Given the estimated annual transition probability $tr_{j,x}(k)$, we convert it into a continuous-time transition rate using

$$\phi_{j,x}(k) = -\log\big(1 - tr_{j,x}(k)\big).$$

Tax and benefit calibration To estimate the tax function and benefit levels, we use the SOEP-CNEF file for 2013-2014, which is the German component of the Cross-National Equivalent File (CNEF) containing extended income informa tion fro m SOEP. For each household type defined by marital status ($m = s, c$) and child state ($k = 1, 2, 3$), we estimate the tax parameters by running the following regression:

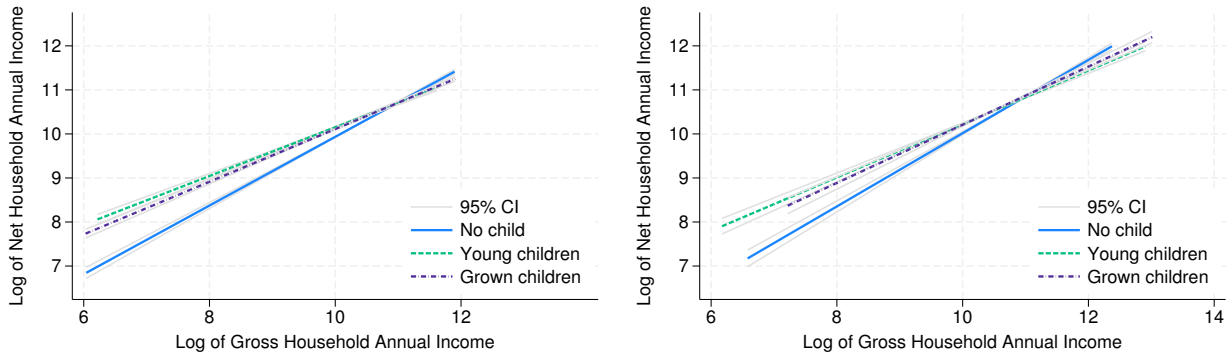
$$\log y_{i,t}^{net} = \beta_{0,k}^{m} + \beta_{1,k}^{m} \log y_{i,t},$$

where $y_{i,t}^{net}$ and $y_{i,t}$ denote, respectively, the net and gross annual household income of household i in year t. The estimated coefficients map into the tax-function parameters as $\tau_{0,k}^{m} = \beta_{0,k}^{m}$ and $\tau_{1,k}^{m} = 1 - \beta_{1,k}^{m}$.

Gross income is measured using the SOEP-CNEF variable for household pre-government income (gross income before taxes and government transfers). Net income is constructed by adding unemployment and maternity benefits to the household post-government income variable. Figure 13 displays the estimated relationship between $\log Y^{net}$ and $\log Y$.

To calibrate the non-employment benefit $b_{j,x}$, we compute the average monthly unemployment benefit by gender and marital status. The parental benefit b_j^k is calibrated as the average monthly maternity benefit received during non-employment for individuals with young children ($k = 2$).

Figure 13: Estimated Tax Functions



(a) Singles **(b)** Couples

Note: Tax functions are estimated based on data from SOEP 2013-2014. Confidence intervals are computed using robust standard errors. See Section 4.2 for details on the estimation of tax functions.

C.2 Stationary distribution

We solve for the stationary distribution by equating inflows to outflows in and out of each worker state. Numerically, we start from an initial guess and iterate on $g^{j,e}(w,h,k,x)$ and $g^{j,n}(k,x)$ until convergence.

First, consider non-employment with child state k. Inflow into this state involves a change in the child state, entry of a new worker (only if $k=1$), or exogenous job separation:

$$\underbrace{\mathbf{1}_{\{k>1\}}\phi_{j,x}(k-1)\left[g^{j,n}\left(k-1,x\right)+\sum_{h'\in\mathcal{H}}\int\left[1-\Omega_j^n(\{w',h'\},k,x)\right]g^{j,e}\left(\{w',h'\},k-1,x\right)dw'\right]}_{\text{change in children state}}$$
$$+\underbrace{\rho_d N_j(x)\mathbf{1}_{\{k=1\}}}_{\text{new worker entrance}}+\underbrace{\sum_{h'\in\mathcal{H}}\delta(h')\int g^{j,e}\left(\{w',h'\},k,x\right)dw'}_{\text{exogenous job separation}},$$

where $N_j(x)$ is the measure of gender j workers with demographic type x, with $\sum_{j\in\{1,2\},x\in\mathcal{X}}N_j(x)=1$. ρ_d is both the model exit rate and the entry rate by assumption, as exiting workers are replaced with an equal measure of new workers with the same gender and demographic type but are childless and non-employed.

Outflow from the non-employment state involves a change in the child state, model exit, or job

finding:

$$g^{j,n}(k,x)\left[\underbrace{\phi_{j,x}(k)}_{\text{children state change}}+\underbrace{\rho_d}_{\text{exit}}+\underbrace{\lambda\sum_{h'\in\mathcal{H}}\Delta^{h'}\int\Omega_j^n\left(\left(w',h'\right);k,x\right)\left(w'\right)dF_{h'}(w')}_{\text{job finding}}\right]$$

Then, consider employment with job (w,h) and child state k and demographic type x. Inflow into this state involves a change in the child state or job finding from non-employment and employment:

$$\underbrace{\mathbf{1}_{\{k>1\}}\phi_{j,x}(k-1)\left[\Omega_j^n(\{w,h\},k,x)g^{j,e}\left(\{w,h\},k-1,x\right)\right]}_{\text{change in child state}}+\underbrace{\lambda\Delta^h f_h(w)\,g^{j,n}(k,x)\,\Omega_j^n\left(\{w,h\};k,x\right)}_{\text{job finding from non-employment}}$$
$$+\underbrace{\Delta^h f_h(w)\,\lambda\sum_{h'\in\mathcal{H}}\int g^{j,e}\left(\{w',h'\},k,x\right)\Omega_j^e\left(\{w,h\},\{w',h'\};k,x\right)dw'}_{\text{job finding from employment}},$$

and outflow from this state involves a change in the child state, model exit, exogenous job separation, and job finding:

$$g^{j,e}(\{w,h\},k,x)\Bigg[\underbrace{\phi_{j,x}(k)}_{\text{children state change}}+\underbrace{\rho_d}_{\text{exit}}+\underbrace{\delta(h)}_{\text{exogenous job separation}}$$
$$\underbrace{+\lambda\sum_{h'\in\mathcal{H}}\int\Delta^{h'}(w')\Omega_j^e\left(\{w',h'\},\{w,h\};k,x\right)dF_{h'}(w')}_{\text{job finding}}\Bigg]$$

C.3 Numerical solution

In this section, we briefly explain the numerical algorithm to solve the equilibrium model laid out in Sec. 3. This approach follows from Fang and Shephard (2019) and Aizawa and Fang (2020).

1. Discretize firm productivity p and denote the p-grid by $\mathbf{p}=\left(p_1,p_2,...,p_{N_p}\right)$. For each grid point p_n, provide an initial guess of $w_{h,n}=w_h\left(p_n\right)$ and the hours requirement choice probability $\Delta_{h,n}=\Delta\left(h;p_n\right)$ for each $h\in\mathcal{H}$. We refer to $\mathbf{w}_h\equiv\left(w_{h,1},w_{h,2},...,w_{h,N_p}\right)$ as the derived wage grid.

2. Construct the offer distributions Δ^h using the discrete version of Eq. 15 and $F_h(w)$ for each $w\in\mathbf{w}_h$ using the discrete version of Eq. 14.

3. Given Δ^h and $F_h(w)$, solve workers' problems by value function iteration. We can derive worker decisions (Ω's). Given worker decisions, solve for the steady state distributions $g^{j,e}$ and $g^{j,n}$ as described in Appendix C.2. Note that the value functions, worker decisions and $g^{j,e}$ are defined on the derived w-grids.

4. Given the distribution of workers $g^{j,e}$ and the offer distributions Δ^h and $F_h(w)$, calculate labor supply $l(w,h)$ using Eq. 6.

5. Given labor supply $l(w,h)$, solve for firms' job-posting decision described in Sec. 3.4.1. To do so, we first numerically solve for $\pi_h(p_1)$ for each $h \in \mathcal{H}$, the maximized profit of the least productive firm on $\mathbf{p}$ given h. Then, we compute profits and posted wages of $p > p_1$ using the envelope condition, which we explain below.

To solve the problem of firm p_1, construct a wage sub-grid for each $h \in \mathcal{H}$. The sub-grid should include points around the candidate (initial guess or wage from the previous iteration) $w_h(p_1)$, i.e.

$$\underline{\mathcal{W}} = \{w_h(p_1) - N_{sg}\epsilon, w_h(p_1) - (N_{sg}-1)\epsilon, ..., w_h(p_1), w_h(p_1)+\epsilon, ..., w_h(p_1)+N_{sg}\epsilon\},$$

where $\epsilon > 0$ denotes the spacing between grid points. For each point on the sub-grid, perform value function iteration with $w_h(p_1)$ replaced by the point on the sub-grid and leave the rest of the wage grid unchanged. Then, compute steady-state distributions and labor supply $l(w,h)$. An update of the wage for firm p_1 is obtained by considering which $w \in \underline{\mathcal{W}}$ maximizes flow profits, i.e.

$$w_h^+(p_1) = \arg\max\{\pi_h(w;p_1) : w \in \underline{\mathcal{W}}\}$$

and the maximized flow profit is $\pi_h(p_1)$ for each h.

Once we solved the firm problem for p_1, we can compute $w_h(p)$ for each $p > p_1$ on $\mathbf{p}$ starting from p_2. This step uses the Envelope Theorem to derive a wage equation. Eq. 9 can be rewritten as

$$w_h(p)\,h = y(p,h) - \frac{\pi_h(p)}{l(w_h(p),h)}. \tag{18}$$

Applying the Envelope Theorem, we have

$$\begin{aligned}\frac{d\pi_h(p)}{dp} &= \frac{\partial \pi_h(w_h(p);p)}{\partial p} \\ &= \frac{\partial y(p,h)}{\partial p} l(w_h(p),h) \\ &= \theta_h h l(w_h(p),h)\end{aligned} \tag{19}$$

$\pi_h(p)$ can be expressed in terms of $\pi_h(p_1)$ such that

$$\begin{aligned}\pi_h(p) &= \pi_h(p_1) + \int_{p_1}^{p} \frac{d\pi_h(x)}{dx} dx \\ &= \pi_h(p_1) + \int_{p_1}^{p} \theta_h hl(w_h(x), h)\, dx \end{aligned} \tag{20}$$

Using Eq. 19 and 20, we can rewrite Eq. 18 as

$$w_h^+(p)\, h = y(p,h) - \frac{\left[\pi_h(p_1) + \int_{p_1}^{p} \theta_h hl(w_h(x), h)\, dx\right]}{l(w_h(p), h)} \tag{21}$$

and the + superscript indicates the updated value.

Given $\pi_h(p)$ from Eq. 20, the hours requirement choice probability function $\Delta(h;p)$ can be updated using Eq. 11 and 13.

6. Repeat steps 2-5 until $w_h(p)$ and $\Delta(h;p)$ converge.

C.4 Preference shock

In solving the model numerically, we assume that, when facing the decision to accept a job offer or to quit their job, the worker draws a one-time idiosyncratic taste shock $\boldsymbol{\alpha} = \{\alpha_1, \alpha_2\}$ from the Type-I Extreme Value distribution with scale parameter σ_α. The taste shock allows us to smooth the labor supply function; we set σ_α to be small such that the shock does not change the model solution.

Given the taste shock, the value functions and decisions in Sec. 3.2 can be modified as follows. The Bellman equation for the value of non-employment (Eq. 2) becomes

$$\begin{aligned}\mathcal{D}_j^n V_j^n(k) &= u^j(\mathcal{N}^n(j,k), 0, k) + \phi_j(k) V_j^n(k') \\ &\quad + \lambda \sum_{h\in\mathcal{H}} \int \Delta^h \mathbb{E}_{\boldsymbol{\alpha}} \max\left\{V_j^e(\{w,h\},k) - \mu(j,k,h) + \alpha_1, V_j^n(k) + \alpha_2\right\} dF_h(w).\end{aligned}$$

The Bellman equation for the value of employment (Eq. 4) becomes

$$\begin{aligned}\mathcal{D}_j^e V_j^e(\{w,h\},k) &= u^j(\mathcal{N}^e(wa_j(h)h, h; j, k), h, k) + \delta(h) V_j^n(k) \\ &\quad + \phi_j(k) \mathbb{E}_{\boldsymbol{\alpha}} \max\left\{V_j^e(\{w,h\},k') - \mu(j,k,h) + \alpha_1, V_j^n(k') + \alpha_2\right\} \\ &\quad + \lambda \sum_{h'\in\mathcal{H}} \int \Delta^{h'} \mathbb{E}_{\boldsymbol{\alpha}} \max\left\{V_j^e(\{w,h\},k) + \alpha_1, V_j^e(\{w',h'\},k) - \mu(j,k,h') + \alpha_2\right\} dF_{h'}(w').\end{aligned}$$

The probability of accepting job offer (w', h') from non-employment (Eq. 3) becomes

$$\Omega_j^n\left(\{w', h'\}; k\right) = \frac{\exp\left(\frac{V_j^e(\{w', h'\}, k) - \mu(j, k, h')}{\sigma_\alpha}\right)}{\exp\left(\frac{V_j^e(\{w', h'\}, k) - \mu(j, k, h')}{\sigma_\alpha}\right) + \exp\left(\frac{V_j^n(k)}{\sigma_\alpha}\right)}.$$

The probability that an employed worker with job (w, h) accepts a job offer (w', h') (Eq. 5) becomes

$$\Omega_j^e\left(\{w', h'\}, \{w, h\}; k\right) = \frac{\exp\left(\frac{V_j^e(\{w', h'\}, k) - \mu(j, k, h')}{\sigma_\alpha}\right)}{\exp\left(\frac{V_j^e(\{w', h'\}, k) - \mu(j, k, h')}{\sigma_\alpha}\right) + \exp\left(\frac{V_j^e(\{w, h\}, k)}{\sigma_\alpha}\right)}.$$

D Demand Side Estimation

As discussed in Section 4.3.2, to estimate the demand-side parameters we construct (i) a theoretical hours-requirement choice function $\Delta(h; p)$ and (ii) an observed counterpart $\widehat{\Delta}(h; p)$, and we choose parameters to minimize the distance between the two. The theoretical choice comes from firms' optimal job-posting decisions given the (estimated) labor supply from Step 1, while the observed choice is the one implied by the (estimated) offer distribution from Step 1.

We proceed as follows. First, compute labor supply $l(w, h)$ using Eq. 6, given the stationary distributions and the Step 1 offer distribution. Using the first-order condition of the firm's wage-posting problem in Eq. 8, the inverse wage function for each $h \in \mathcal{H}$ satisfies

$$p \equiv w_h^{-1}(w) = \frac{l(w, h) + w\,\partial l(w, h)/\partial w}{\theta_h\,\partial l(w, h)/\partial w}. \tag{22}$$

Inverting Eq. (22) yields the wage function $w_h(p)$. In our numerical implementation, $w_h^{-1}(w)$ is strictly increasing in w, so $w_h(p)$ exists and is strictly increasing in p.

Given $w_h(p)$, we compute the expected profit associated with posting jobs at each hours requirement h using Eq. 9. Then the theoretical choice conditional on activity,

$$\frac{\Delta(h; p)}{\Delta^{act}(p)},$$

is obtained from Eq. 11, with $\bar{\pi}(p)$ from Eq. 12 and the activity choice $\Delta^{act}(p)$ from Eq. 13.

Next, we construct the "observed" choice function $\widehat{\Delta}(h;p)$. Let Γ denote the cdf of the firm-productivity distribution (with density γ). The offer distribution implied by $\widehat{\Delta}(h;p)$ satisfies

$$F_h\big(w_h(p)\big) \;=\; \frac{\displaystyle\int_{\underline{p}}^{p} \widehat{\Delta}(h;x)\, d\Gamma(x)}{\Delta^h}, \tag{23}$$

where Δ^h is the (unconditional) measure of firms posting jobs with hours h. Differentiating Eq. (23) with respect to p and applying the chain rule gives

$$f_h\big(w_h(p)\big)\, w_h'(p) \;=\; \frac{\widehat{\Delta}(h;p)}{\Delta^h}\,\gamma(p),$$

so that

$$\widehat{\Delta}(h;p) \;=\; \frac{\Delta^h\, f_h\big(w_h(p)\big)\, w_h'(p)}{\gamma(p)}. \tag{24}$$

To determine $\widehat{\Delta}(h;p)$, we need to pin down Δ^h and $\gamma(p)$. Summing Eq. (24) over $h \in \mathcal{H}$ and using $\sum_h \widehat{\Delta}(h;p) = \Delta^{act}(p)$ yields

$$\gamma(p) \;=\; \frac{\displaystyle\sum_{h\in\mathcal{H}} \Delta^h\, f_h\big(w_h(p)\big)\, w_h'(p)}{\Delta^{act}(p)}. \tag{25}$$

From the supply-side estimation we observe only conditional hours distribution

$$\Delta^{h|act} \;\equiv\; \frac{\Delta^h}{\Delta^{act}},$$

and we know that $\Delta^{act} \;=\; \int_{\underline{p}}^{\bar{p}} \Delta^{act}(p)\,\gamma(p)\,dp$. We need to pin down γ to get Δ^{act}. Define the productivity density *conditional on activity* as

$$\gamma^{act}(p) \;\equiv\; \frac{\Delta^{act}(p)\,\gamma(p)}{\Delta^{act}}.$$

Using Eq. (25), this can be written purely in terms of $\Delta^{h|act}$ and observables:

$$\gamma^{act}(p) \;=\; \sum_{h\in\mathcal{H}} \Delta^{h|act}\, f_h\big(w_h(p)\big)\, w_h'(p), \qquad \int_{\underline{p}}^{\bar{p}} \gamma^{act}(p)\,dp = 1. \tag{26}$$

Moreover, by construction $\gamma^{act}(p) > 0$ implies $\Delta^{act}(p) > 0$, and if $\Delta^{act}(p) = 0$ then $\gamma^{act}(p) = 0$ almost everywhere.

Given $\gamma^{act}(p)$ and $\Delta^{act}(p)$, we recover the unconditional $\gamma(p)$ from the system

$$\begin{cases} \gamma^{act}(p) \int_{\underline{p}}^{\bar{p}} \Delta^{act}(x)\, \gamma(x)\, dx = \Delta^{act}(p)\, \gamma(p), \\ \int_{\underline{p}}^{\bar{p}} \gamma(p)\, dp = 1, \end{cases}$$

whose unique solution is

$$\gamma(p) = \frac{\dfrac{\gamma^{act}(p)}{\Delta^{act}(p)}}{\displaystyle\int_{\underline{p}}^{\bar{p}} \frac{\gamma^{act}(x)}{\Delta^{act}(x)}\, dx}. \tag{27}$$

E Consumption Equivalent Variation (CEV) Calculation

We compute the welfare effect of minimum wage policies on different genders (j) and demographic types (x). Note that j and x are both time-invariant. We consider only the long-run effects for newborn households ($k = 1$ and non-employed). Given the utility function in Eq. 1, the value of a newborn household given minimum wage policy w_{min} is

$$V_j^n(k=1, x; w_{min}) = \mathbf{E}_0 \int_0^\infty e^{-\bar{\rho} t} [\ln c(t, j, x; w_{min}) + \psi^j_{k(t,j,x)} \frac{(\bar{h} - h(t, j, x; p))^{1-\gamma^j_{k(t,j,x)}}}{1 - \gamma^j_{k(t,j,x)}}] dt \tag{28}$$

where $\bar{\rho} \equiv \rho + \rho_d$, and the expectation $\mathbf{E}_0$ at time $t = 0$ is over all future paths of consumption $c(t, j, x; w_{min})$, hours of work $h(t, j, x; w_{min})$, and child state $k(t, j, x)$. While the consumption and hours of work are household decisions and depend on the minimum wage policy w_{min}, the child state k is exogenous.

Define $\Xi(j, x; w_{min})$ as the consumption equivalent variation (CEV) for a newborn household of type (j, x) when changing the minimum wage policy from the benchmark policy (i.e. minimum wage equals 0) to a minimum wage of w_{min}. It is given by

$$\mathbf{E}_0 \left[\int_0^\infty e^{-\bar{\rho} t} [\ln ((1 + \Xi(j, x; w_{min})) c(t, j, x; 0)) + \psi^j_{k(t,j,x)} \frac{(\bar{h} - h(t, j, x; 0))^{1-\gamma^j_{k(t,j,x)}}}{1 - \gamma^j_{k(t,j,x)}}] dt \right] = V_j^n(1, x; w_{min}). \tag{29}$$

The left-hand side can be written as

$$\mathbf{E}_0\left[\int_0^\infty e^{-\bar{\rho}t}[\ln(1+\Xi(j,x;w_{min}))+\ln c(t,j,x;0)+\psi^j_{k(t,j,x)}\frac{(\bar{h}-h(t,j,x;0))^{1-\gamma^j_{k(t,j,x)}}}{1-\gamma^j_{k(t,j,x)}}]dt\right]$$

$$=\int_0^\infty e^{-\bar{\rho}t}\ln(1+\Xi(j,x;w_{min}))dt+\mathbf{E}_0\left[\int_0^\infty e^{-\bar{\rho}t}[\ln c(t,j,x;0)+\psi^j_{k(t,j,x)}\frac{(\bar{h}-h(t,j,x;0))^{1-\gamma^j_{k(t,j,x)}}}{1-\gamma^j_{k(t,j,x)}}]dt\right]$$

$$=\frac{\ln(1+\Xi(j,x;w_{min}))}{\bar{\rho}}+V^n_j(1,x;0).$$

Substituting this into Eq. 29 gives

$$\frac{\ln(1+\Xi(j,x;w_{min}))}{\bar{\rho}}+V^n_j(1,x;0)=V^n_j(1,x;w_{min}).$$

Solving for $\Xi(j,x;w_{min})$ gives the CEV as

$$\Xi(j,x;w_{min})=\exp\left[\bar{\rho}\left(V^n_j(1,x;w_{min})-V^n_j(1,x;0)\right)\right]-1. \tag{30}$$

F Decomposition

F.1 Decomposition of the effect on the gender income gap

Let G_x denote the gender gap in variable x, defined as the ratio between the female value and the male value. The gender income gap (G_i) is the product of the gender wage gap (G_w), and the gender hours-worked gap (G_h). Taking logs, we have

$$\ln G_i=\ln G_w+\ln G_h.$$

We measure the minimum wage effect on the gender income gap in log-point difference between the minimum-wage economy (M) and the benchmark no-minimum-wage economy (B), $\ln G^M_i-\ln G^B_i$. We can decompose the minimum wage effect on the gender income gap such that

$$\ln G^M_i-\ln G^B_i=\underbrace{\left(\ln G^M_w-\ln G^B_w\right)}_{\text{Wage channel}}+\underbrace{\left(\ln G^M_h-\ln G^B_h\right)}_{\text{Hours-worked channel}}.$$

F.2 Decomposition of the productivity effect

In Figure 10, the overall effect of the minimum wage on average productivity is decomposed into four components. The first three components are changes in the average productivity of each type of employment, and the last is due to changes in the hours type.

Let $\hat{p}$ and $\hat{p}'$ be the average employer productivity in the benchmark and minimum wage economies, respectively. The overall effect of the minimum wage on employer productivity is

$$\hat{p}' - \hat{p} = \sum_{h \in \mathcal{H}} \left(m'_h \hat{p}'_h - m_h \hat{p}_h \right),$$

where m_h and m'_h are the fraction of jobs with hours type h in the two economies, and $\hat{p}_h$ and $\hat{p}'_h$ are the average productivity of jobs with hours type h in the two economies. The decomposition is as follows:

$$\sum_{h \in \mathcal{H}} \left(m'_h \hat{p}'_h - m_h \hat{p}_h \right) = \underbrace{\sum_{h \in \mathcal{H}} m_h \left(\hat{p}'_h - \hat{p}_h \right)}_{\text{conditional on hours}} + \underbrace{\sum_{h \in \mathcal{H}} \left(m'_h - m_h \right) \hat{p}_h}_{\text{due to changes in hours}}.$$

The first term on the right-hand side is the change in the average employer productivity conditional on h, while the second term is the effect due to changes in the hours distribution.

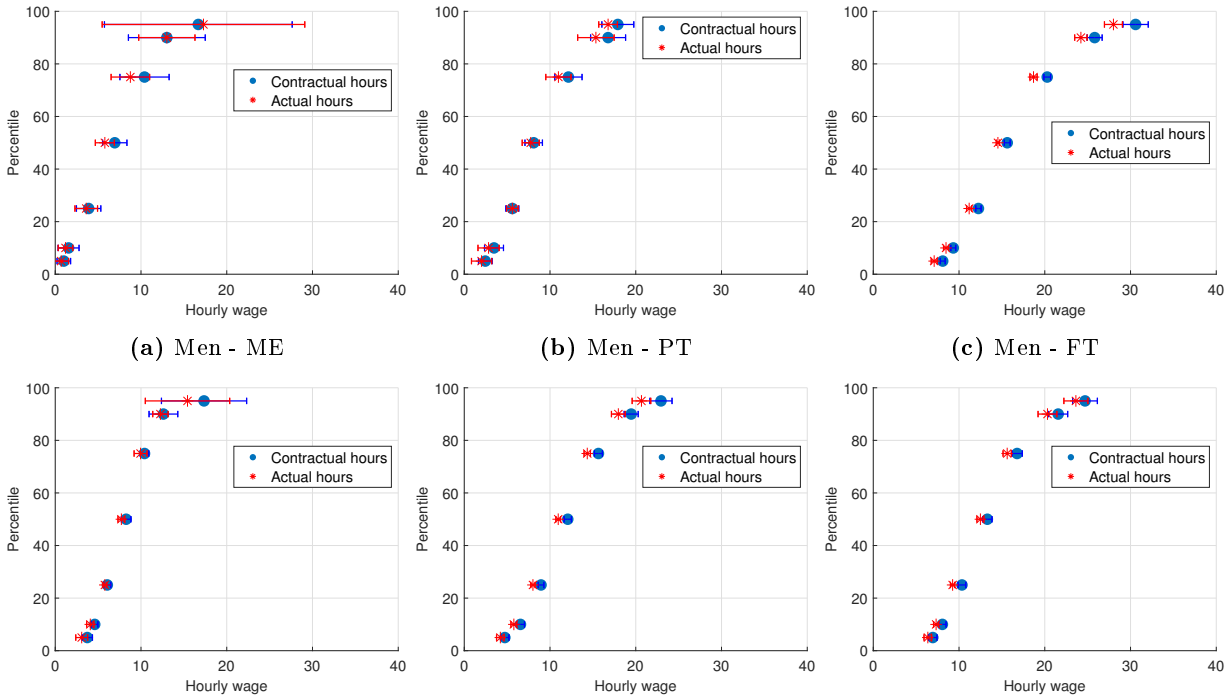
G Additional Results

G.1 Contractual vs. Actual Hours

In computing the moments for model estimation, we use contractual hours following Caliendo et al. (2018). As they discuss, both contractual and actual hours refer to a "usual" workweek, whereas earnings are reported for the previous month and may include bonuses or short-term fluctuations. This timing mismatch affects both concepts in similar ways.

To address the concern that using contractual hours might mask some non-compliance with the minimum wage, we document that hourly wages computed using contractual and actual hours are very similar, especially at the low percentiles of the wage distribution - the part most relevant for assessing non-compliance (Figure 14). Moreover, our key calibration target for the non-compliance penalty parameter κ_0 is the change in the share of full-time jobs paying below 8.50 € after the introduction of the minimum wage. As shown in Table 9, this share does not show a significant difference across hours concepts because the hours definition affects the computation of hourly wages both before and after the introduction of the minimum wage.

Figure 14: Hourly wage distribution in the data using contractual and actual hours



(a) Men - ME **(b)** Men - PT **(c)** Men - FT

(d) Women - ME **(e)** Women - PT **(f)** Women - FT

Note: The figures show the CDF of hourly wage by gender and hours using SOEP, 2013-2014. "Contractual" refers to hourly wages computed based on contractual hours. "Actual" refers hourly wages computed based on actual hours. Horizontal bars represent 95% confidence intervals.

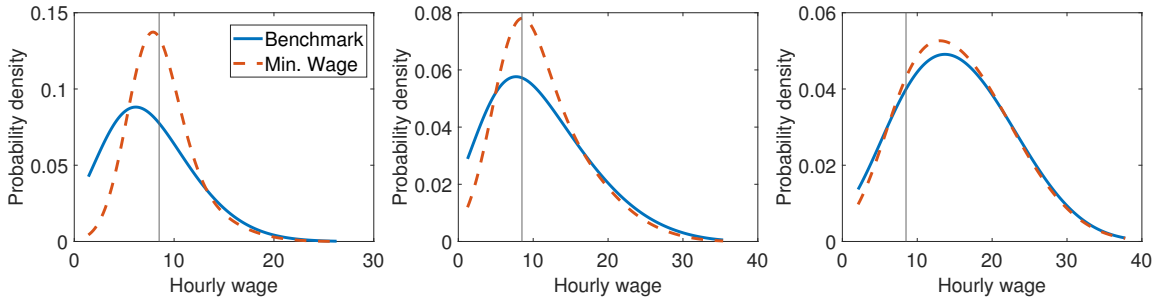
Table 9: Change in the fraction of full-time jobs below 8.5 €

	p.p. change in frac. below 8.5 €	se
A. Data (contractual hours)	-3.72	0.51
B. Data (actual hours)	-3.89	0.62
C. Model	-3.55	-

Note: This table reports the percentage point change in the fraction of full-time jobs earning below 8.5 € after the introduction of the minimum wage. The SOEP estimates compare the baseline period (2013-2014) with the post-reform period (2016). Hourly wages in the data are computed using contractual hours (Row A) and actual hours (Row B). Column "se" reports bootstrap standard errors. The model value (Row C) is the difference in the fraction of full-time jobs below the minimum wage between the steady state with the minimum wage and the steady state without it.

G.2 Additional Figures

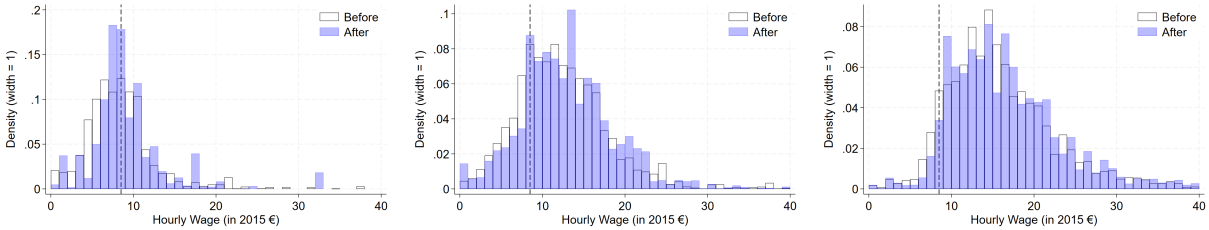
Figure 15: Hourly wage distribution (probability density function)



(a) ME **(b)** PT **(c)** FT

Note: The figures show the probability density functions of hourly wage by hours in the benchmark economy and in the economy with 8.5 € minimum wage. Vertical line represent the minimum wage of 8.5 €.

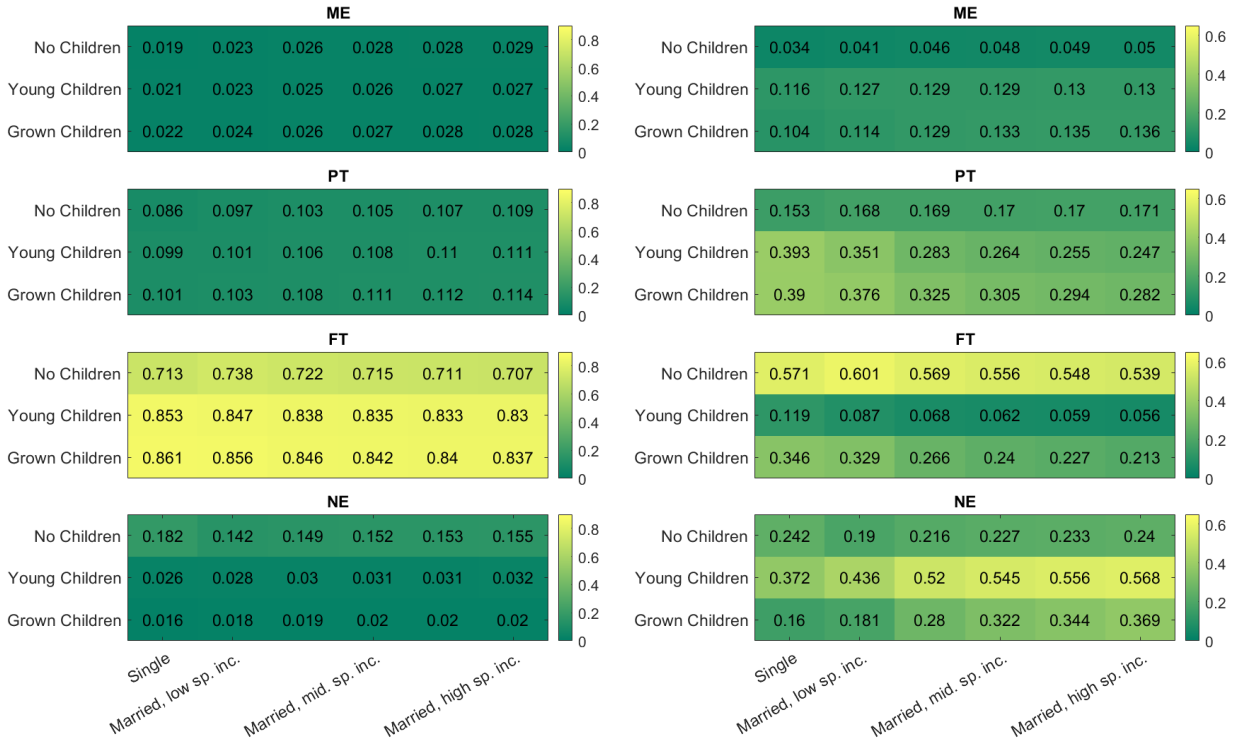
Figure 16: Hourly wage distribution in the data (histogram)



(a) ME **(b)** PT **(c)** FT

Note: The figures show the histograms of hourly wage by gender and hours using SOEP. "Before" refers to the period 2013-2014, before the introduction of the minimum wage. "After" refers to 2016. Wages are in 2015 €. Each bar has width of 1. Vertical line represent the minimum wage of 8.5 €.

Figure 17: Equilibrium employment distribution by demographic types



(a) Men **(b)** Women

Note: The employment distribution is the one in our benchmark model without minimum wages.

H Understanding Key Components of the Equilibrium Job-Posting Model

In this appendix, we consider alternative models to assess the importance of key components of our benchmark economy introduced in Sec. 3: endogenous wage posting, the choice of hours, and demographic type heterogeneity.

H.1 Model with a Fixed Wage Function

To isolate the role of endogenous wage posting, we study an alternative specification in which wages are given by a fixed wage rule similar to Drechsel-Grau (2023), but firms have the option not to comply with the minimum wage. Specifically, instead of choosing the posted wage to maximize profit in Eq. 8, posted wages are given by a fixed wage rule unless the minimum wage is binding. In the absence of a minimum wage policy, the posted wage of firm p for hours type h is simply

$$w_h(p) \;=\; r\theta_h p. \tag{31}$$

When a minimum wage is imposed, we allow affected firms to choose non-compliance (posting the fixed wage according to Eq. 31) or compliance (posting the *minimum fully compliant* wage). Non-compliance is subject to the same penalty as in the benchmark model (see Section 3.6). Recall that the minimum wage is a wage floor on the hourly wages workers receive. Given a posted wage $w_h(p)$, the hourly wage of gender j is given by $a_j(h)w_h(p)$. We call a posted wage $w_h(p)$ *fully compliant* if $\min_j\{a_j(h)w_h(p)\} \geq w_{min}$. The minimum fully compliant wage is then given by $w_h^c(p) = w_{min}/\min_j\{a_j(h)\}$. If the fixed wage is already fully compliant, we assume firms must post it and cannot lower the wage to the minimum fully compliant level.

To solve for the model equilibrium in the fixed-wage model without a minimum wage policy, we do not need to update the wage policy, as the wage is exogenously determined by Eq. 31. We can skip Step 5 (wage update) of the numerical solution algorithm described in Appendix C.3. With a minimum wage policy, we need to solve for firms' endogenous non-compliance decision in equilibrium by modifying Step 5. We explain the wage-updating step at the end of this subsection.

Calibration As in the benchmark model, we calibrate the fixed-wage model to match the economy before the introduction of the minimum wage. In our benchmark model, the relationship between firm productivity and posted wages is characterized by the first-order condition of firms' wage-posting problem (Eq. 22). This condition allows us to recover the firm productivity distribution

from the offer distribution (Eqs. 26 and 27). Here, in the absence of the minimum wage policy, the relationship between firm productivity and wages is instead governed by the parameter r. To ensure comparability across the two models, we impose the same firm productivity distribution as in the benchmark model. We then estimate r together with the remaining model parameters to match the supply-side moments described in Section 4. The parameter r can be identified from the hourly wage distribution.

Unlike the two-step estimation in Section 4, we can estimate the parameters by solving for the model equilibrium at each candidate parameter vector. This is feasible because the fixed-wage function allows us to skip the wage-updating Step 5, which requires the sub-grid method, a very time-consuming step.

Results Calibrated parameter values are reported in Table 10, col. (2). We then compare the implied equilibrium hourly wage distribution with that of the benchmark model in Figure 18, and the equilibrium employment distribution with that of the benchmark model in Table 11, col. "Fixed Wage." The non-compliance penalty parameters κ_0 and κ_1 are kept the same as in the benchmark model.

When we impose a minimum wage of 8.5 € in the fixed-wage model, we find a reduction in the share of non-compliant full-time jobs of 1.8 percentage points, smaller than the reduction of 3.6 percentage points in the benchmark model (Sec. 4.4). Figure 19 shows the hourly wage distribution in the fixed-wage model with and without the minimum wage. There is strong bunching at the minimum wage, especially among part-time and marginal-employment segments.[34] Raising the minimum wage above 8.5 € in the fixed-wage model leads to full compliance in all three hours types. This arises because firms cannot choose the *degree* of non-compliance, since they cannot choose wages endogenously; i.e., the non-compliant wage must follow the fixed wage rule. In contrast, in the benchmark model, firms can choose to post higher (non-compliant) wages as the minimum wage increases. In Figure 16, we plot the 2016 hourly wage distribution. While wages shift upward around the minimum wage, the degree of bunching at the statutory minimum of 8.5 € is modest, and many jobs, particularly in marginal and part-time employment, remain below the minimum wage. Moreover, the fixed wage rule fails to generate the spillover wage effects that have been documented as a key feature of the German minimum wage reform (see, for example, Bossler and Schank, 2023; Bossler et al., 2026).

The fixed wage rule also has important gender implications, shown in Figure 20. In the benchmark model, endogenous wage posting and flexible non-compliance allow firms to choose different wage

[34] In each hours type, the hourly wage distribution exhibits two spikes. This is because if a mass of firms choose to post the minimum fully compliant wage $w_h^c(p)$, the hourly wage is exactly equal to the minimum wage for the gender with a lower $a_j(h)$, but is at a higher level (the second spike) for the other gender.

increases across jobs with different hours requirements, leading to higher compliance in high-hours jobs. In the fixed-wage economy, by contrast, the fixed wage rule effectively raises all affected wages to the level of the minimum wage as the minimum wage is raised beyond 8.5 €, because all firms choose to fully comply, as discussed above. As a consequence, women, who have a stronger preference for low-hours jobs, are less likely to reallocate toward jobs with longer hours, since the minimum wage generates especially large wage increases in the low-hours segment where they are concentrated. While the fixed wage rule reduces the gender wage gap, it does not lead to a meaningful reduction in the gender gap in hours worked. This comparison illustrates that when wage posting is not endogenous (and, thus, the degree of non-compliance is not endogenous), the model may understate the role of the hours-worked margin in shaping the gendered effects of the minimum wage.

Figure 21 compares how firms' hours-posting decisions respond to the minimum wage in the benchmark and fixed-wage models. In both models, minimum wages lead more firms to post full-time jobs and fewer firms to post marginal-employment or part-time jobs. However, the difference in hours posting between the two models is not stark. In the fixed-wage model, wage increases in ME and PT jobs are larger due to greater endogenous compliance, reducing profit per worker. At the same time, firms paying the minimum fully compliant wage face a smaller non-compliance penalty, if any, and attract more labor supply in equilibrium because of the higher wages. Thus, minimum wages in the fixed-wage model do not lead to a more drastic change in firms' hours-posting behavior toward FT jobs than in the benchmark model.

Numerical solution for the fixed-wage model We outline how to update the wage policy in the fixed-wage model with a minimum wage policy. For each h, we first identify the threshold productivity level $p_{min}(h)$ above which the fixed wage rule is fully compliant. For these firms, the posted wage is given by Eq. 31 and does not change throughout the algorithm. As initial guess, firms below the threshold post the non-compliant fixed-rule wage $w_h^{nc}(p) \equiv r\theta_h p$; their wage policy may be updated in the algorithm. To update the wage policy, we consider the marginal firm at each iteration, which is the highest p posting a non-compliant wage $w_h^{nc}(p)$. We compute expected profits $\pi_h(w;p)$ given the non-compliant wage $w_h^{nc}(p)$ and the compliant wage $w_h^c(p)$. To do so, we compute labor supply $l(w,h)$ under each of the two wages, fixing all other firms' posted wages, and compute profits using Eq. 8. If the compliant wage yields a higher profit, we update the wage policy of the marginal firm to $w_h^c(p)$; otherwise the wage policy function remains unchanged.

Table 10: Parameters in Alternative Models

Parameter		(1)	(2)	(3)	(4)
Contact rate, λ		2.590	2.200	1.950	2.593
Exog. separation rate, $\delta(h)$	ME	0.256	0.170	n.a.	0.276
	PT	0.029	0.030	n.a.	0.051
	FT	0.018	0.010	0.018	0.040
Preference parameters,ψ_k^j	male, young child	0.037	0.319	3.400	0.036
	male, grown child	0.314	0.265	3.400	0.307
	female, no child	0.862	2.131	1.700	0.866
	female, young child	1.873	5.267	5.300	1.955
	female, grown child	1.656	3.907	3.980	1.470
Preference parameters,γ_k^j	male, young child	2.669	1.787	2*	2.669
	male, grown child	1.165	2.035	2*	1.165
	female, no child	4.877	2.021	2*	4.740
	female, young child	5.045	2.056	2*	5.310
	female, grown child	4.443	2.077	2*	4.887
Distrib. of disutility $\mu_\alpha(j,k,FT)$	female, young child	0.851	1.657	0*	0.189
	female, grown child	0.703	872	0*	0.759
Labor efficiency, $a_j(h)$	female, ME	1.266	1.200	n.a.	1.294
	female, PT	1.341	1.280	n.a.	1.350
	female, FT	0.851	0.788	0.851	0.837
Production function param., θ_h	ME	0.682	0.620	n.a.	0.690
	PT	0.383	0.607	n.a.	0.395
Job-posting cost (monthly), $\bar{\epsilon}_h$	ME	1958.7	348.0	n.a.	1898.0
	PT	539.2	311.3	n.a.	469.6
Job-posting cost (monthly), σ_ε		1054.5	1185.5	1054.5*	998.0
Wage ratio, r		n.a.	0.235	n.a.	n.a.

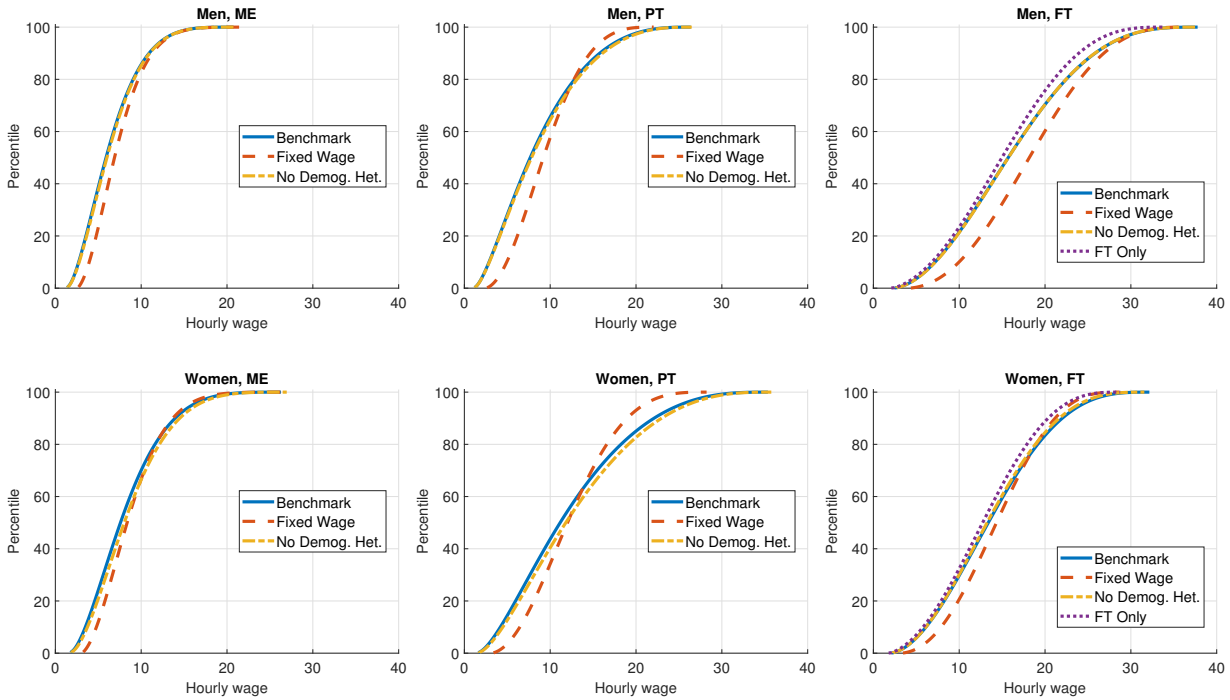
Note: Column (1) is the benchmark model (Sec. 3), column (2) the model with a fixed wage posting function (Appendix H.1), column (3) the model with only full-time jobs (Appendix H.2), and column (4) the model without demographic type heterogeneity (Appendix H.3). Entries marked with '*' are fixed rather than calibrated, and "n.a." indicates parameters that are not applicable in a given model.

Table 11: Equilibrium Employment Distribution in Alternative Models

	Benchmark	Fixed Wage	FT Only	No Demog. Het.
Men - No children				
ME	0.023	0.035	-	0.020
PT	0.096	0.149	-	0.086
FT	0.721	0.641	-	0.701
FTE*	0.787	-	0.799	-
Men - Young children				
ME	0.023	0.037	-	0.022
PT	0.103	0.167	-	0.099
FT	0.846	0.766	-	0.838
FTE*	0.917	-	0.873	-
Men - Grown children				
ME	0.024	0.037	-	0.022
PT	0.104	0.167	-	0.101
FT	0.854	0.781	-	0.845
FTE*	0.926	-	0.876	-
Women - No children				
ME	0.043	0.051	-	0.033
PT	0.164	0.187	-	0.145
FT	0.558	0.542	-	0.577
FTE*	0.672	-	0.763	-
Women - Young children				
ME	0.124	0.160	-	0.115
PT	0.318	0.261	-	0.338
FT	0.086	0.112	-	0.104
FTE*	0.319	-	0.370	-
Women - Grown children				
ME	0.121	0.157	-	0.107
PT	0.337	0.317	-	0.399
FT	0.281	0.292	-	0.245
FTE*	0.526	-	0.529	-

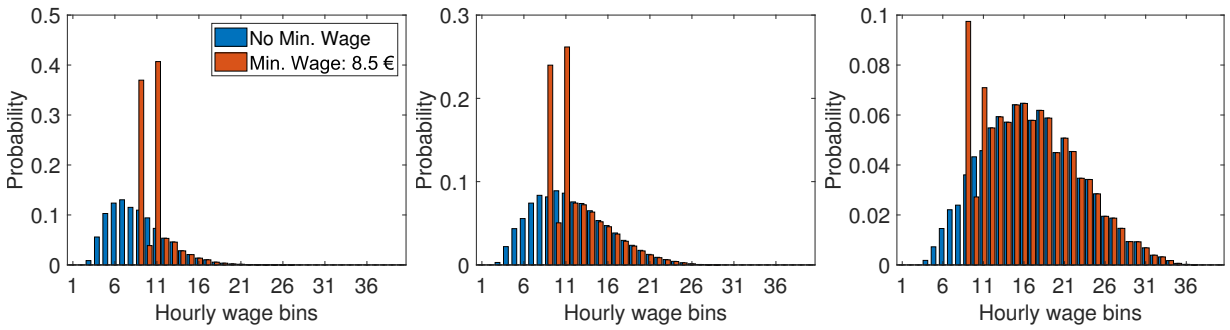
Note: The table reports the equilibrium employment distribution by gender and child state in the absence of a minimum wage for the benchmark and alternative models. "Fixed Wage" refers to the model with a fixed wage posting function (Appendix H.1), "FT Only" refers to the model with only full-time jobs (Appendix H.2), and "No Demog. Het." refers to the singles-only model (Appendix H.3). 'FTE*' denotes the full-time-equivalent employment rate, computed as total FTE divided by population in each gender-child group, and is a targeted moment only in the full-time-only model.

Figure 18: Equilibrium hourly wage distributions in the benchmark and alternative models



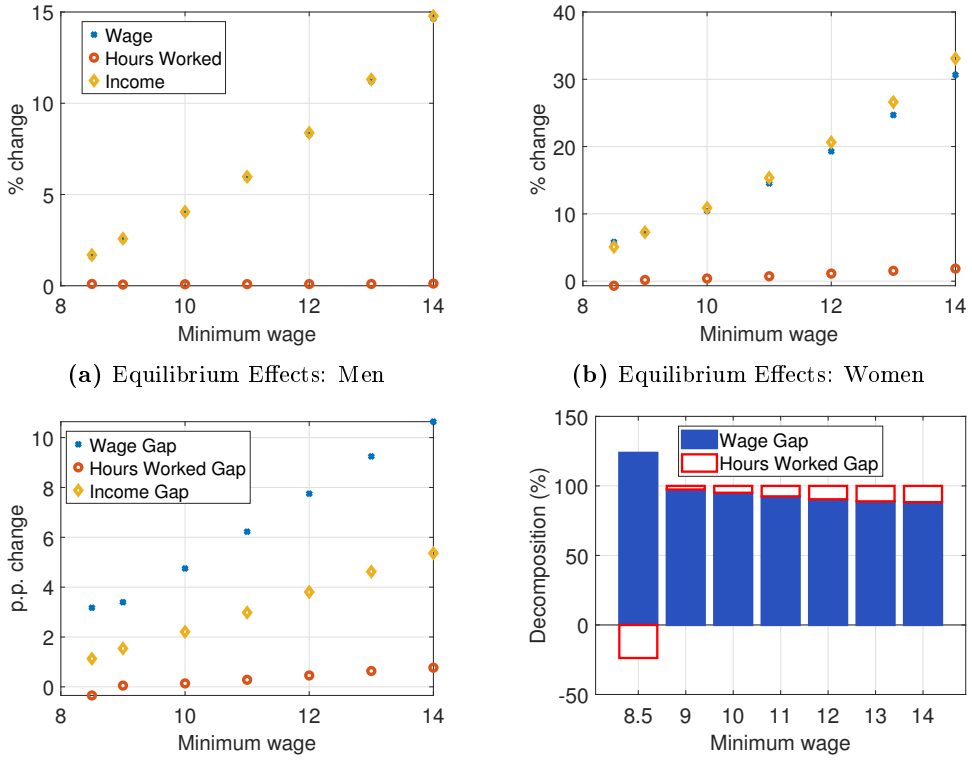
Note: The figures show the cumulative hourly wage distributions by gender and hours type in the benchmark model, the fixed-wage model (Appendix H.1), the model with only full-time jobs (Appendix H.2), and the model without demographic type heterogeneity (Appendix H.3), all in the absence of a minimum wage.

Figure 19: Equilibrium hourly wage distributions in the Fixed-Wage Model: Minimum Wage Effects



Note: The figures show histograms of simulated hourly wages from the fixed-wage model in the absence of a minimum wage and with an 8.5 € minimum wage. Hourly wage bin b includes wages between $(b-1)$ € and b €.

Figure 20: Effects of Higher Minimum Wages in an Economy with a Fixed Wage Function



(a) Equilibrium Effects: Men

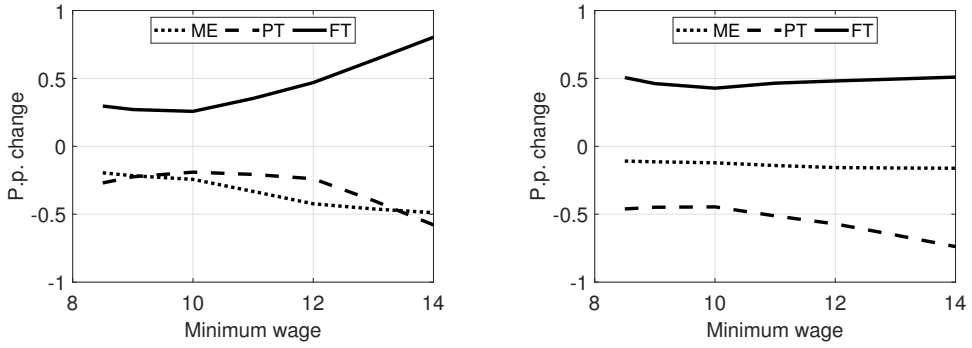
(b) Equilibrium Effects: Women

(c) Gender Gaps

(d) Gender Gap Decomposition

Note: Figures (a) to (c) show the effects of different minimum wage levels, expressed as percentage or percentage-point (p.p.) changes relative to the no-minimum-wage economy. Figure (d) decomposes the effects on the income gap into contributions from the hours-worked gap and the wage gap.

Figure 21: Effects of Higher Minimum Wages on Hours-Posting



(a) Benchmark

(b) Fixed Wage

Note: Figures show the effects of different minimum wage levels on the share of firms posting different hours, expressed as percentage-point (p.p.) changes relative to the no-minimum-wage economy.

H.2 Model with Full-Time Jobs Only

To highlight the importance of the hours margin, which is absent in Blömer et al. (2024), we compare our benchmark model with a version in which firms can post only full-time jobs if they choose to be active.

We calibrate the model to match employment rates in terms of full-time equivalents by gender and child state. Since the model includes only full-time jobs, we can no longer separately identify all of the parameters governing the disutility of work (ψ_k^j, γ_k^j, and $\mu(j,k,h)$). We therefore set $\gamma_k^j = 2$ and $\mu(j,k,h) = 0$ for all j,k,h. In addition, on the demand side, firms no longer choose hours requirements, but only whether to be active. We take the value of σ_ε, the scale parameter of the idiosyncratic job-posting cost shocks, from the benchmark model because it cannot be directly identified when inactive firms are unobserved. We recalibrate the remaining parameters, including ψ_k^j, to match the relevant moments targeted in the benchmark calibration. The calibrated parameters are reported in Table 10, col. (3). Column "FT Only" in Table 11 reports the resulting employment distribution, and Figure 18 shows the equilibrium hourly wage distribution.

Figure 22a shows the impact of the minimum wage on gender gaps in the full-time-only model. Without part-time and marginal employment, the minimum wage does not meaningfully reduce the gender income gap. Two mechanisms explain this result. First, the upward hours-reallocation effect is absent: the minimum wage does not induce women to move into jobs with more hours and lower separation rates. Second, the gender wage gap in the economy without a minimum wage is already small once marginal and part-time jobs are excluded, so the minimum wage does not raise women's wages more than men's. Compared with the benchmark results in Figure 11c, the full-time-only model illustrates that the hours margin plays an important role in evaluating the gendered effects of the minimum wage because it helps us capture existing wage inequality and understand the reallocation of women across hours.

H.3 Model with no Demographic Type Heterogeneity

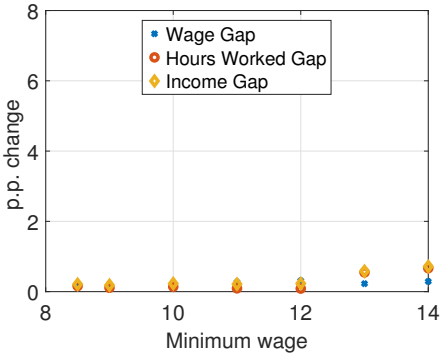
Our benchmark model incorporates heterogeneity in demographic type x, allowing individuals to be either single or married with different levels of spousal income. This modeling choice is motivated by the empirical finding that marital status and spousal income significantly affect employment and hours outcomes (Sec. 2.1). In the model (Sec. 3), singles differ from married individuals because they do not have access to income pooling and face joint taxation. In Sec. 5.4, we show that economic outcomes including employment, hours, welfare, and the distribution of employer productivity vary with the demographic type x.

To assess the quantitative importance of demographic heterogeneity for evaluating minimum wage reforms, we compare the benchmark economy to an alternative model that assumes no demographic type heterogeneity. Specifically, everyone has $x = 1$. We recalibrate the model to match the same moments as in the benchmark model, and report the calibrated parameters in Table 10, col. (4). Column "No Demog. Het." in Table 11 reports the employment distribution in this model, and Figure 18 shows the equilibrium hourly wage distribution.

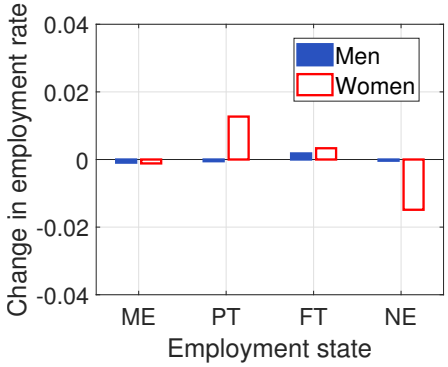
Figure 22b shows the employment effects of the 8.5 € minimum wage. Compared with the benchmark model (Figure 7a), the minimum wage has a more positive effect on women's employment and hours in this alternative model. Since there is no income pooling or joint taxation, increases in gross income lead to a greater increase in net income and utility from consumption for women in this model than for the average woman in the benchmark model. When a minimum wage is imposed, women in this model are more likely to accept jobs with higher hours and wages, leading to a larger increase in employment and hours worked. Men's employment and hours are little affected by the minimum wage, as in the benchmark model.

Figure 22c shows the effects of minimum wages up to 14 € on gender gaps. Although the qualitative patterns resemble those in the benchmark model (Figure 11c), the magnitudes differ. Compared to the benchmark model, the minimum wage has a stronger effect in reducing the gender gap due to the larger reduction in the hours-worked gap (with a maximum reduction of 3.1 p.p. at a minimum wage of 13 €, compared to 1.6 p.p. at 11 € in the benchmark model). As shown in Figure 22d, hours worked account for more than half of the total reduction in the gender income gap up to a minimum wage of 13 € whereas in the benchmark model (Figure 11d) the wage channel plays the more dominant role. These results suggest that incorporating demographic type heterogeneity not only allows us to understand the heterogeneous effects of the minimum wage on different demographic groups, but also provides a more accurate quantitative assessment of the gendered effects of minimum wages.

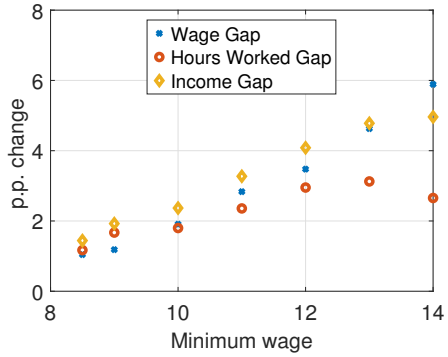
Figure 22: Effects of Minimum Wage Policies on Gender Gaps in Alternative Economies



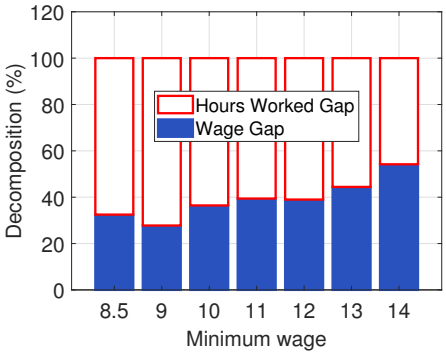
(a) Full-time jobs only: effects on gender gaps



(b) No Demographic Heterogeneity: 8.5 € minimum wage



(c) No Demographic Heterogeneity: effects on gender gaps



(d) No Demographic Heterogeneity: decomposing effects on gender income gap

Note: Panels a and c show the effect of minimum wages on gender gaps in the model with only full-time jobs (panel a) and in the model without demographic type heterogeneity (panel c). Panel b shows the effect of an 8.5 € minimum wage on different types of employment and non-employment by gender. Panel d shows the decomposition of the effect on gender income gap.