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Payroll Tax Reductions on Low Wages and Minimum Wage in France

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Abstract

Introduced in France in the 1990s to reduce the cost of low-skilled labor, payroll tax reductions on low wages were later expanded and extended to higher wages. This study evaluates the impact of the current payroll tax schedule on employment, fiscal surplus, and welfare. We develop a life-cycle matching model in which workers are heterogeneous in terms of age, education, human capital, family status, hours worked and idiosyncratic productivity, and where search effort, hiring and separations are endogenous. Accounting for interactions with the socio-fiscal system, we demonstrate that reducing payroll tax cuts for low wages would result in declines in both employment and fiscal surplus. Furthermore, we show that increasing the minimum wage would significantly reduce employment and fiscal surplus, with the magnitude of the effect depending on whether the payroll tax schedule and other socio-fiscal measures are indexed to the minimum wage. Lastly, we identify the optimal payroll tax schedule, revealing that employment, fiscal surplus, and welfare can all be improved by increasing payroll tax reductions for wages near the minimum wage while reducing them for wages exceeding twice the minimum wage.

JEL Classification: J23; J31; J32; J38; J64

Keywords: Payroll Tax Reductions; Minimum Wage; Search and Matching; Life Cycle

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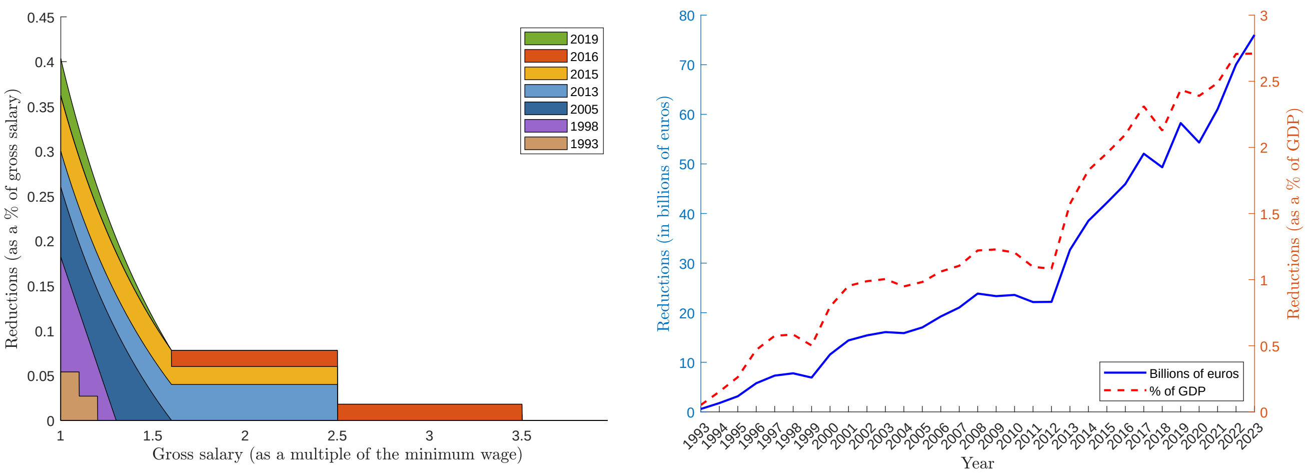
1 Introduction

Ljungqvist and Sargent (1998, 2008) and Blanchard and Wolfers (2000) highlighted the pivotal role of labor market institutions in the rise of unemployment in Europe during the 1980s. In particular, the increase in social transfers and labor taxes emerged as potential drivers of rising unemployment by either discouraging job-seeking efforts or hindering job creation (Malinvaud, 1994; Nickell et al., 2005). To counteract these adverse effects, several countries introduced policies designed to support low-wage workers (Phelps, 1994). The United Kingdom and the United States implemented tax credit schemes for low-wage workers: the Working Tax Credit (WTC) in the UK and the Earned Income Tax Credit (EITC) in the US. Blundell et al. (2016) and Albertini et al. (2024) show that while these measures enhance labor market participation, they may also discourage some young individuals from pursuing education by reducing the returns to education, thereby rendering their long-term effects on employment ambiguous. In Germany, employees in minijobs (*Geringfügige Beschäftigung* in German) are exempt from income tax and social contributions, while employers benefit from reduced payroll taxes. As noted by Steiner and Wrohlich (2005), this policy has increased labor market participation but led to a reduction in hours worked, with only marginal overall effects on employment. More recently, Saez et al. (2019) investigated the impact of a payroll tax cut for young workers introduced in Sweden in 2007. They found no significant effect on the net-of-tax wages of young workers affected by the policy compared to slightly older, unaffected workers, but observed a 2-3 percentage point increase in youth employment. Beginning in the 1990s, France implemented a series of payroll tax reduction schemes targeting low wages. In this paper, we evaluate the impact of these payroll tax cuts on employment, fiscal surplus, and welfare, accounting for potential interactions with the socio-fiscal system and the minimum wage.

After World War II, France introduced a minimum wage and established a Bismarckian social protection system, primarily funded through wage-based social security contributions. Over time, social protection expenditures steadily increased, rising from approximately one-tenth of GDP in 1950 to nearly one-third by 2020. This growth led to higher compulsory levies and increased labor costs. To maintain a high level of social protection while preventing the exclusion of the least qualified workers from the labor market, France implemented payroll tax reductions for low-wage earners in the early 1990s. In 1993, the government introduced reductions in employer social contributions for wages close to the minimum wage. Specifically, certain employer contributions were eliminated for wages between 1 and 1.1 times the minimum wage and halved for wages between 1.1 and 1.2 times the minimum wage. In 1995, this measure was expanded, increasing the thresholds to 1.2 and 1.3 times the minimum wage, respectively. Between 1996 and 2005, the exemption schedule underwent several adjustments, primarily to mitigate threshold effects and extend the scheme's exit point to 1.6 times the minimum wage. This is known as the General Reduction of Employer Contributions ("Réduction Générale des Cotisations Patronales", or "RGCP" in French). This schedule remained relatively stable until the early 2010s, when two significant measures were introduced: the Competitiveness and Employment Tax Credit ("Crédit d'Impôt pour la Compétitivité et l'Emploi," or "CICE") in 2013, and the Action Plan for Business Growth and Transformation ("Plan d'Action pour la Croissance et la Transformation des Entreprises," or "PACTE") in 2015. These policies further reduced contribution rates for wages up to 2.5 times and 3.5 times the minimum wage, respectively. The various payroll tax reduction policies implemented over the past three decades have significantly reshaped the contribution schedule, as illustrated in panel A of Figure 1.

In 2023, France's public debt level (110% of GDP), coupled with a high deficit (5.5% of GDP) and sluggish economic growth (0.9% of GDP), reignited debates on the effectiveness of payroll tax reduction measures. As shown in panel B of Figure 1, the financial cost of these policies has increased significantly over time, with total exemptions amounting to nearly 3% of GDP in 2023.[1] Furthermore, the share of workers earning the minimum wage has risen considerably in recent years, raising concerns about the risk of a low-wage trap. As depicted in panel A of Figure 1, the exemption schedule creates threshold effects, and the sharp reduction in exemptions may discourage some employers from raising wages. While this does not imply that payroll tax reduction policies are entirely ineffective, it does raise critical questions about their overall effectiveness and design. Do payroll tax reductions on low wages create or preserve jobs, and if so, to what extent? Should the contribution schedule be adjusted to smooth out threshold effects? Do the marginal rates induced by the current schedule discourage employers from raising wages or creating higher-skilled positions? Could the system's effectiveness be improved, without compromising the fiscal surplus, by better targeting payroll tax reductions? Who would benefit from such a reform?

FIGURE 1: Payroll tax reductions



A. As a % of gross salary

B. In billions of euros and as a % of GDP

Answering all of these questions is a challenging task. First, payroll tax reductions target workers earning close to the minimum wage, primarily affecting young people and low-skilled workers. To accurately evaluate their effects on individual trajectories and aggregate employment, it is crucial to account for the heterogeneity of workers in terms of age and human capital. Second, these tax reductions have traditionally been defined relative to the minimum wage. Since 2019, the payroll tax schedule is based on three thresholds: 1.6, 2.5, and 3.5 times the minimum wage (hereafter referred to as the 1.6, 2.5, and 3.5 thresholds for simplicity), as illustrated in panel A of

[1]Note that this represents the "naive" cost of the policy, assuming that agents do not respond to changes in payroll taxes. In the remainder of the paper, we estimate the actual cost of payroll tax reductions on low wages, accounting for the scheme's impact on agents' decisions and socio-fiscal adjustments.

Figure 1. However, a 2023 law anchored the last two thresholds to the 2023 minimum wage level, rather than indexing them to the current year's minimum wage.[2] Consequently, any future increase in the minimum wage will shift wages to the right of the distribution without a corresponding adjustment to the 2.5 and 3.5 thresholds–an effect that has yet to be studied. Additionally, an increase in the minimum wage may create a spillover effect across the broader wage distribution (Aeberhardt et al., 2012). In France, wages are predominantly negotiated through sector-specific collective agreements (Gautier et al., 2022). The wage grid is not directly linked to the minimum wage. However, when the minimum wage increases, the lowest wages must be adjusted, often leading to a renegotiation of the entire wage grid to preserve a consistent wage hierarchy based on skill levels. This is why, as highlighted by Laroque and Salanié (2004), Kalai-Smorodinsky bargaining is more appropriate than Nash bargaining for modeling wage formation in France. Third, payroll tax reductions on low wages interact with the broader socio-fiscal system. Any modification to the contribution schedule can impact the fiscal surplus either directly, through changes to the schedule's parameters, or indirectly, by influencing agents' behavior. For instance, reducing tax relief may, all else being equal, increase tax revenues but also raise labor costs. This, in turn, could lead to fewer job creations (or more job losses) or lower wages. Given the highly progressive nature of the French socio-fiscal system, such changes would likely result in more individuals becoming eligible for social benefits or lower taxes, ultimately increasing public spending or reducing tax revenues. Therefore, analyzing the effects of payroll tax reductions on employment and fiscal surplus requires considering the complex interactions with the socio-fiscal system.

Several studies have examined the impact of payroll tax reductions on low wages in France. Using matched employer-employee data, Crépon and Desplatz (2001) found that payroll tax reductions implemented between 1994 and 1997 led to the creation or preservation of approximately 470,000 jobs. Similarly, using longitudinal data from the 1990s, Kramarz and Philippon (2001) demonstrated that higher labor costs at the lower end of the wage distribution significantly reduced employment among minimum wage workers. Cahuc and Lehmann (2002) develop a matching model to compare two policies targeting low-wage workers: one aimed at increasing the income of low-skilled workers (similar to the WTC or EITC), and another focused on reducing employers' social security contributions. Their analysis reveals that the first policy improves welfare for the unemployed, while the second policy is more effective at reducing the unemployment rate. Chéron et al. (2008) develop a search model that incorporates wage posting and specific human capital investment, demonstrating that payroll tax reductions for low-wage workers can improve both employment and welfare. However, as emphasized by Malinvaud et al. (1998), they note that such reductions should not be overly concentrated near the minimum wage, as this could discourage investments in training and the creation of higher-skilled jobs.[3] While their analysis considers the fiscal implications of financing these policies, it does not account for

[2]Since 2024, the 2.5 and 3.5 thresholds have been set as fixed amounts in euros (equivalent to 2.5 and 3.5 times the 2023 minimum wage), while the 1.6 threshold remains indexed to the current minimum wage.

[3]While noteworthy, this effect does not appear to be predominant in the case of France. The report written by the group of experts on the minimum wage in France (available on strategie.gouv.fr) suggests that, while labor costs are very low at the minimum wage level and rise significantly beyond it, low-paid workers in France do not face greater difficulties in climbing the wage ladder compared to their counterparts in other countries.

spillover effects across the broader wage distribution. Additionally, they assume that agents are infinitely lived, which limits the ability to analyze the differentiated effects of payroll tax reductions and minimum wage policies over the life cycle. Breda et al. (2024) demonstrates, using a matching model, that the payroll tax reductions introduced in 1995 had a positive effect on employment. In the spirit of Hosios (1990), they point out that the decentralized equilibrium is inefficient because workers and firms do not internalize the effects of their actions on others, and wage bargaining fails to align the private returns from matching with the social returns. While interesting, their analysis has several limitations: i) The existence of a unique wage under Nash bargaining cannot be demonstrated when the marginal tax rate is decreasing (see Breda et al. (2024), Appendix B), which leads them to assume proportional bargaining rather than standard Nash bargaining; ii) While they account for social transfers paid to the non-employed, these transfers are solely based on the previous wage. In France, however, social transfers are influenced by additional factors, notably age and family status–two dimensions absent from their model; iii) They assume agents live infinitely and do not accumulate human capital over their lifetimes. As a result, they overlook the effects of payroll tax policies on human capital accumulation and wage trajectories over the life cycle.

In this paper, we propose a new evaluation of payroll tax reductions for low-wage workers in France. Our contribution to the existing literature is threefold. First, we develop a life-cycle matching model in which workers are heterogeneous in terms of age, education, human capital, family status, hours worked and idiosyncratic productivity, and where search effort, hiring and separations are endogenous. The model is designed to take into account the specific features of the French socio-fiscal system, such as threshold effects and non-linearities, as well as its potential interactions with payroll tax reduction policies. Second, unlike traditional models that assume infinitely-lived agents, we incorporate finite lifespans and evolving family statuses over the life cycle. This approach allows for a more detailed analysis of interactions with the socio-fiscal system, particularly for policies that depend on age and family composition (e.g., number of children). It also enables us to examine the differentiated effects of payroll tax reductions and minimum wage policies across various stages of the life cycle. Third, unlike most models that assume Nash bargaining, we adopt Kalai-Smorodinsky wage bargaining. This approach more effectively captures spillover effects from minimum wage increases on the broader wage distribution, providing a more realistic representation of how wage-setting mechanisms interact with labor market policies.

Our findings can be summarized as follows. First, we demonstrate that our model accurately replicates employment and income profiles over the life cycle, as well as the distribution of hourly wages. By comparing different payroll tax schedules, we show that payroll tax reductions are essential for supporting employment, particularly at the lower end of the wage distribution. Reducing payroll tax cuts at the minimum wage level would result in a significant decline in both employment and fiscal surplus. Secondly, we show that an increase in the minimum wage would significantly reduce both employment and fiscal surplus. In the event of a single and moderate increase in the minimum wage, the 2023 law, which sets the 2.5 and 3.5 eligibility thresholds at their 2023 euro values, would have a modest impact, as high-skilled employment is less sensitive to changes in payroll taxes. Finally, we identify the optimal payroll tax schedule, defined as the one that maximizes welfare. Our analysis reveals that employment, fiscal surplus, and welfare can all be simultaneously increased by reducing payroll tax rates for wages near the minimum wage while raising them for wages exceeding twice the minimum wage.

The remainder of the paper is organized as follows. Section 2 describes the model. Section 3 details the calibration strategy and the estimation procedure. Section 4 presents the simulations. A final section concludes.

2 Model

We develop a life-cycle matching model with directed search, in the spirit of Albertini et al. (2024). The model includes several sources of heterogeneity, including age, education, human capital, family status, hours worked and idiosyncratic productivity. Search effort, hiring and separations are endogenous. Hourly wages are determined by Kalai-Smorodinsky bargaining (hereinafter "KS"). The model also incorporates payroll taxes, as well as taxes and transfers, to reflect current legislation.

2.1 Heterogeneities

Age. We consider a one-firm-one-job model. The age of the firm coincides with that of the worker and is denoted by a. Workers enter at age $a_0 = 19$ and retire at age $a_A = 61$. In each period, age increases deterministically, so that $a' = a + 1$. At each period, the oldest cohort is replaced by a new cohort of the same size, so that the population remains constant.

Human capital. Each worker is characterized by a level of human capital $h \in \Omega_h = \{1, ..., H\}$, which reflects the knowledge and experience accumulated while employed. Human capital is general in the sense of Becker (1962), which implies that it is transferable across all firms in the market. It appreciate at a rate μ_n during periods of employment (learning by doing) and depreciates at a rate μ_u during periods of unemployment (Ljungqvist and Sargent, 1998). The evolution of human capital can be represented by a Markov process in which $\mu_n(h, h')$ is the probability that an employed worker with human capital h moves to human capital $h' > h$, and $\mu_u(h, h')$ is the probability that an unemployed worker with human capital h moves to human capital $h' < h$:

$$\mu_n(h,h') = \begin{cases} 1-\bar{\mu}_n & \text{if} \quad h < H \quad \text{and} \quad h' = h \\ \bar{\mu}_n & \text{if} \quad h < H \quad \text{and} \quad h' = h+1 \end{cases}$$
$$\mu_u(h,h') = \begin{cases} 1-\bar{\mu}_u & \text{if} \quad h > 1 \quad \text{and} \quad h' = h \\ \bar{\mu}_u & \text{if} \quad h > 1 \quad \text{and} \quad h' = h-1 \end{cases}$$

Note that human capital cannot appreciate beyond $h = H$ and cannot depreciate below $h = 1$.

Permanent productivity. Each worker is characterized by a permanent productivity $e \in \Omega_e = \{e_1, e_2, e_3\}$, which reflects the level of education. Specifically, e_1, e_2, and e_3 correspond respectively to an education level below high school, equivalent to high school, or above high school. Throughout the paper, we will use the terms low/mid/high to refer to workers with education levels $e_1/e_2/e_3$, respectively. Each worker draws a permanent productivity level e from the distribution $\Gamma(.)$ before entering the labor market and retains it permanently until retirement.

Idiosyncratic productivity. At the time of hiring, workers draw an idiosyncratic productivity x' from the unconditional distribution $X_0(x')$. This productivity level subsequently evolves according to a Markov process with transition matrix $X(x'|x)$.

Family status. We consider four family statuses, depending on the number of children: no children, one child, two children, and three or more children. Each period, the family status evolves stochastically according to an age- and education-dependent conditional distribution $F_{a,e}(f'|f)$. This modeling of family status allows us to capture the structure of the family based on education level and its evolution over the life cycle.

Hours. The data show that some workers hold part-time jobs, often low-paying positions, and receive substantial social transfers. To account for this without introducing excessive complexity into the model, which already incorporates many sources of heterogeneity, we assume that workers can choose a level of hours $\ell \in \Omega_\ell = \{\underline{\ell}, \overline{\ell}\}$. $\underline{\ell}$ corresponds to a part-time job, and $\overline{\ell}$ corresponds to a full-time job, with $\underline{\ell} < \overline{\ell}$.

Worker's output. Worker's output is given by:

$$y(x,h,\ell,e) \quad = \quad A(e)\, h\, x\, \ell \tag{1}$$

where $A(e)$ represents an education-dependent productivity factor.

2.2 Taxes and transfers

Payroll tax exemption. As shown in Figure 1, the payroll tax schedule involves kinks and non-linear progressivity. Let w be the worker's hourly wage and w_{min} the minimum hourly wage in the economy. The firm's payroll tax, denoted τ_p, is given by:

$$\tau_p(w) \quad = \quad \min\left(\left[\bar{\tau} - \frac{T_1}{T_2}\left(\underline{\tau}_1 \frac{w_{min}}{w} - 1\right)\right], \bar{\tau}\right) - CICE\mathbb{1}_{\frac{w}{w_{min}} \leq \underline{\tau}_2} - PACTE\mathbb{1}_{\frac{w}{w_{min}} \leq \underline{\tau}_3} \tag{2}$$

where $\bar{\tau}$ is the standard payroll tax rate, T_1 and T_2 are tax relief parameters, and $\underline{\tau}_1$, $\underline{\tau}_2$, and $\underline{\tau}_3$ are the wage thresholds up to which these reliefs can be applied. CICE and PACTE are two payroll tax reduction schemes.[4] Note that the tax rate depends on the hourly wage and, therefore, is independent of the number of hours worked.

Transfers. Let $b_e(f, w\ell)$ denote the net amount of social transfers received by an employed individual, depending on the family status f and earned income $w\ell$. In order to facilitate comparison with the data, transfers are expressed as a function of the full time minimum wage ($w_{\text{min}}\overline{\ell}$), as follows:

$$b_e(f, w\ell) \quad = \quad \psi_0(f) - \psi_1(f)\left(\frac{w\ell}{w_{\text{min}}\overline{\ell}}\right)^{\psi_2(f)} \tag{3}$$

[4]See service-public.fr for more details.

where ψ_0 and ψ_1 are estimated parameters (see Figure 12 in Appendix D for more details). We denote by $b_u(f,a,e)$ the net amount of social transfers received by an unemployed worker, which corresponds to the average of the transfers observed in the data on the state space f,a,e (see Appendix C for more details).[5]

Social contribution and income tax Let τ_s denote the employee social security contribution rate and τ_i the income tax rate. To account for the progressivity of the income tax, we adopt the formulation proposed by Feldstein (1969):

$$\tau_i(f,w\ell) = \eta_0(f)\left(\frac{w\ell}{w_{\min}\bar{\ell}}\right)^{1-\eta_1(f)} \quad (4)$$

where $\eta_0(f)$ governs the level and $\eta_1(f)$ the progressivity of the income tax, both of which depend on family status. As for transfers to the employed, the income tax is expressed as a function of the full time minimum wage.

2.3 Matching

We consider directed search over family status f, human capital h, type of job (part-time or full-time) ℓ, age a, and education level e. The number of hires per unit of time in each submarket (f,h,ℓ,a,e) is given by the following matching function:

$$m = m(s\,u,v) \quad (5)$$

where s represents the search effort, u is the number of unemployed workers, and v is the number of vacancies. The matching function (5) is increasing and concave in its two arguments and exhibits decreasing returns to scale. The job-finding probability per efficient unit of unemployed worker, p, and the vacancy-filling probability, q, in each submarket (f,h,ℓ,a,e), are defined as follows:

$$p = m/(s\,u) \quad (6)$$
$$q = m/v \quad (7)$$

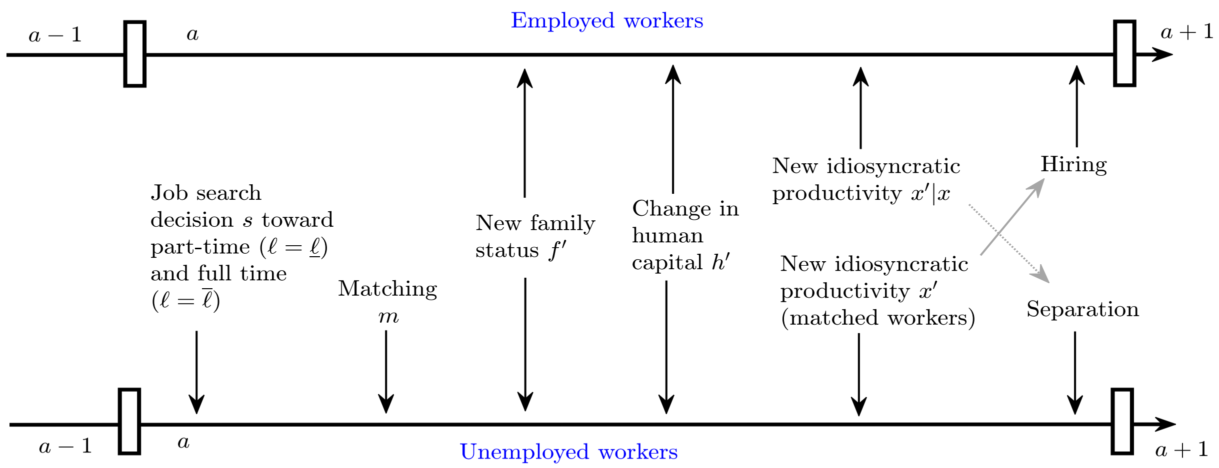
2.4 Timing of events

At the beginning of age a, unemployed workers determine their optimal search effort for each type of job (part-time or full-time). Some unemployed individuals are then matched with a firm. They subsequently draw a new family status f' (conditional on their previous status) and a new human capital level h' (conditional on their previous level). They then draw an idiosyncratic productivity level x' from the unconditional distribution X_0. Depending on the value of x', the match subsequently results in either hiring or separation.

[5] We do not follow the same methodology as for $b_e(.)$, which involves expressing social transfers as a function of earned income and estimating the related parameters. The reason is that our model does not track employment history, which is necessary to determine replacement income in the case of unemployment. While adding this dimension would certainly enrich the model, it would come at a very high computational cost. Instead, we opt for an alternative, more tractable approach that involves directly calculating social transfers based on family status, age, and education level using the French Labor Force Survey. This approach allows us to capture the fact that individuals with children, lower skill levels, and those in mid-career tend to receive higher levels of social transfers.

Similarly, employed workers draw a new family status f' and a new human capital level h' from conditional distributions. However, unlike new hires, they draw a new idiosyncratic productivity level x' from the conditional distribution X. The job can then be destroyed, either exogenously (at rate δ_e) or endogenously, or it may continue. Figure 2 displays the timing of events.

FIGURE 2: TIMING OF EVENTS



2.5 Bellman equations

Employed workers. The value function of an employed worker is:

$$W(f,x,h,\ell,a,e) = w(f,x,h,\ell,a,e)\ell(1-\tau_s) - \tau_i(w(f,x,h,\ell,a,e)\ell) + b_e(f,w\ell) - \kappa(\ell,a,e)\frac{\ell^{1+\omega}}{1+\omega} \quad (8)$$
$$+ \underbrace{\beta\sum_{h'}\mu_n(h,h')\int\int\left[\begin{array}{c}(1-\delta_e)\,W(f',x',h',\ell,a',e)\\ +\delta_e\;U(f',h',a',e)\end{array}\right]dX(x'|x)dF_{a,e}(f'|f)}_{W'}$$

An employed worker earns $w\ell$, pays employee social security contributions proportional to her salary (at the rate τ_s) and income tax τ_i based on her earned income. She receives net social transfers b_e. κ measures work disutility and depends on age, education, and job type (part-time or full-time). Finally, the last term represents the expected value of employment accounting for the risk of separation and changes in family status, idiosyncratic productivity, human capital, and age.

Unemployed workers. An unemployed worker receives an income $b_u(f,a,e)$. She then determines her optimal search effort s for each type of job (part-time or full-time), given the search cost function $k(s)$, with $k'(s) > 0$ and $k''(s) \geq 0$, and the expected gain from searching. We assume that unemployed workers search simultaneously for part-time and full-time jobs. The value function of an unemployed worker is:

$$U(f,h,a,e) = \max_{s_\ell}\left\{b_u(f,a,e) - \sum_\ell k(s_\ell)\right. \quad (9)$$
$$\left. + \underbrace{\beta\sum_{h'}\mu_u(h,h')\int\int\left[\begin{array}{l}(1-\sum_\ell p(f,h,\ell,a,e)\,s_\ell)\,U(f',h',a',e)\\ +\sum_\ell p(f,h,\ell,a,e)\,s_\ell W(f',x',h',\ell,a',e))\end{array}\right]dX_0(x')dF_{a,e}(f'|f)}_{U'}\right\}$$

An unemployed worker is matched with a vacant job at the rate $p \times s$ and decides whether to accept or reject the offer. Note that, as long as she remain unemployed, her human capital is likely to depreciate with probability μ_u. The unemployed worker determines the search effort that maximizes her expected utility. The marginal cost of the search effort is:

$$k'(s_\ell) = p(f,h,\ell,a,e)\beta \sum_{h'} \mu_u(h,h') \int \int W(f',x',h',\ell,a',e) - U(f',h',a',e) dX_0(x') dF_{a,e}(f'|f) \quad (10)$$

The first-order condition implies that the optimal search effort is such that the marginal gain from the effort equals its marginal cost.

Filled job. The value of a filled job for a firm is:

$$\begin{aligned} J(f,x,h,\ell,a,e) &= y(x,h,\ell,e) - w(f,x,h,\ell,a,e)\ell(1+\tau_p(w)) \\ &+ \underbrace{\beta \sum_{h'} \mu_n(h,h')(1-\delta_e) \int \int J(f',x',h',\ell,a',e) dX(x'|x) dF_{a,e}(f'|f)}_{J'} \end{aligned} \quad (11)$$

The firm receives an instantaneous profit, which corresponds to the difference between the worker's output, y, and the cost of labor, which includes the wage $w\ell$ and the employer's social security contributions proportional to the wage (at the rate τ_p). Finally, the last term represents the expected value of a filled job accounting for the risk of separation and changes in family status, idiosyncratic productivity, human capital, and age.

Vacant job. Each firm is free to open a vacancy directed at a worker with family status f, human capital h, age a and education level e. Opening and maintaining a vacancy involves a per-period cost c. The value of a vacant job for a firm is:

$$V(f,h,\ell,a,e) = -c + \underbrace{\beta \left[\begin{array}{c} q(f,h,\ell,a,e) \int J(f,x',h,\ell,a',e) dX_0(x') \\ +(1-q(f,h,\ell,a,e)) \max_{f,h,\ell,a,e} V(f,h,\ell,a,e) \end{array} \right]}_{V'} \quad (12)$$

Terminal conditions. The worker's life horizon is finite. We therefore have the following terminal conditions:

$$W(f,x,h,\ell,a_A,e) = 0 \quad (13)$$
$$J(f,x,h,\ell,a_A,e) = 0 \quad (14)$$
$$V(f,h,\ell,a_A,e) = 0 \quad (15)$$
$$U(f,h,a_A,e) = 0 \quad (16)$$

2.6 Job creation and job destruction condition

Firms continue to enter the market as long as the expected value of a vacancy is positive. The free entry condition is such that $V(f,h,\ell,a,e) = 0$. This implies that, at equilibrium, the expected cost of a vacant job is equal to the expected value of a filled job:

$$\frac{c}{q(f,h,\ell,a,e)} = \beta \int J(f,x',h,\ell,a',e)dX_0(x') \tag{17}$$

Let $\mathbb{1}_d\{f,x,h,\ell,a,e\}$ be an indicator function representing the separation decision, defined as follows:

$$\mathbb{1}_d\{f,x,h,\ell,a,e\} = \mathbb{1}\{J(f,x,h,\ell,a,e) \leq 0\} \times \mathbb{1}\{W(f,x,h,\ell,a,e) \leq U(f,h,a,e)\} \tag{18}$$

2.7 Wage negotiation

In the literature, the standard approach is to consider a wage bargaining process based on the Nash criterion. However, Nash bargaining does not appear to be suitable in the French context, characterized by a high minimum wage and sectoral wage agreements. Indeed, several empirical studies based on French data show that an increase in the minimum wage affects not only wages close to the minimum wage but also higher wages. (Laroque and Salanié, 2004; Aeberhardt et al., 2012; Gautier et al., 2022). Laroque and Salanié (2004) and L'Haridon et al. (2013) suggest using a KS bargaining process, which captures how an increase in the minimum wage propagates through the rest of the wage distribution. Accounting for spillover effects is all the more important since a law passed in 2023 fixed the 2.5 and 3.5 eligibility thresholds for payroll tax reductions at their 2023 euro levels, rather than indexing them to the current minimum wage. This means that any future increase in the minimum wage will cause wages to shift to the right, without a corresponding adjustment in the eligibility thresholds. It is therefore crucial to accurately model how the wage distribution shifts to precisely identify who is eligible for a payroll tax reduction and the corresponding amount. In this context, the KS bargaining process plays a key role, as it better captures how a minimum wage increase propagates through the rest of the wage distribution.

The KS solution is characterized by a proportional concession of each agent relative to their most favorable negotiation point,[6] referred to as the utopia point.[7] For each agent, the utopia point corresponds to the maximum utility attainable subject to the constraint that no party receives less than her status-quo utility. For the sake of exposition we drop subscript (f,x,h,ℓ,a,e). We denote by $J_{\underline{w}}$ as the firm's utopia point, representing the value of a filled job (for the firm) when paying the lowest possible wage $\underline{w}$ to the worker, subject to the constraint that the value of unemployment is not greater than the value of employment (for the worker). Similarly, we denote $W_{\overline{w}}$ as the worker's utopia point, representing the value of employment (for the worker) when receiving the highest possible wage $\overline{w}$, subject to the constraint that the value of a vacant job is not greater than the value of a filled job (for the firm). In our life-cycle framework, we assume that negotiation concerns only the current period, with

[6] See L'Haridon et al. (2013) for more details on wage bargaining using the Kalai-Smorodinsky solution in a matching model.

[7] Note that hours worked are not bargained; they are set once and for all at the beginning of the relationship. Heterogeneities in hours worked arise from the job search behavior of unemployed workers. Adding bargaining over hours would increase computational complexity and is beyond the scope of this paper.

the equilibrium wage for the next age already known. The utopia points of the firm and the worker are defined as follows:

$$J_{\underline{w}} = y - \underline{w}\ell(1+\tau_p(\underline{w})) + J' \tag{19}$$
$$W_{\overline{w}} = \overline{w}\ell(1-\tau_s) - \tau_i(\overline{w}\ell) + b_e(\overline{w}\ell) + W' \tag{20}$$

At the firm's utopia point, the firm captures the entire rent, and the worker's net surplus is zero:

$$W_{\underline{w}} - U = 0$$

which, after some rearrangements, gives:

$$\underline{w}\ell(1-\tau_s) = \max(w_{min}\ell(1-\tau_s), U - b_e(\underline{w}\ell) + \tau_i(\underline{w}\ell) - W') \tag{21}$$

Note that $\underline{w}$ is the lowest possible wage in the economy. When the minimum wage increases, it shifts the firm's utopia point and, consequently, the negotiated wage (including when $w > w_{\text{min}}$). The entire wage distribution is affected, with a more pronounced effect at the lower end of the distribution.

Similarly, at the worker's utopia point, the worker captures the entire rent, and the firm's net surplus is zero:

$$J_{\overline{w}} = 0$$

which, after some rearrangements, gives:

$$\overline{w}(1+\tau_p(\overline{w})) = y + J' \tag{22}$$

The KS solution satisfies:

$$\frac{J_w - V}{J_{\underline{w}} - V} = \frac{W_w - U}{W_{\overline{w}} - U}$$

At equilibrium, $V = 0$. The negotiated wage can therefore be expressed as follows:

$$w\ell = \frac{[\overline{w}\ell(1-\tau_s) + b_e(\overline{w}\ell) - b_e(w\ell) - (\tau_i(\overline{w}\ell) - \tau_i(w\ell))]\, J_{\underline{w}} + \underline{w}\ell(1+\tau_p(\underline{w})) \times [W_{\overline{w}} - U]}{J_{\underline{w}}(1-\tau_s) + (1+\tau_p(w))[W_{\overline{w}} - U]} \tag{23}$$

The equilibrium wage thus corresponds to a weighted average of the maximum wage (weighted by the firm's utopia point) and the minimum wage (weighted by the worker's utopia point), divided by the sum of the utopia points of the two agents. It should be noted that, due to the existence of wage-proportional policies (τ_s) and non-linear policies ($\tau_p(w), \tau_i(w), b_e(w)$), the above equation requires a non-linear solver.

2.8 Laws of motion

The economy is characterized by a continuum of individuals of mass one. Each individual is either employed or unemployed. The evolution of each type of worker is described by a law of motion. We use $n(f, x, h, \ell, a, e)$ to denote the stock of employed workers and $u(f, h, a, e)$ to denote the stock of unemployed workers. Let $a_{-1} = a - 1$

denote the previous age, and let $\mathbb{1}_c\{f,x,h,\ell,a,e\} = 1 - \mathbb{1}_d\{f,x,h,\ell,a,e\}$ be an indicator variable defining the decision to continue the match, equal to one if the joint surplus is positive and zero otherwise. The laws of motion are given by:

$$\begin{aligned} n(f,x,h,\ell,a,e) &= \mathbb{1}_c\{f,x,h,\ell,a,e\}\Bigg[\underbrace{(1-\delta_e)\sum_{h'}\mu_n(h',h)\int\int n(f',x',h',\ell,a_{-1},e)dX(x|x')dF_{a_{-1},e}(f|f')}_{\text{Workers who stay employed}} \\ &+ \underbrace{X_0'(x)\sum_{h'}\mu_u(h',h)\int u(f',h',a_{-1},e)p(f',h',\ell,a_{-1},e)s(f',h',\ell,a_{-1},e)dF_{a_{-1},e}(f|f')}_{\text{New matches}}\Bigg] \end{aligned} \tag{24}$$

$$\begin{aligned} u(f,h,a,e) &= \underbrace{\sum_{h'}\mu_n(h',h)\int\int n(f',x',h',\ell,a_{-1},e)\left[\begin{array}{c}(1-\delta_e)\mathbb{1}_d\{f,x,h,\ell,a,e\}\\ +\delta_e\end{array}\right]dX(x|x')dF_{a_{-1},e}(f|f')}_{\text{Separations}} \\ &+ \underbrace{\sum_{h'}\mu_u(h',h)\int u(f',h',a_{-1},e)\left(1-\sum_{\ell}p(f',h',\ell,a_{-1},e)s(f',h',\ell,a_{-1},e)\int \mathbb{1}_c\{f,x',h,\ell,a,e\}dX_0(x')\right)dF_{a_{-1},e}(f|f')}_{\text{Workers who stay unemployed}} \end{aligned} \tag{25}$$

The initial conditions are:

$$u(f,h,a_0,e) = \begin{cases} \Gamma(e) & \text{if} \quad f=f_1,\ h=h_1 \\ 0 & \text{otherwise} \end{cases} \tag{26}$$

$$n(f,x,h,\ell,a_0,e) = 0 \quad \forall\, h,f,x,e \tag{27}$$

We assume that every worker enter the labor market at age[8] a_0 with the lowest human capital h_1, and the family status f_1.

2.9 Government budget

The government collects taxes and provides social transfers. The fiscal surplus, FS, is given by:

$$\begin{aligned} FS &= \underbrace{\sum_e\sum_a\sum_\ell\sum_h\int\int n(f,x,h,\ell,a,e)\ell w(f,x,h,\ell,a,e)\left[\tau_p(w(f,x,h,\ell,a,e))+\tau_s\right]+\tau_i(\ell w(f,x,h,\ell,a,e))\Big]\,df\,dx}_{\text{Taxes on earned income}} \\ &- \underbrace{\sum_e\sum_a\sum_h\int\left[\left(\sum_\ell\int n(f,x,h,\ell,a,e)b_e(\ell w(f,x,h,\ell,a,e))dx\right)+u(f,h,a,e)b_u(f,h,a,e)\right]df\Big]}_{\text{Transfers}} \end{aligned} \tag{28}$$

The government budget is balanced with lump-sum transfers T:

$$T = FS \tag{29}$$

[8] Alternatively, we assumed that workers enter the labor market as they finish their studies (and therefore, potentially at different ages). However, a significant share of students are also employed. Since our model does not allow individuals to be both students and employed, this makes the comparison between the model and the data more challenging. We simulated our model under this alternative assumption. While the life-cycle profiles are more difficult to match, our results remain unchanged.

2.10 Definition of the equilibrium

DEFINITION 1. *Given exogenous processes for human capital h, age a, family status f, idiosyncratic productivity x, and net social transfer $b_u(a,f,e)$; and given a terminal condition for the value functions W,U,J,V, and initial conditions for employment (n) and unemployment (u), the equilibrium is a list of (i) quantities and rates $m(h,a,f,e)$, $p(h,a,f,e)$, $q(h,a,f,e)$, and $v(h,a,f,e)$; (ii) value functions $W(f,x,h,\ell,a,e)$, $U(f,h,a,e)$, $J(f,x,h,\ell,a,e)$, $J_{\underline{w}}(f,x,h,\ell,a,e)$, and $W_{\overline{w}}(f,x,h,\ell,a,e)$; (iii) wages $w(f,x,h,\ell,a,e)$, $\overline{w}(f,x,h,\ell,a,e)$, $\underline{w}(f,x,h,\ell,a,e)$; (iv) search efforts $s(f,h,\ell,a,e)$ and separation decisions $\mathbb{1}_d\{f,x,h,\ell,a,e\}$; (v) stationary distributions of employment $n(f,x,h,\ell,a,e)$ and unemployment $u(f,h,a,e)$; and (vi) fiscal surplus FS and lump-sum transfer T_t, satisfying the following conditions:*

(i) *$m(f,h,\ell,a,e)$, $p(f,h,\ell,a,e)$, $q(f,h,\ell,a,e)$, and $v(f,h,\ell,a,e)$ are the solutions of the matching function (5), the job-finding rate (6), the vacancy-filling rate (7), and the job-creation condition (17), respectively;*

(ii) *Value functions $W(f,x,h,\ell,a,e)$, $U(f,h,a,e)$, $J(f,x,h,\ell,a,e)$, $J_{\underline{w}}(f,x,h,\ell,a,e)$, and $W_{\overline{w}}(f,x,h,\ell,a,e)$ are solutions of the system that combines (8), (9), (11), (19), and (20);*

(iii) *Wages $w(f,x,h,\ell,a,e)$, $\overline{w}(f,x,h,\ell,a,e)$, $\underline{w}(f,x,h,\ell,a,e)$ satisfy equations (21), (22), and (23);*

(iv) *Search efforts $s(f,h,\ell,a,e)$ and separation decisions $\mathbb{1}_d\{f,x,h,\ell,a,e\}$ solve (10) and (18);*

(v) *Distributions $n(f,x,h,\ell,a,e)$ and $u(f,h,a,e)$ solve the law of motion described by (24) and (25);*

(vi) *FS and T satisfy the government budget defined by (28) and (29).*

3 Quantitative analysis

3.1 Functional forms

- Following Elsby and Michaels (2013), the idiosyncratic productivity shock is governed by the following process:

$$x' = \begin{cases} x & \text{with probability} \quad 1-\lambda \\ \tilde{x} \sim G_0(.) & \text{with probability} \quad \lambda \end{cases}$$
$$G_0(x) = Pareto(d) \quad \text{over} \quad [\underline{x}\overline{x}]$$

  where $\underline{x}$ scales the wage distribution and helps to match the fraction of workers earning the minimum wage, while d governs the dispersion of the wage distribution. Unlike more standard processes, such as the normal distribution, the above specification can generate a mass point at the minimum wage and fat tails.

- Human capital is defined by the following function:

$$h_i = \left(\frac{h_H - h_1}{H-1} \times i\right)^{\gamma}, \quad i = 1, ..., H$$

  where $\gamma \in]0,1[$ determines the curvature of human capital.

- We consider a Cobb-Douglas matching function:

$$m(s\,u, v) = \chi(s\,u)^{\rho} v^{1-\rho}$$

where χ represents the matching efficiency and depends on skill, and ρ denotes the elasticity of hirings with respect to unemployment.

- The search cost function is expressed as follows:

$$k(s) = \frac{k_0}{1+\xi}\left((1-s)^{-(1+\xi)} - 1\right) - k_0\, s$$

where k_0 and ξ are parameters that determine the level and curvature of the search cost function. This specification ensures that search intensity is constrained to the interval $[0, 1]$.

- Labor disutility is represented by the following functional form:

$$\kappa(\ell, a, e) = \bar{\kappa}_e + \begin{cases} 0 & \text{if } \; a < a^{\star} \;\&\; \ell = \underline{\ell} \\ C_s(1 - \mathcal{E}(a, e)) & \text{if } \; a < a^{\star} \;\&\; \ell = \overline{\ell} \\ \rho_e(a - a^{\star})^2 & \text{if } \; a \geq a^{\star} \end{cases}$$

where $\bar{\kappa}_e$ is a disutility that depends on the level of education. To capture the decline in hours worked starting at age 50, we introduce an age-dependent disutility that is zero before age $a^{\star}$ and increases convexly thereafter. Additionally, to account for the low employment rate and the high prevalence of part-time jobs among young individuals, we incorporate a disutility associated with full-time work during studies. This reflects the fact that some students hold part-time jobs alongside their studies. Specifically, we calculate the cumulative proportion of individuals entering the labor market by age and education level, denoted as $\mathcal{E}$ (see Appendix E). Low-skilled individuals tend to enter the labor market earlier and thus face a lower disutility of full-time work, C_s. Conversely, higher-skilled workers enter the labor market later and experience a greater disutility from full-time work during their studies, which often motivates them to take part-time jobs or abstain from working while pursuing education.

3.2 State space

Table 1 presents the state space of the model, which is simulated on a quarterly basis. Workers enter the labor market at age $a_1 = 19$ and retire at age $a_A = 61$. In addition to age, workers are categorized by their education (3 levels), human capital (5 levels), family status (4 statuses), and hours worked (full-time or part-time). Filled jobs are further characterized by an idiosyncratic productivity level (10 levels).

TABLE 1: MODEL STATE SPACE

Parameter	Symbol	Value
Time frequency (quarter)	dt	0.25
Age grid	$\{a_1, ..., a_A\}$	[19, 61]
Number of education levels	n_E	3
Number of human capital levels	n_H	5
Number of family statuses	n_F	4
Number of hours worked levels	n_L	2
Number of idiosyncratic productivity levels	n_x	10

3.3 Calibrated parameters

We calibrate certain parameters and estimate the remaining ones using the simulated method of moments. The calibrated parameters are presented in Table 2. The model is simulated on a quarterly basis. The quarterly discount factor, β, is set to 0.99, which corresponds to an annual discount factor of approximately 0.96, assuming a real annual interest rate of about 4%. The standard value for the inverse of the Frisch elasticity of labor supply is typically set in the range of 1 to 2 in macroeconomic models. This corresponds to a Frisch elasticity (which measures the responsiveness of labor supply to changes in wages) between 0.5 and 1. In our model, the Frisch elasticity (and its inverse, ω) is equal to 1. The elasticity of the matching function with respect to unemployment, ρ, is set to 0.5, which is a standard value in the search and matching literature. This elasticity reflects the responsiveness of job matches to changes in unemployment, implying a balanced contribution of both vacancies and unemployed workers to the matching process. The number of hours worked is endogenous. The worker can choose to work either part-time ($\ell = 0.5$) or full-time ($\ell = 1$). Hours worked generate a disutility, which increases with age starting from the age $a^\star = 47$. The proportions of low/mid/high individuals are set at 0.46, 0.20, and 0.34, respectively, to reflect the distribution of individuals in the economy with education levels below high school, equivalent to high school, or above high school, respectively. Individuals enter the labor market with the lowest level of human capital, normalized to $h_1 = 1$, and can subsequently accumulate human capital up to the maximum level $h_H = 7$.

Net social transfers for unemployed workers are determined from data based on family status, age and level of education. We apply a cubic spline approximation to avoid erratic values linked to a low sample size for certain ages (see Appendix C). Net social transfers for employed workers and income tax (for both unemployed and employed workers) are determined from equations (3) and (4) (see Appendix D). For the payroll tax, we consider the function given by Equation (2) and take the parameters directly from legislation (see Figure 1). By doing so, we can explicitly investigate how the non-linear structure of the tax schedules and the kinks affect the labor market. Lastly, the hourly minimum wage in the model is set to replicate the observed ratio of the hourly minimum wage to average hourly wage of 62%.[9]

[9]We do not calibrate the minimum wage directly but instead derive its value through iteration. We solve the model for a given value of the minimum wage and calculate the mean wage using the stationary distribution. We then update the minimum wage and solve the model again until the updated

TABLE 2: CALIBRATED PARAMETERS

Parameter	Symbol	Value
Discount factor	β	0.99
Inverse of the Frisch elasticity	ω	1.00
Matching function elasticity	ρ	0.50
Hours worked	ℓ	[0.50, 1.00]
Threshold age for work disutility	$a^\star$	47
Prop. low/mid/high	Γ_e	[0.46, 0.20, 0.34]
Human capital range	$[h_1, h_H]$	[1.00, 7.00]
Standard payroll tax rate	$\bar{\tau}$	0.41
Curvature 1	T_1	0.32
Curvature 2	T_2	0.6
CICE level	$CICE$	0.06
CICE threshold	$\underline{\tau}_2$	2.50
PACTE level	$PACTE$	0.02
PACTE threshold	$\underline{\tau}_3$	3.50
Employee social contribution rate	SSC	0.22

3.4 Estimated parameters

We estimate the remaining parameters using the method of simulated moments, which involves finding the parameters that minimize the distance between the moments generated by the model and those observed in the data. Some parameters to be estimated are specific to an education level, while others are common across all education levels.

The targeted moments in the estimation procedure are: (i) the employment rate by age and education level (see Figure 3); (ii) the hourly wage percentiles (see Figure 4); (iii) the income deciles by age (see Figure 6), and (iv) the proportion of part-time workers by age and education level (see Figure 7).

Table 3 reports the estimated parameters. Matching efficiency decreases with the level of education, ranging from 0.17 for low-skilled workers to 0.10 for high-skilled workers, which is standard in the search and matching literature. This variation reflects the fact that low-skilled jobs are generally more abundant, and job requirements are often less specialized, making matches quicker and easier to achieve. Conversely, for high-skilled positions, the job requirements are more specific, and the matching process tends to be more selective, leading to lower matching efficiency for more educated workers. The exogenous separation rate decreases with education, going from 0.05 for low-skilled workers to 0.01 for high-skilled workers. This is consistent with the observation that high-skilled workers experience fewer transitions into unemployment. TFP, which measures the efficiency with which inputs are used in the production process to generate output, is approximately 25% higher for high-skilled workers compared to low-skilled workers. The scale and curvature parameters of the disutility of labor appear to increase with education.

The parameter governing the shape of human capital, γ, involves an accumulation process that is increasing and concave, which is standard in the literature. The estimated rate of human capital accumulation during employment is significantly lower

minimum wage converges to its previous value between two consecutive iterations.

than the rate at which it depreciates during non-employment spells. While stronger, this difference aligns with the findings of Ljungqvist and Sargent (2008). The estimated search cost parameters, k_0 and ξ, involve that the search cost for part-time and full-time jobs are approximately 10% and 23.7% of the minimum wage, respectively. The estimated cost of posting a vacancy, $c = 0.42$, represents 23.6% of the minimum wage. The arrival rate of productivity shock is $\lambda = 0.66$, implying that idiosyncratic productivity changes, on average, every 5 months. This is consistent with Elsby and Michaels (2013), who estimate an average duration of approximately 7 months. The estimated support of idiosyncratic productivity ranges from 0.38 to 3.20, with the highest idiosyncratic productivity being more than eight times the lowest. This large dispersion, combined with a low Pareto curvature, replicates the observed wage dispersion.

TABLE 3: ESTIMATED PARAMETERS

SPECIFIC PARAMETERS	SYMBOL	VALUE		
		Low	Mid	High
Matching efficiency	χ	0.17	0.11	0.10
Exogenous separation rate	δ	0.05	0.03	0.01
TFP	E	1.71	2.01	2.12
Labor disutility scale	$\bar{\kappa}$	0.01	0.14	0.50
Labor disutility curvature (x1000)	ρ	0.31	0.72	0.98
COMMON PARAMETERS	**SYMBOL**	**VALUE**		
		COMMON		
Curvature - human capital	γ	0.54		
Prob. switch human cap.	$\bar{\mu}_n$	0.03		
Prob. switch human cap.	$\bar{\mu}_u$	0.45		
Search cost scale	k_0	0.24		
Search cost curvature	ξ	1.33		
Vacancy posting cost	c	0.42		
Persistence idio. prod.	λ	0.66		
Min idio. prod.	x_1	0.38		
Max idio. prod.	x_n	3.20		
Curvature	d	0.67		

3.5 Model vs. Data

How well does our model replicate the main features of the labor market? Figure 3 compares employment rates by age and education level generated by the model with those observed in the data. The model accurately captures the inverted U-shape of the employment rate over the life cycle: employment is low at the beginning of the life cycle (due to young individuals entering the labor market), rises with age until around 50, and then declines sharply (reflecting horizon effects and increasing labor disutility). Additionally, the model successfully reproduces the employment rate differential by education level throughout the life cycle. Specifically, from age 23 onward, the employment rate diverges, becoming significantly higher for more educated workers, consistent with the patterns observed in the data.

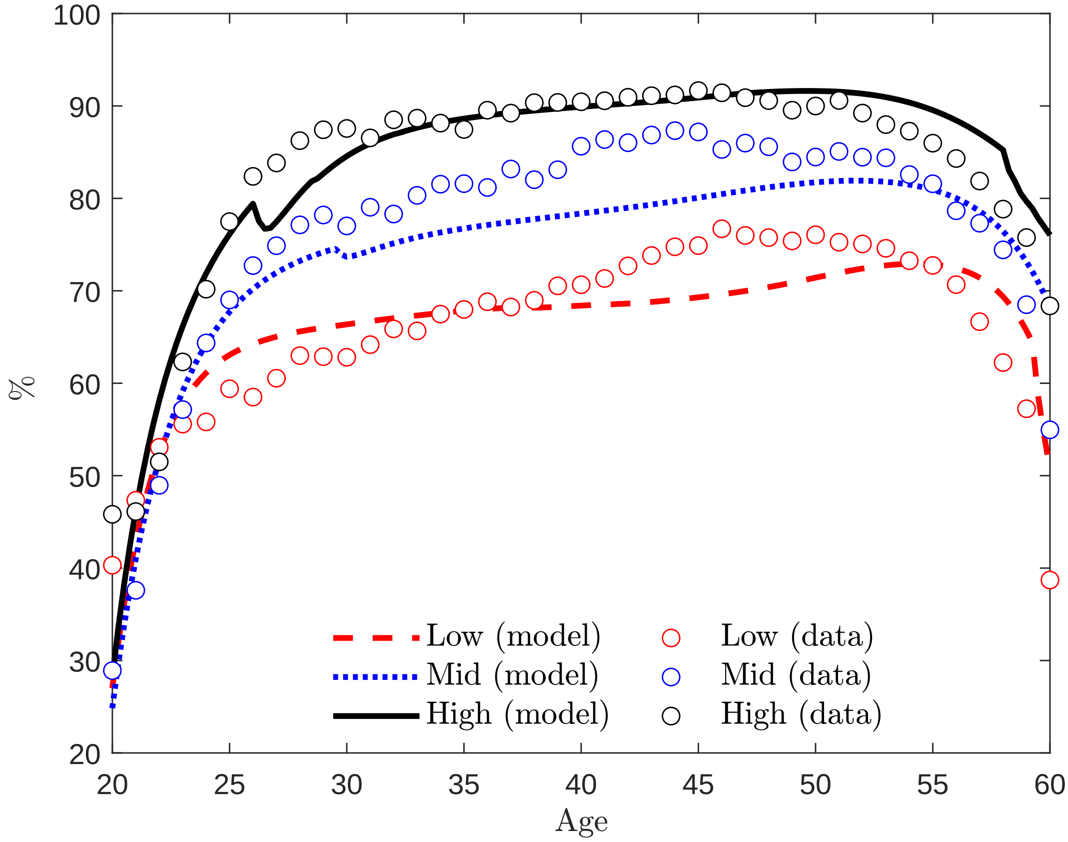


Figure 4 compares the hourly wage density function generated by the model with that observed in the data. The model accurately replicates the proportion of workers earning the minimum wage (just under 15% during the observed period) and the distribution of wages up to 3.5 times the minimum wage (which corresponds to the maximum wage for eligibility for payroll tax relief).

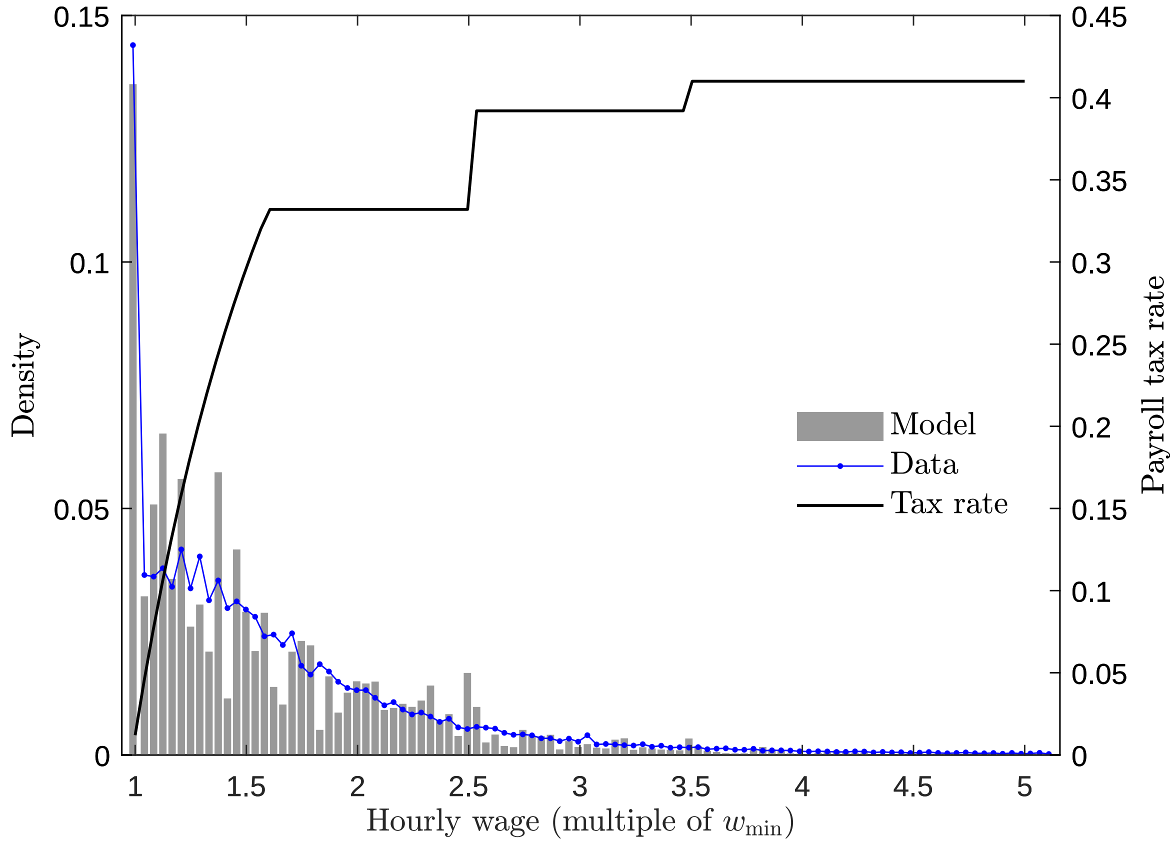


Figure 5 evaluates the model's ability to replicate income dispersion. The model generates income deciles that are very close to those observed in the data (see panel A). It slightly overestimates wages at the lower end of the distribution and underestimates them slightly at the upper end, leading to a Gini coefficient (see panel B) that is slightly lower than observed in the data (0.24 vs. 0.29).

FIGURE 5: Income inequality

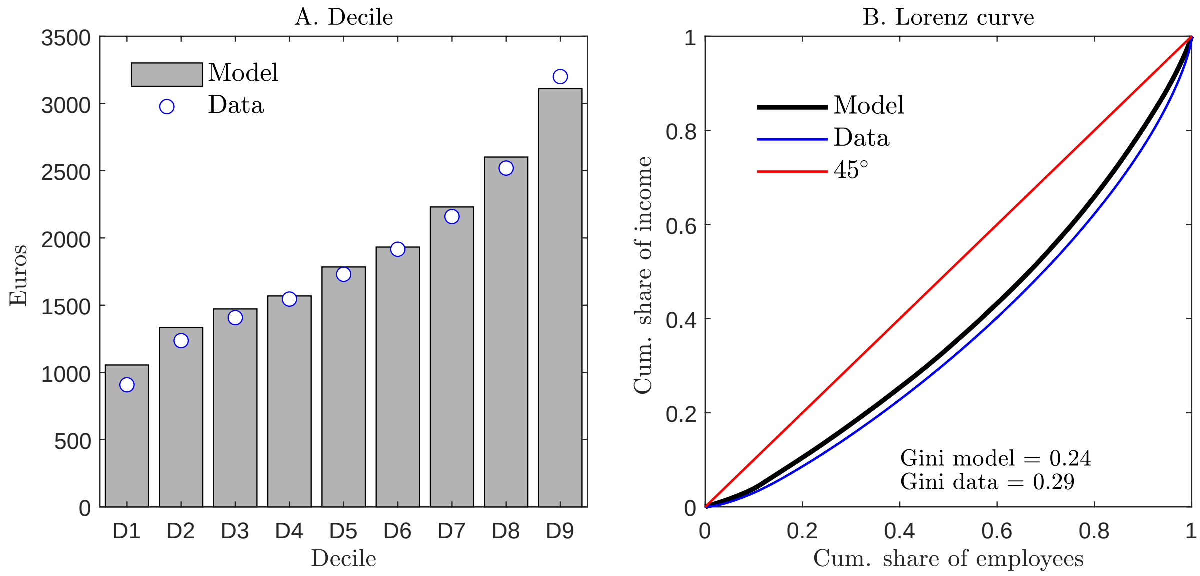
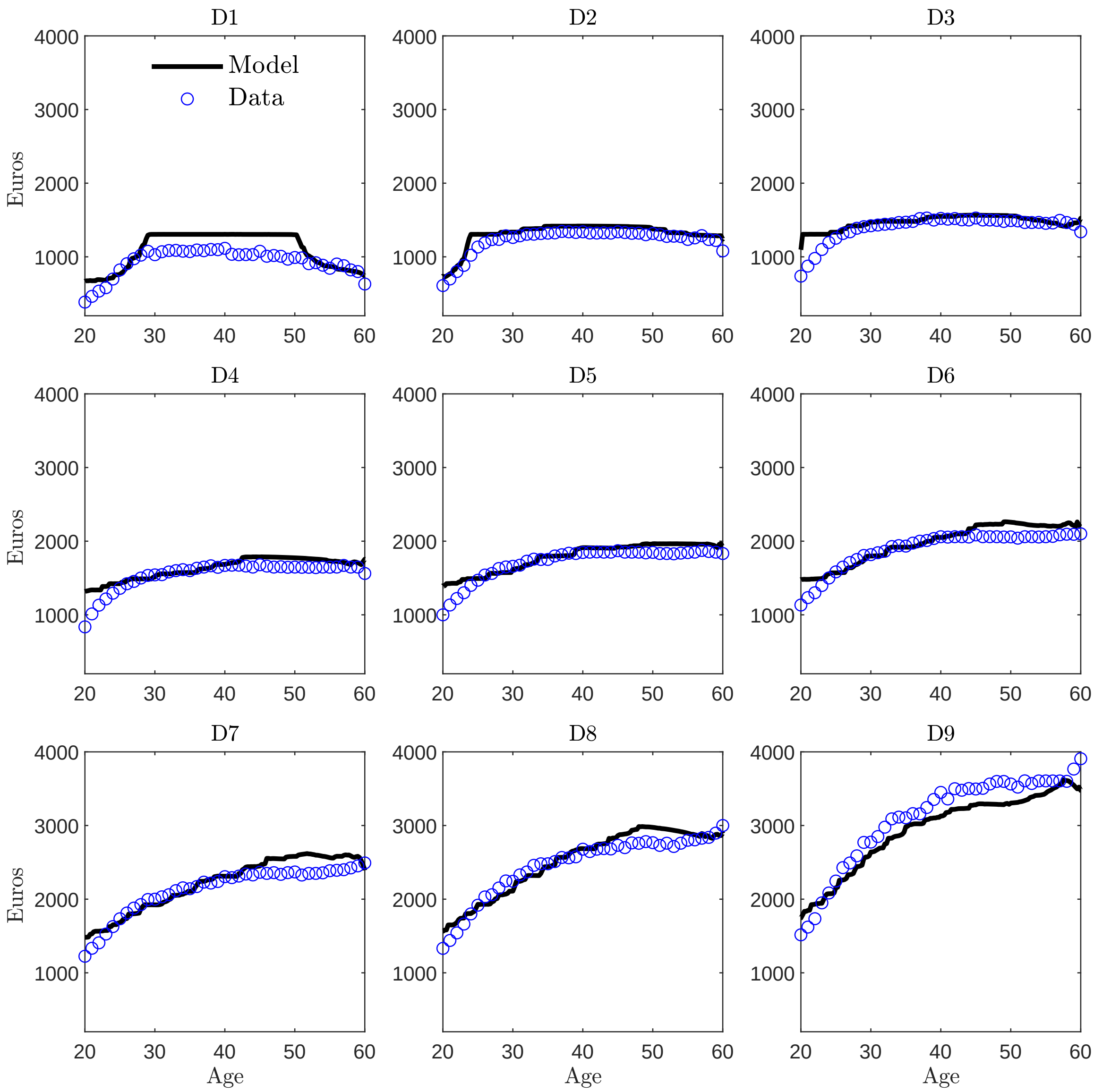
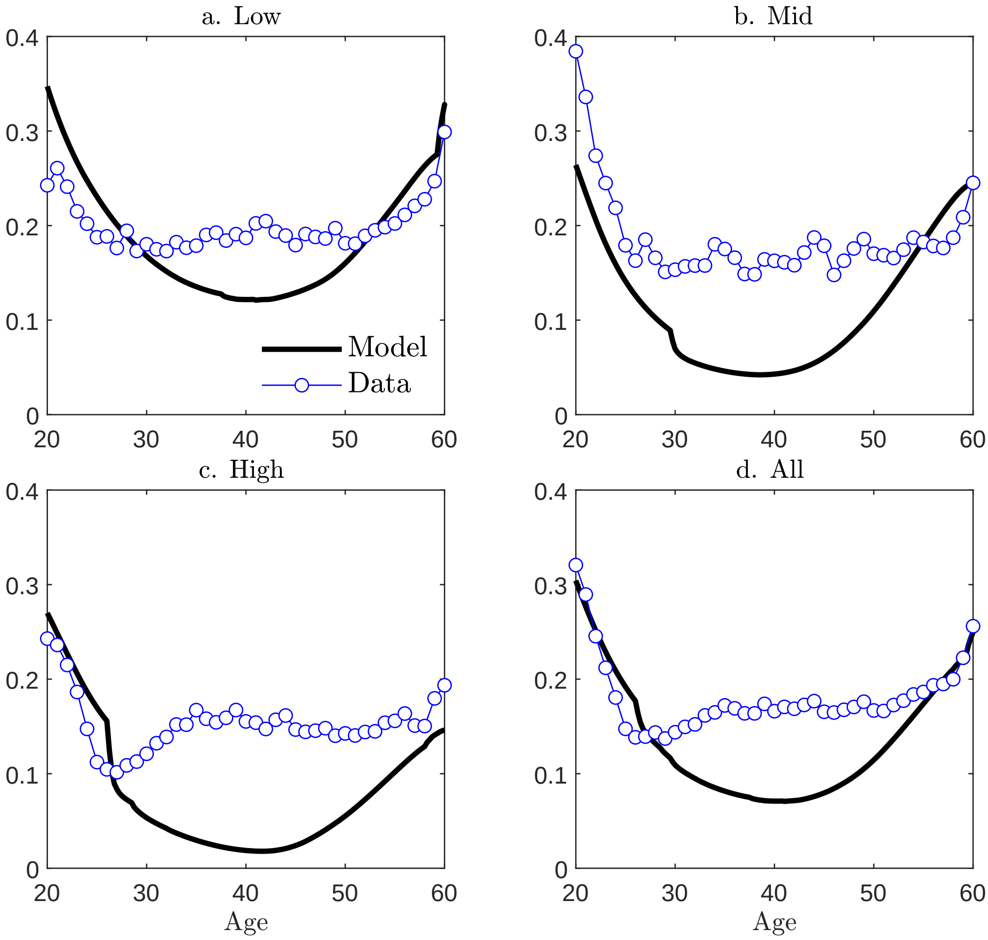


Figure 6 provides a detailed view of wage inequalities over the life cycle. The model not only replicates income dispersion at the aggregate level (as shown in Figure 5) but also captures the dynamics of inequality throughout the life cycle. Specifically, the model produces a profile that rises until around age 30 and then remains relatively stable for the lower deciles, while showing a sharper increase for the upper deciles.



Finally, Figure 7 shows the proportion of part-time workers by age and education level. The model properly replicates the U-shaped pattern observed in the data. However, it slightly underestimates the proportion of part-time workers among individuals of median age.



It is important to note that while replicating employment rates by age and education level using a life-cycle matching model is relatively straightforward (Figure 3), accurately reproducing the distribution of hourly wages (Figure 4) and income (Figure 5), as well as capturing the dynamics of income inequality (Figure 6) and part-time work over the life cycle (Figure 7), presents a significantly greater challenge. To our knowledge, few models achieve high accuracy across all these dimensions.[10] Although our model does not perfectly capture every aspect, it successfully reproduces the key characteristics of the French labor market.

4 Simulations

In this section, we use our model to conduct counterfactual experiments. First, we assess the impact of existing payroll tax reduction schemes on low wages. Next, we evaluate the consequences of a minimum wage increase under the 2023 law, which fixed the 2.5 and 3.5 eligibility thresholds for tax relief at the 2023 minimum wage level

[10]We also assess the model's ability to replicate the response of the wage distribution to a minimum wage increase, using the estimates of Gautier et al. (2018) and Gautier et al. (2022). Consistent with their estimates and the KS bargaining framework, our findings indicate that an increase in the minimum wage impacts the entire wage distribution, with the effect diminishing in magnitude as wages increase. The results are available upon request.

rather than indexing them to the current minimum wage. Finally, we numerically identify the set of policy parameters that maximize welfare.

4.1 Alternative tax schedules

The standard employer social contribution rate in France is approximately 40% of the gross salary. However, three measures provide contribution relief for salaries below 3.5 times the minimum wage (see Appendix A): the RGCP, which offers gradually decreasing relief for salaries below 1.6 times the minimum wage; the CICE, which provides proportional relief for salaries up to 2.5 times the minimum wage; and the PACTE law, which offers proportional relief for salaries up to 3.5 times the minimum wage. The current payroll tax schedule is illustrated in Figure 8 (see Benchmark). To highlight the role of each measure, we simulate five scenarios:

(1) Removing the relief provided by the PACTE law;

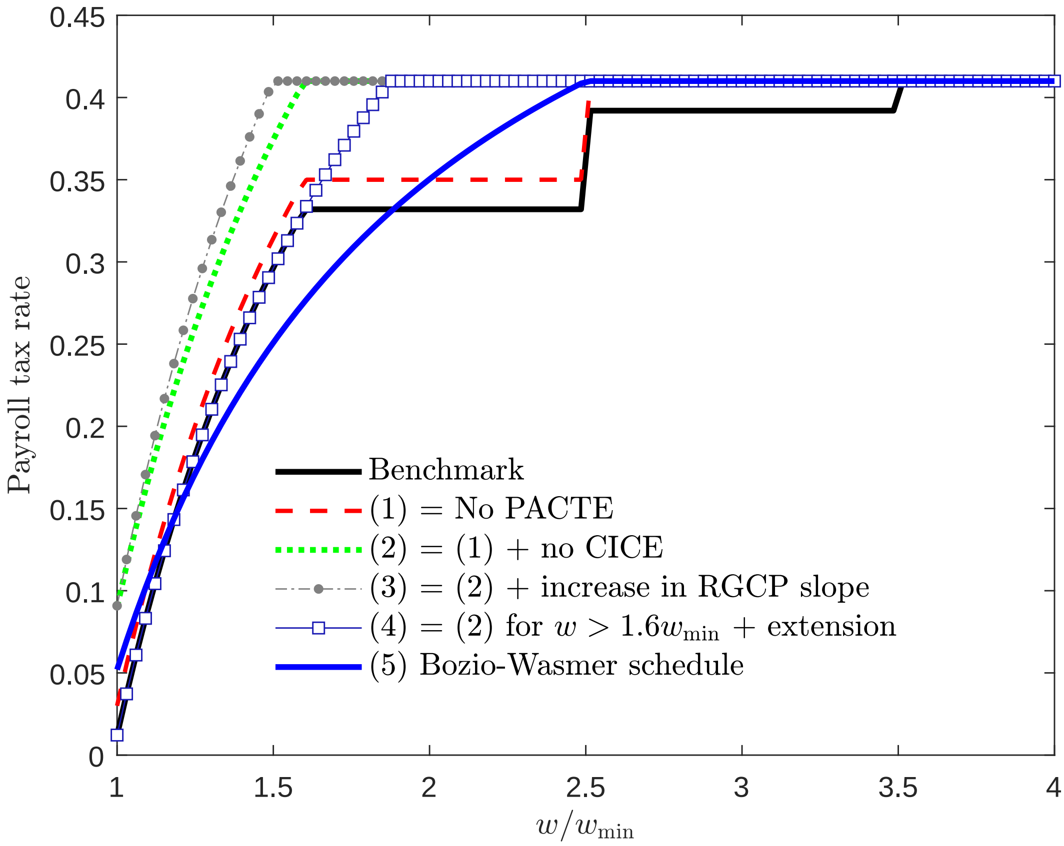
(2) Removing the relief provided by the PACTE law and the CICE;

(3) Removing the relief provided by the PACTE law and the CICE, while lowering the maximum eligibility threshold for the RGCP to 1.5 times the minimum wage (instead of 1.6 times the minimum wage);

(4) Removing the relief provided by the PACTE law and the CICE only for wages above 1.6 times the minimum wage, and extending the RGCP until the maximum contribution rate is reached;

(5) Applying the payroll tax schedule proposed in the Bozio-Wasmer report.[11]

[11] The Bozio-Wasmer report is available on the France Strategie website.



The five counterfactual payroll tax scenarios are depicted in Figure 8. The simulation results are presented in Table 4. Scenarios (1) to (3) lead to decreases in both employment and fiscal surplus, with effects becoming stronger as payroll tax reliefs are reduced. Removing the PACTE law (scenario 1) has minimal impact, as it results in minor payroll tax reliefs spread across a broad portion of the wage distribution. However, additionally repealing the CICE in addition to the PACTE law (scenario 2) has a greater effect, since the CICE offers more substantial payroll tax reliefs targeted at the lower end of the wage distribution. Reducing the maximum threshold for RGCP eligibility to 1.5 times the minimum wage (from 1.6) in addition to repealing the CICE and PACTE law (scenario 3) further deteriorates both employment and fiscal surplus. In all these scenarios, reducing payroll tax reliefs (and consequently increasing the contribution rate) for low wages leads to higher payroll tax revenues. However, the employment rate declines due to reduced search intensity and contact rates, along with higher separation rates. This leads to a reduction in the amount collected from income taxes and employee social contributions. Additionally, higher unemployment results in an increase in transfers, particularly those directed toward the unemployed. As a result, the additional payroll tax revenue fails to offset the combined decrease in income tax and social contribution revenues, as well as the rise in transfers, leading to an overall decline in fiscal surplus.

Scenario (4), which removes the PACTE and CICE for wages exceeding 1.6 times the minimum wage and extends the RGCP until the maximum contribution rate is reached, produces better outcomes: employment is barely affected, and the fiscal surplus increases slightly. This reveals an important insight: payroll tax reductions have minimal impact beyond twice the minimum wage but exert a significant influence at the lower end of the wage distribution. By maintaining contribution relief for lower wages while reducing it for middle and higher wage ranges, it is possible to enhance the fiscal surplus without negatively affecting employment.

Finally, the schedule proposed by Bozio and Wasmer (scenario 5) results in reductions in both employment and the fiscal surplus. This schedule increases contributions for workers earning the minimum wage, pushing some low-skilled individuals out of the labor market. As a result, there is an approximately 1.5 percentage point decline in the employment rate, an increase in transfers directed to the unemployed, and a reduction in tax revenues, including payroll taxes.

TABLE 4: ALTERNATIVE PAYROLL TAX - AGGREGATE VARIABLES

Variable	Benchmark	Change in payroll tax				
		(1)	(2)	(3)	(4)	(5)
Employment rate	71.65	-0.75	-4.44	-4.59	-0.13	-1.47
Fraction part-time	12.62	0.66	3.10	3.43	0.25	0.41
Search intensity	59.83	0.01	-0.49	-0.45	-0.23	-0.08
Contact rate	21.61	-0.66	-3.53	-3.60	0.06	-1.50
Separation rate	7.94	0.08	0.56	0.61	-0.02	0.10
Fiscal surplus	100.00	99.51	93.92	93.87	101.81	97.16
Payroll tax	100.00	102.88	108.58	109.70	105.30	99.58
Income tax	100.00	97.32	88.50	87.68	97.00	97.76
SSC	100.00	97.76	89.73	89.02	97.93	97.89
Transfers employed	100.00	101.08	101.85	102.79	101.45	98.23
Transfers unemployed	100.00	102.84	117.74	118.39	100.57	105.44

(1) = no PACTE, (2) = (1) + no CICE, (3) = (2) + increase in RGCP slope, (4) = (2) for $w > 1.6w_{\text{min}}$ + extension, (5) Bozio-Wasmer schedule. Labor market variables: percentage-point deviations relative to the benchmark economy. Variables related to the fiscal surplus are presented in base 100 (benchmark).

Table 5 presents the wage distribution under each scenario. Compared to the benchmark, all scenarios result in a leftward shift of the wage distribution, notably showing an increase in the proportion of workers earning the minimum wage and a decrease in the proportion of workers earning more than 2.5 times the minimum wage.

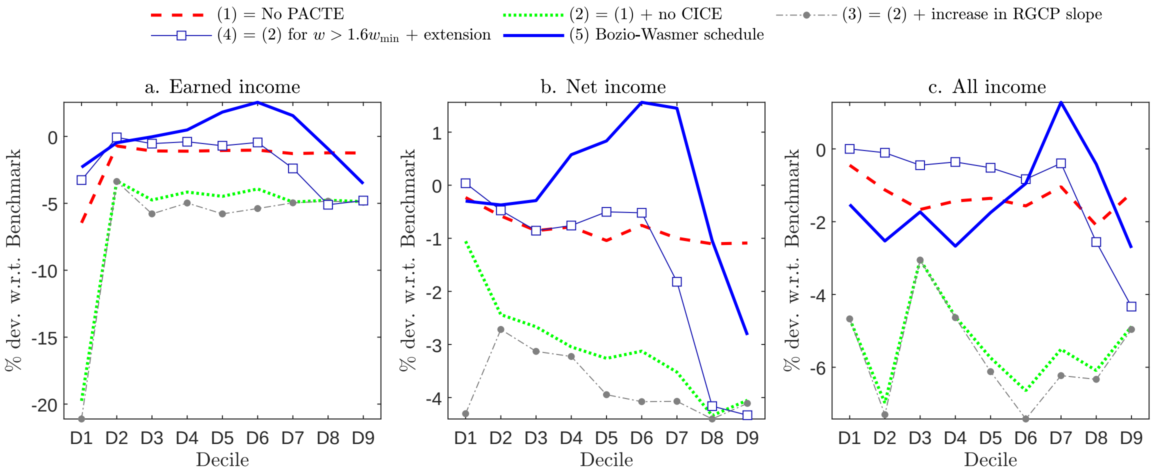
TABLE 5: ALTERNATIVE PAYROLL TAX - HOURLY WAGE DISTRIBUTION

Variable	Benchmark	Change in payroll tax				
		(1)	(2)	(3)	(4)	(5)
$w = w_{\text{min}}$	13.9	14.3	16.3	16.5	14.3	14.0
$w \in]w_{\text{min}}, 1.6w_{\text{min}}]$	48.9	49.8	49.2	49.0	49.0	46.4
$w \in]1.6w_{\text{min}}, 2.5w_{\text{min}}]$	27.7	26.9	26.3	26.3	28.7	31.4
$w \in]2.5w_{\text{min}}, 3.5w_{\text{min}}]$	7.5	7.2	6.4	6.4	6.3	6.4
$w > 3.5w_{\text{min}}$	1.9	1.8	1.8	1.8	1.8	1.8

(1) = no PACTE, (2) = (1) + no CICE, (3) = (2) + higher slope, (4) = (2) for $w > 1.6w_{\text{min}}$ + continuation, (5) Bozio-Wasmer schedule. Share of employment by wage range.

Beyond these aggregate results, it is worth considering the individual-level impacts. Who would be the winners and losers under each scenario? Figure 9 illustrates the variation in income deciles for each scenario relative to the benchmark. Panel A represents labor income before taxes and transfers, panel B shows labor income after taxes (social security contribution and income tax) and transfers, and panel C displays total income (labor income after taxes and transfers for employed workers, and income after taxes and transfers for unemployed workers). Relative to the benchmark, all these scenarios would result in a decrease in labor income. After accounting for taxes and transfers, every decile experiences a decline in total income across all scenarios (see panel C). A notable exception is the Bozio-Wasmer schedule, which would lead to an increase in total income for individuals earning slightly above the median income.

FIGURE 9: Alternative payroll tax - Income



Earned income: $w\ell(1 - SSC)$; Net income: Earned income $+b_e(w\ell) - T(w\ell)$; All income: Net income for the employed and income $b_u(f, a, e)$ for the unemployed.

4.2 Effect of minimum wage increase

In 2023, in response to the expanding scope of the scheme, a law was enacted[12] to fix the CICE and PACTE eligibility thresholds (2.5 and 3.5 times the minimum wage, respectively) at their 2023 euro values.[13] Consequently, the maximum wage eligible for payroll tax reductions under CICE and PACTE is now defined as a fixed amount in euros, rather than as a multiple of the current minimum wage. This implies that any future increase in the minimum wage–whether driven by inflation or government decisions–will shift the wage distribution via the Kalai-Smorodinsky mechanism but will not impact the CICE and PACTE eligibility thresholds (see Figure 10). In the event of a minimum wage increase, and following the renegotiation of the entire wage distribution, some high-skilled and middle-skilled workers who previously qualified for payroll tax reductions may become ineligible under the new rules.

To illustrate the effect of this law, we simulate the impact of a 5% increase in the minimum wage. This corresponds to a shift from the green dotted line to the green solid line in Figure 10. We compare three scenarios:

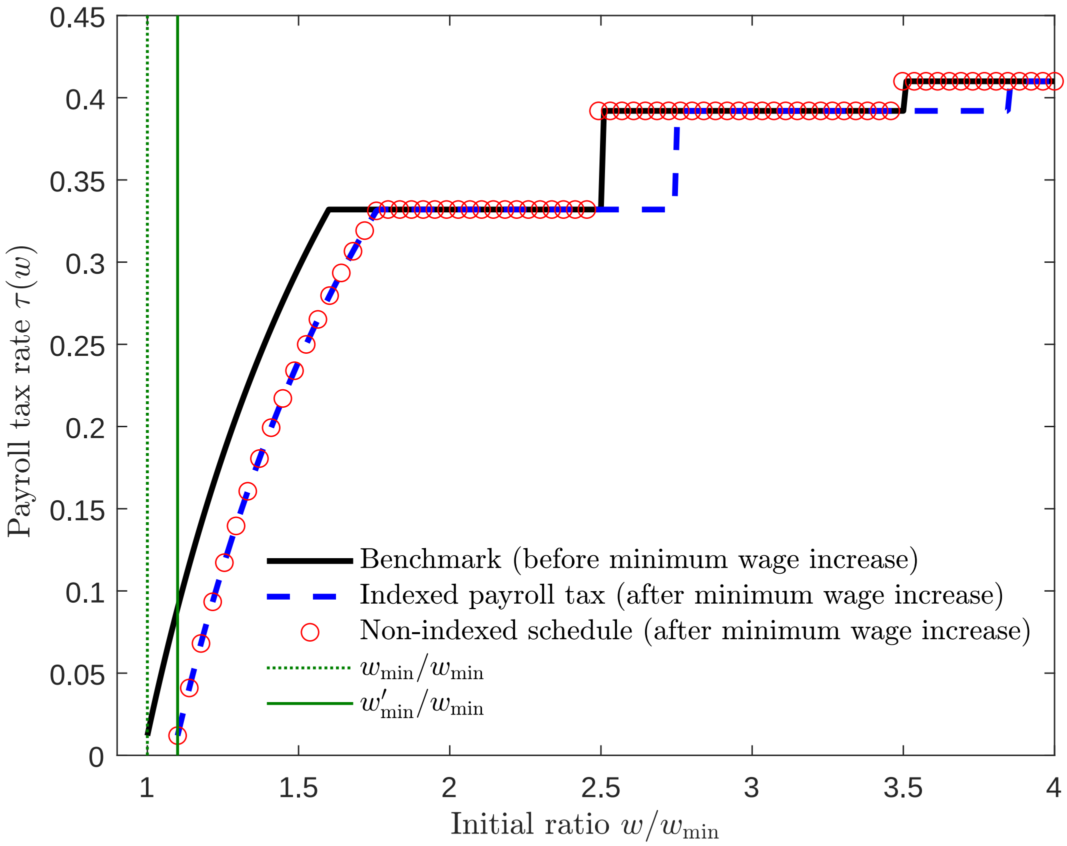
(1) An increase in the minimum wage with the payroll tax schedule indexed to the

[12]See Article 20, Act No. 2023-1250 of December 26, 2023, on Social Security Financing for 2024.
[13]Note that the law does not fix the 1.6 threshold at its 2023 euro value.

current minimum wage (as was the case before 2024 and the enactment of Act 2023-1250), while leaving the rest of the socio-fiscal system unchanged.

(2) An increase in the minimum wage with the payroll tax reduction thresholds, 2.5 and 3.5 minimum wages, fixed at their 2023 levels in euros (applicable from 2024 onward, as specified in Act 2023-1250), while leaving the rest of the socio-fiscal system unchanged.

(3) An increase in the minimum wage with the payroll tax reduction thresholds, 2.5 and 3.5 minimum wages, fixed at their 2023 levels in euros (applicable from 2024 onward, as specified in Act 2023-1250), assuming that the rest of the socio-fiscal system adjusts in line with the minimum wage.



As shown in Table 6, an increase in the minimum wage leads to a deterioration in both employment and fiscal surplus across all scenarios.[14] The effect is particularly pronounced when transfers and taxes increase as much as the minimum wage (scenario 3).[15] In the case of a 5% increase in the minimum wage, the 2023 law would have a modest impact. This is not surprising, as shown in Figure 4, very few workers earn more than 2.5 times the minimum wage. In the long term, i.e. after several increases in the minimum wage, the 2023 law could have a more substantial impact. The law stipulates that the 2.5 and 3.5 thresholds cannot drop below twice the current minimum

[14] Appendix G.2 presents the effect of a minimum wage increase on the income distribution.

[15] Decoupling the RGCP from the minimum wage would have a substantial negative effect on both employment and fiscal surplus. Results are available upon request.

wage. In the following section, we show that, in the long term, the 2023 law could lead to a schedule that is close to the optimal payroll tax schedule.

TABLE 6: **MINIMUM WAGE INCREASE - AGGREGATE VARIABLES**

Variable	Benchmark	$\nearrow w_{\min}$ by 5%		
		(1)	(2)	(3)
Employment rate	71.65	-2.07	-2.05	-2.21
Fraction part-time	12.62	-0.41	-0.35	0.44
Search intensity	59.83	-0.66	-0.67	-0.46
Contact rate	21.61	-2.16	-2.13	-2.13
Separation rate	7.94	-0.03	-0.01	0.11
Fiscal surplus	100.00	94.88	94.36	89.51
Payroll tax	100.00	94.77	94.31	93.85
Income tax	100.00	99.35	99.03	91.89
SSC	100.00	98.86	98.67	98.11
Transfers employed	100.00	93.32	93.49	100.83
Transfers unemployed	100.00	107.62	107.60	114.70

(1) Indexed payroll tax; Non-indexed transfers and taxes, (2) Non-indexed thresholds; Non-indexed transfers and taxes, (3) Non-indexed thresholds; Indexed transfers and taxes. Labor market variables: percentage point deviations with respect to the benchmark economy. Variables related to the fiscal surplus in base 100 (benchmark).

4.3 Optimal policy

The counterfactual experiments conducted in Section 4.1 consistently result in a decrease in employment and, in most cases, a deterioration in the fiscal surplus. This raises the question of how to improve the existing payroll tax schedule. In this section, we numerically identify the optimal payroll tax schedule, defined as the schedule that maximizes welfare. To avoid threshold effects, we focus on smooth, continuous tax schedules. Specifically, we analyze three types of functions:

$$\begin{aligned}
\text{Power} \quad \tau(w) &= \max\left(0,\ \phi_1 - \phi_2\left(\frac{w}{w_{\min}}\right)^{-\phi_3}\right) \\
\text{Linear} \quad \tau(w) &= \max\left[0, \min\left(\phi_1, \phi_2\left(\frac{w}{w_{\min}}\right) + \phi_3\right)\right] \\
\text{Logistic} \quad \tau(w) &= \phi_1 / \left[1 + \phi_2 \exp\left(-\left(\frac{w}{w_{\min}} + \phi_4\right)\phi_3\right)\right]
\end{aligned}$$

For each function, we numerically determine the set of parameters that maximize welfare,[16] namely:

$$\phi_i = \arg\max_{\phi_i} \mathcal{W}(\phi_i) \tag{30}$$

$$sc \qquad FS(\phi_i) \geq FS^{\text{bench.}}, \tag{31}$$

[16]Since our objective is to investigate the optimal tax exemption, we conduct our experiment under the assumption that the tax rate is positive or nil and does not exceed the maximum tax rate $\bar{\tau}$. This imposes a restriction on ϕ_1, which must be less than or equal to $\bar{\tau}$.

where $\mathcal{W}$ represents aggregate welfare, and $FS(\phi_i)$ denotes the fiscal surplus under the different approximation functions of the tax schedule. $FS^{\text{bench.}}$ refers to the fiscal surplus in the benchmark economy.

Before examining the properties of the optimal tax schedule, we first investigate inefficiencies in the model. There are two types of inefficiencies: those stemming from matching frictions and those arising from labor market institutions. The former are well-documented in the literature. Decentralized bargaining equilibria involve social inefficiencies, which also apply to our setup with KS wage negotiation (see L'Haridon et al. (2013) for an extended discussion). The latter result in distortions due to the proportional nature of taxes and transfers relative to wages. To disentangle their respective contributions, we determine welfare under different economies:

(1) **Benchmark**: Economy with minimum wage, transfers, and taxes. The payroll tax schedule corresponds to the current system.

(2) **Laissez-Faire**: Economy without minimum wage, transfers, or taxes.

(3) **First-Best Optimum**: Economy without minimum wage, transfers, or taxes. To determine the first-best optimum, we simulate the model under Nash bargaining, assuming that the Hosios condition is satisfied.

(4) **Second-Best Optimum**: Economy with minimum wage, transfers, and taxes. The payroll tax schedule is the one that maximizes welfare (see Figure 11).

Comparing the first three columns of Table 8 allows us to isolate the sources of inefficiencies in the model. The comparison between the first-best optimum and the laissez-faire economy reveals that matching frictions impose a welfare loss of approximately 8%. Similarly, the comparison between the laissez-faire economy and the benchmark economy suggests that labor market institutions generate a welfare loss of nearly 20%. Since the benchmark economy is characterized by various institutions, we decompose this result to quantify the share of the welfare loss attributable to each institution. Table 7 shows that the welfare loss in the benchmark economy is primarily driven by the minimum wage (approximately half of the loss), which restricts many low-skilled workers from entering the labor market. The payroll tax, including tax rebates, accounts for approximately 15% of this welfare loss. Interestingly, transfers to employed workers play negatively, meaning that they actually reduce the welfare loss. Transfers to unemployed account for around 25% of the welfare loss, while the income tax play a modest role.

TABLE 7: DECOMPOSITION BY LABOR MARKET INSTITUTIONS

Variable	Welfare loss	Employment loss
All institutions	19.56	12.40
Transfers unemployed	5.56	7.00
Transfers employed	-3.25	-6.86
Income tax	0.84	0.06
Social security contributions	4.62	2.00
Payroll tax	3.05	0.23
Minimum wage	10.46	8.99

Welfare loss and employment loss in the benchmark economy compared to the laissez-faire economy. The welfare loss is expressed as a percentage deviation, while the employment loss is expressed as a percentage point deviation.

We now propose to determine the payroll tax schedule that maximizes welfare.[17] When the fiscal surplus is unconstrained, the optimal tax schedule implies a rate close to 0 up to 2.5 or 3.5 times the minimum wage (depending on the function considered), then increasing beyond that. When the fiscal surplus is constrained to be at least equivalent to the benchmark, the optimal tax schedule implies a rate close to 0 up to 1.25 times the minimum wage, increasing up to 2 times the minimum wage, and reaching its maximum beyond that. In our preferred scenario (Logistic function, panel C), the optimal schedule suggests, relative to the benchmark: i) Reducing the payroll tax rate between 1 and 1.6 times the minimum wage; ii) Increasing it beyond 1.6 times the minimum wage. In practice, one way to move towards this optimal tax schedule would be to eliminate the tax reliefs introduced by the PACTE law and the CICE and reallocating the freed-up resources to strengthen the RGCP.

Table 8 compares the aggregate outcomes across the different scenarios. When the fiscal surplus is allowed to fall below its benchmark value, the logistic function delivers the best performance. This results in an increase in the employment rate by approximately 2.71 percentage points and a welfare gain of 7.09%. However, such a tax schedule would lead to a reduction in the fiscal surplus by nearly 30%. When the fiscal surplus is constrained to be at least equivalent to the benchmark, the logistic function again achieves the best performance, though all specifications produce similar welfare gains. In this case, employment increases by 0.64 percentage points, welfare rises by over 1.44%, and the fiscal surplus slightly exceeds its benchmark level. A decomposition of the fiscal surplus reveals that the reduction in payroll taxes collected is more than offset by the decrease in transfers and the increase in income tax revenue, both driven by higher employment. Comparable performance can be achieved with either a power function or a linear function.

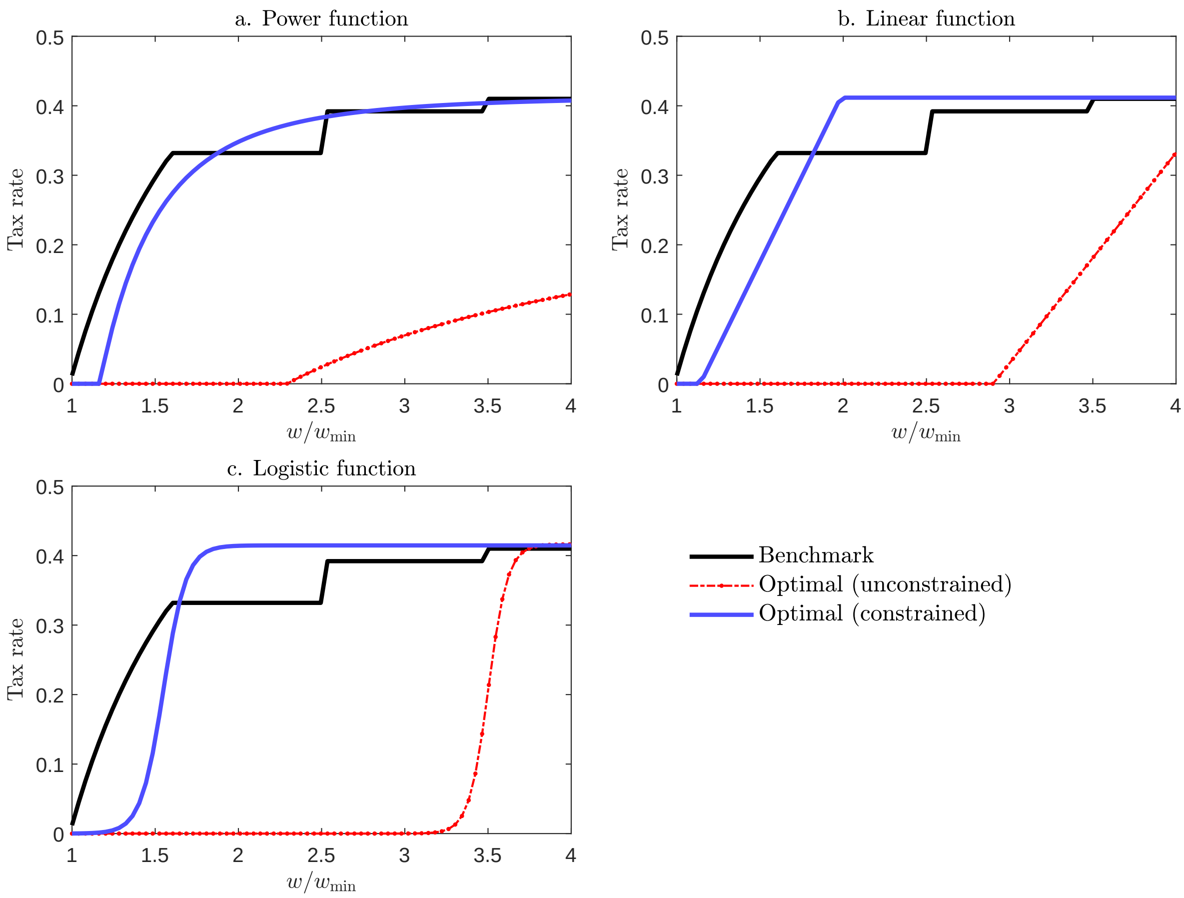
[17]It would be possible to consider a modification of the minimum wage combined with an adjustment of the payroll tax schedule. However, examining such a policy mix is beyond the scope of this paper.

TABLE 8: OPTIMAL PAYROLL TAX - AGGREGATE VARIABLES

Variable	Benchmark	Laissez Faire	First-best optimum	Power U	Power C	Linear U	Linear C	Logistic U	Logistic C
Welfare	100.00	119.56	127.06	104.85	101.26	106.85	101.40	107.09	101.44
Employment rate	71.65	12.40	19.14	1.36	0.54	2.58	0.64	2.71	0.64
Fraction part-time	40.61	-2.48	-8.77	-1.10	0.32	-1.71	0.45	-1.78	0.62
Search intensity	59.83	2.31	0.52	0.87	-1.04	0.77	-1.36	0.74	-1.86
Contact rate	21.61	11.47	44.61	-0.54	0.39	0.53	0.46	0.61	0.43
Separation rate	7.94	-1.70	-1.85	-0.66	-0.39	-0.66	-0.44	-0.67	-0.54
Fiscal surplus	100.00	0.00	0.00	67.63	100.02	71.57	100.24	71.17	100.52
Payroll tax	100.00	0.00	0.00	15.83	94.29	17.81	93.61	16.23	93.45
Income tax	100.00	0.00	0.00	142.75	103.76	144.07	104.09	145.20	104.12
SSC	100.00	0.00	0.00	128.92	103.31	130.88	103.78	131.63	103.95
Transfers employed	100.00	0.00	0.00	75.95	93.89	75.77	92.46	75.60	91.01
Transfers unemployed	100.00	0.00	0.00	93.96	97.87	89.35	97.44	88.86	97.43

U: unconstrained, C: constrained, $FS \geq FS_{bench}$. Labor market variables: percentage point deviations with respect to the benchmark economy. Variables related to the fiscal surplus in base 100 and expressed in percentage deviation from the benchmark economy.

FIGURE 11: Optimal payroll tax schedule



Our results highlight that tax relief measures play a crucial role for wages close to the minimum wage, while their impact is minimal beyond twice the minimum wage.

They also demonstrate that it is possible to simultaneously increase employment, fiscal surplus, and welfare by optimizing the parameters of the payroll tax schedule.

5 Conclusion

In this paper, we analyze the impact payroll tax reductions for low-wage workers in France. We develop a life-cycle matching model in which workers are heterogeneous in terms of age, education, human capital, family status, hours worked and idiosyncratic productivity, and where search effort, hiring and separations are endogenous. The numerous sources of heterogeneity introduced in our model allow us to accurately account for interactions with the socio-fiscal system. Furthermore, the use of a Kalai-Smorodinsky bargaining enables us to better capture how wages are negotiated in the presence of a minimum wage and to more precisely evaluate the impact of tax relief policies.

We calibrate the model to the French economy, estimate the remaining parameters, and demonstrate that it accurately reproduces the main characteristics of the French labor market. Using this model, we evaluate tax relief policies for low wages in France. By comparing different payroll tax schedules, we highlight the essential role of payroll tax reductions, showing that they positively impact employment, with stronger effects when targeting the lower end of the wage distribution. We also show that an increase in the minimum wage would have a negative effect on employment and fiscal surplus. The 2023 law does not appear to generate any substantial additional impact (at least for a moderate and single increase in the minimum wage). However, the effect would be more pronounced if transfers and taxes rise in line with the increase in the minimum wage. Finally, we identify the optimal payroll tax schedule. Our findings indicate that it is possible to simultaneously enhance employment, fiscal surplus, and welfare by increasing payroll tax reductions for wages near the minimum wage while reducing them for wages exceeding twice the minimum wage. Interestingly, the 2023 law will naturally reduce payroll tax relief for wages exceeding twice the minimum wage (simply due to inflation). Therefore, reinforcing tax relief for wages near the minimum wage would be sufficient to move toward the optimal schedule in the long term.

While we provide new insights into the role of payroll tax reductions for low wages, some questions remain unanswered. For instance, what policies could support workers in transitioning toward the higher end of the wage distribution? One potential solution is to combine payroll tax reductions for low wages with a training support policy. Payroll tax reductions could incentivize the employment of low-skilled workers and foster human capital accumulation through learning by doing, while training subsidies could encourage investments in skill development. This dual approach would enhance worker productivity, enabling progression toward higher wage levels and ultimately reducing the burden on payroll tax reductions. Exploring this question is part of our future research agenda.

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