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JEL Codes: E24, J21, J24, J31, O33
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Job Polarization and Unskilled Employment Losses in France*

Sébastien Bock†

March 2017

Abstract

This paper provides an explanation for the decline in unskilled employment in a context of job polarization in France between 1982 and 2008. I argue that job polarization induced significant unskilled employment losses. Unskilled employment losses were enhanced by high and increasing labor taxation until 1993 while this trend has been mitigated by the implementation of labor cost reduction policies since then. The key mechanism is that job polarization displaces unskilled workers from routine jobs toward manual jobs and non-market work. Labor taxation interacts with job polarization by changing the value of unskilled jobs with respect to non-market work.

Keywords: Job polarization, reallocation, unskilled employment, labor taxation.
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1 Introduction

This paper provides an explanation for the decline in unskilled employment in a context of job polarization in France between 1982 and 2008[1]. I argue that the interaction of job polarization and high labor taxation induced significant unskilled employment losses while this trend has been mitigated by the implementation of labor cost reduction policies since 1993. Through the lens of a general equilibrium model with occupational choice, I show that while job polarization reallocated unskilled employment opportunities from routine jobs toward manual jobs, labor taxation policies interact with this reallocation process by changing the incentive to work especially in manual jobs. This is because manual workers produce services that are close substitutes to non-market goods which makes the incentive to work in such jobs particularly sensitive to labor taxation.

Therefore, this work intertwines two segments of the literature on labor reallocation. The first segment of literature focuses on job polarization. Autor and Dorn (2013) show that the U.S experienced a polarization of its occupational structure during the last three decades, i.e the simultaneous increase in employment shares in low-paid jobs and high-paid jobs intensive respectively in manual tasks and abstract tasks while the relative size of middle-paid jobs intensive in routine tasks decreases. This reallocation process occurred because routine workers are easily substituted with new Information and Communication Technologies (ICT). In contrast to routine jobs, manual jobs are not substitutable with such technologies. The disappearing unskilled routine jobs should be replaced by low-skilled manual jobs. By disentangling the effect of job polarization and trade shocks, Autor et al. (2013) find that job polarization has no significant impact on aggregate employment and unskilled employment while trade shocks explain most of the fall in the U.S employment during the 2000s. Catherine et al. (2015) also find evidence of job polarization in France but suggest that labor market policies might have induced a particularly high unemployment rate. Langot et al. (2015) investigate the impact of labor market institutions and biased technical change on job polarization, aggregate employment and inequalities from 1980 to 2008. They build a multi-sectoral search and matching model with endogenous occupational choice. The authors claim that the U.S benefited from employment gains resulting from task-biased technical change while France suffered employment losses from it mostly because of the rise in the minimum wage.

The second segment of literature focuses on the deterioration of European employment outcomes. Prescott (2004) finds that labor taxation explains Europe's deficit in hours worked with respect to the U.S. From a sectoral perspective, Rogerson (2008) suggests

[1]The time-span studied starts in 1982 because data at the occupational level are not available in the French Labor Force Survey (FLFS) prior to this date. It ends in 2008 in order to avoid the influence of the great recession which goes beyond the frame of this study.

that continental Europe has developed a smaller service sector with respect to the U.S between 1956 and 2003. This is because Europe has much higher labor tax rates than the U.S and that services are easily substituted with home produced goods. In the specific case of France, Piketty (1998) and Cahuc and Debonneuil (2004) identify explicitly the underdeveloped sectors. They claim that if France had the same employment rate in the sales and hospitality industry as the United States, there should be respectively an additional 2.8 million employed workers in 1996 and 3.4 million employed workers in 2001. This last figure almost represents the number of unemployed workers in France in 2015.

This paper takes the literature a step further by focusing on how labor taxation impacts the employment outcomes arising from job polarization through non-market work. I make my point in two main arguments. First, I produce consistent facts on the dynamics of the occupational structure and employment outcomes in France from 1982 to 2008. I show that France has experienced job polarization but also a decline in unskilled employment. There has been an imperfect reallocation of routine jobs towards manual jobs. Second, I build a parsimonious general equilibrium model with endogenous occupational choice based on Rogerson (2008), Acemoglu and Autor (2010), and Autor and Dorn (2013). A key feature of the model is that households can produce goods in non-employment that are substitutes for services performed by unskilled manual workers. This feature allows labor taxation to have an asymmetric effect on employment across skill levels and tasks performed by those respective skill levels. The calibrated model accounts for job polarization, the unskilled employment losses, the decline in total labor income share and changes in labor taxation policies observed in France between 1982 and 2008. Three main results arise from this approach. First, job polarization induced unskilled employment losses in France between 1982 and 2008. Second, unskilled employment losses induced by job polarization were more important for higher and increasing average labor tax rates which explains why unskilled employment losses mostly concentrated from 1982 to the early 1990s. Third, the implementation of payroll tax reduction policies targeted on low-paid workers mitigated the declining trend in unskilled employment since the mid 1990s. They are especially efficient in a context of job polarization. Without those policies, unskilled employment losses would have more than doubled.

The paper is decomposed as followed. Section 2 documents the reader with stylized facts based mostly on the FLFS. In section 3, I build a parsimonious general equilibrium model with endogenous occupational choice based on Rogerson (2008), Acemoglu and Autor (2010), and Autor and Dorn (2013). In section 4, I calibrate the model in order to match the task employment rates and the decline in labor income share in France. In section 5, I use the model in order to account for the dynamics of the unskilled employment rate in France between 1982 and 2008. Section 6 concludes.

2 Stylized facts

This section presents three key observations. First, France experienced job polarization between 1982 and 2008 like the U.S. Second, the unskilled employment rate declined significantly. Third, this decline is entirely due to a fall in unskilled routine employment. The expansion of unskilled manual jobs was not sufficient to absorb the unskilled routine employment losses. Appendix A describes the data and its cleansing while appendix B provides additional facts and robustness checks.

2.1 Job polarization

A polarizing employment structure

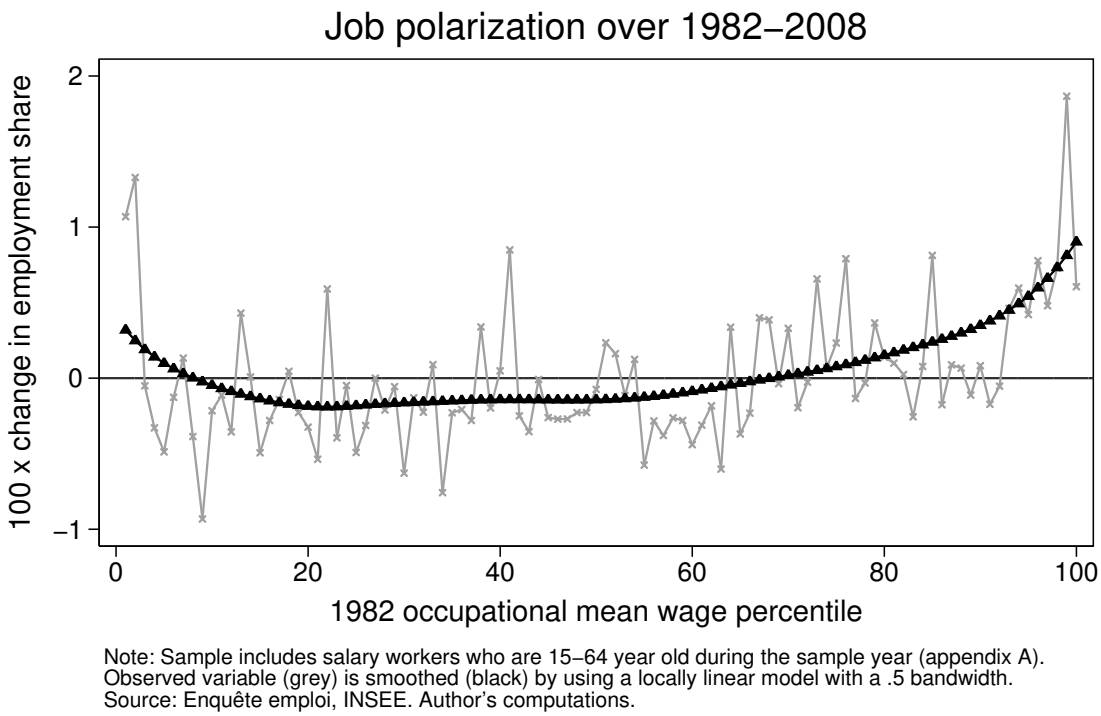
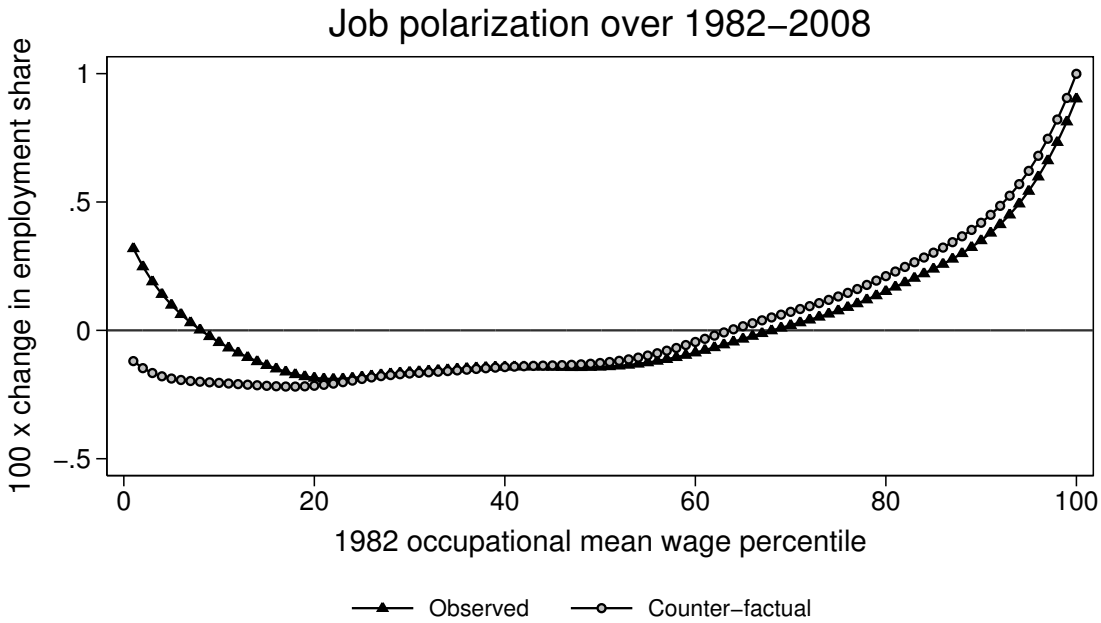


Figure 1: Job polarization

Figure 1 displays changes in employment share across the occupational mean wage distribution. Like the United-States, France has been experiencing job polarization. Employment shares increase simultaneously at the bottom and the top of the occupational wage distribution while they decrease at the middle of the wage distribution between 1982 and 2008. Those changes reflect significant changes in the occupation employment structure. For example, the first percentile of employees working in the lowest paid occupations in

1982 has seen its employment share increase by a smoothed .32pp. This rise represents a 32% increase. As for the United-States, top expanding jobs regroup a large variety of occupations. There are high-paid abstract occupations such as engineers and research managers in computer sciences, teachers certified in secondary education but also low-paid manual services such as childcare assistants, housekeepers, caregivers, cooks and kitchen assistants, and so forth. In most declining jobs, one can find many middle-paid routine jobs which are mostly low-skilled manufacturing and clerical jobs such as unskilled production workers in textile, secretaries, typists and stenographers, and various unskilled industrial workers. Job polarization occurred all over the period studied and is a robust pattern (appendix B.1).

The contribution of low-skilled manual occupations



Note: Sample includes salary workers who are 15–64 year old during the sample year (appendix A).
Observed variable is smoothed by using a locally linear model with a .5 bandwidth.
Source: Enquête emploi, INSEE. Author's computations.

Figure 2: Counter-factual employment structure

As highlighted by Acemoglu and Autor (2010), the growth in employment shares for high-paid occupations is consistent with the canonical model of skill-biased technical change. However, the growth at the bottom of the wage distribution is at odds with the standard theory of skill-biased technical change. Autor and Dorn (2013) found that it is due to the reallocation of labor from routine occupations which are substitute to ICT capital to low-skilled manual jobs which are not substitute to ICT capital. Routine manufacturing

jobs and clerical jobs are replaced by low-skilled manual jobs such as child care, nursing, cooking and hospitality jobs.

In order to identify which jobs are expanding at the bottom of the occupational wage distribution, I build a counter-factual occupational employment structure that aims at capturing the contribution of manual jobs to the rise of low-paid occupation employment shares[2]. In this counter-factual I assume that the employment shares in manual occupations remain at their initial level. The retrieved weights are then reallocated uniformly across the other occupations such that the sum of occupational employment shares is equal to one[3]. Counter-factual changes in employment shares between 1982 and 2008 are displayed in Figure 2. The spike at the bottom of the wage distribution completely disappears once I assume that manual occupational employment shares remain at their initial level. The curve becomes strictly increasing as suggested by the standard theory of skill-biased technical change. For example, the first percentile of least-paid occupations should have experienced a smoothed 12% decline in its employment share instead of a smoothed 32% increase between 1982 and 2008. Therefore, low-skilled manual jobs contributed for all of the rise in employment shares located at the bottom of the occupational wage distribution.

2.2 Occupational wages

According to Autor and Dorn (2013), the rise in manual employment comes from a rise in low-skilled manual labor demand. This is why wages at the bottom of the occupational wage distribution have increased relatively more rapidly in the U.S. I verify such assessment for France.

Figures 3 displays respectively changes in real log hourly wage at the occupational level over the entire time period studied. There are two striking facts. First, real hourly wages grow more rapidly for low-paid jobs than for middle-class jobs and high-paid jobs between 1982 and 2008. This pattern is consistent both over the whole period and across sub-periods suggesting that it is an ongoing process (appendix B.2). This reflects the rise in labor demand for manual jobs as in the U.S. However, it could also reflect other factors such as a persistent rise in the minimum wage. Even though the minimum wage probably contributes significantly to the rise in wages for low-paid jobs, this issue is not addressed in this study. Second, the real hourly wage declines for high-paid jobs.

[2]Appendix A.2 displays the allocation of job codes across task groups while appendix A.6 describes precisely the counter-factual re-weighting method.

[3]The re-weighting method redistributes uniformly the weights across the distribution. This explains why employment shares slightly increase for higher percentiles whereas the smoothing hides the rise for the middling percentiles. These increases are solely of technical nature and do not have any economic meaning.

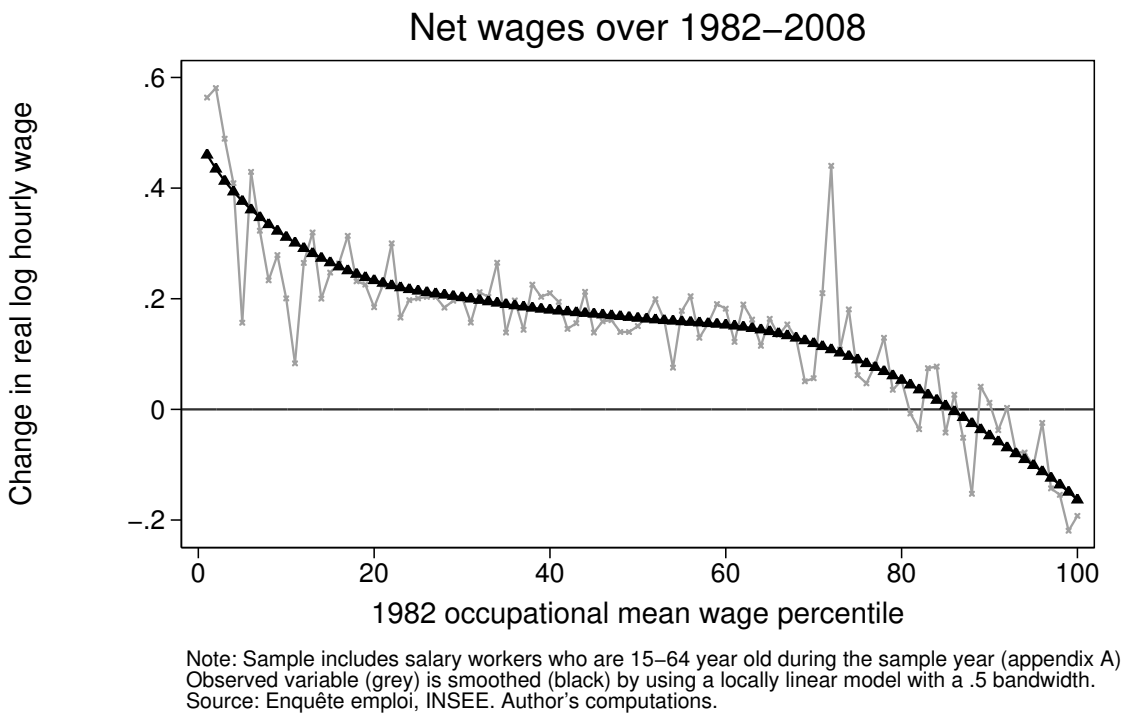


Figure 3: Occupational wage changes

This last observation is at odds with what is observed in the United-States. High-paid occupations have seen their real hourly wage increase in the U.S. In France, high-paid workers have seen their real hourly wages decline both in absolute terms and with respect to low and middling-paid occupations. Based on those observations, this pattern might be the result of labor taxation policies implemented since the mid 1990s. Since wages are reported net of employee and employer social security contributions, changes in labor tax scheme across the wage distribution could induce a decline in real net wages. Such changes in the labor tax scheme have occurred in France since the early 1990s through the implementation of labor cost reduction policies focused on low-paid jobs[4]. Since 1993, the successive governments have progressively introduced payroll tax subsidies focused on low-paid workers in order to increase unskilled employment by reducing its labor cost. Since the implementation of the Veil Law in 1994, those policies have to be financed through additional tax receipts that are generated from an increase in social security contributions and income taxes mostly born by high-paid workers.

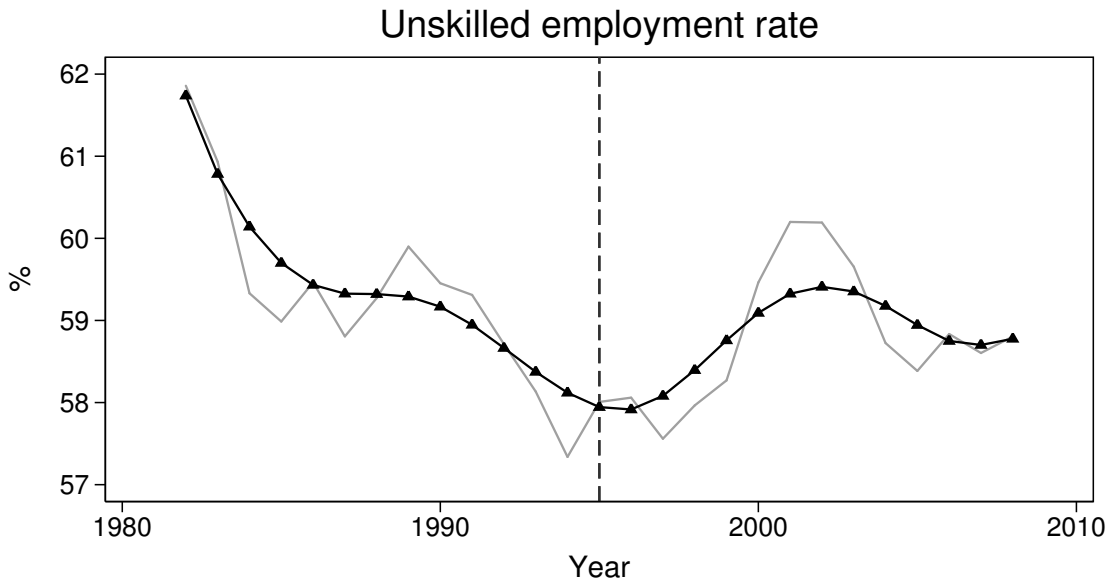
To sum up, France has been subject to job polarization from 1982 to 2008. There has been a reallocation of workers from middle-paid jobs towards low-paid and high-paid jobs. However, instead of experiencing wage polarization as in the United-States,

[4]Appendix B.4 provides a description of aggregate indicators of labor taxation and a brief history of differentiated payroll tax reduction policies introduced since 1993.

high-paid workers in France have seen their real wage grew less rapidly and even decline due to the implementation of labor taxation policies which aimed at increasing unskilled employment since the mid 1990s.

2.3 An incomplete reallocation of unskilled labor

The decline in unskilled employment



Note: Sample includes 15–64 year old individuals during the sample year (appendix A). Unskilled indivuduals are defined as individuals who have at most a high–school degree (Bac). Observations are corrected for 1990, 2003 breaks (grey) and then smoothed (black) using a locally linear model with a 0.4 bandwidth.
Source: Enquête emploi, INSEE. Author's computations.

Figure 4: Unskilled employment rate

Figure 4 displays the unskilled employment rate which is defined as the ratio between unskilled employees over the unskilled working age population. From 1982 to 2008, it declined by 2.94pp even though it experienced a rise from the mid 1990s to the early 2000s. Indeed, the unskilled employment rate fell by slightly less than 3.77pp from 61.72% to 57.95% between 1982 and 1995 while it rose by 1.46pp from 57.95% to 59.41% between 1995 and 2002, and then declined between 2002 and 2008 to reach 58.78%. Despite the implementation of payroll tax subsidies on low-paid workers since 1993 and the persistent rise in women's participation to the labor market, the rise in unskilled employment does not seem to be a persistent trend. The unskilled employment rate displays a downward trend over the entire period. France has suffered significant unskilled employment losses over the last three decades.

The contribution of unskilled employment

I now turn to the aggregate employment rate skill decomposition in order to understand how the dynamics of the unskilled employment rate contributed to the dynamics of the aggregate employment rate between 1982 and 2008. Its contribution depends on the evolution of the skill composition of the working age population.

Therefore, I decompose the aggregate employment rate into an unskilled component and a skilled component, which can themselves be broken down across tasks

$$e_t = \sum_{k\in\{m,r,a\}} \theta_t^{SK} e_t^{SK,k} + \sum_{k\in\{m,r,a\}} \theta_t^{UN} e_t^{UN,k}$$

with $e_t^{s,k} = E_t^{s,k}/P_t^s$ the share of employed workers of skill level $s \in \{SK, UN\}$ in job type $k \in \{m, r, a\}$ over the working age population with skill level s and m, r, a referring respectively to manual, routine and abstract jobs, and θ_t^s the share of skill s working age population over the entire working age population. Then, changes in the aggregate employment rate are decomposed into an employment effect and into a skill composition effect

$$\Delta e_{t-x,t} = \underbrace{\sum_{k\in\{m,r,a\}} \left(\theta_{t-x}^{SK}\Delta e_{t-x,t}^{SK,k} + \theta_{t-x}^{UN}\Delta e_{t-x,t}^{UN,k}\right)}_{\text{Employment effect}} + \underbrace{\sum_{k\in\{m,r,a\}} \left(e_t^{SK,k}\Delta\theta_{t-x,t}^{SK} + e_t^{UN,k}\Delta\theta_{t-x,t}^{UN}\right)}_{\text{Skill composition effect}}$$

with $\Delta y_{t-x,t}$ the percentage point change of variable y between year t and year $t-x$. On the one hand, the employment effect reflects changes in employment rates by skill level for a given initial skill structure of the working age population. It gives the contribution of changes in employment opportunities by skill level and task to the dynamics of the aggregate employment rate for a given skill structure. A negative employment effect between date t and date $t-x$ means that a given individual has less chance of being employed at date t with respect to date $t-x$ for a given initial skill structure. On the other hand, the skill composition effect reflects changes in the skill composition of the working age population for given final employment rates by skill level. It gives the contribution of changes in the skill composition of the working age population to the dynamics of the aggregate employment rate for given employment opportunities. For example, since the skilled employment rate is always higher than the unskilled employment rate at any point in time, an increase in the skill intensity of the working age population mechanically induces a positive impact on the aggregate employment rate for given employment rates by skill levels because relatively more workers will face more employment opportunities.

Table 1 reports the results of the aggregate employment rate decomposition. I do not

report the skill composition across tasks since tasks are only relevant for the employment effect. From 1982 to 2008, the aggregate employment rate increased by .86pp. However, this increase is mostly due to a change in the skill composition of the working age population. If the skilled and unskilled employment rates had remained at their final level, the aggregate employment rate would have risen by 3.55pp. This rise is explained by an increase in the relative supply of skilled individuals who are characterized by a higher employment rate with respect to unskilled individuals. On the contrary, if the skill composition of the working age population had remained constant, the aggregate employment rate would have fallen by 2.69pp. This entire decline would have stemmed from a fall in the unskilled employment rate (-2.72pp) between 1982 and 2008. Unskilled employment opportunities have shrunk over the last three decades.

By decomposing the overall period in two sub-periods, the story slightly changes. From 1982 to 1995, the employment effect had a negative impact on the aggregate employment rate. For a constant skill composition of the working age population, the aggregate employment rate should have fallen by 3.84pp. The unskilled employment rate would have contributed for 91% of this decline. From 1995 to 2008, the employment effect had a small positive effect on the aggregate employment rate. For a constant skill composition of the working age population, the employment rate should have increased by 1.25pp. The unskilled employment rate would have contributed for 59% of this increase. This suggest that the differentiated payroll tax subsidies implemented since the mid 1990s had potentially a positive impact on aggregate employment. However, the employment effect was not sufficient to counterbalance its initial negative impact on the aggregate employment rate. For any of the periods studied, the skill composition effect had a positive effect on the aggregate employment rate. Between 1982 and 1995, this effect was not sufficient to counterbalance the negative employment effect. Between 1995 and 2008, the skill composition effect deepened the positive impact of the employment effect. Indeed, it contributed for 65.4% of the rise in the aggregate employment rate.

To summarize, the aggregate employment rate experienced a slight rise between 1982 and 2008 that was induced by an increase in relative skill supply. Without this change in relative skill supply, the aggregate employment rate would have fallen by 2.69pp because of the declining unskilled employment rate. Unskilled workers have seen their employment opportunities decline significantly.

Job polarization in France: an incomplete labor reallocation process

Studies on job polarization including Autor and Dorn (2013), and Langot et al. (2015) make the assumption that skilled workers fill in abstract intensive jobs while unskilled workers perform in routine or manual intensive jobs. With respect to previous results,

this would imply that the fall in unskilled employment reflects an incomplete reallocation of labor from routine jobs towards manual jobs. Many unskilled workers would loose their jobs during the polarization process. It is then essential to check if the negative unskilled employment effect mostly comes from routine employment.

As expected, the negative impact of the employment effect on the aggregate employment rate comes from the unskilled employment effect and especially from routine employment. The unskilled routine employment effect represents a fall of 8.82pp between 1982 and 2008. The unskilled manual employment effect tends to absorb part of the fall in unskilled routine employment. It contributes for an 4.92pp increase. However, the unskilled manual employment effect is insufficient to counterbalance the unskilled routine employment effect. The unskilled abstract employment effect also tends to go against the routine employment effect with an increase of 1.18pp but it is even lower than the unskilled manual employment effect. It is also noteworthy that the skilled employment effect was almost insignificant (0.03pp) between 1982 and 2008. The skilled abstract component was negative (-0.63pp) while the manual and routine components were positive by respectively 0.12pp and 0.54pp. Abstract employment did not rise sufficiently to absorb completely the rise in skill supply in contrast to manual and routine employment. This suggests that there is some potential occupational downgrading for skilled workers which is confirmed by the evolution of employment's task composition by skill level displayed in Table 2. I do not investigate further this feature in this paper.

Those facts seem consistent with our intuition that France has suffered significant unskilled employment losses through the polarization of its occupational structure between 1982 and 2008. Unskilled routine employment opportunities have shrunk while unskilled manual employment opportunities increased but not sufficiently to counterbalance unskilled routine employment losses. This is at odds with what is observed in the U.S[5]. I suggest that labor taxation policies might impact the outcomes arising from job polarization because the incentive to work in manual jobs -which are located at the bottom of the wage distribution- or to remain in non-employment are deeply influenced by labor taxation policies.

[5]Autor et al. (2013) find that job polarization has a neutral effect on aggregate employment in the U.S between 1980 and 2007. They claim that routine employment losses induced by the diffusion of ICT capital are compensated by employment gains in abstract and manual jobs in most demographic groups with the exception of women. The non-college group which is comparable to this study's unskilled group has experienced a decline in routine employment but also an offsetting rise in manual employment. Since the 2000s, the U.S have experienced an accelerating decline in aggregate employment due to a rise in trade exposure with a striking role played by non-college workers which is confirmed by Autor et al. (2012). Beaudry et al. (2013) also provide similar evidence. The U.S employment rate rose significantly from 1980 to 2000 and then declined. The high-school to college employment rate ratio followed the same pattern. The rise in high-school employment thus contributed to the increase in aggregate employment in the U.S from 1980 to the early 2000s.

	Employment effect									Skill composition effect			Total
	$\theta^{SK}_{t-x}\Delta e^{SK,k}_{t-x,t}$				$\theta^{UN}_{t-x}\Delta e^{UN,k}_{t-x,t}$				Total	$e^{SK}_{t}\Delta\theta^{SK}_{t-x,t}$	$e^{UN}_{t}\Delta\theta^{UN}_{t-x,t}$	Total	$\Delta e_{t-x,t}$
	M	R	A	Total	M	R	A	Total					
$1982-1995$	0.03	0.15	-0.53	-0.36	2.47	-6.70	0.74	-3.49	-3.84	1.94	-1.48	0.46	-3.38
$1995-2008$	0.13	0.51	-0.13	0.51	2.37	-2.06	0.43	0.74	1.25	10.98	-8.00	2.99	4.24
$1982-2008$	0.12	0.54	-0.63	0.03	4.92	-8.82	1.18	-2.72	-2.69	13.05	-9.50	3.55	0.86

Table 1: Skill x task decomposition of aggregate employment changes

Skill level		Unskilled				Skilled			
Occupation		Manual	Routine	Abstract	Total	Manual	Routine	Abstract	Total
Year	1982	10.95	65.69	23.36	100	0.76	9.49	89.75	100
	1995	16.16	57.90	25.95	100	1.20	12.39	86.40	100
	2008	20.53	53.01	26.46	100	2.63	17.61	79.76	100

Table 2: Task composition of employment by skill level

3 A general equilibrium model

In this section, I build a parsimonious general equilibrium model with occupational choice that aims at understanding the unskilled employment losses suffered by France in a context of job polarization and labor taxation policy changes from 1982 to 2008. In order to do so, I rely on Rogerson (2008), Acemoglu and Autor (2010), and Autor and Dorn (2013). In this study, I allow three exogenous trends to drive the dynamics of the model. There are polarization shocks embodied by a decline in the capital price and changes in relative non-market productivity and there are labor taxation policies shocks.

3.1 The production side

This model is composed by three main sectors which are perfectly competitive: a goods sector, a service sector and a non-market production sector. They use three inputs which are unskilled labor, skilled labor and capital. Those inputs are used to accomplish manual, routine and abstract tasks. Therefore, each worker is characterized by a set of skills $\{a, r, m\}$ with a, r and m referring respectively to abstract, routine and manual tasks. There is a unit mass of skilled labor which is only used to perform abstract tasks and thus characterized by the set of skill levels $\{1, 0, 0\}$[6]. There is a unit mass of unskilled labor that can accomplish two types of tasks, i.e. routine and manual tasks. Unskilled workers have the same ability to accomplish manual tasks. However, they are heterogeneous with respect to their ability to perform routine tasks, which is captured by the efficiency parameter $\eta \in [0; +\infty[$ with density function $f(\eta) = e^{-\eta}$ as in Autor and Dorn (2013). Consequently, each unskilled worker is characterized by a skill set $\{0, \eta, 1\}$. Capital can also perform routine tasks.

3.1.1 The goods sector

The production of goods

Firms in the goods sector maximize their profit subject to their production technology. Their technology is characterized by the fact that they use abstract tasks, routine tasks and capital as inputs. Therefore, the representative firm program in the goods sector is

$$\begin{aligned} \Pi_g &= max\ Y_g - p_k K - w_r l_r - w_a l_a \\ s.t. \quad & Y_g \leq l_a^{1-\beta} \left[((1-\alpha_k) l_r)^{\mu} + (\alpha_k K)^{\mu} \right]^{\frac{\beta}{\mu}} \end{aligned}$$

[6]One could have assumed instead that skilled workers have a set of skills $\{1, 1, 1\}$ with $w_a > w_r, w_m$. Thus, skilled workers would always choose to produce abstract tasks.

with l_r, l_a routine and abstract labor, K and p_k capital and its rental rate, α_k the capital input share, and $\mu, \beta \in [0;1]$. The price of the good is normalized to one. In order to produce goods, firms have to combine abstract labor with an intermediary good $X = [((1-\alpha_k)l_r)^\mu + (\alpha_k K)^\mu]^{\frac{1}{\mu}}$ which is produced by routine labor and capital. The elasticity of substitution between abstract tasks and total routine tasks both accomplished by low-skilled workers and capital is equal to unity while the elasticity of substitution between routine tasks accomplished by low-skilled workers and those produced by capital is $\sigma_r = \frac{1}{1-\mu}$. Capital is a substitute for routine labor which means that $\sigma_r > 1$ or equivalently $\mu > 0$. If the price of capital falls, firms in the goods sector will tend to substitute unskilled routine workers for capital. The first order conditions for routine and abstract tasks are respectively

$$\begin{aligned} w_a &= (1-\beta)\, l_a^{-\beta} \left[((1-\alpha_k)l_r)^\mu + (\alpha_k K)^\mu\right]^{\frac{\beta}{\mu}} \\ w_r &= \beta(1-\alpha_k)^\mu l_r^{\mu-1} l_a^{1-\beta} \left[((1-\alpha_k)l_r)^\mu + (\alpha_k K)^\mu\right]^{\frac{\beta}{\mu}-1} \end{aligned}$$

Those equations describe the wage rates for workers that accomplish respectively abstract tasks and routine tasks. The first order condition for capital is

$$p_k = \beta \alpha_k^\mu K^{\mu-1} l_a^{1-\beta} \left[((1-\alpha_k)l_r)^\mu + (\alpha_k K)^\mu\right]^{\frac{\beta}{\mu}-1}$$

Labor supply

Since unskilled workers choose to work either in the goods or the service sectors and thus accomplish either routine or manual tasks, a condition is needed to determine their labor supply for each of the two type of tasks. An unskilled worker with an ability level in routine tasks of η decides to accomplish routine tasks and thus work in the goods sector if the net wage for routine tasks is higher than the net wage for market service work

$$\eta\,(1-\tau_r)\,w_r \geq (1-\tau_{ms})\,w_{ms}$$

with τ_{ms}, τ_r and τ_a the average labor tax rates respectively on market service, routine and abstract wages. There is a threshold level $\overline{\eta}$ such that when an unskilled worker has a skill level $\eta > \overline{\eta}$, he chooses to accomplish routine tasks. When an unskilled worker is characterized by $\eta < \overline{\eta}$, he accomplishes manual tasks. Unskilled labor allocated to the goods sector is a function of the threshold $\overline{\eta}$

$$\begin{aligned} l_r &= \int_{\overline{\eta}}^{+\infty} \eta e^{-\eta} d\eta \\ &= (1+\overline{\eta})\, e^{-\overline{\eta}} \end{aligned}$$

The threshold level $\overline{\eta}$ is determined within the general equilibrium framework. $\overline{\eta}$ is endogenous. Skilled workers only work in the goods sector and accomplish abstract tasks. For simplicity and as in Autor and Dorn (2013), I assume that skilled labor supply is inelastic such that

$$l_a = 1$$

In other words, skilled workers will allocate their entire time endowment to execute abstract tasks. Therefore, it is assumed that there is no non-employment for skilled labor.

Capital

Capital in efficiency terms is produced and supplied in a competitive framework. The production technology of capital is described by

$$K = Y_k \frac{e^{\delta_k t}}{\theta}$$

with Y_k the amount of final goods used to produce capital, $\delta_k > 0$ and $\theta = e^{\delta_k}$ an efficiency term. Capital fully depreciates at each period. In contrast to Rogerson (2008), technological progress comes from the term δ_k which represents the growth rate of capital productivity. The price of capital is equal to its marginal cost

$$\begin{aligned} p_k &= \frac{Y_k}{K} \\ &= \theta e^{-\delta_k t} \end{aligned}$$

At the beginning of time $t = 0$, the price of capital is equal to one. Then, as time passes, the price of capital decreases until it converges to zero.

3.1.2 The market service sector and non-employment

Unskilled manual services can be produced either in the market service sector which is perfectly competitive, or in non-employment which is a non-market sector that provides no wages but is not taxed.

The market service sector

The representative firm in the market service sector maximizes its profit subject to its production function. It only uses unskilled labor in order to accomplish manual tasks

$$\begin{aligned} \Pi_{ms} &= max\ pY_{ms} - w_{ms} l_{ms} \\ s.t. \quad & Y_{ms} \leq A_{ms} l_{ms} \end{aligned}$$

with p the relative price of services $\frac{p_s}{p_g}$ since we have normalized the price of goods to one. I normalize the manual market service marginal productivity of labor to unity ($A_{ms} = 1$) as in Autor and Dorn (2013). The first order condition for manual market service labor is

$$w_{ms} = A_{ms}p$$

This equation describes the wage provided for manual tasks in the market service sector. Unskilled labor supply for manual tasks is defined by two conditions. Firstly, manual tasks are executed by workers characterized by a skill level $\eta < \overline{\eta}$ such that

$$\begin{aligned} l_s &= \int_0^{\overline{\eta}} e^{-\eta} d\eta \\ &= 1 - e^{-\overline{\eta}} \end{aligned}$$

Secondly, unskilled workers can choose to allocate their labor either to the market service sector or to the non-market sector

$$l_s = l_{ms} + l_n$$

which states that total employment allocated to the service sector is equal to the sum of employment in the market and the non-market service sectors. The allocation of labor between the market service and the non-market sectors depends on consumer preferences. The intuition is that the allocation of unskilled labor is sequential. First, unskilled workers determine whether to work in the goods or the service sectors (market service or non-market), and thus whether they accomplish routine or manual tasks. Then, they choose to work either in the market service sector or in the non-market sector.

The non-market production sector

Households can also produce manual services in non-employment. This feature is captured by the non-market sector. The non-market production technology only uses manual tasks. This assumption is realistic since this sector produces substitutes for low-skilled manual services such as cooking, childcare work, gardening and so forth. The non-market sector is characterized only by a production technology

$$Y_n = A_n l_n$$

with l_n time allocated to the execution of non-market manual tasks and A_n the relative non-market labor productivity. Non-market labor productivity is assumed to change over

time. A_n is initially normalized to unity and changes at a δ_n annual rate. Rogerson (2008) suggests that non-market productivity has declined with respect to market service productivity in Europe. One should expect a negative growth rate during the calibration exercise[7]. Time allocated in the non-market production sector can thus change. On the one hand, when non-market labor productivity declines, producing unskilled manual services in the non-market sector becomes less rewarding. Therefore, less labor will be allocated to the non-market sector because of the rise in the opportunity cost of not working in the market service sector. On the other hand, while the wage obtained by working in the market service sector is subject to taxation, the non-market sector provides no wage but is entirely protected from taxation. Consequently, when the labor tax rate on market service labor increases, more unskilled workers are allocated to the non-market sector. This mechanism illustrates how labor taxation can induce unskilled employment losses. The calibration and the general equilibrium framework will determine how those effects interact.

3.2 The demand side

On the demand side of the economy, the representative consumer chooses its levels of consumption for goods, market services and non-market goods given prices and wages. He also has to choose its labor supply as described previously. In this section, I describe another choice that the representative agent has to make. Indeed, he has to choose the amount of time he is willing to dedicate to market work and to non-market work. This choice is central in this model due to the presence of taxation. The representative household can either work in the market sector and then receives a net wage, or he can dedicate some of his time to non-market production and receive no wage but the output coming from the non-market sector is not taxed. Therefore, I assume that the utility function is a CES function composed of goods and a composite service good

$$C = \left[a_g C_g^{\varepsilon} + (1-a_g) F(C_{ms}, C_n)^{\varepsilon}\right]^{\frac{1}{\varepsilon}}$$

where $\varepsilon < 1$, C_g, C_{ms} and C_n are respectively consumption of goods, market services and non-market produced goods. The composite service good is also a CES function composed of market services and non-market goods

$$F(C_{ms}, C_n) = \left[a_s C_{ms}^{\nu} + (1-a_s) C_n^{\nu}\right]^{\frac{1}{\nu}}$$

[7] $A_n = e^{(t-1)\delta_n}$, $\forall t \in R^+$ with $\delta_n < 0$.

where $\nu < 1$. The elasticity of substitution between goods and services both in the market and the non-market sectors is $\sigma_g = \frac{1}{1-\varepsilon}$ while the elasticity of substitution between market services and non-market production goods is $\sigma_s = \frac{1}{1-\nu}$. I assume that $\sigma_g > 1$ and $\sigma_s < 1$ or equivalently that $\varepsilon < 0$ and $\nu > 0$. Those assumptions mean that goods and the composite service good are complementary, while market services and non-market goods are substitutes. The program of the representative agent is

$$\begin{aligned}
\max_{\{C_g, C_{ms}, C_n, l_n\}} \quad & \left[a_g C_g^{\varepsilon} + (1-a_g) F(C_{ms}, C_n)^{\varepsilon}\right]^{\frac{1}{\varepsilon}} \\
s.t. \quad & C_g + pC_{ms} = \sum_{i \in \{a,r,ms\}} (1-\tau_i) w_i l_i + T \\
& 1 - e^{-\overline{\eta}} = l_{ms} + l_n \\
& Y_n = A_n l_n \\
& Y_n = C_n
\end{aligned}$$

Given prices, wages and lump sum transfers from the government, the representative agent chooses the path of the following variables $\{C_g, C_{ms}, C_n, l_n\}_t$. First order conditions for respectively C_g and C_{ms} are

$$a_g C^{1-\varepsilon} C_g^{\varepsilon-1} = \lambda \tag{1}$$

$$a_s (1-a_g) C^{1-\varepsilon} F(C_{ms}, C_n)^{\varepsilon-\nu} C_{ms}^{\nu-1} = \lambda p \tag{2}$$

with λ the Lagrangian multiplier associated to the household budget constraint. By combining first order conditions for non-market consumption and labor, one obtains the following equation

$$(1-a_g)(1-a_s) C^{1-\varepsilon} F(C_{ms}, C_n)^{\varepsilon-\nu} C_n^{\nu-1} A_n = \lambda (1-\tau_{ms}) w_{ms} \tag{3}$$

By combining equations (1) and (2), I get

$$p = \frac{a_s (1-a_g)}{a_g} \frac{F(C_{ms}, C_n)^{\varepsilon-\nu} C_{ms}^{\nu-1}}{C_g^{\varepsilon-1}}$$

This equation states that the marginal rate of substitution between goods and market services is equal to the marginal rate of transformation between goods and market services. By combining equations (2) and (3), I obtain the following condition

$$\frac{(1-\tau_{ms}) w_{ms}}{p} = \frac{(1-a_s)}{a_s} \left(\frac{C_n}{C_{ms}}\right)^{\nu-1} A_n$$

This equation states that the marginal rate of substitution between market services and non-market goods is equal to the *distorted* marginal rate of transformation between market services and non-market production goods. By using the previous equation, market clearing conditions and the manual wage rate equation, market service labor supply can be expressed as a linear function of non-market work

$$l_{ms} = \left(\frac{A_{ms}}{A_n}\right)^{\frac{v}{1-v}} \left(\frac{(1-\tau_{ms})\, a_s}{(1-a_s)}\right)^{\frac{1}{1-v}} l_n$$

3.3 Market clearing conditions and the government constraint

In order to close the model, it needs to be consistent with market clearing conditions

$$\begin{aligned} Y_g &= C_g + p_k K \\ Y_{ms} &= C_{ms} \\ Y_n &= C_n \end{aligned}$$

It is important to note that, since capital is generated from a fraction of output, the market clearing condition of the goods sector states that the output from the goods sector is divided between consumption for final goods and capital formation. Furthermore, the government constraint holds such that there is no deficit

$$T = \sum_{i \in \{a,r,ms\}} \tau_i w_i l_i$$

3.4 General equilibrium conditions

The general equilibrium is defined as a set of sequences that describes the path of variables across time. Thus, solving the model requires to solve nineteen deterministic sequences for the set of nineteen variables $\{Y_g, Y_{ms}, Y_n, C_g, C_{ms}, C_n, l_r, l_{ms}, l_n, l_a, p, w_r, w_{ms}, w_a, \overline{\eta}, K, p_k, T, A_n\}_t$. This model can be summarized by nineteen equations combining labor supply, market clearing, demand and supply side equilibrium conditions:

$$w_r = \beta(1-\alpha_k)^{\mu} l_r^{\mu-1} l_a^{1-\beta} \left[((1-\alpha_k)l_r)^{\mu} + (\alpha_k K)^{\mu}\right]^{\frac{\beta}{\mu}-1} \tag{4}$$

$$w_a = (1-\beta)\, l_a^{-\beta} \left[((1-\alpha_k)l_r)^{\mu} + (\alpha_k K)^{\mu}\right]^{\frac{\beta}{\mu}} \tag{5}$$

$$p_k = \beta \alpha_k^{\mu} K^{\mu-1} l_a^{1-\beta} \left[((1-\alpha_k)l_r)^{\mu} + (\alpha_k K)^{\mu}\right]^{\frac{\beta}{\mu}-1} \tag{6}$$

$$w_{ms} = A_{ms} p \tag{7}$$

$$\overline{\eta} = \frac{(1-\tau_{ms})\, w_{ms}}{(1-\tau_r)\, w_r} \tag{8}$$

$$l_{ms} + l_n = 1 - e^{-\overline{\eta}} \tag{9}$$

$$
\begin{aligned}
l_r &= (1+\overline{\eta})\, e^{-\overline{\eta}} && (10)\\
l_a &= 1 && (11)\\
p &= \frac{a_s\,(1-a_g)}{a_g}\frac{F(C_{ms},C_n)^{\varepsilon-\nu}C_{ms}^{\nu-1}}{C_g^{\varepsilon-1}} && (12)\\
l_{ms} &= \left(\frac{A_{ms}}{A_n}\right)^{\frac{\upsilon}{1-\upsilon}}\left(\frac{(1-\tau_{ms})\,a_s}{(1-a_s)}\right)^{\frac{1}{1-\upsilon}} l_n && (13)\\
C_g + pC_{ms} &= \sum_{i\in\{a,r,ms\}} (1-\tau_i)w_i l_i + T && (14)\\
T &= \sum_{i\in\{a,r,ms\}} \tau_i w_i l_i && (15)\\
Y_{ms} &= A_{ms} l_{ms} && (16)\\
Y_n &= A_n l_n && (17)\\
Y_g &= C_g + p_k K && (18)\\
Y_{ms} &= C_{ms} && (19)\\
Y_n &= C_n && (20)\\
p_k &= e^{-(t-1)\delta_k} && (21)\\
A_n &= e^{(t-1)\delta_n} && (22)
\end{aligned}
$$

In order to obtain qualitative and quantitative results, the model is solved numerically because this system is non-linear. Since the model can be seen as a sequence of static programs, standard solvers for non linear system of equations can be used. In this case, the initial guess needs to be updated at each step because the model displays non-stationary behaviors induced by the exogenous trends.

4 Calibration

The model is calibrated in order to match unskilled employment rates by task in 1982 and 2008. It aims at rationalizing the unskilled employment losses suffered by France between 1982 and 2008 captured by the unskilled employment effect displayed in Table 1. The employment rate data used are the smoothed times series computed in subsection 2.3.

The data reveal that the unskilled employment rate has declined between 1982 and 2008. The unskilled manual employment rate has increased while the unskilled routine employment rate has significantly declined[8]. France occupational structure has polar-

[8]In order to build a parsimonious model of labor allocation, I keep two simplifying assumptions made in the standard model of Autor and Dorn (2013): skilled agents can only accomplish abstract tasks while unskilled agents can only accomplish routine or manual tasks. However, Table 2 shows that some unskilled workers work in abstract jobs and some skilled workers work in manual and routine jobs. I believe that those assumptions do not distort significantly the results obtained. Since the share of unskilled individuals

ized all over the last three decades. Furthermore, manual wages have increased more rapidly than for middle-paid and high-paid jobs mostly intensive in respectively routine and abstract tasks. Such predictions (appendix C.1) occur in the model under the specific conditions that the consumption elasticity of substitution between goods and the composite service good is lower than the scaled production elasticity of substitution $\varepsilon < \mu/\beta$, and that goods and the composite service good are complements $\varepsilon < 0$. Furthermore, the literature has found that routine labor is substitutable with capital which translates theoretically into an elasticity of substitution between capital and routine labor larger than unity ($\mu > 0$). One should expect to obtain parameter values that respect those conditions once imputed.

Employment data to match

Year	$e_t^{UN} = e_t^{UN,r} + e_t^{UN,m}$	$e_t^{UN,r} = \int_{\overline{\eta}}^{+\infty} e^{-\eta} d\eta$	$e_t^{UN,m} = l_{ms}$	$1 - e_t^{UN} = l_n$
1982	.6174	.5498	.0676	.3826
2008	.5878	.4671	.1207	.4122

Labor share data to match

Year	Labor share	ΔLabor share
1982	.7684	-
2008	.6539	-11.45pp

External parameters

β	A_{ms}	ν	$\tau_{a,1982}$=$\tau_{r,1982}$=$\tau_{ms,1982}$	$\tau_{a,2008}$	$\tau_{r,2008}$	$\tau_{ms,2008}$
.67	1	.45	.35	.39	.34	.29

Calibrated parameters

δ_k	α_k	δ_n	a_s	a_g	ε	μ
.031	.40	-.016	.37	.96	-.84	.42

Table 3: Benchmark calibration

Practically, the calibration strategy consists in calibrating seven constant parameters (δ_k, α_k, δ_n, a_s, a_g, ε, μ) in order to match seven moments that include unskilled employment rates by task in 1982 and 2008 (e_t^{UN}, $e_t^{UN,k}$ for $t = 1982, 2008$ and $k \in \{m, r\}$) and

working in abstract jobs is relatively stable between 1982 and 2008 and most of the unskilled employment effect is coming from manual and routine jobs, I include unskilled abstract employment within unskilled routine employment. Furthermore, I assume that all skilled individuals work in abstract occupations even though the share of skilled individuals working in manual and routine jobs approximately doubled between 1982 and 2008. Indeed, the skilled employment effect is close to zero whether skilled manual and routine jobs are included into abstract jobs or not, meaning that the skilled employment rate almost did not changed in 1982 with respect to 2008. Therefore, I set h_a to unity as if there was full employment for skilled individuals.

the decline in total labor income share[9] given six external parameters (β, τ^{Obs}_{1982}, $\tau^{Obs}_{a,2008}$, $\tau^{Obs}_{r,2008}$, $\tau^{Obs}_{ms,2008}$, ν). Concerning external parameters, I rely whenever it is possible on the literature or empirical evidence. In order to parametrize the routine input share parameter in the goods sector β, I rely on the EU KLEMS (O'Mahony and Timmer, 2009) sector level data since output data at the occupational or task level are not available[10]. I set the goods sector routine input share β to its 1982 value .67. I also use the EU KLEMS data to compute the initial level and the change in total labor income share between 1982 and 2008 in order to calibrate respectively α_k the capital weight parameter and δ_k the growth rate of capital productivity. I find that the total labor share represented 76.8% of total income in 1982 and declined by 11.45pp between 1982 and 2008. Since differentiated labor tax rates time series do not exist for France over the time span studied, I use McDaniel (2007)'s tax time series and the June 2009 social security report (Amer et al., 2009)[11] to compute benchmark labor taxation parameters. I assume for simplicity that payroll tax rates were the same across the wage distribution from 1982 to 1993. Therefore, I set all tax parameters to McDaniel (2007)'s average labor tax rate time series displayed in subsection 2.4 from 1982 to 1993. From 1993 to 2008, France relied massively on payroll tax reduction policies on low-paid workers to increase employment. In order to proxy payroll tax rate reductions by task group, I use the social security report (Amer et al., 2009) which provides average payroll tax rate reduction by sector for 2008. The personal service sector was subject to a 10pp payroll tax rate reduction while high skilled sectors such as the energy or the financial sectors had near zero payroll tax rate reduction. Manufacturing and construction sectors benefited from payroll tax rate reductions that range from 2pp to 8pp for an average of 5pp. Furthermore, the bulk of the drop in payroll tax rates and labor cost on the minimum wage occurred mainly from 1994 to 2003 according to the social security report (Amer et al., 2009). Based on those information, I apply a linear decline of 10pp to the manual labor tax rate from 1994 to 2003 while the routine labor tax rate is subject to a 5pp decline. In contrast, I assume that the abstract labor tax rate followed the McDaniel (2007) average labor tax rate without any labor tax rate reduction. I display the computed tax time series in appendix B.4. I use the first and last period figures of those time series during the calibration. I set the elasticity of sub-

[9] Appendix C.4 displays additional facts and results on the evolution of factor shares.

[10] I assume that the agriculture, forestry, fishing, mining, quarrying, manufacturing, electricity, gas and water supply, construction, wholesale and retail trade, repair, transportation and storage sectors are routine intensive sectors while the information, communication, financial, insurance, real estate, professional scientific, technical, administrative and support service sectors are abstract intensive sectors. Those two groups of sectors constitute a proxy for the model's goods sector. I use the accommodation, food service, community, social and personal service sectors as a proxy for the market service sector.

[11] I refer to section 7-2 on the evolution of the labor cost since 1980 of the June 2009 social security report (Amer et al., 2009). This report is available on the following website: `http://www.securite-sociale.fr/Rapports-2009`.

stitution between market services and non-market goods to 1.82 ($\nu = .45$) like Rogerson (2008), who relies on empirical estimates in the literature.

By solving the model simultaneously for 1982 and 2008, and using previously discussed external parameter values, observed employment rate data, and the decline in labor income share, the seven parameters δ_k, α_k, δ_n, a_s, a_g, ε, μ can be imputed. Table 3 reports the results of the calibration. As expected, non-market labor productivity declines, goods and the composite good are complements, and routine labor and capital are substitutes. The utility weight of goods a_g is particularly high. This comes from the fact that the model's goods sector includes much more than the manufacturing industry. It includes also many jobs in high-skilled services industries while the model's market service sector represents only manual unskilled services. The market service weight in the composite service good a_s is comparable to Rogerson (2008)'s calibrated value.

5 Results

In this section, I use the calibrated model to provide an interpretation of the decline of unskilled employment in France in a context of job polarization and change in labor taxation policies. To do so, I first display the model's intuitions and assess its fit to observed patterns of unskilled employment rates. Second, I investigate the intertwined effects of labor taxation and job polarization. Third, I assess to which extent polarization shocks embodied by δ_k, and δ_n and change in labor taxation policies τ are accountable for the decline in unskilled employment. In appendix C, I provide some sensitivity analysis on σ_s the elasticity of substitution between market services and non-market goods which defines how changes in labor taxation and non-market labor productivity interact, and results on the evolution of the labor share.

5.1 Intuitions and model's fit

In this subsection I display the model's intuitions and fit to the data. They are captured in Figure 5 and Figures 22 to 24 in appendix C.

As in Autor and Dorn (2013), the model displays changes in the occupational and the income structures. As time passes, the price of capital falls. Capital becomes less and less expensive. Since capital and routine labor are substitutes, i.e. $\mu \in [0; 1]$, it thus becomes cheaper to produce the intermediate routine input X with capital rather than with routine labor. Relative demand for routine labor falls which induces a decline in routine employment. On the demand side, households become richer as the price of capital falls. Since goods and services are complementary, i.e. $\varepsilon < 0$, the demand for services increases with the demand for goods. This is why one can observe a rise in the

share of manual employment and a decline in the share of routine employment (Figure 22). France experiences job polariaztion. In order to produce more market services, producers have to increase wages paid for manual labor relatively to routine labor so that they can absorb unskilled labor from the goods sector into the market service sector. All wages rise. Even though the relative demand for routine labor decreases, the routine wage has to rise in order to keep some workers in the goods sector. Capital and routine labor are imperfect substitutes. However, net wage rates do not grow at the same pace. The manual to routine net wage ratio tends to grow while the abstract to manual net wage ratio decreases reflecting the double property of complementary of goods and manual services, and substitutability between capital and routine labor (Figure 23). This is in line with the observed changes in wages across the wage distribution (section 2.2). The interaction of the supply and demand devices induces an increase in the relative price of services.

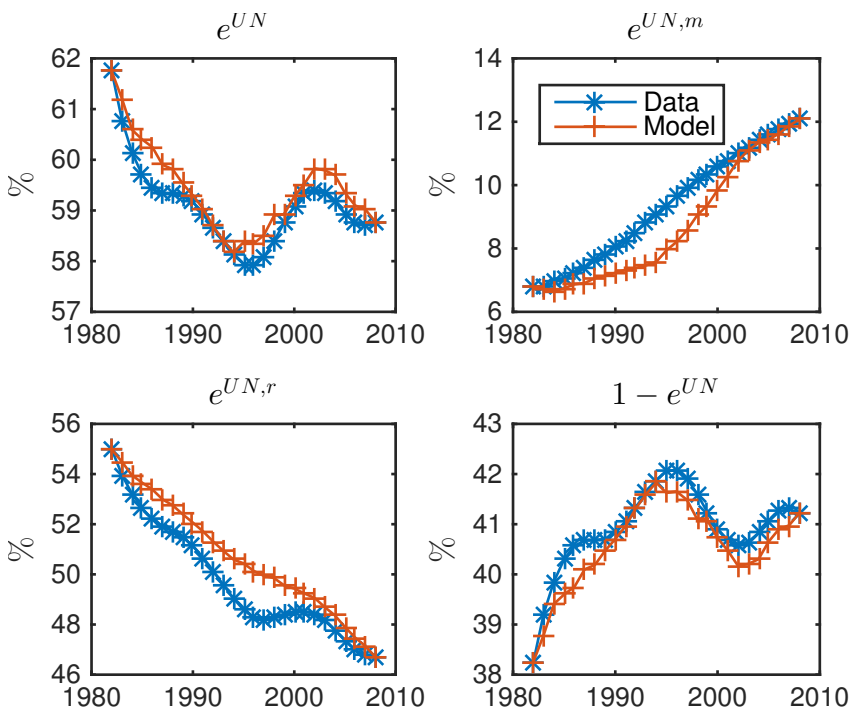


Figure 5: Unskilled employment rate decomposition

In contrast to Autor and Dorn (2013), the model also shows a decline in unskilled employment. Figure 5 displays the unskilled employment rate task decomposition for the model and for the data. The model fits approximately the dynamics of unskilled employment rates patterns despite the fact that only initial and final observations are matched in the calibration exercise. The decline in unskilled employment is explained by a sharp decline in routine employment. The rise of manual employment is not sufficient to counterbalance the decline in routine employment. The reallocation of labor is imperfect

due to the presence of the non-market sector. Market services are substitutable with non-market goods. Therefore, part of unskilled labor is not reallocated to the market service sector but to the non-market sector. As shown previously, the proportion of workers allocated to non-employment depends on market service labor taxation, relative non-market productivity and other preference parameters. I will study further to which extent the different shocks are accountable for the decline in unskilled employment.

To summarize, under empirically relevant parametric assumptions, the diffusion of ICT capital led to job polarization in France between 1982 and 2008. In contrast to Autor and Dorn (2013), the rise of unskilled manual employment does not fully compensate the decline in unskilled routine employment inducing significant unskilled employment losses from 1982 to the mid 1990s. Then, unskilled employment stabilizes because of the payroll tax reduction policies on low-paid workers and the decline in relative non-market productivity.

5.2 Labor taxation and job polarization

In this subsection, I study how labor taxation policies affect the employment outcomes arising from job polarization. I show mainly that higher and non-redistributive labor taxation policies amplify unskilled employment losses induced by job polarization. In order to do so, I build three counter-factual experiments. I consider three economies with different labor taxation policies. The first economy is the observed case with the French taxation levels and payroll tax subsidies targeted on low-paid workers. The second economy has French taxation levels but no payroll tax subsidies. The third economy has U.S taxation levels without payroll tax subsidies. For each of those economies, I compare the evolution of the unskilled employment rate with and without polarization shocks (δ_k and δ_n) between 1982 and 2008 which gives the unskilled employment losses induced by job polarization. Table 4 displays the results of the counter-factual analysis.

Case	Description	$\Delta e^{UN}_{1982-2008}$	ΔC_{ij}
C_1	French taxation with subsidies with polarization shocks	-2.96	-4.12
C_2	French taxation with subsidies without polarization shocks	1.16	
C_3	French taxation without subsidies with polarization shocks	-6.13	-4.88
C_4	French taxation without subsidies without polarization shocks	-1.26	
C_5	U.S taxation without subsidies with polarization shocks	-3.50	-3.55
C_6	U.S taxation without subsidies without polarization shocks	0.06	

Table 4: Counter-factual analysis - Job polarization and labor taxation

The results show that higher labor tax rates enhance unskilled employment losses induced by job polarization:

$$\Delta C_{34} < \Delta C_{12} < \Delta C_{56}$$

With French labor tax rate levels and no payroll tax subsidies ($C3$ and $C4$), unskilled employment losses induced by job polarization are more severe. The unskilled employment rate declines by 6.13pp with job polarization ($C3$) while it falls only by 1.26pp without job polarization ($C4$). Thus, the unskilled employment rate decline induced by job polarization amounts to 4.88pp. Unskilled employment losses are more severe in this case because higher labor tax rates reduce the value of manual jobs relative to non-employment. As job polarization occurs, routine jobs disappear. Unskilled routine workers are substituted by capital and are progressively reallocated either in manual jobs or in non-employment. Since labor tax rates are equal and high for all workers including manual workers, a higher share of unskilled routine workers will be reallocated towards non-employment because of the low relative value of manual jobs.

With U.S taxation levels and no payroll tax subsidies ($C5$ and $C6$), the unskilled employment rate declines by 3.50pp with job polarization ($C5$) while it increases by 0.06pp without job polarization ($C6$). Thus, the unskilled employment losses induced by job polarization with U.S taxation levels are substantially reduced. They amount to a 3.55pp decline in the unskilled employment rate which is lower than any of the three cases studied. U.S tax rate levels are almost two times lower than French tax rate levels at any given point in time. Therefore, the relative value of manual jobs to non-employment is larger than in the previous case. As job polarization occurs, routine jobs still disappear and unskilled routine workers are still progressively reallocated either in manual jobs or in non-employment. However, the share of unskilled routine workers reallocated towards manual jobs is larger than in the previous case because of the higher relative value of manual jobs to non-employment.

In the French economy with payroll tax subsidies ($C1$ and $C2$), unskilled employment losses induced by job polarization are inbetween the two previous cases. The unskilled employment rate declines by 2.96pp with job polarization ($C1$) while without job polarization shocks ($C2$) the unskilled employment rate rises by 1.16pp between 1982 and 2008. Thus, the unskilled employment losses induced by job polarization in the French economy with payroll tax subsidies targeted on low-paid workers amount to a 4.12pp decline. Labor cost reduction policies targeted on low-paid workers generate an additional amplification mechanism that goes against the standard amplification mechanism that was described in the previous cases. In this case, workers are taxed differently depending on the task they perform because manual jobs are mostly located in the first percentiles of the occupational wage distribution while routine jobs are located in the middle and abstract jobs at the

top of the occupational wage distribution. The decline in labor tax rate levels induced by the implementation of payroll tax subsidies targeted on low-paid workers are higher for manual workers than for routine workers. Those differentiated labor tax rates across types of workers change the relative value of manual jobs to routine jobs. The opportunity cost of working in routine jobs rather than manual jobs increases which incites some unskilled workers to switch from routine to manual jobs. This mechanism deepens the reallocation of labor induced by job polarization from routine jobs to manual jobs. For a given relative value of manual jobs to non-employment, payroll tax subsidies focused on low-paid workers create additional manual jobs but also increase non-employment where unskilled workers can produce non-market goods. However, since the implementation of payroll tax subsidies in the mid-1990s, labor tax rates on manual jobs decreased and became lower than in the case with French tax rate levels without payroll tax subsidies. Therefore, the relative value of manual jobs to non-employment became higher than in the case without payroll tax subsidies. The results indicate that the positive amplification effect is larger than the negative amplification effect which makes employment losses induced by job polarization lower than in the case without payroll tax subsidies.

Those counter-factual experiments suggest that the unskilled employment losses induced by job polarization are enhanced by high and non-redistributive taxation policies.

5.3 Accounting for the decline in unskilled employment

In this subsection, I assess to which extent polarization shocks (δ_k and δ_n) and changes in labor taxation policies τ are accountable for the evolution of the unskilled employment rate between 1982 and 2008. In order to compute the contribution of each type of shocks to the dynamics of the unskilled employment rate, I subsequently shut down the polarization and the taxation policy shocks. The results are reported in Table 5.

The contribution of polarization shocks (δ_k and δ_n)

In order to account for the role played by polarization shocks, I shut down taxation policy trends. I also provide the separate contribution of each polarization shock, i.e capital diffusion δ_k and change in relative non-market productivity δ_n.

The polarization shocks ($\delta_k \times \delta_n$) have a negative impact on the dynamics of the unskilled employment rate. Between 1982 and 2008, they contribute for a 4.57pp decline in the unskilled employment rate. The unskilled employment losses induced by polarization shocks are substantial both from 1982 to 1994 with a contribution of -1.90pp and from 1994 to 2008 with a contribution of -2.68pp. This is because the polarization shocks

	Δe^{UN}	$\Delta e^{UN,r}$	$\Delta e^{UN,m}$	$\Delta(1-e^{UN})$
Overall Period 1982-2008				
Data	-2.96	-8.27	5.31	2.96
Benchmark ($\delta_k \times \delta_n \times$Taxation Policy)	-2.96	-8.27	5.31	2.96
Polarization Shocks ($\delta_k \times \delta_n$)	-4.57	-8.45	3.88	4.57
δ_k	-4.70	-5.53	0.83	4.70
δ_n	-0.02	-2.76	2.74	0.02
Residual	0.14	-0.16	0.30	-0.14
Taxation Policy	1.16	0.19	0.97	-1.16
Residual	0.45	-0.01	0.46	-0.45
From 1982 to 1994				
Data	-3.62	-5.93	2.31	3.62
Benchmark ($\delta_k \times \delta_n \times$Taxation Policy)	-3.57	-4.38	0.82	3.57
Polarization Shocks ($\delta_k \times \delta_n$)	-1.90	-3.44	1.54	1.90
δ_k	-1.78	-2.10	0.31	1.78
δ_n	-0.13	-1.31	1.18	0.13
Residual	0.02	-0.03	0.05	-0.02
Taxation Policy	-1.52	-0.91	-0.60	1.52
Residual	-0.15	-0.03	-0.12	0.15
From 1994 to 2008				
Data	0.66	-2.34	2.99	-0.66
Benchmark ($\delta_k \times \delta_n \times$Taxation Policy)	0.61	-3.88	4.49	-0.61
Polarization Shocks ($\delta_k \times \delta_n$)	-2.68	-5.01	2.33	2.68
δ_k	-2.92	-3.43	0.52	2.92
δ_n	0.12	-1.45	1.57	-0.12
Residual	0.12	-0.13	0.25	-0.12
Taxation Policy	2.68	1.11	1.57	-2.68
Residual	0.61	0.02	0.59	-0.61

Table 5: Accounting for the decline in unskilled employment

increase the relative value of manual jobs and non-employment with respect to routine jobs. Therefore, part of the losses in routine jobs induced by capital substitution are reallocated in manual jobs and part are reallocated in non-employment.

I now analyse the two polarization shock separatly. The negative contribution of polarization shocks is mostly due to the fall in capital price (δ_k) which displaces unskilled workers mostly from routine jobs toward non-employment by reducing the relative value of routine jobs to non-employment and manual jobs all over the period studied. Only a small portion of unskilled routine workers are displaced into manual jobs. The decline in relative non-market productivity (δ_n) explains most of the reallocation from routine jobs towards manual jobs. It has an ambiguous effect on unskilled employment. On the one hand, it increases the relative value of manual jobs with respect to routine jobs. Thus, some routine workers are reallocated towards manual jobs but a fraction of them will also be reallocated

towards non-employment. On the other hand, it also increases the relative value of manual jobs with respect to non-employment which reallocates non-employed workers towards manual jobs. This shock has almost no effect (-0.02pp) on unskilled employment between 1982 and 2008 which suggests that the two effects almost compensate each other over the entire period. Nevertheless, the negative effect of non-market productivity shocks is stronger between 1982 and 1994 with a 0.13pp decline while the positive effect is dominant with a 0.12pp increase between 1994 and 2008. Moreover, as polarization shocks interact with taxation, capital efficiency shocks and non-market productivity shocks also produce an interaction effect that contributes for a 0.14pp increase in the unskilled employment rate between 1982 and 2008. The interaction of capital diffusion and the decline in non-market productivity enhances the manual employment gains. Both trends are needed to replicate simultaneously the polarization of the employment structure and the rise in unskilled manual services observed in the data.

Those results indicate that polarization shocks embodied by δ_k and δ_n played a crucial role in the decline in unskilled employment during the last three decades in France. They incompletely reallocated unskilled workers from routine jobs towards manual jobs.

The contribution of labor taxation policies

I now turn to the contribution of changes in labor taxation policies to the unskilled employment rate dynamics. To do so, I turn off the polarization shocks.

Despite the initial unskilled employment losses induced by the rise in labor tax rates in France, the unskilled employment gains generated by payroll tax subsidies focused on low-paid workers are larger. Taxation policies contributed for a 1.16pp increase in the unskilled employment rate between 1982 and 2008.

From 1982 to 1994, labor tax rates were high and increased. They contributed for a 1.52pp decline in the unskilled employment rate. This type of fiscal policy reduces unskilled employment through routine and manual jobs which account respectively for a 0.91pp and 0.60pp decline in the unskilled employment rate. High and increasing labor tax rate decrease the relative value of both routine and manual jobs with respect to non-employment. The negative impact of high and increasing labor tax rates on labor supply is well known in the literature and has been identified by Prescott (2004) as a important factor to explain differences in labor supply across countries such as France and the U.S.

From 1994 to 2008, payroll tax subsidies focused on low-paid workers were implemented with the explicit aim of increasing employment. Those taxation policies contributed positively to the unskilled employment rate dynamics with a 2.68pp increase[12].

[12]In my empirical computations, I found 30,682,930 unskilled individuals aged between 15 and 64 year old in 1994. Therefore, payroll tax reduction policies targeted on low-paid workers *per se* generated

It increased unskilled employment through both routine (1.11pp) and manual (1.57pp) employment by increasing the relative value of routine and manual jobs. Nevertheless, the rise in manual employment is slightly higher than the rise in routine employment. This is because payroll tax subsidies are decreasing with the wage. Therefore, manual jobs which are located at the very bottom of the wage distribution benefited of higher payroll tax subsidies which increased the relative value of manual jobs with respect to routine jobs and non-employment. By comparing counter-factual changes in the unskilled employment rate C_1 and C_2 in Table 4, one can have an idea of the additional unskilled employment losses that would have occured if labor cost reduction policies targeted on low-paid workers would not have been implemented. The unskilled employment rate would have decreased by 6.13pp instead of 2.96pp between 1982 and 2008. In other words, unskilled employment losses would have more than doubled.

This accounting exercise shows that high and increasing labor tax rates contributed to the decline in unskilled employment between 1982 and 1994 while this trend has been mitigated by the implementation of labor cost reduction policies focused on low-paid workers, i.e payroll tax subsidies targeted on low-paid workers.

The amplification effect

The sum of the contribution of polarization shocks and taxation policies does not add up to the total change in the unskilled employment rate (-2.96 $\neq$ -3.41). The residual is explained by the interaction of job polarization and labor taxation policies.

This amplification effect contributes for an 0.45pp increase in the unskilled employment rate. When computing the contribution of polarization shocks, all labor tax rates are constant. They are set to the inital tax rate value in 1982. When studying labor taxation policies, the polarization shocks are turned off and labor tax rates change. Therefore, the separate contributions of polarization shocks and labor taxation policies do not include the amplification effect described previously that arises from the interaction of job polarization with labor taxation policies.

On the one hand, the interaction effect contributed for a 0.15pp decline in the unskilled employment rate between 1982 and 1994. Indeed, as job polarization occured, part of unskilled workers were reallocated towards manual jobs but also to non-employment. Since labor tax rates were high and increasing, the relative value of manual and routine jobs with respect to non-employment declined which increased the share of unskilled workers reallocated to non-employment. On the other hand, the interaction effect contributed for

$30,682,930 \times 2.68\% = 822,303$ unskilled jobs between 1994 and 2008. According to Ourliac and Nouveau (2012), studies on the subject claim that payroll tax reduction policies targeted on low-paid workers saved at least 400,000 jobs in a worst case scenario and 1,100,000 jobs in the best case in France between 1993 and 2009.

a 0.61pp increase in the unskilled employment rate between 1994 and 2008 which compensated the initial negative interaction effect. Job polarization still occured. However, the relative value of manual and routine jobs with respect to non-employment increased because of the implementation of labor cost reduction policies focused on low-paid workers which increased the share of unskilled workers reallocated to manual jobs instead of non-employment. This suggests that payroll tax subsidies targeted on low-paid workers are especially efficient at increasing unskilled employment during job polarization.

To sum up, job polarization induced significant unskilled employment losses in France between 1982 and 2008. High and increasing labor tax rates enhanced the unskilled employment losses induced by job polarization between 1982 and 1994 while this trend has been mitigated by the implementation of labor cost reduction policies targeted on low-paid workers which are especially efficient when job polarization occurs.

6 Conclusion

This paper studies the evolution of unskilled employment in a context of job polarization and changes in labor taxation policies in France between 1982 and 2008. I rely on *four* main observations. France has experienced a polarization of its occupational employment structure between 1982 and 2008 *(i)* and a decline in unskilled employment that occurred mainly between 1982 and 1995 *(ii)*. Without the rise in the skill composition of its working age population, France would have experienced a decline of 2.69pp of its aggregate employment rate instead of a .86pp increase. The rise in manual employment was not sufficient to counterbalance the decline in routine employment *(iii)*. France had a high and increasing average labor tax rate but had implemented massive payroll tax reduction policies on low-paid workers since 1993 *(iv)*. In order to understand the interactions that lie behind those patterns, I build a parsimonious general equilibrium model with occupational choice. I allow for three types of exogenous trends in the model. A decline in the capital price, exogenous changes in labor taxation policies and a trend in relative non-market labor productivity. A key assumption made is that market services and non-market goods are substitutes which makes unskilled employment sensitive to taxation. I calibrate the model in order to match initial and final period unskilled employment rates by task and the decline in total labor income share. Three key results arise from this approach. First, job polarization induced significant unskilled employment losses in France between 1982 and 2008. Job polarization displaces unskilled workers from routine jobs toward manual jobs and non-market work. In fact, the rise in unskilled manual employment is not sufficient to counterbalance the decline in unskilled routine employment. Second, unskilled employment losses induced by job polarization were enhanced by the high and

increasing labor tax rate between 1982 and the mid 1990s. Third, the declining trend in unskilled employment was mitigated by the implementation of payroll tax reduction policies targeted on low-paid workers since the mid 1990s which are especially efficient in a context of job polarization. Without those policies, unskilled employment losses would have more than doubled. Labor taxation interacts with job polarization because as job polarization occurs, unskilled workers are reallocated from middle-paid routine jobs toward low-paid manual jobs that produce services that can be easily substituted with non-market goods. This makes the incentive to work in manual jobs especially sensitive to labor taxation policies.

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Appendix A Data

A.1 One data set and two samples

I use the FLFS to study the evolution of aggregate employment and its occupational employment structure from 1982 to 2008. The study starts in 1982 because pre-1982 FLFS lack in precision concerning some variables. On the other side, the study ends in 2008 because of the great depression. This event goes beyond the frame of this study.

I retain two separate samples to study respectively changes in the occupational employment structure and the evolution of aggregate employment because some variables are not always reported. In both samples, I focus on individuals aged between 15 and 64 years. I also drop military contingent.

In the first sample which is used to study changes in the occupational structure across the wage distribution, I focus on employed salary workers. I restrict the first sample to salary workers because wages or income earned by other types of workers are not reported in the FLFS. The survey only reports wages for employed workers under a labor contract[13]. Some occupational groups do not report their earnings or the number of observations for some occupational groups is too small to be considered as representative. Therefore, eight occupational groups are dropped which include artisans, wholesalers, heads of companies, agricultural, liberal, religious and related miscellaneous occupations[14]. All computations in section 2.1 use the first sample data.

However, wages are not required to study the evolution of employment rates. This is why such restrictions are not necessary in the second sample. Furthermore, I need the entire working age population in order to compute employment rates. Therefore, non participants, unemployed workers and excluded occupations in the first sample are included in the second sample. All computations in section 2.2 use the second sample data.

A.2 Building variables

Yearly averages

In 2003 the FLFS has been subject to drastic changes. From 1982 to 2002, the survey was conducted on a yearly basis and the data was collected in March, while from 2003 onward the data has been collected on a quarterly basis. From 1982 to 2002, the data was directly taken as yearly, while from 2003 to 2008 I compute yearly averages. I do

[13] Abowd et al. (2000) provide a precise description of the wage sample for pre-2003 FLFS.

[14] Occupational groups CSE 11, 12, 13, 21, 22, 23, 31, 44 and 69 are dropped when the study focuses on changes in the occupational employment structure over the wage distribution.

not explicitly treat the data for seasonal effects. However, since all pre-2003 survey data are collected in March in contrast to post-2003 survey data, I believe that most of those effects are corrected by the statistical break correction model presented in appendix A.4.

Real hourly wage

The French Labor Force Survey reports the monthly net nominal wage of salary workers[15]. Therefore, employer and employee social security contributions are already deduced but not the income tax. Before 1990, wages were not reported precisely but by wage groups. I deal with this issue by allocating to each observation the average wage of the reported category. From 1990 onward, precise monthly wages are reported. The real log hourly wage rate $w_{i,t}$ is then computed

$$w_{i,t} = ln\left(\frac{W_{i,t}}{h_{i,t}}\frac{12}{52}\frac{100}{p_t}\right)$$

with $W_{i,t}$ the nominal monthly wage, $h_{i,t}$ usual hours worked per week and p_t the basis year 2005 CPI in year t. Missing values for usual hours worked per week are imputed by allocating the average usual weekly hours worked within each usual weekly hours worked category captured by variables DU or DUHAB for respectively pre-2003 FLFS and post-2003 FLFS when available. Once the real log hourly wage is computed, one can obtain an occupational mean real log hourly wage $w_{occ,t}$ which is then used to rank occupations

$$w_{occ,t} = \sum_{i \in Occ} w_{i,t} \frac{\omega_{i,t}}{\sum_{j \in Occ} \omega_{j,t}}$$

with Occ the set of observations included in occupation Occ and $\omega_{t,j}$ the sample person weight.

Skill levels

In this study, education is a proxy for skills. Variable DDIPL which report the highest diploma obtained by an individual is used to compute variables by skill levels. Before 1990, people had to explicitly write the name of their diploma while after 1990 they were asked to check a category of diploma. Therefore, the rate of non-reported answers is high especially for non-participants and unemployed survey participants. Those unreported answers induce breaks in computed time series. I solve this issue in two steps. In a first step I impute missing values for employed workers using an ordered logistic model[16] with

[15] Monthly and yearly bonuses are included in the monthly wage.

[16] The results obtained in this paper are not affected by such a method. In fact, I obtain almost the same results by only applying the statistical break correction model described in the next appendix

explanatory variables on age categories, gender and occupational groups (CSE). However, most unreported values are coming from non-employed workers. This model can not be applied to non-participants since CSE relates to jobs. In order to neutralize the effect of remaining missing observations related to non-participants, I use in a second step a statistical break correction model presented in appendix A.4.

Tasks

Tasks are defined by occupational codes. Table 6 displays the crosswalk between occupational codes and task groups. Manual, routine and abstract occupational group definitions are based on Autor and Dorn (2013). In this study, I define manual occupations as *low-skilled manual service* occupations. This definition of manual jobs is restrictive but it captures as for the U.S the bulk of the employment growth at the bottom of the occupational mean wage distribution. Other manual occupations such as farmers (CSE11, 12 and 13) and drivers (CSE64) are included in the routine group even though they are manual. They are considered to be routine-manual occupations. Those occupations are not included in service occupations as in Autor and Dorn (2013). Thus, manual occupations include mostly personal service workers (CSE56) and some public service civil servants (CSE52). Including all manual occupations into the manual occupational group would not change the conclusions of this study. Routine jobs are located in the middle of the occupational mean wage distributions. They include occupations such as foremen (CSE48), business administrative personnel (CSE54), salespeople (CSE55), drivers (CSE64), maintenance, storage and transportation workers (CSE65), skilled industry and artisan laborers (CSE62 and 63), and unskilled industry and in construction finishing laborers (CSE67 and 68). A substantial portion of those jobs have been subject either to automation or computerization since the last three decades which explains why the middle class has been shrinking ever since. Abstract jobs include occupations that usually require a relatively high diploma because of the complexity of cognitive tasks accomplished. They include occupations such as wholesalers (CSE22), head of companies (CSE23), liberal professions (CSE31), public service professionals (CSE33), professors and scientific professions (CSE34), business administration and commerce jobs (CSE37), technicians (CSE38), business engineers and technicians (CSE38), intermediate health and social work personnel (CSE43), technicians (CSE47), and so on and so forth.

without using the ordered logit imputation.

	Tasks		
Occupational classifications	Manual	Routine	Abstract
PCS 1982	CSE: 56, 52 (except 5211, 5212, 5213, 5214, 5215)	CSE: 11, 12, 13, 21, 48, 54, 55, 62, 63 (except 6301, 6354), 64, 65, 67, 68 (except 6891), 69	CSE: 22, 23, 31, 33, 34, 35, 37, 38, 42, 43, 44, 45, 46, 47, 53
	Additional job codes: 6301, 6354, 6891	Additional job codes: 5211, 5212, 5213, 5214, 5215	Additional job codes: -
PCS 2003	CSE: 56, 52 (except 521a, 521b, 522a, 523a, 524a)	CSE: 11, 12, 13, 21, 48, 54, 55, 62, 63 (except 631a, 636d), 64, 65, 67, 68 (except 684a), 69	CSE: 22, 23, 31, 33, 34, 35, 37, 38, 42, 43, 44, 45, 46, 47, 53
	Additional job codes: 631a, 636d, 684a	Additional job codes: 521a, 521b, 522a, 523a, 524a	Additional job codes: -

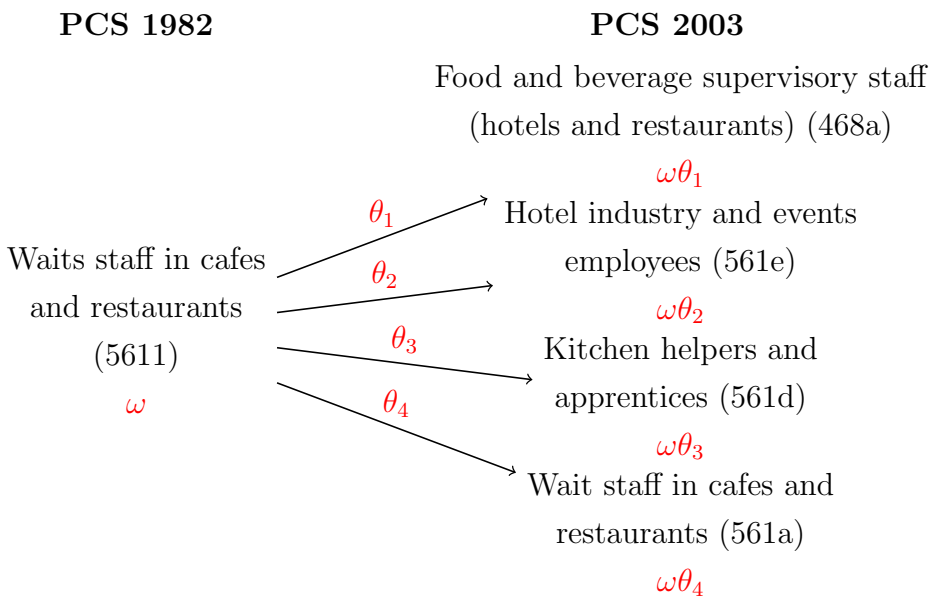
Note: This table describes the allocation of occupational codes across tasks for the overall sample without occupational restriction, i.e. the employment outcome sample. In the job polarization sample, one needs to add some occupational restrictions described in appendix A.1.

Table 6: Occupational codes and tasks

A.3 Occupational classification crosswalk

In order to observe changes in the occupational structure, one needs to observe the same jobs across time. The French occupational classification has changed once between 1982 and 2008. The FLFS used the PCS 1982 from 1982 and 2002, while it used the PCS 2003 from 2003 to 2008.

In order to deal with this break I exploit a singularity of the 2003 survey which provides a variable (p1982) that reports the occupational code for each individual according to the 1982 classification. Therefore, it is possible to map several 2003 occupational codes for each 1982 occupational code. I compute the distribution of 2003 jobs for each 1982 job. The following figure illustrates this method through a fictional example



with $\sum_{i=1}^{4}\theta_i = 1$, ω the PCS 1982 occupation's sample weight, θ_i the share of the PCS 1982 occupation's sample weight that is allocated into occupation i of PCS 2003 classification. Since the variable used to compute these distributions is only available in 2003, I assume that those shares are constant across time. This stability assumption allows me to impute new sampling weights by applying the crosswalk weights to pre-2003 surveys. As a result, I obtain data on 374 consistent occupations based on the 2003 occupational classification from 1982 to 2008. Even though this assumption is strong, I believe that it is the best way to produce a crosswalk from the 1982 to the 2003 occupational classifications. If one decided to produce a "handmade" mapping between the two classifications without using the information available, the result obtained might be misleading due to the misallocation of 2003 jobs into the 1982 jobs.

I produce multiple robustness checks. I display results by sub-periods (1982-1989, 1990-2002 and 2003-2008) in order to avoid classification inconsistencies, and check whether

the stability assumption does not induce some significant bias. I also check several results by focusing on occupational groups (CSE) rather than occupations since occupational groups are consistent across years. Results are robust. Results obtained by using the crosswalk over the entire period reflect sub-periods patterns and occupational group patterns that avoid classification inconsistencies. The crosswalk is used only in some figures of section 2.1.

A.4 Statistical break correction model

In order to deal with remaining breaks, I use a purely statistical break correction model which is a simplified version of the model used by the French national statistical institute (INSEE) to compute long run time series[17]. Such correction model is applied only on sufficiently aggregated variables and time series because it does not work on very disaggregated time series such as employment shares at the occupational level. Indeed, when corrected, a small number of occupational employment shares become negative. Therefore, this method is applied on most time series used in this study except for time series computed at the occupational levels.

This break correction model works in two steps. First, time series are corrected for the 2003 break. I regress a sufficiently aggregated variable $\widetilde{\widetilde{y}}_t$ on a time trend and $ind2003_t$ an indicator variable that is equal to one when FLFS are pre-2003 surveys. The model is estimated on a restricted sample of five years that includes year 2001 to year 2005. Then I correct $\widetilde{\widetilde{y}}_t$ by subtracting the OLS estimated break coefficient $\hat{\beta}_1$ to the raw time series for pre 2003 years in order to obtain a first step corrected variable $\widetilde{y}_t$.

$$\begin{aligned}
\widetilde{\widetilde{y}}_t &= \alpha_1 + \delta_1 t + \beta_1\, ind2003_t + \varepsilon_t \\
\widetilde{y}_t &= \widetilde{\widetilde{y}}_t - \hat{\beta}_1\, ind2003_t
\end{aligned}$$

Secondly, I correct the variable corrected in the first step for the second break that occurred in 1990 by applying the same type of model but this time the model is estimated on year 1988 to year 1992.

$$\begin{aligned}
\widetilde{y}_t &= \alpha_2 + \delta_2 t + \beta_2\, ind1990_t + \varepsilon_t \\
y_t &= \widetilde{y}_t - \hat{\beta}_2\, ind1990_t
\end{aligned}$$

The resulting variable y_t is a usable variable considered to be corrected for all breaks.

One exception is made. In section 2.2, I compute a skill decomposition of changes in

[17] `http://www.insee.fr/fr/themes/detail.asp?ref_id=ir-martra12&page=irweb/martra12/dd/doc/documentation.htm`

the aggregate employment rate. In order to compare observed changes in the aggregate employment rate with imputed ones computed from the skill decomposition counterfactual changes, I impute the skill composition of the working age population by using corrected employment rates

$$\begin{aligned} \theta_t^{UN} &= \frac{e_t - e_t^{SK}}{e_t^{UN} - e_t^{SK}} \\ \theta_t^{SK} &= 1 - \theta_t^{UN} \end{aligned}$$

with θ_t^{UN}, θ_t^{SK}, e_t^{SK}, e_t^{UN} and e_t respectively the imputed share of skilled and unskilled individuals among the entire working age population, corrected employment rates by skill level and the corrected aggregated employment rate. Using the corrected skill composition instead of the imputed one would not change the results significantly but would induce small differences in observed and imputed changes in the aggregate employment rate. This is due to the purely statistical nature of the break correction model. For illustration purposes, Figures 6 to 12 display the corrections induced by the statistical break correction model for respectively the aggregate employment rate, employment rates by skill level, and employment shares by occupational groups.

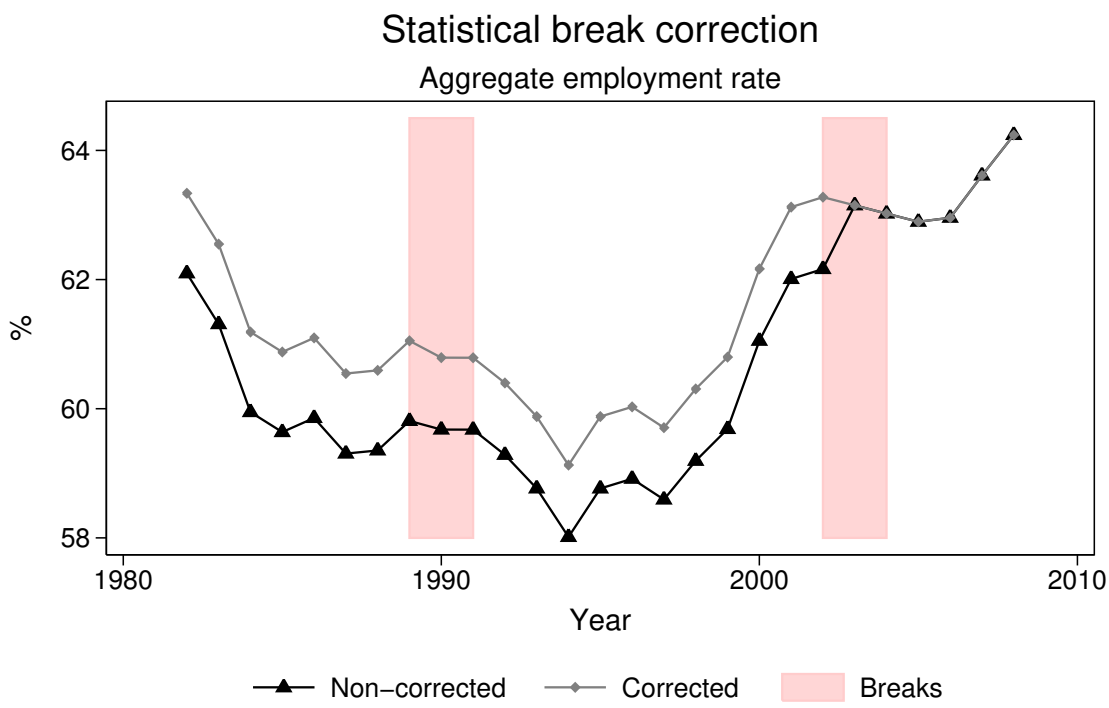


Figure 6: Statistical break correction (e_t)

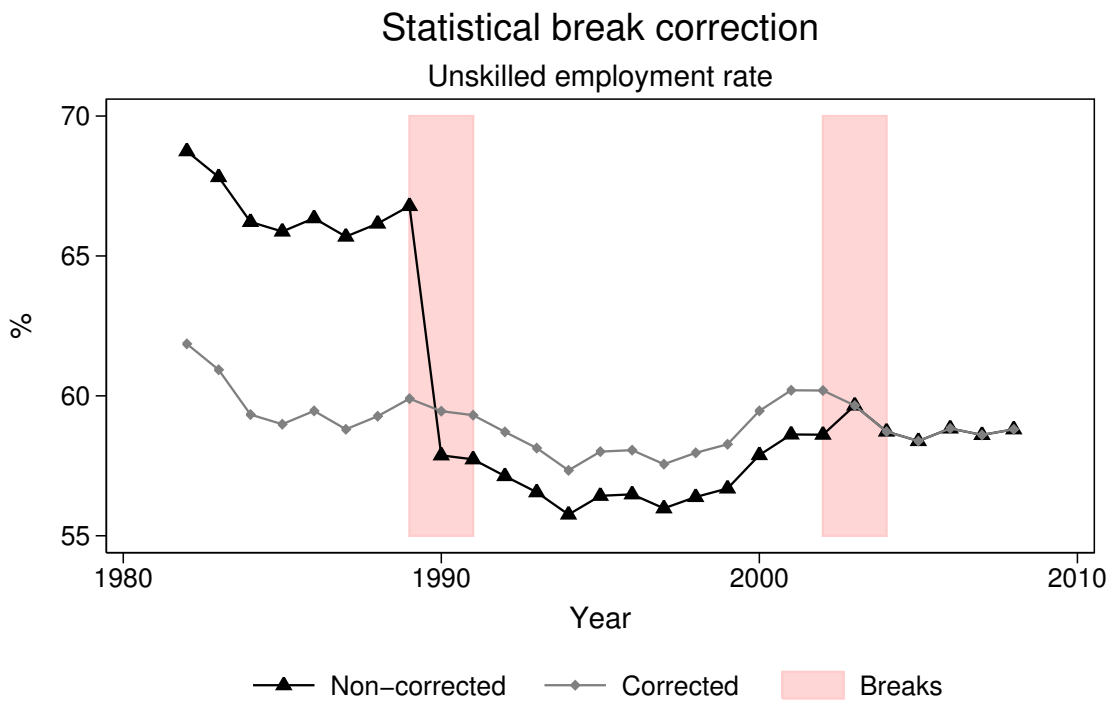


Figure 7: Statistical break correction (e_t^{UN})

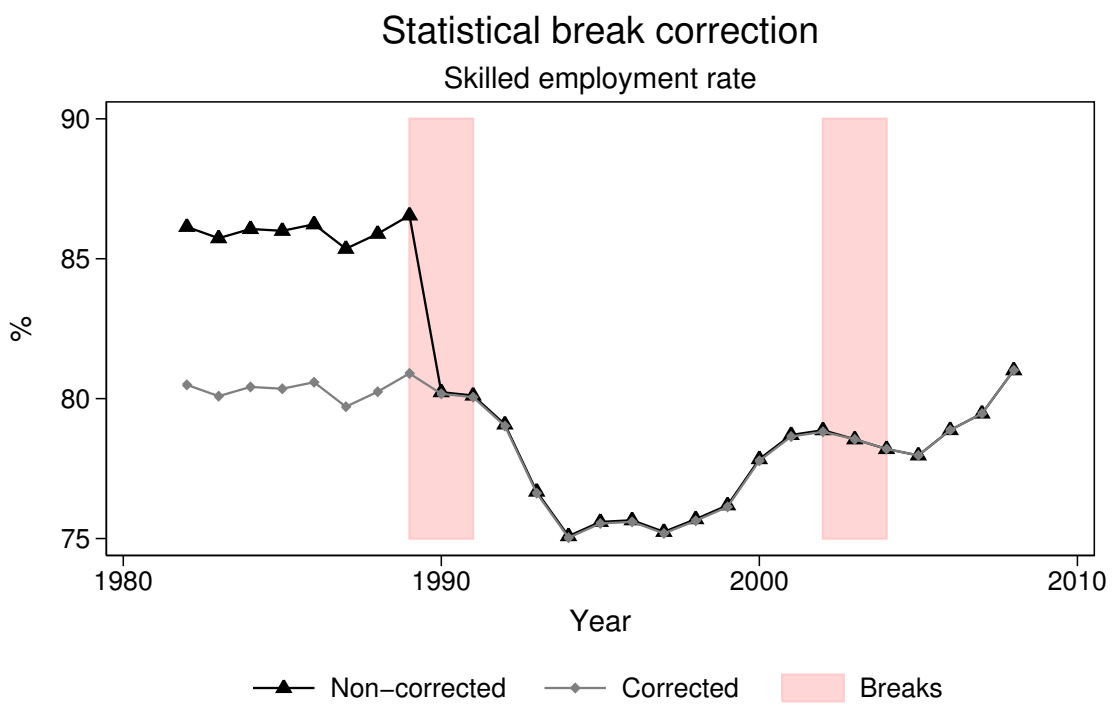


Figure 8: Statistical break correction (e_t^{SK})

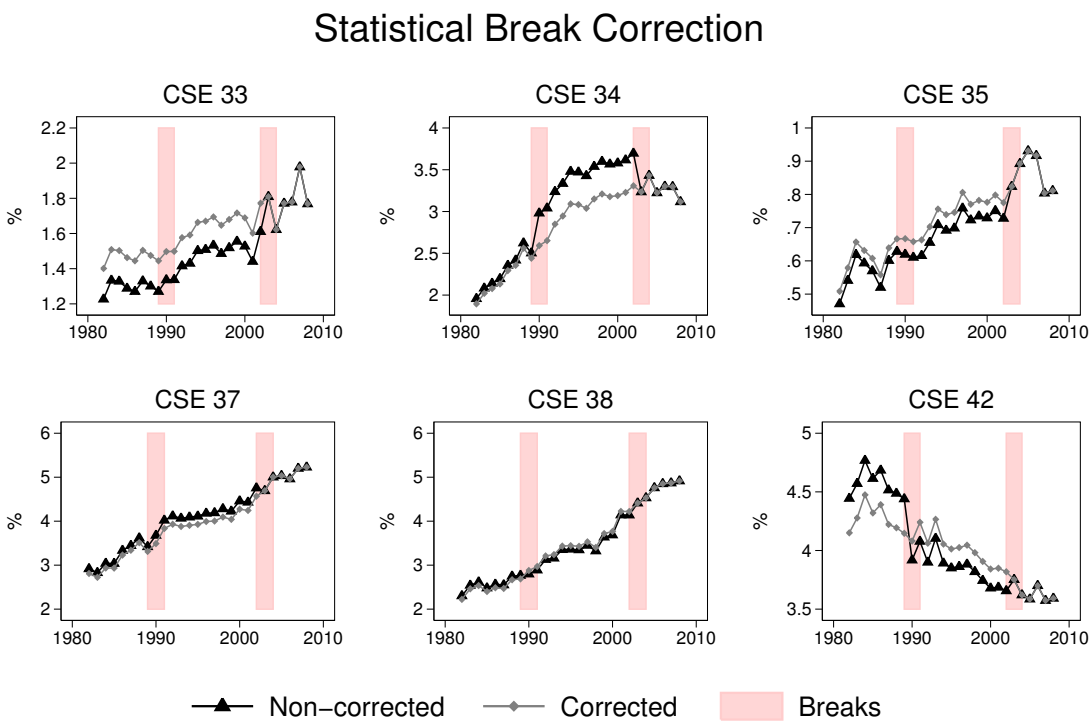


Figure 9: Statistical break correction (employment share by CSE)

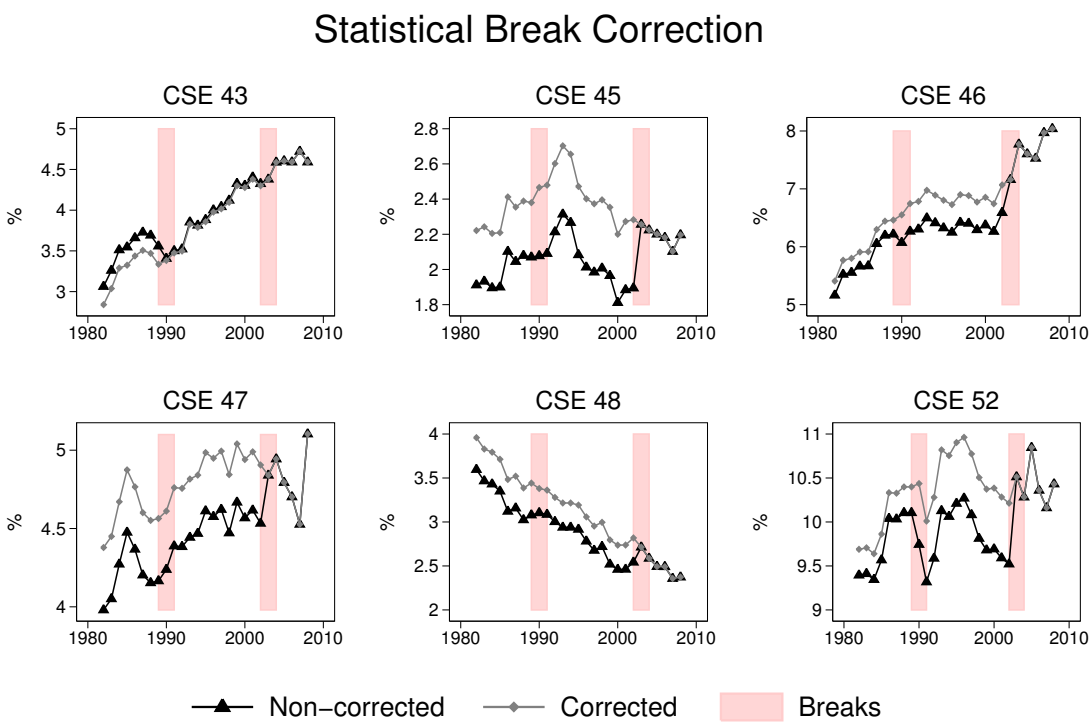


Figure 10: Statistical break correction (employment share by CSE)

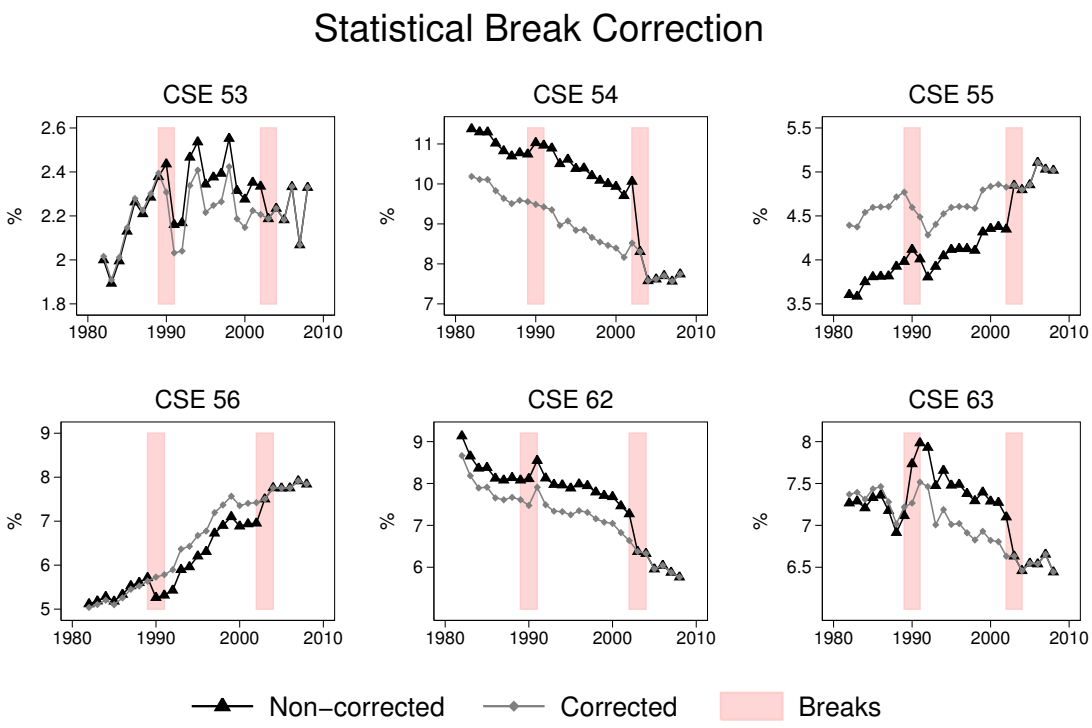


Figure 11: Statistical break correction (employment share by CSE)

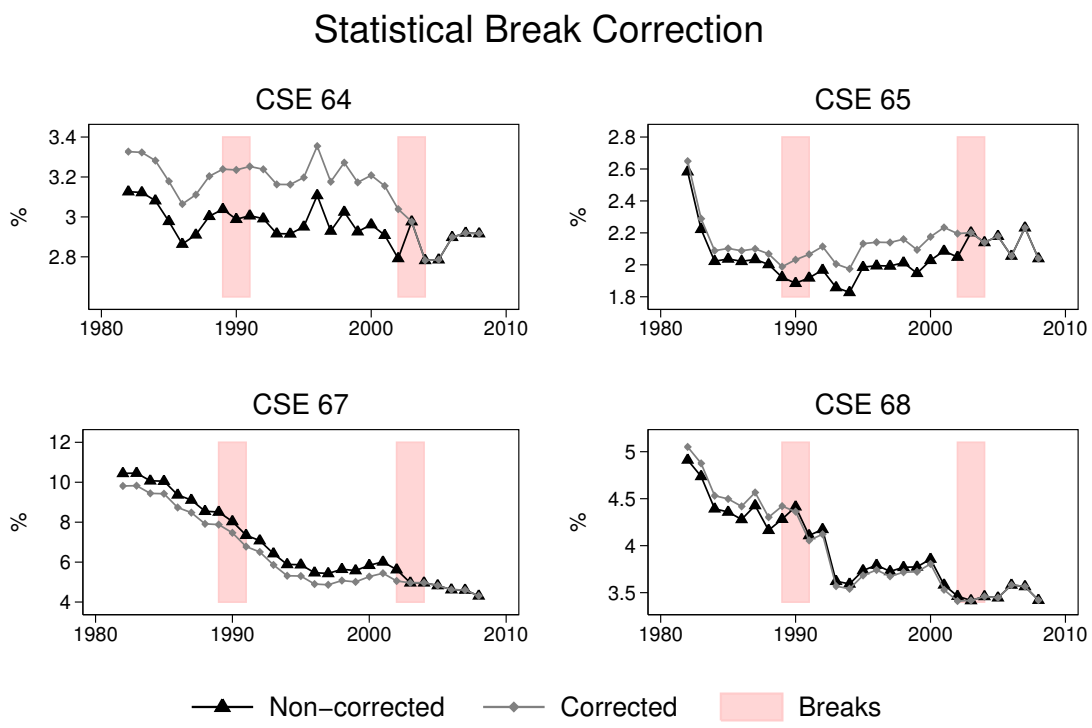


Figure 12: Statistical break correction (employment share by CSE)

A.5 Percentile weights

In order to study changes in the occupational structure or wages across the occupational wage distribution in percentiles, one needs to compute percentile weights. Since there are 374 occupations for 100 percentiles, more than one occupation might occupy a given percentile. Some occupations are larger than others and some might even overlap percentiles. I compute percentile weights for basis year t_0 that take into account such issues exactly as in Autor and Dorn (2013).

Occupations are ranked by their mean wage such that $w_{occ-1,t_0} \leq w_{occ,t_0} \leq w_{occ+1,t_0}$ with w_{occ-1,t_0} the occupation's mean wage preceding w_{occ,t_0}, and w_{occ+1,t_0} the occupation's mean wage following w_{occ,t_0}. Then, the cumulative distribution of occupational wages w_{occ,t_0} is computed by using ω_{occ,t_0} the occupational weights and denoted $G(w) = P\left(w_{occ,t_0} \leq w\right)$. An occupation *occ* is included in percentile p if $G(w_{occ-1,t_0}) \leq p$ and $p-1 \leq G(w_{occ,t_0})$. The proportion of occupation *occ*'s weight to take into account within percentile p is defined by

$$\Xi_{occ,p,t_0} = \begin{cases} \frac{1}{G(w_{occ,t_0})-G(w_{occ-1,t_0})} & \text{if } G(w_{occ-1,t_0}) < p-1 \text{ and } G(w_{occ,t_0}) \geq p \\ \frac{p-G(w_{occ-1,t_0})}{G(w_{occ,t_0})-G(w_{occ-1,t_0})} & \text{if } G(w_{occ-1,t_0}) \in [\![p-1;p] \text{ and } G(w_{occ,t_0}) > p \\ 1 & \text{if } G(w_{occ-1,t_0}) \geq p-1 \text{ and } G(w_{occ,t_0}) \leq p \\ \frac{G(w_{occ,t_0})-(p-1)}{G(w_{occ,t_0})-G(w_{occ-1,t_0})} & \text{if } G(w_{occ-1,t_0}) < p-1 \text{ and } G(w_{occ,t_0}) \in [p-1;p] \\ 0 & \text{if } G(w_{occ+1,t_0}) < p-1 \text{ or } p < G(w_{occ-1,t_0}) \end{cases}$$

Those five cases represent respectively a full overlap, a left overlap, full underlap, a right overlap and no inclusion at all in percentile p. Those percentile weights are then used to compute employment share changes and real log hourly wage changes across the occupational wage distribution in percentiles. Results are displayed in section 2.

A.6 Counter-factual re-weighting

I use the same counter-factual re-weighting method as Autor and Dorn (2013) based on the seminal work of DiNardo et al. (1995) and Fortin et al. (2010). In order to study changes in the occupational employment structure between two years, I focus on the first sample that only includes employed salary workers. The data of the two periods studied are pooled. The counter-factual curve is built by re-weighting the data through person weights $\omega_{i,t_0}^{t_0}$ or occupational weights $\omega_{occ,t_0}^{t_0}$ with the propensity score $P\left(T=1 \mid Occ\right)$ with $T=1$ if the observation is an initial year observation and $T=0$ if the observation is a final year observation. The propensity score can be interpreted as the share of initial year weighted observations for a given occupation. The sampling weight for the initial year

$\omega_{i,t_0}^{t_0}$ can be expressed as

$$\omega_{i,t_0}^{t_0} = f\left(x_i \mid T_x = t_0, Occ\right) h\left(Occ \mid T_{Occ} = t_0\right)$$

with $f\left(x_i \mid T_x = t_0, Occ\right)$ a scaling function that represents the observation x_i employment share within occupation Occ employment at the initial year while $h\left(Occ \mid T_{Occ} = t_0\right)$ is the occupation Occ employment share observed at the initial year[18]. The counter-factual weight $\omega_{i,t_0}^{t_1}$ is obtained by re-scaling final year's weights

$$\begin{aligned}
\omega_{i,t_0}^{t_1} &= f\left(x_i \mid T_x = t_1, Occ\right) h\left(Occ \mid T_{Occ} = t_0\right) \\
&= \psi_i(Occ) f\left(x_i \mid T_x = t_1, Occ\right) h\left(Occ \mid T_{Occ} = t_1\right) \\
&= \psi_i(Occ) \omega_{i,t_1}^{t_1}
\end{aligned}$$

From a practical point of view, building a counter-factual employment structure is equivalent to re-scaling the observed weights $\omega_{i,t_1}^{t_1}$ by the $\psi_i(Occ)$ factor for final year observations

$$\begin{aligned}
\psi_i(Occ) &= \frac{h\left(Occ \mid T = t_0\right)}{h\left(Occ \mid T = t_1\right)} \\
&= \frac{P\left(T = t_0 \mid Occ = Manual\right)}{1 - P\left(T = t_0 \mid Occ = Manual\right)} \frac{1 - P\left(T = t_0\right)}{P\left(T = t_0\right)}
\end{aligned}$$

since $h\left(Z = z\right) = \frac{h(Z|t_z=t_i)P(t=t_i)}{P(t=t_i|Z=z)}$ with $i = 0, 1$. Factor $\psi_i(Occ)$ can be computed by using a probit or a logit on the pooled data set.

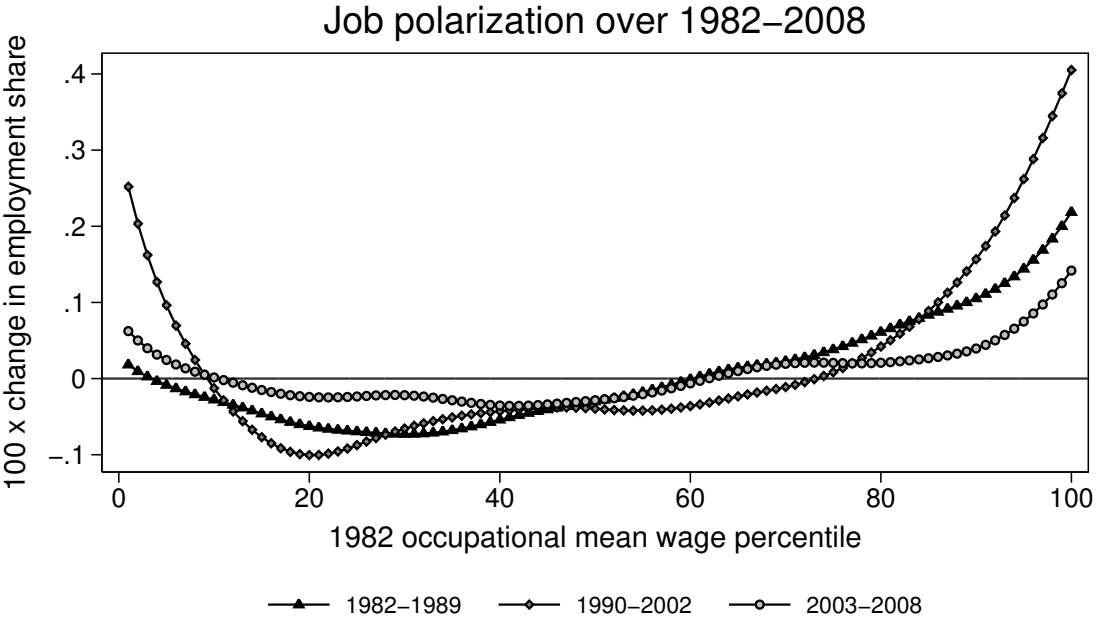
Appendix B Additional facts and robustness checks

B.1 Job polarization

In Figure 13, the "U-shape" job polarization pattern is observable between 1982 and 1989, between 1990 and 2002 and from 2003 to 2008[19]. In order to check even further the robustness of this pattern, I change the unit of analysis. Instead of focusing on the occupational level, I use occupational groups (CSE). I rank them by their mean real log hourly wage and compute changes in employment shares between 1982 and 2008. In Figure 14, I

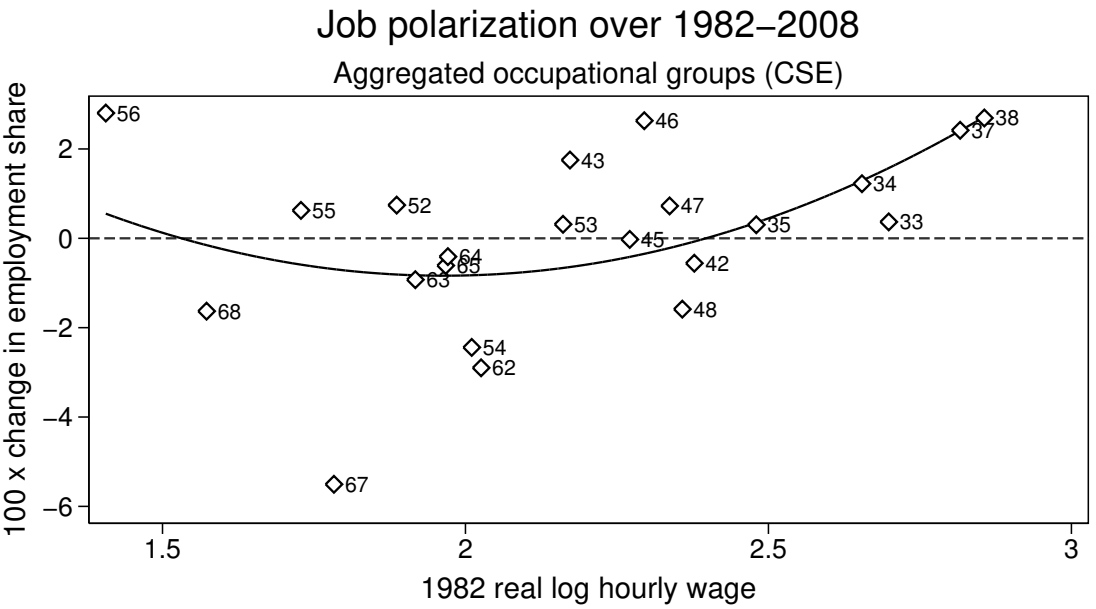
[18] If one uses occupational level data $f\left(x_i \mid T_x = t_0, Occ\right)$ would always be equal to unity.

[19] I choose those three sub-periods in order to avoid the influence of survey breaks with the exception of changes in occupational codes. Therefore, I use the occupational crosswalk that can still induce some bias. However, I find similar patterns without the occupational crosswalk and thus by using the standard occupational codes within sub-periods. Bias coming from the occupational crosswalk isn't significant at all.



Note: Sample includes salary workers who are 15–64 year old during the sample year (appendix A). Observed variable is smoothed by using a locally linear model with a .5 bandwidth.
Source: Enquête emploi, INSEE. Author's computations.

Figure 13: Periodic changes



Note: Sample includes salary workers who are 15–64 year old during the sample year (appendix A). Observations are corrected for 1990, 2003 breaks. The smoothed curve is obtained by using a unweighted quadratic fit.
Source: Enquête emploi, INSEE. Author's computations.

Figure 14: Aggregated occupational groups

obtain the same pattern as previously[20]. Table 7 displays occupational group employment shares and their respective change between 1982 and 2008. Most top-paid occupational groups experienced a rise in their employment share such as business administration and commerce occupations (CSE37) with an increase of 2.42pp, or business engineers and technicians (CSE38) with a rise of 2.69pp. On the other side, some middling-paid occupational groups experienced a fall in their employment share such as skilled industry laborers (CSE62) with a decline of 2.90pp between 1982 and 2008, or business administrative personnel (CSE54) which regroups many clerical jobs with a decline of 2.44pp. Some low-paid occupational groups on the contrary tended to expand significantly. Personal service workers (CSE56) experienced a rise of 2.80pp while public service servant (CSE52) employment share increased by .74pp. Some other low-paid occupational groups experienced a significant decline over the last three decades such as unskilled industry laborers (CSE67) with a drop of 5.51pp.

A glance at Tables 8 and 9 gives a first hint on the type of jobs that are disappearing or expanding the most. Table 8 displays a list of the fifteen most growing and fifteen most declining occupations. As for the United-States, top expanding jobs regroup a large variety of occupations. There are high-skilled abstract occupations such as engineers and research managers in computer sciences, teachers certified in secondary education but also low-skilled manual services such as childcare assistants, housekeepers, caregivers, cooks and kitchen assistants, and so forth. In most declining jobs, one can find many routine jobs which are mostly low-skilled manufacturing and clerical jobs such as unskilled production workers in textile, secretaries, typists and stenographers, and various unskilled industrial workers. Table 9 displays the fifteen most paid and least paid occupations in 1982. At the bottom of the wage distribution where employment shares tend to increase, one can find jobs such as bakers, childcare assistants, home health aides, housekeepers, janitors, cleaners, unskilled secondary construction workers. Many of those jobs are low-skilled manual jobs. At the opposite side of the wage distribution where employment shares also increase, one can find jobs such engineers, managers, financial market executives, banking executives, technical directors of large companies, which are mostly high-skilled abstract jobs. The enumeration of those jobs confirms previous findings on job polarization.

B.2 Wages

In Figure 15 and 16, I display respectively periodic changes in real log hourly net wage at the occupation level and changes in real log hourly net wage through aggregated occupa-

[20]The rise of low-paid occupation employment shares displayed by the smoothed curve seems low compared to previous figures. This is due to an aggregation effect induced by the use of aggregate occupational groups. This is why data at the occupational level are necessary to replicate the "U-shaped" curve.

	OCCUPATIONAL GROUPS	Share in % 1982	Share in % 2008	Change in %pts 1982-2008
	Aggregate Occupational Groups (CSE)			
11	Small-size farmers	-	-	-
12	Medium-size farmers	-	-	-
13	Large-size farmers	-	-	-
21	Artisans	-	-	-
22	Wholesalers and similar occupations	-	-	-
23	Heads of companies	-	-	-
31	Liberal professions	-	-	-
33	Public service professionals	1.40	1.77	0.37
34	Professors, scientific professions	1.89	3.12	1.22
35	Information, art and teaching professionals	0.51	0.81	0.30
37	Business administration and commerce personnel	2.81	5.23	2.42
38	Business engineers and technicians	2.22	4.91	2.69
42	Professors in schools, institutes, similar organizations	4.15	3.59	-0.56
43	Intermediate health and social work personnel	2.84	4.59	1.75
44	Clergy	-	-	-
45	Professional administration in public function	2.22	2.20	-0.02
46	Intermediate business administration and commerce personnel	5.41	8.04	2.63
47	Technicians	4.38	5.10	0.72
48	Foremen	3.96	2.37	-1.59
52	Public service civil servants	9.69	10.43	0.74
53	Police officers and military personnel	2.02	2.33	0.31
54	Business administrative personnel	10.19	7.75	-2.44
55	Salespeople	4.39	5.02	0.62
56	Personal service employees	5.04	7.84	2.80
62	Skilled industry laborers	8.67	5.77	-2.90
63	Skilled artisan laborers	7.37	6.44	-0.93
64	Drivers	3.33	2.92	-0.41
65	Maintenance, storage, and transportation skilled workers	2.65	2.04	-0.61
67	Unskilled industry laborers	9.82	4.31	-5.51
68	Unskilled laborers in construction finishing	5.05	3.42	-1.63
69	Agricultural Laborers	-	-	-

Note: The sample includes individuals aged between 15 and 64 years during the survey year. It includes employed salary workers who are the only ones to report their wages consistently from 1982 to 2008. Time series shares by occupational groups are corrected for 1990 and 2003 breaks. Most occupational label translations are taken from IPUMS international website: `https://international.ipums.org/international/`.

Table 7: Changes in employment shares by occupational groups

15 Most Declining Occupations (ascending order)

675a	Unskilled production workers in textile and dressmaking, tanneries, and leather work
543d	Administrative employees of various companies
542a	Secretaries
543a	Financial or accounting service employees
542b	Typists, stenographers, (non secretarial) word processing operators
681a	Unskilled structural works construction workers
671b	Unskilled workers in public works, construction and extraction work, excluding state and local government
682a	Unskilled metalworkers, locksmiths, mechanical repairers
641a	Drivers and long-haul truck drivers (fully employed)
675b	Unskilled production workers in woodworking and furniture
421a	Primary school teachers
544a	Employees and operators of computer usage
524a	Civil Service administrative officials (including education)
672a	Unskilled workers in electricity and electronics
673b	Unskilled production workers for metal formation

15 Most Growing Occupations (ascending order)

423b	Continuing education trainers and facilitators
636d	Cooks and kitchen assistants
463d	Commercial and technical sales technicians, service representatives working with companies or professionals (excluding banking, insurance, IT)
461f	Supervisors and administrative technicians of other administrative services
479b	Expert fully-employed or independent technicians, various technicians
553a	Non-specialized vendors
451f	Class B administrative staff of local authorities and hospitals (except Education, Heritage)
525c	Civil service officials (outside of schools, hospitals)
523a	Deputy civil service administrators (including education)
341a	Professors specializing and certified in secondary education
431f	General care nurses, fully employed
526a	Caregivers (civil service or private sector)
388a	Engineers and research managers, research and development in computer science
563a	Childcare assistant, nannies, host families
563b	Home health aides, housekeepers, family workers

Note: The sample includes individuals aged between 15 and 64 years during the survey year. It includes employed salary workers who are the only ones to report their wages consistently from 1982 to 2008. Most occupational label translations are taken from IPUMS international website: `https://international.ipums.org/international/`.

Table 8: Occupational employment share change rank 1982-2008

15 Least Paid Occupations (ascending order)

683a	Baker, butcher apprentices
563a	Childcare assistants, nannies, host families
563b	Home health aides, housekeepers, family workers
564a	Janitors, caretakers
562b	Fully employed hairdressers
563c	Domestic workers
682a	Unskilled metalworkers, locksmiths, mechanical repairers
681b	Unskilled secondary construction workers
636b	Pork butchers (except meat industry)
684a	Cleaners
564b	Employees in various services
344c	Medical, odontology, and pharmacy interns
554a	Food vendors
675a	Unskilled production workers in textile and dressmaking, tanneries, and leather work
561a	Servers, restaurant assistants, waiters (bar, pub, cafe or restaurant)

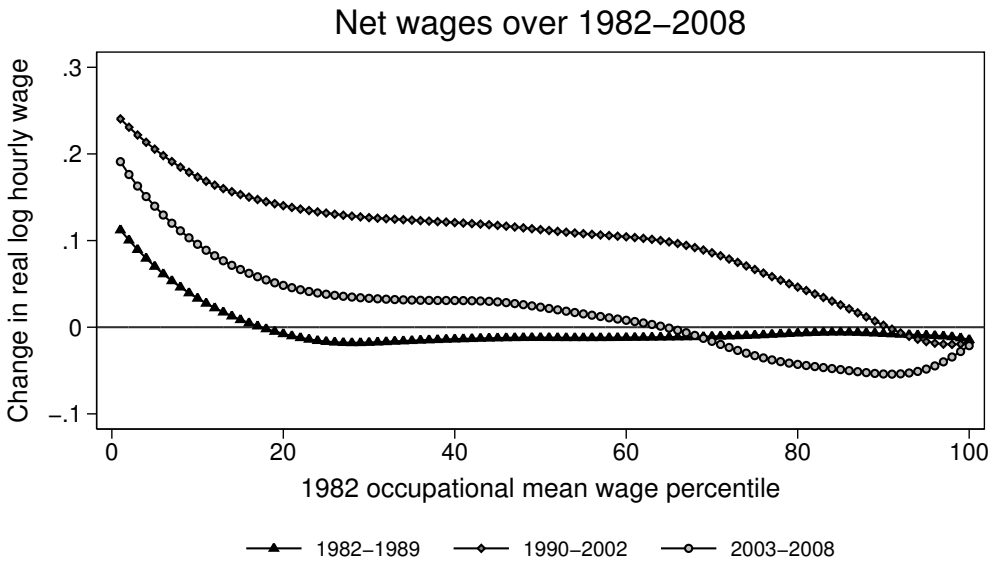
15 Most Paid Occupations (ascending order)

384a	Engineers and research managers, R&D in mechanics and metalworking
376c	Commercial bank executives
384b	Engineers and managers in manufacturing in mechanics and metalworking
344b	Non-hospital, affiliated doctors
385a	Engineers and research managers, R&D of processing industries (food, chemicals, metallurgy, heavy materials)
388d	Engineers and technical sales executives in IT and telecommunications
342a	Higher education instructors
386d	Engineers and managers in the production and distribution of energy, water
381a	Engineers and research and farming managers for agriculture, fisheries, water and forests
385b	Engineers and managers of manufacturing processing industries (food, chemicals, metallurgy, heavy materials)
383b	Engineers and managers in manufacturing of electrical, electronic materials
331a	Public service management personnel (State, local authorities, hospitals)
371a	Top administrative, finance and commercial management for large companies
333a	Magistrates
380a	Technical directors of large companies

Note: The sample includes individuals aged between 15 and 64 years during the survey year. It includes employed salary workers who are the only ones to report their wages consistently from 1982 to 2008. Most occupational label translations are taken from IPUMS international website: `https://international.ipums.org/international/`.

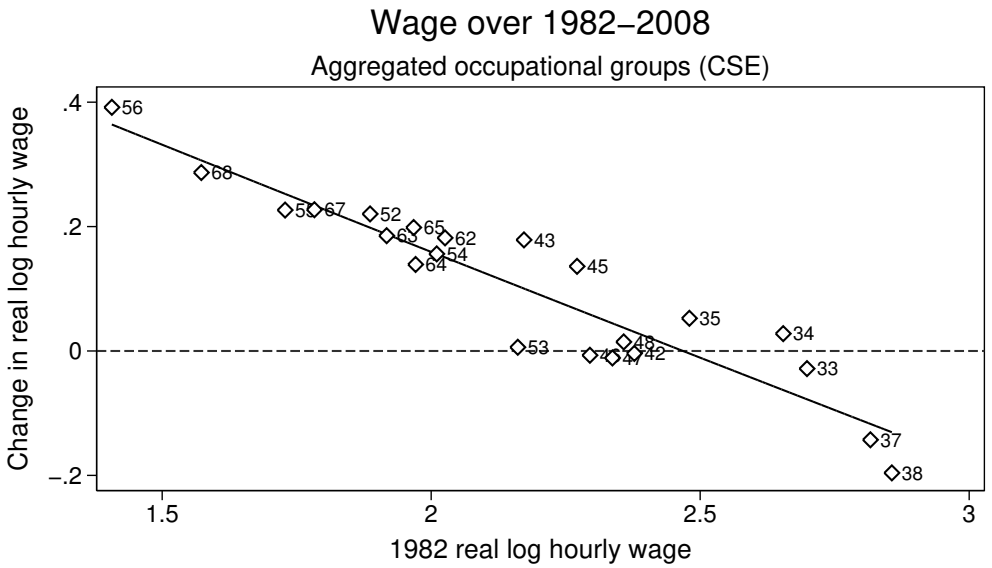
Table 9: Occupational mean wage rank 1982

tional groups. As for job polarization, the wage pattern is consistent across sub-periods and across aggregated occupational groups suggesting its robustness.



Note: Sample includes salary workers who are 15–64 year old during the sample year (appendix A).
Observed variable is smoothed by using a locally linear model with a .5 bandwidth.
Source: Enquête emploi, INSEE. Author's computations.

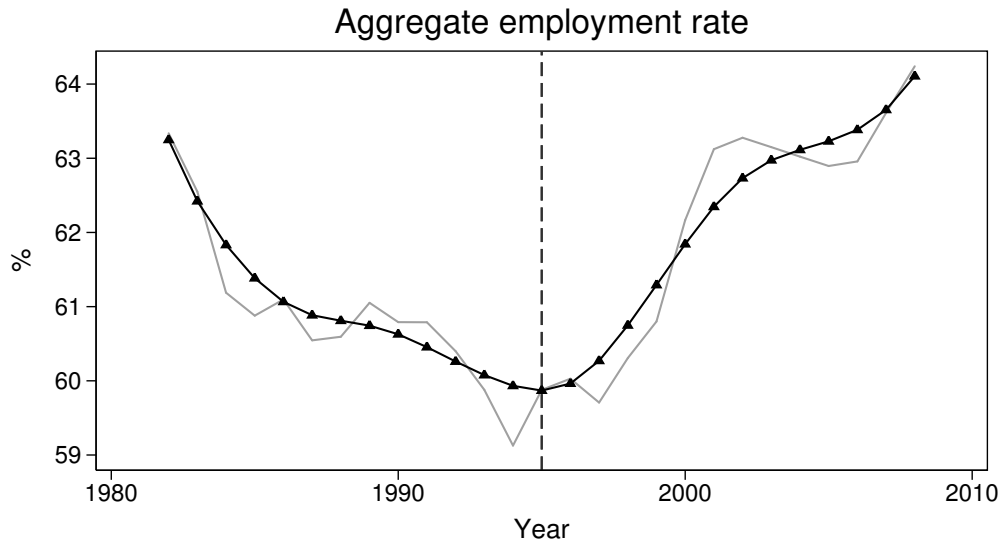
Figure 15: Periodic changes



Note: Sample includes salary workers who are 15–64 year old during the sample year (appendix A).
The smoothed curve is obtained by using a unweighted quadratic fit.
Source: Enquête emploi, INSEE. Author's computations.

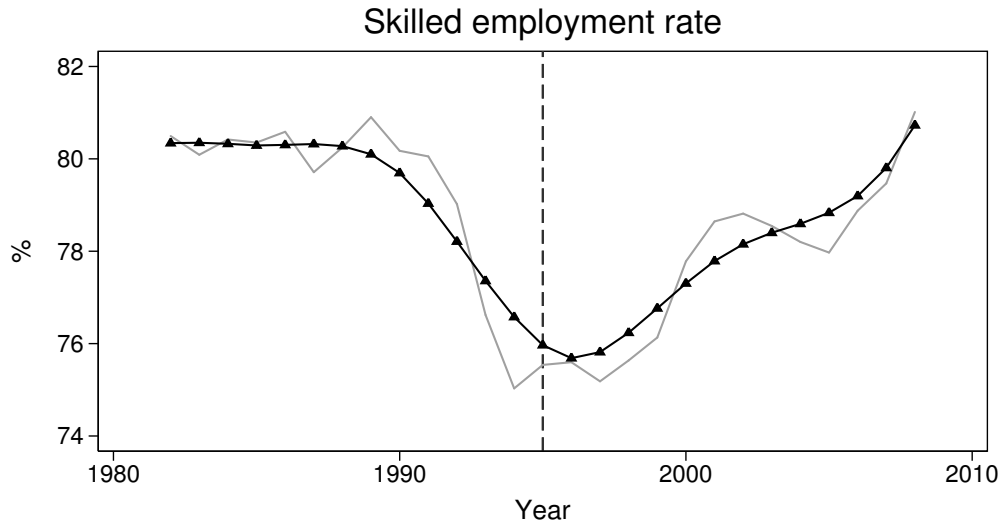
Figure 16: Aggregated occupational groups

B.3 Employment rates



Note: Sample includes 15–64 year old individuals during the sample year (appendix A). Observations are corrected for 1990, 2003 breaks (grey) and then smoothed (black) using a locally linear model with a 0.4 bandwidth.
Source: Enquête emploi, INSEE. Author's computations.

Figure 17: Aggregate employment



Note: Sample includes 15–64 year old individuals during the sample year (appendix A). Skilled indivuduals are defined as individuals who have at least a post high–school degree (Bac+2). Observations are corrected for 1990, 2003 breaks (grey) and then smoothed (black) using a locally linear model with a 0.4 bandwidth.
Source: Enquête emploi, INSEE. Author's computations.

Figure 18: Skilled employment rate

Changes in the occupational employment structure occurred concomitantly with changes in the aggregate employment level. The aggregate employment rate rose by 0.86pp between 1982 and 2008. This overall increase hides non autonomous changes within this interval of time. Figure 17 displays the French rate between 1982 and 2008. On the one hand, the employment rate declined by 3.38pp from 63.25% to 59.87% between 1982 and 1995. On the other hand, from 1995 onward, it increased by 4.24pp to reach 64.12% in 2008. Those changes in the aggregate employment rate hide very different employment behaviors across skills.

The evolution of aggregate employment reflects changes in skilled and unskilled employment rates. Skilled individuals are those who have at least a post high-school degree while unskilled individuals are those who have at most a high school degree. The skilled and unskilled employment rates are defined respectively by the following equations

$$\begin{aligned} e_t^{SK} &= \frac{E_t^{SK}}{P_t^{SK}} \\ e_t^{UN} &= \frac{E_t^{UN}}{P_t^{UN}} \end{aligned}$$

with e_t^s the skill s employment rate, E_t^s the skill s employment level, P_t^s skill s working age population with $s \in \{SK, UN\}$, SK and UN referring respectively to skilled and unskilled individuals.

The skilled employment rate remained stable from 1982 to 1990 which means that the fall of the employment rate during this period couldn't come from the fall in skilled employment. However, from 1990 to 1996, the skilled employment rate fell by 4.65pp from 80.34% to 75.69%. In contrast with the previous period, the skilled employment rate rose significantly by 5.04pp from 75.69% to 80.73% between 1996 to 2008.

B.4 Labor taxation

Average labor tax rates

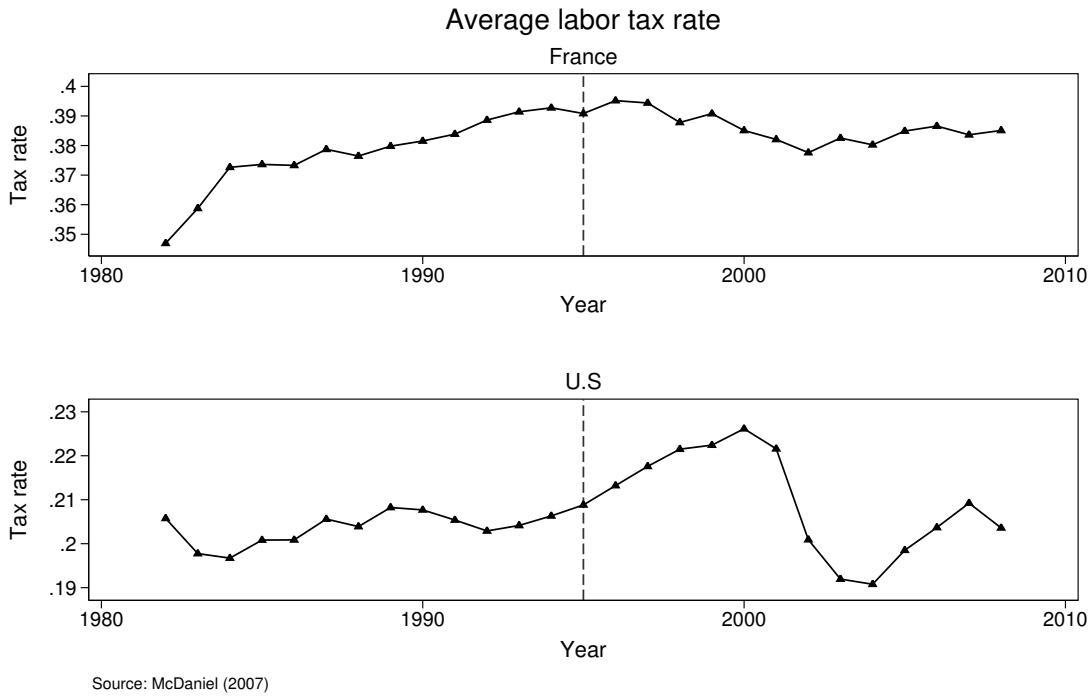


Figure 19: $\tau = \tau_{SS} + \tau_{inc}$

In this paper, I claim that labor taxation policies might be a feature that altered the impact of job polarization on unskilled employment in France. Labor taxation is acknowledged for being particularly high in France. Furthermore, the literature[21] suggests that low-skilled employment is much more sensitive to its labor costs compared to skilled employment. Therefore, labor taxation might impact strongly unskilled employment and the reallocation of labor specific to job polarization. McDaniel (2007) imputes tax rates time series for several countries including France based on OECD national accounts publications. Based on those time series, I compute an average labor tax rate

$$\tau = \tau_{SS} + \tau_{inc}$$

[21] On the one hand, Kramarz and Philippon (2001) and Gianella (1999) find that the elasticity of employment to the labor cost of low wage workers is close to one. On the other hand, Hamermesh (1993) and Cahuc and Carcillo (2012) claim that the elasticity of employment to the labor cost is decreasing with the wage. The higher the wages, the less employment is sensitive to its cost. One plausible explanation is that capital labor substitution might not be the same across the wage distribution.

with τ_{SS} the average social security tax rate and τ_{inc} the household average income tax rate. The French average labor tax rate τ_{fr} is displayed in Figure 19. From 1982 to 2008 it increased by 3.82pp from 34.69% to 38.51%. Changes in the average labor tax rate can be decomposed into two main sub-periods as done previously with employment rates. From 1982 to 1995, it increased by 4.39pp from 34.69% to 39.08%. From 1995 to 2008, the average labor tax rate stayed relatively stable and even declined slightly to reach 38.51%. The French average labor tax rate is particularly high with respect to many other developed countries. For example, the French average labor tax rate was almost twice as high as its U.S counterpart in 1995.

Digressive payroll tax reduction policies

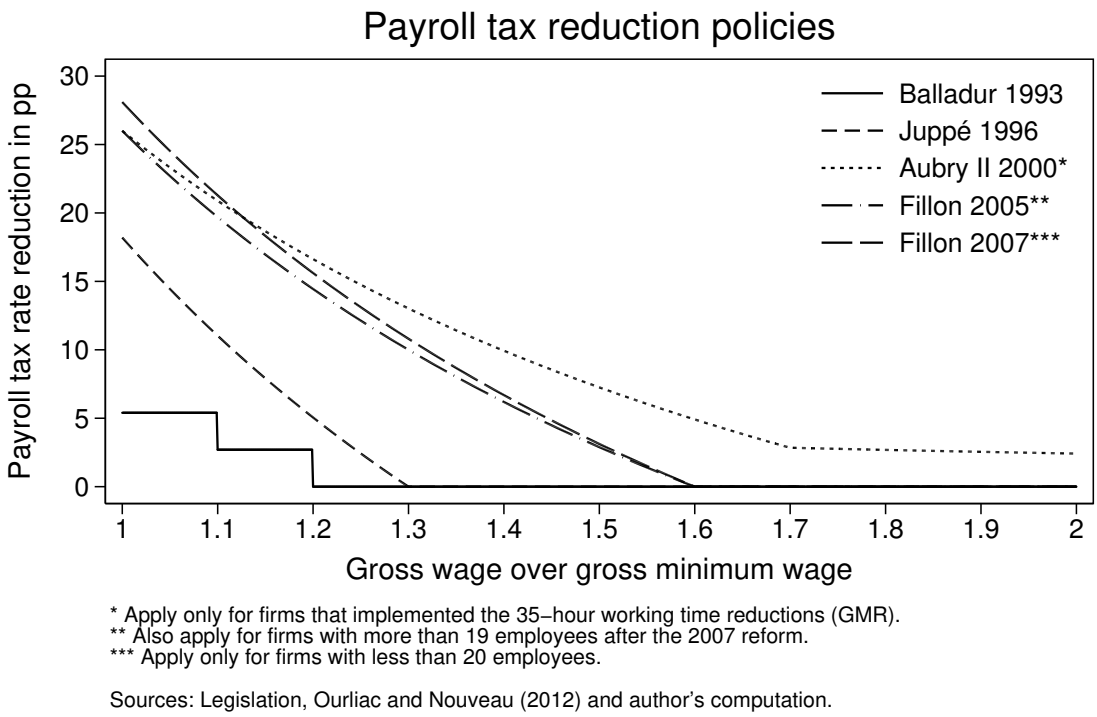


Figure 20: Payroll tax rate reduction

There is a drawback from only referring to the average labor tax rate. It hides the implementation of labor cost reduction policies targets in low-paid workers. From 1993 to 2008, France massively relied on payroll tax reduction policies focused on low-paid workers to increase employment. According to Ourliac and Nouveau (2012), the main policy evaluation reports that those policies saved between 400,000 and 1,100,000 jobs depending on the time span, the reforms studied and the methodology used.

Those policies costed more than 20 billion euros in 2008 which represents more than 1% of French gross domestic product at the time while they used to cost only 3.1 billion euros in 1995. The Veil law was introduced in July 25th 1994 to ensure that labor cost reduction policies could not be conducted at the expense of a degrading fiscal deficit. The law (Article L. 131-7 of the French social security code) establishes a cost compensation principle such that labor cost reduction policies must be financed by additional fiscal receipts. Since 1994, most social contribution exemptions on low-paid jobs have been financed by increases in social contributions and income taxes mostly borne by high-paid workers as observed by Catherine et al. (2015).

In Figure 20, I display payroll tax rate reductions for some major policies. Those policies were implemented in two main steps. From 1993 to 1998, the Balladur[22] and the Juppé laws[23] progressively implemented a 18.2pp digressive payroll tax rate reduction for workers paid at the minimum wage that cancels out at 1.3 minimum wage. From 1998 to 2007, additional payroll tax reductions were implemented in order to counter the increase in the labor cost induced by the working time reduction policies implemented by the Aubry I and II laws[24]. The Aubry I law introduced a lump-sum financial aid independent of worker's salary for firms that implemented directly the working time reduction policy. The Aubry II law introduced an additional payroll tax reduction targeted on low-paid workers for firms that implemented the 35-hour working time reduction policy[25]. Instead of benefiting from the Juppé payroll tax reduction, those firms benefited from a reduction by 26pp of the payroll tax rate for the minimum wage that declined until 1.7 minimum wage. Above this threshold, employers received a 609.79 euros lump-sum financial aid in 2000 independent of worker's salary. The Fillon law[26] progressively unified and generalized the digressive payroll tax reductions to reach a 26pp payroll tax rate reduction for the minimum wage that cancels out at 1.6 minimum wage for all firms. In 2007, a slight modification was introduced[27]. The payroll tax rate reduction was of 26pp for the minimum wage for firms with more than nineteen employees and of 28.1pp for the minimum wage for firms with less than twenty employees and canceled out at 1.6 minimum wages.

[22]The Balladur law of 1st July 1993 suppressed family social contributions (-5.4pp) for workers paid at the minimum wage to 1.1 minimum wage and suppressed half of them for those paid from 1.1 to 1.2 minimum wage.

[23]Law of 1st October 1996 law and law of 1st January 1998.

[24]Respectively the law of 13 June 1998 and the law of 19 January 2000. Those laws are also well known under the name of "thirty five hour laws".

[25]In order to benefit from additional payroll tax reductions, firms that implemented the 35-hour working time reduction reform had to pay minimum wage workers a monthly wage equal to what they would have received before the reform. This is called the monthly guarantee of remuneration (GMR).

[26]Law of 17 January 2003. The payroll tax rate reduction was implemented progressively and took its final form with the reform of 1st of July 2005.

[27]Law of 1st July 2007.

Labor taxation in the model

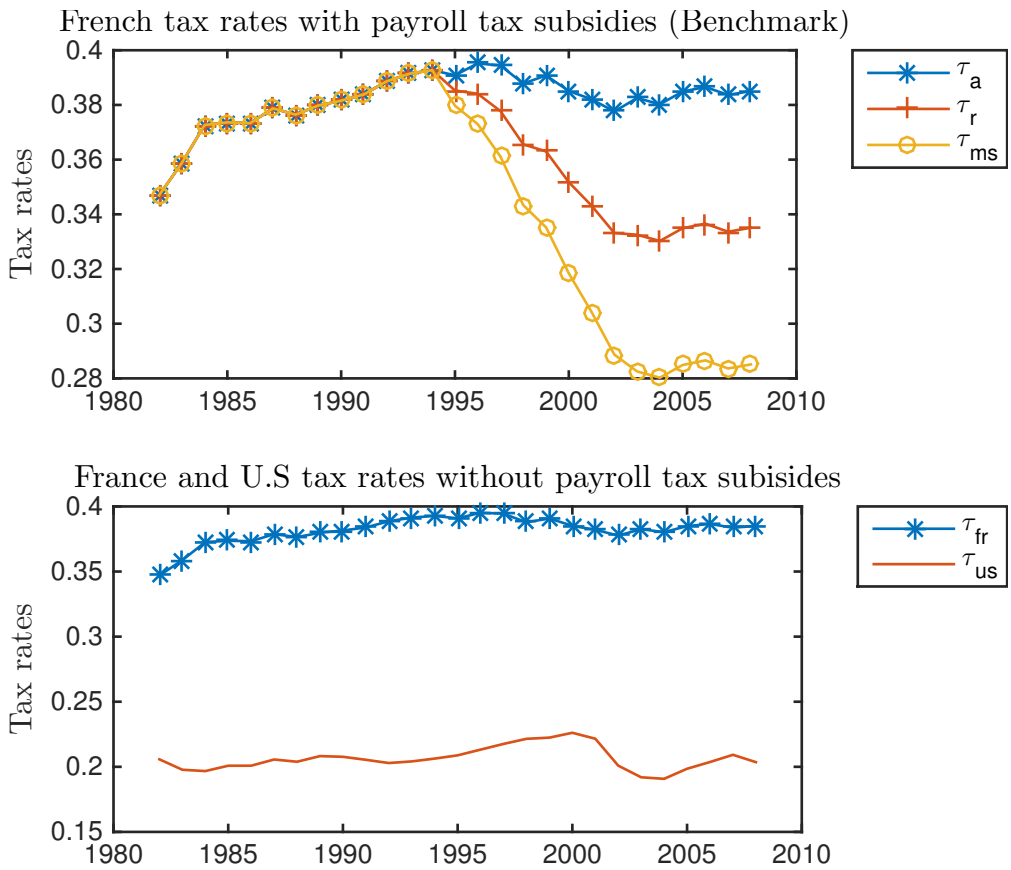


Figure 21: Tax rates with and without labor cost reduction policies

Appendix C Additional results

C.1 The asymptotic economy

Preliminary computations

As in Autor and Dorn (2013), I now turn to asymptotic wages and allocation of labor in order to understand how this economy behaves in the long run. The computation of asymptotic wages and labor allocation allows us to have a preliminary idea of the parameter values that one should obtain during the calibration.

One cannot use the social planner program. Because of distortionary taxation, this exercise has to rely on the decentralized equilibrium. In this section, I focus mainly on the role played by the diffusion of ICT capital. The growth device of the model is perfectly deterministic. As time passes, the price of capital falls and the capital stock increases

because capital and routine labor are substitutes (i.e $\mu \in [0;1]$)

$$\begin{aligned} \lim_{t\to+\infty} p_k &= 0 \\ \lim_{t\to+\infty} K &= +\infty \end{aligned}$$

Indeed, as time passes, the price of capital tends to zero because of capital diffusion. Therefore, capital is less expensive and goods producers buy more capital. Since routine labor is bounded[28] and is a substitute for capital, producers progressively substitute capital to routine labor. Therefore, the production of $X = [((1-\alpha_k)l_r)^\mu + (\alpha_k K)^\mu]^{\frac{1}{\mu}}$ is asymptotically[29] determined by capital

$$X \sim \alpha_k K \tag{23}$$

According to the definition of Y_g and equation (11), the asymptotic production of the goods sector is defined by

$$Y_g \sim (\alpha_k K)^\beta$$

Using equation (6),the price of capital is equal to

$$p_k = \beta \alpha_k^\mu K^{\mu-1} X^{\beta-\mu}$$

This implies that asymptotically

$$\begin{aligned} p_k &\sim \beta \alpha_k^\beta K^{\beta-1} \\ p_k K &\sim \beta (\alpha_k K)^\beta \end{aligned}$$

Given the definition of good consumption $C_g = Y_g - p_k K$, I obtain the asymptotic consumption of market goods

$$C_g \sim (1-\beta)(\alpha_k K)^\beta \tag{24}$$

In order to find asymptotic wages and allocation of labor, some of the equilibrium conditions and variables have to be rewritten. Employment for each task and sector can be written as a function of market service employment. According to equation (13)

$$l_n = \Theta l_{ms}$$

[28] Indeed, we have $l_r = (1+\overline{\eta})\, e^{-\overline{\eta}}$ with $\overline{\eta} \in [0;+\infty[$ and therefore $l_r \in [0;1]$.

[29] $x \sim y$ and $\lim_{t\to+\infty} \frac{x}{y} = 1$ are two equivalent notations.

with $\Theta = \left(\frac{A_{ms}}{A_n}\right)^{\frac{\nu}{\nu-1}} \left[\frac{a_s(1-\tau_{ms})}{1-a_s}\right]^{\frac{1}{\nu-1}}$. Variables l_s, $\overline{\eta}$, l_r are also written as a function of l_{ms} by using equations (9) and (10)

$$
\begin{aligned}
l_s &= (1+\Theta)\, l_{ms} && (25)\\
\overline{\eta} &= -ln\,(1-(1+\Theta)\, l_{ms}) && (26)\\
l_r &= [1-ln\,(1-(1+\Theta)\, l_{ms})]\,[1-(1+\Theta)\, l_{ms}] && (27)
\end{aligned}
$$

Asymptotic wages

One needs asymptotic wages to compute the asymptotic allocation of labor. The asymptotic routine wage is computed by using equations (4), (23) and (27)

$$
\begin{aligned}
w_r &= \beta(1-\alpha_k)^{\mu} l_r^{\mu-1} X^{\beta-\mu}\\
w_r &\sim \beta(1-\alpha_k)^{\mu}\,[1-ln\,(1-l_s)]^{\mu-1}\,[1-l_s]^{\mu-1}\,(\alpha_k K)^{\beta-\mu} && (28)
\end{aligned}
$$

with $l_s = (1+\Theta)\, l_{ms}$. For the abstract wage, I obtain

$$
\begin{aligned}
w_a &= (1-\beta)\, X^{\beta}\\
w_a &\sim (1-\beta)\,(\alpha_k K)^{\beta} && (29)
\end{aligned}
$$

Equations (7) and (13) give the asymptotic manual wage

$$
\begin{aligned}
w_{ms} &= \Omega^{-1} l_{ms}^{\varepsilon-1} C_g^{1-\varepsilon} && (30)\\
w_{ms} &\sim \Omega^{-1} l_{ms}^{\varepsilon-1}\,(1-\beta)^{1-\varepsilon}\,(\alpha_k K)^{\beta(1-\varepsilon)} && (31)
\end{aligned}
$$

with $\Omega = \frac{a_g}{a_s(1-a_g)} A_{ms}^{-\nu}\,[a_s A_{ms}^{\nu} + (1-a_s)\,(A_n\Theta)^{\nu}]^{\frac{\nu-\varepsilon}{\nu}}$. By using (8), (26) and (28), the asymptotic manual wage rate can be rewritten as

$$
\begin{aligned}
w_{ms} &= -ln\,(1-l_s)\, w_r && (32)\\
w_{ms} &\sim -ln\,(1-l_s)\,\beta(1-\alpha_k)^{\mu}\,[(1-ln\,(1-l_s))\,(1-l_s)]^{\mu-1}\,(\alpha_k K)^{\beta-\mu} && (33)
\end{aligned}
$$

with $l_s = (1+\Theta)\, l_{ms}$.

Asymptotic allocation of employment

By rearranging equation (30), I obtain a relation that links manual employment in the market sector with the manual wage rate

$$
l_{ms}^{\varepsilon-1} = \Omega C_g^{\varepsilon-1} w_{ms}
$$

Therefore, asymptotic manual employment in market services $\lim_{t\to+\infty} l_{ms}(t)$ is the solution to

$$\left(\frac{l_s}{1+\Theta}\right)^{\varepsilon-1} = -\Omega\beta(1-\alpha_k)^{\mu}(1-\beta)^{\varepsilon-1} ln(1-l_s)\left[(1-ln(1-l_s))(1-l_s)\right]^{\mu-1}(\alpha_k K)^{\beta\varepsilon-\mu}$$

with $l_s = (1+\Theta)\, l_{ms}$. As in Autor and Dorn (2013), it depends on the value of production and consumption elasticities of substitution[30]. By using the previous equation, one can solve the asymptotic level of l_s and thus l_{ms} and l_n

$$\lim_{t\to+\infty} l_s = \begin{cases} 1 & \text{if } \varepsilon < \frac{\mu}{\beta} \\ ]0;1[& \text{if } \varepsilon = \frac{\mu}{\beta} \\ 0 & \text{if } \varepsilon > \frac{\mu}{\beta} \end{cases} \tag{34}$$

In contrast to Autor and Dorn (2013), because of the existence of a non-market sector, the allocation of market services employment cannot be directly computed. One needs an additional condition to disentangle market service employment from non-market labor. Therefore, I use the market service employment equation (25) such that I obtain

$$\lim_{t\to+\infty} l_{ms} = \begin{cases} \frac{1}{1+\Theta} & \text{if } \varepsilon < \frac{\mu}{\beta} \\ \frac{1}{1+\Theta} l_s & \text{with } l_s \in]0;1[\text{ if } \varepsilon = \frac{\mu}{\beta} \\ 0 & \text{if } \varepsilon > \frac{\mu}{\beta} \end{cases} \tag{35}$$

$$\lim_{t\to+\infty} l_n = \begin{cases} \frac{\Theta}{1+\Theta} & \text{if } \varepsilon < \frac{\mu}{\beta} \\ \frac{\Theta}{1+\Theta} l_s & \text{with } l_s \in]0;1[\text{ if } \varepsilon = \frac{\mu}{\beta} \\ 0 & \text{if } \varepsilon > \frac{\mu}{\beta} \end{cases} \tag{36}$$

with $\Theta = \left(\frac{A_{ms}}{A_n}\right)^{\frac{\nu}{\nu-1}} \left[\frac{a_s(1-\tau_{ms})}{1-a_s}\right]^{\frac{1}{\nu-1}}$. Parameters ε, β and μ are crucial for determining the asymptotic allocation of employment for total manual services. In contrast to Autor and Dorn (2013), because of the existence of a non-market sector, the allocation of market service employment depends on Θ. In other words, the asymptotic allocation of employment to the market service sector and the non-market sector depends on ε, β and μ, but also on ν, τ_{ms}, a_s, A_{ms} and A_n. In this paper, I'm mostly interested in τ_{ms}, A_n and ν . The allocation between the two sub-service sectors depends on non-market labor productivity A_n, the average labor tax rate on market service work τ_{ms}, and the elasticity

[30]The asymptotic allocation of l_s depends on ε, β and μ. Then, l_{ms} and l_n are defined both by l_s and the share parameter Θ which depends on preference and technology parameters such as ν and τ.

of substitution between market services and non-market production goods $\sigma_s = \frac{1}{1-\nu}$ which modulates the effect of τ_{ms} and A_n. Since I assumed that market services and non-market produced goods are substitutes ($\nu < 0$), Θ is an increasing function of τ_{ms} and A_n. On the one hand, a higher market service labor tax rate implies that there are more unskilled non-employment and less employment in the market service sector asymptotically for a given level of non-market labor productivity. Even if there is no market service labor taxation ($\tau_{ms} = 0$), there is still some unskilled non-employment. The representative agent consumes non-market goods because they are a good substitute to market services but also because he has a taste for diversity. The more he values non-market goods (low a_s), the more he consumes them. On the other hand, lower non-market labor productivity for a given market service labor tax rate induces a decline in unskilled non-employment and an increase in market service employment because of the rising opportunity cost of not working in the market service sector.

Asymptotic wage inequality

Finally, I compute the asymptotic wage ratios. When those are indeterminate, I compute the asymptotic relative labor share. The manual to routine wage ratio is computed from equation (32) and (34)

$$\lim_{t\to+\infty} \frac{w_{ms}}{w_r} = \begin{cases} +\infty & \text{if } \varepsilon < \frac{\mu}{\beta} \\ -ln\left(1-l_s\right) & \text{if } \varepsilon = \frac{\mu}{\beta} \\ 0 & \text{if } \varepsilon > \frac{\mu}{\beta} \end{cases} \tag{37}$$

The asymptotic abstract to manual wage ratio is computed by combining (29) and (31)

$$\lim_{t\to+\infty} \frac{w_a}{w_{ms}} = \Omega\left(1-\beta\right)^{\varepsilon}\left(\alpha_k K\right)^{\beta\varepsilon} l_{ms}^{1-\varepsilon}$$

The asymptotic economy replicates the observed rise in market service employment and relative wage as for the decline in routine employment when $\varepsilon < \frac{\mu}{\beta}$. Therefore, I focus on the case where $\varepsilon < \frac{\mu}{\beta}$ which means that $l_{ms} = \frac{1}{1+\Theta}$. In fact, three sub-cases are distinguishable depending on the value of ε:

$$\lim_{t\to+\infty} \frac{w_a}{w_{ms}} = \begin{cases} +\infty & \text{if } \varepsilon > 0 \\ \frac{\Omega}{1+\Theta} & \text{if } \varepsilon = 0 \\ 0 & \text{if } \varepsilon < 0 \end{cases} \tag{38}$$

According to the literature, the empirically relevant case that replicates the process of structural transformation and labor market polarization occurs when $\varepsilon < 0$ such that goods and manual services are complementary. In such case, the abstract wage grows less rapidly than the market service wage as observed in the data. On the contrary, when $\varepsilon > \frac{\mu}{\beta}$, $\varepsilon \in [0;1]$ and $l_{ms} = 0$ given A_n. Therefore, the asymptotic abstract to manual relative labor share tends to zero[31]

$$\lim_{t \to +\infty} \frac{l_a w_a}{l_{ms} w_{ms}} = 0 \tag{39}$$

The abstract to routine wage ratio is then computed

$$\lim_{t \to +\infty} \frac{w_a}{w_r} = \frac{(1-\beta)\,(\alpha_k K)^{\mu}}{\beta(1-\alpha_k)^{\mu}\,[1 - ln\,(1-l_s)]^{\mu-1}\,[1-l_s]^{\mu-1}}$$

When $\varepsilon < \frac{\mu}{\beta}$, $l_s = 1$ and the abstract to routine relative labor share tends to zero

$$\lim_{t \to +\infty} \frac{l_a w_a}{l_r w_r} = 0 \tag{40}$$

When $\varepsilon \geq \frac{\mu}{\beta}$, $l_s \in [0;1[$. Since $\mu \in [0;1]$, the abstract to routine wage ratio tends to infinity

$$\lim_{t \to +\infty} \frac{w_a}{w_r} = +\infty \tag{41}$$

[31]This case is not relevant empirically. In this case, consumption goods and services (both market and non-market produced) are substitutes. Rogerson (2008) and Autor and Dorn (2013) are two examples in which $\varepsilon < 0$ in order to replicate observed patterns which means that goods and services are complements.

C.2 Additional figures

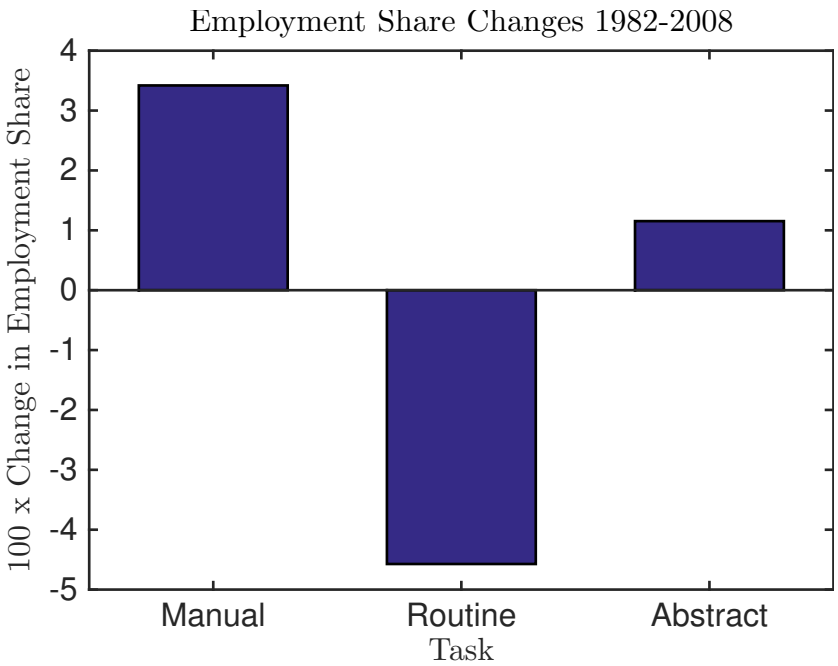


Figure 22: Job polarization

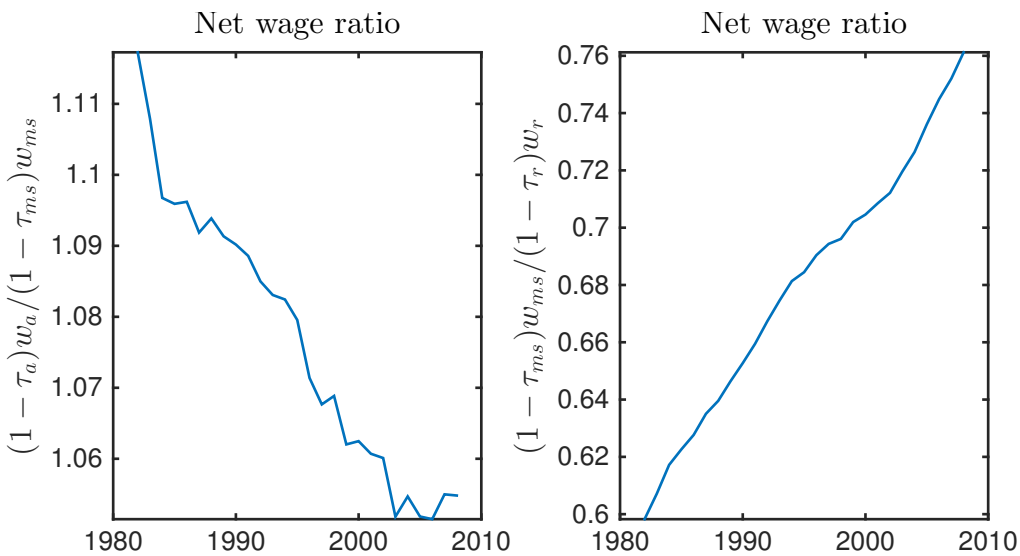


Figure 23: Relative net wage change

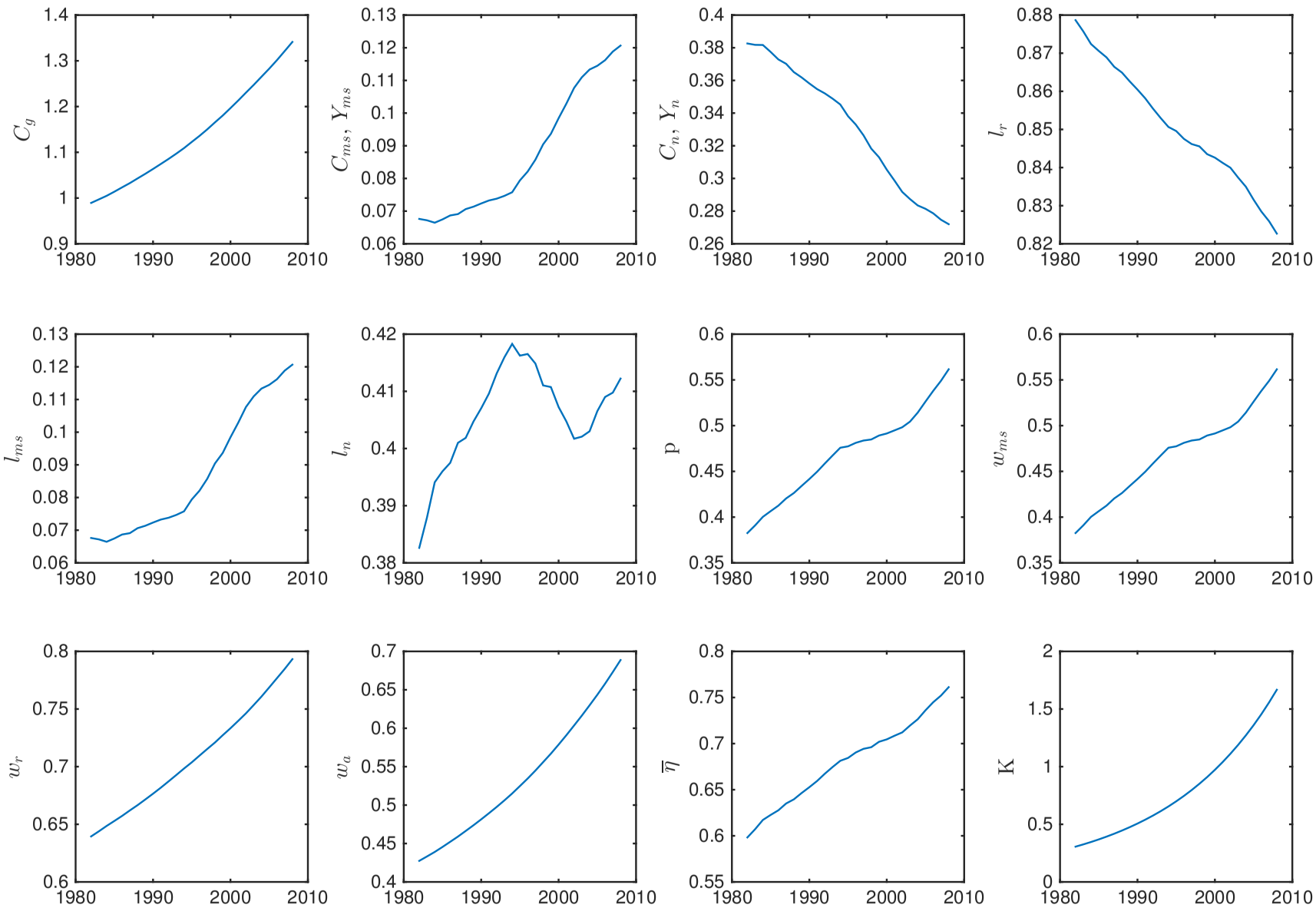


Figure 24: Qualitative features - Benchmark case

C.3 Sensitivity analysis

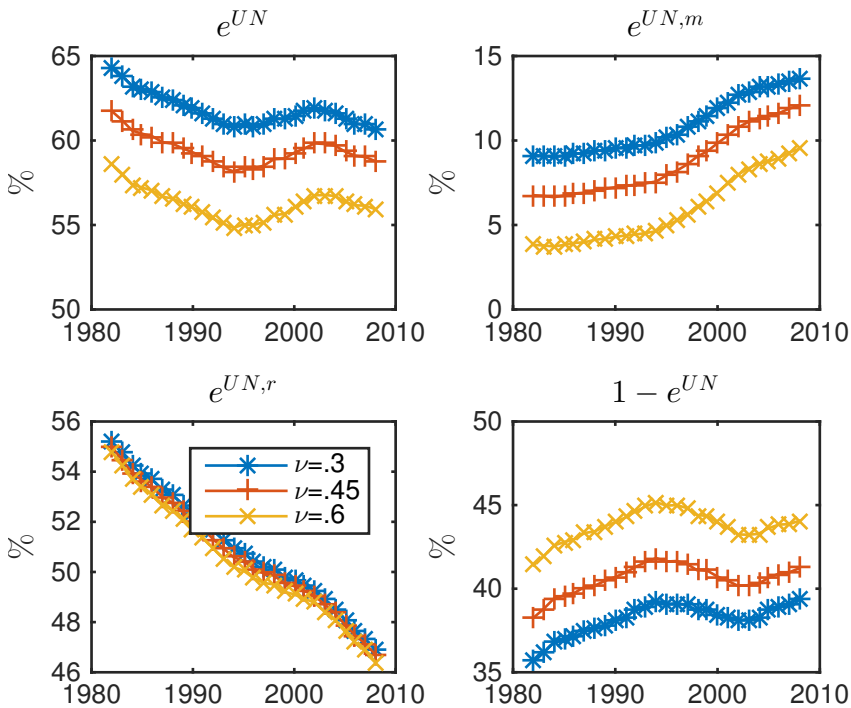


Figure 25: Sensitivity analysis ν

The decline of the unskilled employment rate relies on the assumption that market services are substitutable with non-market goods. This assumption is captured by the elasticity of substitution between market services and non-market goods $\sigma_s = 1/(1-\nu)$ which determines how the effects of labor taxation and non-market labor productivity interact. Therefore, I analyze to which extent previous results are sensitive to changes in this parameter value.

In Figure 25, I consider three cases in which I use the calibrated model and where ν is set successively to .3, .45 and .6 which is an upper bound in the empirical literature. The higher the elasticity of substitution between market services and non-market goods, the lower the unskilled employment level. In the case where $\nu = .6$, the unskilled employment rate drops by 2.67pp from 58.60% to 55.93% instead of 3.71pp from 64.33% to 60.62% in the $\nu = .3$ case between 1982 and 2008. Those changes in the unskilled employment rate occur mainly through manual labor. Routine employment is not sensitive at all to changes in ν compared to unskilled manual employment and unskilled non-employment. This is because as ν increases, non-market goods become close substitutes to market services produced by manual workers.

Changes in the unskilled employment rate become more non autonomous for higher values of ν. A higher elasticity of substitution between market services and non-market

goods makes the employment rate more sensible to the effects of labor taxation and the decline in relative non-market labor productivity. The unskilled employment rate decreases by 3.57pp in the $\nu = .6$ instead of 3.41pp in the $\nu = .3$ case between 1982 and 1993. Afterwards, the unskilled employment rate increases by .90pp instead of declining by .31pp in the $\nu = .3$ case between 1993 and 2008. From 1982 to 1993, the decline in capital price and in non-market productivity induces a reallocation of unskilled workers from routine jobs into manual jobs but since labor taxation is high and increasing, the fall in unskilled routine non-employment dominates the increase in manual employment. From 1993 to 2008, payroll tax reduction policies are implemented and relative non-market labor productivity still deteriorates. Those two trends have the same effect on unskilled employment. The combined effect of a decline in relative non-market labor productivity and labor tax policies explains why the unskilled employment rate increases during this time span. To sum up, higher values of the elasticity of substitution between market services and non-market goods enhance the effect of labor taxation and relative non-market productivity changes.

C.4 The labor income share

In this appendix, I display additional facts and results on factor income shares. In the left panel of Figure 26, I display the total labor shares computed with the EU KLEMS data and the calibrated model in France between 1982 and 2008.

The labor income share is computed as the ratio of total labor compensation over the total value added. It declined by 11.45pp from 76.84% to 65.39% while the capital income share increased by 11.45pp from 23.16% to 34.61% between 1982 and 2008. This is at odds with the Kaldor (1957)'s stylized facts which state that labor income and profit shares in total income remained constant in capitalist economies. Blanchard (2005) suggests that the decline in the labor income share might be the result of labor hoarding. Bentolila and Saint-Paul (2003) provide multiple alternative explanations for explaining movements in the labor share. They find that capital-augmenting technological progress induced significant shifts in the labor income share between 1972 and 1993 in OECD countries. Neiman and Karabarbounis (2014) claim that the decline in the labor income share is mainly due to the decline in the relative price of investment goods mostly attributed to the development of information technologies and the computer age.

The results of the model are in line with those findings. The model's labor income share decrease by 11.45pp from 76.84% to 65.39% as in the data. This is because the model was calibrated to match those features. Furthermore, this decline in the labor income share is caused by the diffusion of ICT capital which is modeled as a decline in its price. In the right panel of Figure 26, I display the labor income share in the benchmark

case and in the case without capital diffusion. Without capital diffusion, the labor share would not have declined. It would even have slightly increased by .2pp from 76.8% to 77% because of the decline in non market productivity and the implementation of payroll tax reduction policies targeted on low-paid workers. However, there is one shortcoming. The decline in labor share mostly occurs from 1982 to the end of the 1990s while in the model the decline is occurring linearly from 1982 to 2008. This is because the decline in capital price occurs at a constant rate in the model while it might have occurred faster from 1982 to the end of the 1990s.

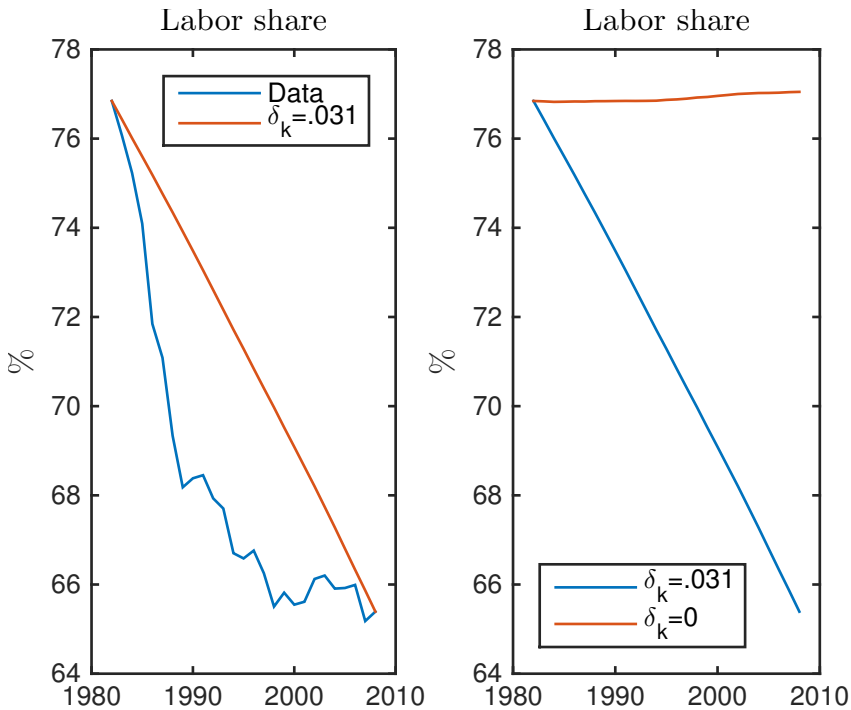


Figure 26: Factor income shares