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Forty Years of Decreasing Wage Inequality in France : The Role of Supply and of Hidden Skill-Biased Technical Change

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Forty Years of Decreasing Wage Inequality in France: The Roles of Supply and of Hidden Skill-Biased Technical Change. *

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Abstract

This paper relates changes in the high-skilled / medium-skilled relative wage of full-time male wage-earners in France with changes in supply and skill-biased demand shifts, including skill-biased technical change (SBTC). Using annual employer-employee administrative data matched with Census data from 1967 to 2009, we document a strong decrease in this relative wage concomitantly with a strong increase in the relative supply. Estimating a labor supply and demand model, in which experience groups are imperfect substitutes, we show that the strong increase in educational attainment in France has hidden so far the effects of SBTC. The magnitude of these effects is however between half and 100% of what is usually found in the U.S. for the same period. Then, education supply has stabilized since the mid-1990s for young cohorts. Our simulations show that if this stabilization goes on whereas the skill-biased demand keeps increasing or even remains constant, there will be a rise in wage inequality in the next two decades for the cohorts of workers who experienced the supply stabilization. Finally, we discuss why this increase in wage inequality may even be stronger.

Keywords: wage inequality, skill-biased technical change, education, supply and demand, labor market institutions, France. **JEL codes**: J24, J31, C21.

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1 Introduction

The skill-biased technical change hypothesis (SBTC) (see $e.g.$ Katz and Murphy, 1992; Acemoglu, 2002; Autor, Katz, and Kearney, 2008; Acemoglu and Autor, 2011) has emerged as one major explanation for the remarkable increase in the U.S. wage inequality that has occurred since the 1980s (see, e.g., Goldin and Katz, 2008, Juhn, Murphy, and Pierce, 1993, Card and Lemieux, 2001). The relative wage of college-educated workers with respect to high school workers increased because the relative labor supply slowed down whereas concomitantly, the relative demand for high-skill workers was increasing due to favorable technical changes.[1]

A part of that literature confronts the SBTC hypothesis and its refinements (polarization, routinization, offshoring...)[2] to changes in wage inequality observed in other Western countries. As market factors, technical changes favoring high-skill labor should affect similarly relative wages of other countries. The U.K., Canada, Germany, and Portugal do provide evidence in favor of that SBTC hypothesis. Over the 1980s and the 1990s, education premiums and residuals inequalities increased in these countries but not always at the same period and more or less strongly, see $e.g.$ Card and Lemieux (2001), Dustmann, Ludsteck, and Schonberg (2009), Machado and Mata (2005). This can related to different timings of changes in the labor supply or country-specific institutional contexts. For France, trends are reversed: education premiums and wage inequalities have fallen since the 1970s.[3] Does then France provide a case against the SBTC hypothesis?

The U.S. experienced a strong increase in wage inequalities, concomitantly with an increase in the relative high-skilled / medium-skilled supply and wage since the 1970s, see Figure 1. These simultaneous increases in the relative supply and wages in the U.S. imply for sure an increase in the relative demand. Reversely, France experienced a decrease in wage inequalities as well as a decrease in the relative high-skilled / medium-skilled wage whereas the relative supply strongly increased. In France, the democratization of education, and especially the wider access to post-secondary education that has occurred since the end of the 1980s may have hidden the increase in demand for high-skilled workers. In this paper, we use a supply and demand model *à la* Card and Lemieux (2001) to estimate the extent of demand effects on the high-skilled/ medium-skilled relative wage.

While there is much evidence of SBTC, including wage and employment polarization, in the U.S., SBTC has not been so much explored in France. Goux and Maurin (2000), using 4 surveys (1970, 1977, 1985, 1993), provided evidence of technical change in France but of a smaller extent than in the U.S. They found that computers and new production technologies were responsible for a fall of around 15% in the unskilled workers' share – high school drop-out – of total employment in the years 1970-1993. Goos and Manning (2009), studying distribution of employment between occupations in Europe, found evidence of job polarization in France between 1993-2006 but did not relate it to wages. Machin and Van Reenen (1998) used a panel on seven OECD countries between 1973 and 1989, including France

[1] Another potential explanation for the the rising demand for high-skilled workers could be the increasing trade with low-wage countries. Yet, Michaels, Natraj, and Van Reenen (2014) find that the trade effects, positive on the wage bill share of college-educated workers, negative on the share of middle-skilled workers, are smaller and non significant when they control for technology.

[2] see Autor, Levy, and Murnane (2003), Goos and Manning (2009)

[3] Another notable exception in which education premiums fell is Austria (Fersterer and Winter-Ebmer, 2003).

and found a significant association between skill-upgrading and R&D intensity. They concluded that skill-biased technical change is an international phenomenon. Recently, Verdugo (2014) showed that the increase in educational attainment in France explains a large part of the wage inequality decline in France in the last two decades. However, the supply and demand model he used did not allow him to identify the extent of changes in demand.

In this paper, we address the changes in the French wage structure between 1967 and 2009. We focus on full-time private sector male workers.[4] We use an annual linked employer-employee administrative data (*DADS panel*) matched with the Census sample database (*échantillon démographique permanent*), with high quality information on wages and education.[5] As a first contribution, we document a strong decrease in wage inequalities over 1967-2009, even stronger once we control for education and experience composition changes. At the top, the university / high school relative wage gap strongly decreased over the period concomitantly with a strong increase in the relative supply. Second, we estimate supply and demand models with and without experience-group perfect substitution (Katz and Murphy, 1992, Card and Lemieux, 2001, Autor, Katz, and Kearney, 2008, Acemoglu and Autor, 2011), and find that SBTC in France has an effect on the relative wage equalling between half to 100% of what is found in the U.S.. Up to now, the strong increase in educational attainment has partly hidden the effects of demand. However, due to the recent stabilization of the supply, consequences for wage inequality in the future may be dramatic. Using our estimates, we simulate how the relative wage would evolve in the future if the relative supply continues to slow down and stabilizes. Our simulations show that wage inequalities will increase in the next two decades for the cohorts who experienced the stabilization of the relative supply, as workers are only partially substitutes by experience groups. The magnitude of this increase and the fact that it will continue later depends on how technical changes will continue to affect the relative demand. The implications in terms of political response are important. If France keeps slowing down its investment in post-secondary education, wage inequality may increase in the next two decades, such as what happened in the U.S. in the 1980s. Future inequality trends may increase even more if technical changes are endogenous, see $e.g.$ Acemoglu (2002). The more the supply in high-skilled workers increases, the more profitable it may become for firms to invest in skill-biased technologies.

This paper is organized as follows. Section 2 presents the data. Section 3 describes the strong decrease in wage inequality related to the education democratization. In Section 4, we present the supply and demand model, the results about hidden skill-biased technical change and their implications in terms of simulations. Section 5 is dedicated to a robustness analysis of our results with respect to selection into employment issues, minimum wage, labor cost, changes in unobserved ability of skill groups, and workers bargaining power. Section 6 concludes.

[4]The analysis is restricted to male wage earners to limit labor market participation issues. Papers in the literature run separated regressions for men and women (see Lemieux, 2006 or Autor, Katz, and Kearney, 2008) or only focus on men (Dustmann, Ludsteck, and Schonberg, 2009).

[5]The wage information is compulsorily reported by the firm to social and fiscal organisms to compute social contributions and pensionable earnings.

2 Data

We use the panel subsample of the *Déclarations Annuelles de Données Sociales* (DADS) matched with the Census, *Echantillon démographique permanent* (EDP) dataset.[6] The wage and experience variables are constructed using the information from the DADS panel and the education variables from the EDP dataset. The analysis is conducted from 1967 to 2009, except for 1981, 1983, 1990 - years of Census for which wage data are unavailable- and 1994 - because of poor quality data. Abowd, Kramarz, and Margolis (1999) used similar data for the period 1976-1987 and Buchinsky, Fields, Fougère, and Kramarz (2003), for 1967-1999.

The DADS is an exhaustive administrative database of annual employer-employee wage bill information with compulsory completion by any firm establishment. It contains information on wages, working periods and private sector employers of wage earners born at chosen dates. The panel DADS is a subsample extracted from the DADS for scientific use.

The EDP database collects Census information - e.g. education at the Census dates - and civil state administrative information for a sample of the population. Since 2004, the French exhaustive population Census, which used to occur once a decade, has been replaced by annual Census surveys, in which nearly 10% of the population are interviewed. We use the data of the exhaustive population Censuses 1968, 1975, 1982, 1990, 1999 and the Census surveys 2004 to 2009. Hence among young cohorts, that is, individuals who finished their studies after 1999, the last exhaustive Census year, the education level is only known for individuals interviewed by at least one Census survey after the end of their studies. This concerns approximately 80% of those who ended their studies between 1999 and 2004, but only 13% for the ones who finished in 2008. So, we weight the observations concerning those individuals to avoid a deformation of the per-year population structure.[7]

2.1 Wage, education, and experience

The variables used in the analysis are the wage, the highest degree obtained (education) and the experience accumulated as a wage earner in the private sector.

The **wage variable** is the real -deflated by the consumer price index- net -social contributions excluded- daily wage in 2009 euros, $i.e.$, the sum of net earnings - including all one-shot remunerations paid during the year for a given job spell, divided by the number of working days for that given job spell. The DADS

[6] Those databases are produced by INSEE (French National Institute of Statistics and Economic Studies).

[7] We obtain weights for the individuals who ended their studies after 1999 and for whom degrees are collected – $i.e.$ were interviewed by at least a Census survey after the end of their studies – in the following way. First, note that the school-leaving year is not observed, we only know whether or not an individual completed his/her studies at the date of the Census survey. So, we simulate a school-leaving year for each individual calibrated on the school-leaving year distribution by degree and cohort observed in the Labor Force Survey. Then, for each individuals with the same school-leaving year, we invert the sampling probability of being interviewed in at least one annual Census survey after that school-leaving year. For instance, those who finished their studies in 2000 are weighted by one over the probability of being interviewed in at least one Census survey between 2004 and 2009, and those who finished in 2006, by one over the probability of being interviewed at least once in the Census survey 2007 to 2009. The weighted distributions of degrees per cohort obtained in our data do not differ from those observed in the Labor Force Survey.

wage information is used by the social security and fiscal organisms. This insures the data quality in comparison to self-reported wage information of survey data such as the Labor Force Survey, which may suffer of declaration bias. More precisely, wages and bonuses are totally covered. Profit sharing and wage-saving schemes are covered but only for the part immediately paid to the worker.[8] This may be a limitation, especially for the recent years, during which these remuneration schemes have stretched. However, the involved amounts are still quite moderate and usually proportional to wages, see Amar and Pauron (2013).

The **education variable** indicates the highest degree obtained at the end of studies. We follow Abowd, Kramarz, and Margolis (1999) and construct seven groups of education: no degree reported or elementary school level, junior high school degree, basic vocational degree, advanced vocational or technical degree, high school degree (BAC), some college (BAC+1, BAC+2) and university degree (BAC+3 and more). In the rest of this paper, we will refer as 'college' or 'postsecondary' group the union of some college and university groups. We will then focus on the high school and college groups. The French labels of education groups are detailed in Table 3 in the Appendix together with their shares in the panel population.[9]

The **experience variable** refers to the experience accumulated as a wage earner in the private sector. It is constructed as the sum of the shares of working days per year from a given individual's first occurrence in the DADS panel up to the current working period.[10]

2.2 Sample

The analysis is restricted to the 15- to 64-year-old male wage earners working full-time in the private sector and born in France. To ensure that the wage distribution is representative of the total number of days worked in the economy, the working periods are weighted by the number of working days for which they account. Working periods corresponding to internships and apprenticeships are excluded from the analysis because remunerations are often fixed and do not correspond to a valuation of skills. We also exclude student working periods because the level of education attained at this point is unknown. Finally, our sample contains approximately 40,000 observations per year.

[8] In 2010, 49% of the employees of firms of more than 10 employees receive some profit sharing schemes, for in average 6.9% of wages. Profit sharing schemes include "intéressement", and "participation". The "intéressement", created in 1959, is optional but its coverage increased a lot in the end of the 1980s (590 000 covered workers in 1986, and 2 million in 1990). The "intéressement" equals 3%-4% of the wages. The "participation", created in 1969, is mandatory for firms of more than 100 employees, and more than 50 employees since 1990 but the design of the scheme is firm-specific. It has also developed since 1986. The participation amount is not immediately perceived by he worker, it is first blocked on an account for 5 years.

[9] Declared education may differ between Censuses. We favor the information in the Census that follows directly the end of studies or after having turned 27. The idea is to minimize potential memory bias. When no degree are declared in that Census, we use the information reported in the following ones. Individuals with missing information after all are excluded from the analysis.

[10] Before 1976, the DADS panel is only available for a subsample of individuals. So, we assume that individuals present in the DADS in 1976 or before with a school-leaving year anterior to the year of first appearance, were employed between the end of their studies and their first occurrence in the panel. We argue this is not a strong assumption because the unemployment and part-time work were not frequent in the 60's-70's, especially for men. Furthermore, the DADS data is missing for 1981, 1983 and 1990. To correct the experience variables for the following years, we average the shares of working days per year for the year just before and for the year just after the missing year and we add this average to the experience variable.

3 A decrease in wage inequality related to the democratization of education

Whereas in 1967 France was one of the developed countries presenting the highest levels of wage inequality, in 2009, it belongs to the group of those showing the lowest ones. In this section, we document raw and skill-composition adjusted wage inequality decreasing trends over this period. The relative wage of college graduates with respect to high school graduates has continuously decreased since 1990. The democratization of education, and especially the wider access to post-secondary education, provides a first and major explanation for this but may also hide changes in demand effects.

3.1 Overall wage inequalities

The overall raw wage inequality among the private-sector-full-time male workers have declined in France from 1967 to 1973 and then, since the 1990s, whereas it remained stable in between, see Figure 2. From 1967 to 2009, the Q90-Q10 log wage difference decreased by 0.17.[11] In comparison, in the U.S., over the same period, the Q90-Q10 weekly log wage differences of full-time male workers increased by approximately 0.4 - resp. the hourly log wage differences by approximately 0.2.[12]

– Insert here Figure 2 –

The decrease in wage inequality is dramatically more pronounced once we control for skill-composition changes. Wage inequality only plateaued during the 1980s. The decrease in skill composition-adjusted wage inequality was driven by decreases at both tails of the wage distribution. Inequalities decreased at a constant pace at the bottom half of the distribution during the whole period. For the top half of the distribution, even though raw inequalities declined only at the very beginning of the period, and since the mid-2000s, skill-composition adjusted inequalities decreased also in the 1990s, with a sharp acceleration during the 2000s.

The evolution of the very top wage inequalities slightly balances the picture. Amar (2010) and Landais (2008) show that the wage growth rate of top 1% wage earners has dramatically increased since the end of the 1990s. This phenomenon is up to now more concentrated than what has happened in the U.S. or the U.K. Godechot (2012) finds it concerns mainly the top 0.1% and that the Finance sector is responsible for half of the rise in inequality. The Q99-Q90 log wage differential reported in Figure 2 has indeed increased since the mid-2000s, but in a moderate way.

[11] In terms of wage levels, the Q90 wage was 3.5 times (=exp(1.26)) higher than the Q10 in 1967, whereas in 2009, it was 3.0 times higher.

[12] Similarly, the Gini coefficient (for annual earnings in commerce and manufacturing) increased from 0.4 to 0.5 in the U.S., whereas it slightly decreased from .32 to .29 in France.

3.2 Skill-group wage trends

The increasing top wage inequality trends in the U.S. have been explained by the increasing relative wage of high-educated workers with respect to less educated workers (college and university wrt high school). Reversely, in France, the decrease in top wage inequalities is concomitant with a decrease in the relative position of high-educated workers (some college and university wrt high school), especially for low-experienced groups, see Figure 3, which reports the predicted median log wages for workers holding a university degree and a high school degree with one and 25 years of experience.[13]

Skill-group wages increased quite uniformly from 1967 to the beginning of the 1970s. Since then, group patterns have differed. For low-experienced workers, wages were stable during the 1970s except for university degree owners who experienced a decrease. Changes were rather similar for all education groups in the 1980s but, since the mid-1990s, the gap between the university group and the high school group decreased. Among more experienced workers, both wages of university and high school graduates decreased between the mid-1970s and the mid-1990s, and then, remained stable. Figure 3 also reports other group wages: an advanced vocational degree, a basic vocational degree, and no degree at all, which follow similar trends as wages of high school graduates.[14]

– Insert here Figure 3 –

3.3 The democratization of education: a rising supply of high-skilled workers

The decrease in the high-skilled group wage relative to lower-skilled group is firstly related to a rising supply of college workers (see also Verdugo (2014)). From 1967 to 2009, the composition of the French male labor force changed dramatically. The education level largely increased: the share of workers with no diploma decreased from 62% in 1967 to 18% in 2009. Older - and less educated - workers were gradually replaced by more educated new cohorts due to a succession of pro-education policies: first, increases in the minimum school-leaving age, which was raised from 12-13 to 13-14 years-old in 1936, and from 14 to 16, in 1959;[15] second, a strong promotion of the democratization of education, which occurred since the 1960s to the 1990s gradually at each level of education. In the 1960s, related to the increase in the school-leaving age, the access to Junior/Basic degrees largely widened: 40% of new labor market entrants held a basic vocational degree in 1967, see Figure 4. This share remained stable until 1990. Since 1990, changes in the labor force education have principally occurred through increasing shares of high school, advanced vocational and post-secondary degree holders. Once more, a political

[13] As a given skill group may not contain enough observations in a given year, we use wages predicted for each skill group. We prefer median than mean regression for robustness issues. We estimate a LAD regression model, in which education group dummies are interacted with experience (in years) up to a third-order polynomial to allow for different education-group-rewarding profiles of experience and to account for the non-separability of those two human capital types (see Rubinstein and Weiss, 2006; Belzil, 2006; Heckman, Lochner, and Todd, 2006).

[14] The cases of junior high school (very similar to basic vocational) and some college (very similar to university) degree owners are not reported for readability.

[15] Before 1936, individuals could quit school at 12 if they had completed a *certificat d'étude*, 13 if not. After 1936, both minimum leaving school ages were increased by one year. The Berthoin reform in 1959 established a unique legal minimum leaving school age at 16.

impulse led to these evolutions. In the mid-1980s, the government promoted the national objective of bringing 80% of a cohort to the baccalaureate level, $i.e.$, up to finishing general or vocational high school training. A new vocational high school degree was created, the "Baccalauréat professionnel". In the 1990s, the share of new entrants with a basic vocational degree decreased to the benefit of this advanced vocational one. The passing rate of the Baccalaureat also increased from 65% in the beginning of the 1980s to 73% in the beginning of the 1990s. This widened the access to post-secondary education. The share of new entrants with post-secondary education, either some years of college or a university degree, doubled from 1989 to 2000 (17% in 1989 for 32% in 2000).

– Insert Figure 4 here –

3.4 College / High-school relative wage and relative supply

The French democratization of education has lead to an increasing relative labor supply of college workers (high-skilled) versus less-educated workers, in particular high school workers (medium-skilled). This increase constantly accelerated since 1967 until 2009. The fact that the college/ high school relative wage decreased is consistent with the rising supply, see Figure 5, which relates relative college/ high school wage trend to composition-adjusted relative supply trend.[16]

– Insert Figure 5 here –

The relative college/high school wage strongly decreased over the period, except at the turn of the 1960s and during the 1980s, whereas the relative college / high school supply sharply increased since the 1970s, with an acceleration during the 1980s, and a slow-down since the 2000s.

For the U.S., a graphical analysis shows directly that supply effects can not explain the increase in the relative wage that happened since the 1990s, and that there must have been changes in the demand. For France, such a graphical assessment is less straightforward as relative wage and relative supply evolve in opposite directions. However, trends during the 1980s provide some hints on the importance of changes in demand: the relative supply sharply increased while the decrease in relative wage experienced a break.

In the next section, we provide evidence that even in the French context of wage inequality decrease, there have been skill-biased demand changes.

[16]The composition-adjusted college / high school log relative wage is derived from the predicted median wages for four experience groups (0-9, 10-19, 20-29 and 30-39 years) and three groups of education (high school, some college and university). The log relative labor supply is constructed following the literature, e.g. Katz and Murphy (1992) or Autor, Katz, and Kearney (2008). The medium-skilled labor supply index is computed in high school equivalents: workers with a degree lower than high school weight in the index less than one, with a weight equal to the relative wage. Resp. the high-skilled labor supply index is in college equivalents. See the Appendix for details.

4 Hidden skill-biased technical change

We use high-skilled/ medium-skilled labor supply and demand models to estimate the extent of skill-biased demand shift effects on the relative wage, which we interpret as SBTC. If the evolutions of the demand for educated workers in the U.S. are driven by SBTC, we would expect it to happen also in France. We document indeed the presence of SBTC in France. The strong increase in educational attainment have partly hidden those effects up to now. However, due to the recent stabilization of the supply, consequences for wage inequality in the future may be dramatic.

4.1 Model of supply and demand

We follow the setting of Card and Lemieux (2001), Autor, Katz, and Kearney (2008), Acemoglu and Autor (2011), amongst others. We assume an aggregate constant elasticity (CES) of substitution production function, with two factors, high-skilled labor (H), $i.e.$ college graduates, and medium-skilled labor (L), $i.e.$ high school graduates. The model extends Katz and Murphy (1992) and allows for imperfect substitution between different groups of experience within an education group by introducing two sub-aggregate CES forms:

$$Y_t = \left((A_{Lt}L_t)^\rho + (A_{Ht}H_t)^\rho\right)^{1/\rho}, \tag{1}$$

$$\text{with} \qquad L_t = \left(\sum_j \alpha_j L_{jt}^\eta\right)^{1/\eta} \quad \text{and} \quad H_t = \left(\sum_j \beta_j H_{jt}^\eta\right)^{1/\eta} \tag{2}$$

where L_{jt} and H_{jt} are the quantities employed of high school (L) college (H) equivalents belonging to the group of experience j, observed at period t. We consider four groups of experience: 0-9, 10-19, 20-29, and 30-39 years of real experience. α_j and β_j are the relative efficiency parameters between labors of different experience groups. They are assumed to be constant in time. A_{Lt} and A_{Ht} are the factor-augmenting technology terms of period t. Finally, the elasticities of substitution between labor types are accounted by ρ and η. $\rho = 1 - 1/\sigma$, where σ is the aggregate elasticity of substitution between high-skilled and medium-skilled labors. $\eta = 1 - 1/\sigma_E$, where σ_E is the partial elasticity of substitution between different experience groups within the same education group. σ_E is assumed to be equal in the two education groups. Deriving the marginal products of each type of labor and equalling them to the wage rate entails that the wage ratio of high-skilled vs medium-skilled workers belonging to experience group j is

$$\frac{w_{Hjt}}{w_{Ljt}} = \left(\frac{A_{Ht}}{A_{Lt}}\right)^\rho \frac{\alpha_j}{\beta_j} \left(\frac{H_{jt}}{L_j t}\right)^{\eta-1} \left(\frac{H_t}{L_t}\right)^{\rho-\eta}. \tag{3}$$

This leads to estimate

$$log(w_{Hjt}/w_{Ljt}) = \beta_0 + \beta_1(log(H_{jt}/L_{jt}) - log(H_t/L_t)) + \beta_2 log(H_t/L_t) + X_t\gamma + \delta_j + \epsilon_{jt}. \tag{4}$$

where $\beta_1 = -1/\sigma_E$ and $\beta_2 = -1/\sigma$. $log(H_t/L_t)$ stands for the relative aggregate supply (in Log), and $log(H_{jt}/L_{jt})$, the experience-group relative labor supply. δ_js account for the experience-group relative efficiency parameters. X_t contains both time trends to reflect the unobserved relative technology term and other demand shifters.

4.2 Results

The estimation results are reported in Table 1. Results presented in columns (1)-(4) rely on relative wage gap constructed from median regressions weighting by job durations, and relative supply indexes constructed in working day units following the literature (see e.g. Katz and Murphy, 1992, Autor, Katz, and Kearney, 2008, and the appendix for details). In columns (1b)-(4b), the relative wage gap is constructed from wage median regressions, in which each worker who worked full-time at least once, weights for one, and the relative supply indexes are computed in worker units. So workers who did not work full year weight as much as those who did. We do this as a first attempt to study whether selection into employment changes the results. We will complete this issue in the next section. Further, the relative supply indexes are computed with male observations only.[17] Columns (1)-(3) and (1b)-(3b) refer to the pooled OLS estimates on all the experience groups with group specific effects. We also estimate the model proposed by Card and Lemieux (2001), in which time dummies absorb both supply and demand shifters, see columns (4) and (4b). Finally, we estimate the canonical Katz and Murphy (1992) model, in which experience groups are assumed to be perfect substitutes. Results are reported in Table 2, in the Appendix.

– Insert Table 1 here –

First, the R^2s of the regressions are around 60%, which is lower than what is found in the U.S. – 89% in Acemoglu and Autor (2011). To compare the fit of the models by experience groups, we compute the contribution of each experience group to the total squared residuals. The 30-39 experience group contributes for more than one half of the total squared errors. Therefore, the model seems to perform better for workers with low levels of experience, who are also those who, up to now, have faced the more important relative supply changes.

Then, we focus on the estimates of the aggregate elasticity of substitution between college and high school workers and of the partial elasticity of substitution between experience groups within an education group. As expected in a supply/demand model, we observe negative effects of the aggregate supply on the relative wage gap, and of the own experience-group relative supply. Point estimates for the aggregate elasticity of substitution between high-skilled and medium-skilled labors, σ, range from 2.1 to 3.6 (with large standard deviations), which is not so far to what is usually found in the U.S. or the U.K. – between 1.6 and 3.[18] Dustmann, Ludsteck, and Schonberg (2009) find for Germany an elasticity of substitution between medium-skilled and low-skilled workers around 4. In the Katz-Murphy version of the model,

[17] To check if the strong feminization of the labor force during the period changes results, we also considered relative supply indexes computed on male and female observations. Results are the same and available on request.

[18] See Autor, Katz, and Kearney (2008), Acemoglu and Autor (2011), Card and Lemieux (2001).

our estimates for σ are somewhat larger. They vary around 4 when the supply indexes are computed in day units, and 6 with worker unit supply indexes, see Table 2.

In contrast with the aggregate elasticity, the partial elasticity of substitution between the experience groups is always precisely estimated. Depending on the specification used, the estimates range between 4.6 and 5.2, which is close, but again a little higher than what is found for the U.S.. Acemoglu and Autor (2011) report a an elasticity of substitution between potential experience groups of 3.7 when they use both men and women. Card and Lemieux (2001) find elasticities of substitution between age groups around 5 when they focus on men only. Our estimates for the partial elasticity of substitution across experience groups are similar when we consider the Card and Lemieux (2001) model in which time dummies account for both aggregate supply and demand shifters: 5.2 for day unit supply indexes, and 4.6 for worker unit supply indexes. We differ here from the results of Verdugo (2014), who estimates this model on the French Labor Force Survey data, 1990-2008. He finds much higher estimates of the partial elasticity of substitution between experience groups: between 8 and 12.5.

Further, we examine time trends and demand shifters. In the last row of Table 1, we report the p-values of F-tests for a null time trend.[19] This nullity can be rejected at 10%. To give an idea of the magnitude of the skill-biased technical change involved, but keeping in mind the precautions due to potential imprecision, we compare the French estimated levels of the time trend to those found in the U.S. by Autor, Katz, and Kearney (2008).[20] Depending on the specifications used in Table 1, the increase in the relative log wage gap due to demand shifters – minimum wage excluded – ranges from .51 to .70 after 40 years, vs .94 for the U.S..[21] That represents between 55% to 80% of what is found for the U.S, (see also Figure 7 in the appendix, which shows how the predicted time trends vary upon our main specifications reported in Table 1, and others relative to the robustness checks detailed after).

The minimum wage is included as a demand shifter, in columns (2), (3), (2b), and (3b). We also report the partial R^2 of the different covariates to study their explanatory powers in explaining the relative wage gap. Partial R^2s of the minimum wage are between 5 and 6%, when quadratic time trends are used to capture demand shifters including SBTC, and null with a cubic time trend. The explanatory power of the minimum wage is hence quite small compared to the one of the experience-group relative supply (40%). Changes in the minimum wage do not seem relevant to explain university to high school wage gap, relative to the supply.

Finally, we find evidence in favor of SBTC. Our estimates suggest a magnitude of these demand effects in France between half to 80% of what is found in the U.S., but a similar magnitude to the U.S. is not rejected. Contrary to the U.S., the additional supply was not over-compensated by the increased demand for high-skilled labor because of the strong increase in the supply. In the Tinbergen's context of racing education and technology (Tinbergen, 1974, 1975), for France, education leads the race. Yet, the decrease in the relative wage would have been much more pronounced if the demand for high-educated labor had not increased due to SBTC.

[19] F-tests do not account for the fact that relative wages are predicted.

[20] The time variable used in the analysis is centered in 1963 to allow direct comparisons with Autor, Katz, and Kearney (2008).

[21] Using estimates of Table 2, the increase in the relative log wage gap due to time demand shifters is smaller between .17 to .36.

4.3 Simulations

The strong increase in educational attainment has hidden an increase in the demand for high-skilled labor. This is somewhat similar to what happened in the U.S. in the 1970s, see Goldin and Katz (2007). As documented before, since the beginning of the 2000s, the education structure of the new labor market entrants has somewhat stabilized. May this lead to a turning point for wage inequality trends such as in the U.S., in the 1980s, when the wage inequality started to grow since the college labor supply slowed down? We propose a simple simulation exercise to give a first answer. We simulate the relative wage gap until 2030 using estimates of Table 1 and projections of the aggregate and the experience-group supply indexes. We use a simplistic framework to obtain these projections. To focus on the effect of changes in education rather than changes in sizes of cohorts, we consider that in the future the experience structure of the supply is fixed to the one observed in 2009. So, for each future year, the number of workers or of working days per one-year of experience group are fixed to the levels observed in 2009. Only, their education structures change and are simulated recursively. The education structure of each one-year experience group simulated for a given year is the one observed (or simulated) the year before for the group with one year less of experience. In a sense, we make the implicit assumption that each year, each worker gains one year of experience and we do not allow for inflows and outflows of the working population. The education structure of new entrants is the one observed in 2009.

Results are reported in Figure 6 when supply indexes are computed in number of workers (and in Figure 10 in the additional graphics part, when supply indexes are computed in numbers of days worked). If the relative labor supply continues to slow down and the time trend effect on the relative wage goes on or even stabilized, the relative wage of workers with less than 10 years of experience will sharply increase from 2010 to 2020. The magnitude of this increase depends on the form of the time trends, we report the simulations for a constant, a linear, a quadratic, and a cubic time trend, but all specifications lead to this sharp increase in the relative wages up to 2020. What will happen after 2020 depends on the form the time trend assumed, the increase will continue if the effects of technical changes follow a linear or quadratic rate, stabilize if they stabilize (constant trend), or decrease if they decrease (cubic trend). An increase in the relative wage is found a decade later for the group of workers with 10 to 19 years of experience, and so on. So as workers are only partially substitutes by experience groups, the predicted increase in the relative wage of younger workers is only partially smoothed.

– Insert Figure 6 here –

5 Robustness checks: selection, minimum wage, labor cost, and other demand shifters

In this section, we conduct complementary analyzes to check the robustness of our results. The latter may suffer from some caveats. First, unemployment changes may affect differently the two skill groups, leading to unexpected changes in wage gap and supply indexes. Second, we provide more evidence that minimum wage does not affect our estimates. Third, we considered net wages up to now as total labor

costs, $i.e.$ total wage paid by the firm, which are more relevant measures, are not available during the whole period. We provide evidence that SBTC may be stronger than estimated. Finally, we discuss the sensitivity of our results with respect to other unobserved demand shifters, such as changes in group unobserved ability ('quality') and changes in workers' bargaining power.

5.1 Selection into employment

The relative wage and the relative labor supply may be mis-estimated if unemployment affects differently high school workers and college workers and if these differences in the employment selection processes change over time. In the following, we run several exercises, which all lead us to think that variations of selection into employment cannot be taken as a major cause for the relative wage decrease.

First, we compare the results of Table 1 for which the relative wages and supply indexes are computed weighting by the job duration (columns (1)-(4)), and those using also full-time private sector workers but with one annual wage observation per worker only, and without weighting by the job spell duration (columns (1b)-(4b)). The wage in that case refers, for workers who occupied several jobs sequentially in the year, to the average daily wage over these different job spells. So workers who did not work full year – potentially due to some unemployment spells – weight as much as those who worked full year. We only miss individuals fully and continuously unemployed during more than one calendar year, a very small group.[22] The time trend estimates slightly differ but the magnitudes involved are quite similar, see Figure 7.

– Insert Figure 7 here –

Further, we construct an alternative dataset in which we exploit the panel structure of our data. We add the individuals, observed the year before and the year after, but missing for a particular year. We impute a wage for each of them, equal to the average of their wages the year after and the year before and include them in the analysis. The estimates for the elasticities of substitution and for the time trend are very similar to those of our main specification, see Table 4 in the Appendix, and Figure 7.

Lastly, we follow Autor, Katz, and Kearney (2008) and control for the unemployment trends and changes in the employment selection process by including the unemployment rate as a control variable in the relative wage equation. However, with this method, the results are not very conclusive. In the Katz-Murphy model, we do find a negative effect of unemployment rate (non significant), an elasticity of substitution not far from our previous findings, between 4 and 6.4, depending on weighting or not by job duration when we compute wages and labor supply indexes, and time trends are similar to those previously estimated; see columns (3) and (3b) of Table 2. However, in the Card-Lemieux model, we find a positive coefficient on the unemployment rate, which is inconsistent with a selection effect of unemployment.

[22] We also miss self-employed and public servants. We have data on the public sector since 1988, a too short time period to run our estimations. However, inequalities and wage trends are very similar when the public sector is included. Moreover Verdugo (2014) finds similar trends on the sub-period 1990-2008 using the French Labor Force Surveys that provide information on both private and public sector wage earners.

5.2 More on minimum wage

High-school worker wages are in average closer to the minimum wage than university workers wages. They may have therefore been more affected by the strong increase in the minimum wage that occurred over the period than the university ones, especially through spill-over effects whose intensity decreases over the wage distribution.[23] We include the minimum wage as a demand shifter in the supply and demand model and find that its changes explain only between 5 and 6% of the relative wage gap. The minimum wage affects the wage structure for lower than high school educated groups. As another way to document this issue, we compare the shares of university and high school workers the more affected by the minimum wage increase. For each year between 1967 to 2009, less than 10% of high school and university graduates with more than 10 years of experience are paid less than 1.1 $\times$ the minimum wage. At the very beginning of their careers, less than 30% of high school workers are paid less than 1.1 $\times$ the minimum change. Changes in minimum wage do not play a major role on the university / high school wage gap, as we consider median wages. Further, we study the relation between minimum wage changes and within-education group wage inequalities. Wages of university and high school workers do not again seem to be particularly affected by changes in the minimum wage. We focus on the explanatory powers (R^2) of the minimum wage relative position with respect to the median within-group wage on the within-group wage inequality for workers up to 10 years of experience, see Table 6. The evolution of that relative position plays only a role at the bottom half of the high school wage earners distribution at the very beginning of their careers. It accounts for 25% of the bottom inequality evolutions for high school workers with one year of experience, 11% for those with 5 years of experience, and virtually zero for those with 10 years of experience. It plays a negligible role for wage inequality trends of university workers, and for high school worker top inequalities. The effects of the minimum wage are therefore important at the bottom of the wage distribution but not at the top.

– Insert here Table 6 –

Even in the French context of a high-leveled minimum wage, minimum wage does not play a substantial role on the college / high school relative wage gap, and even if it did, changes in minimum wage would negatively affect the wage gap, entailing an under-estimation of the SBTC trends. In contrast, its rise explains well the decrease of wage inequalities at the bottom half of the distribution, see Charnoz, Coudin, and Gaini (2011), Verdugo, Fraisse, and Horny (2012).

[23] The French minimum wage is unique and covers all workers, with no regional nor sectorial differences. Since 1970, its level is increased by a percentage that cannot by law be less than one-half of the growth in the real hourly earnings of manual workers (skilled and unskilled). Its growth is given by a fixed linear combination of the blue collar hourly wage growth ("salaire horaire de base ouvrier"), the inflation changes and some discretionary one-shot increases, called "coups de pouce" or *boosts*, which the government can add to the automatic reevaluation. The minimum wage increased also since the late 1990s to the mid-2000S following the implementation of the 35-hour workweek reduction, (Law Aubry I and II, and Law Fillon), see Figure 12 in the appendix.

5.3 Total labor cost and net wages

Net wages differ from the total labor cost for the firm by the payroll-tax amount -either paid by the employer or the employee.[24] Part of the payroll-tax legislation depends on the remuneration level, and the size of firm. Changes in payroll tax legislation may entail that total labor cost and net wage trends may slightly differ, which may affect our estimates of SBTC.

The payroll taxes continuously increased since the mid-1970s to the end of the 1990s, even during the slow 1980s growth. First, the employee-paid contributions increased, then the employer-paid ones did, see INSEE (2009). Consequently, the net wage to labor cost ratio at the median decreased from 1975 to the mid-1990s, and has stabilized since then, see Figure 8, which reports the trends of the net wage to labor cost ratios at the median level and at minimum wage level.[25] Since 1993, several payroll-tax subsidies for low wages were paid to firms to protect low-qualified employment. They were largely extended between 1995 and 1996. In July 1993, these payroll-tax subsidies represented around 5% of the brut wage at the minimum wage and 18% in October 1996. They concerned wages up to $1.33\times$ the minimum wage, $i.e.$ almost one third of the workers in the private sector but the level of the subsidies was digressive with the wage level. At the end, since the beginning of the 1990s up to 1996, the employer-paid contributions at the minimum wage decreased of 18 percentage points, from 40% to 22%, see Crépon and Desplatz (2001) and Kramarz and Philippon (2001). Since 1997, and parallel to the implementation of the 35h workweek reduction, payroll-tax subsidies have in part been extended to higher wages, up to 1.6 $\times$ the minimum wage, again in a digressive way. These changes explain the increase in the net minimum wage to labor cost ratio since the mid-1990s but does not affect the ratio at the median.

– Insert Figure 8 here –

We have individual information on the total labor cost paid by the firms since 1995 only.[26] This does not provide enough time variation to conduct a complete analysis with the labor cost similar to the one undertaken with net wages. However, two results lead us to believe that due to changes in payroll-tax legislation, the SBTC effect on the relative wage found previously may underestimate the true effect. First, since 1995 the relative labor cost has decreased less than the relative wage, see Figure 9. Second, when we attempt to control for changes in payroll taxation between 1967 and 2009, by including the median total labor cost to median net wage ratio in the Card-Lemieux regressions, we obtain elasticity estimates very similar to those found previously. We also obtain time trend estimates that predict after the mid-1990s a stronger increase in the relative wage than what we have found previously, see Table 5 in the appendix for detailed results. The increase in the relative wage due to changes in demand after 40 years is now very similar to the U.S., between 82% to 102% of the effect found by Autor, Katz, and

[24]Including two taxes, the "contribution sociale généralisée", (CSG) introduced in 1990 and the "contribution pour le remboursement de la dette sociale" (CRDS), introduced in 1996.

[25]The daily labor costs are computed using the average number of hours worked per day. Those two series are borrowed from Nouveau and Ourliac (2012a) and Nouveau and Ourliac (2012b).

[26] The total labor cost, computed in 2009 euros, is constructed by adding to the wage variable, the total amount of the social contributions - either paid by the firm or the employee. Those social contributions are computed *a posteriori* by applying the applicable legislation rules, which depend on the year, the wage level, the number of employees in the firm, etc.. The programs used to compute the labor cost at an individual level were constructed by the INSEE Division "marchés et entreprise", see Cottet, Quantin, and Régnier (2012)

Kearney (2008). However, the coefficient relative to the median total labor cost to median net wage ratio, is imprecisely estimated.

– Insert Figure 9 here –

Figure 8 reports also the ratio between the minimum wage labor cost and the median wage labor cost. The latter declined strongly between 1993 and 1996, and has been rather stable after then. One may deduce an important point. Even though the minimum wage has strongly increased since the end of the 1990s, the rate of growth of the total labor cost paid by the firm for a worker at the minimum wage has been much smaller. Hence, the effects on selection into employment may be of lesser extent than what an analysis based only on net wages would have suggested.

5.4 Other demand shifters

Other demand shifters, not accounted for in the model, may be related to changes in quality of skill groups, or in the French institutional wage setting related to workers' bargaining power.

Changes in quality of skill groups. If more and more students accede to a given level of education – for which the access relied previously on a stricter selection – the intrinsic ability of that education group, valued by wages but not acquired in school, may decrease in average, and may be more and more heterogenous. Carneiro and Lee (2011) find that the U.S. college premium increase between 1960 and 2000 would have been one fourth higher than observed if the quality had remained constant. The French massive education democratization lead by political impulse, with profound changes in the educational system provides a context, in which such changes in "quality" per skill group may occur. In the mid-1980s, not only the number of Baccalaureat candidates increased, but also the corresponding passing rate. Another fact may plead in favor of changes in quality. If the intrinsic ability of the post-secondary young-worker population became more heterogenous, we expect a corresponding increase in the within-skill group wage inequality, at least in the top. And we do observe that within-education group top wage inequalities are very related to group volume changes, see Figure 11. When the supply of high school young workers increased in the mid-1980s, the corresponding within-group wage inequality for young workers sharply increased, and the same occurred for the university graduates since the mid-1990s. Therefore, the time trends we estimate capture not only SBTC but also quality change effects on demand. If so, the pure part of our time trend estimates due to SBTC may be under-estimated. Note that changes in quality could also affect the estimates for elasticities of substitution.

Unions, collective bargaining, and bargaining power. Another demand-shifter that we do not account for is related to changes in bargaining power of workers, through unions, and collective agreements. These latter can indeed have an important role on wage settings and wage structure evolution. DiNardo, Fortin, and Lemieux (1996), amongst others, evaluate the role of de-unionization in explaining the increase in wage inequality in the U.S.. Dustmann, Ludsteck, and Schonberg (2009) evaluates that, in Germany, de-unionization may account for one third of the increase in the lower tail of the wage distribution between 1995 and 2004. Contrary to other countries, the rate of unionized workers in France is not a suitable measure of the strength of the protected worker groups. Despite its low rate of unionization, close to

8% – 5% in the private sector, France has a very high rate of collective bargaining coverage, close to 98% because each worker benefits from the agreements signed by the representative unions at the different levels of negotiations, and unions are represented in many companies. While the unionization rate decreased from the mid 1970s to the mid 1990s, more and more employees declare benefitting from an union representative in their job place or in their firm.[27]

The decrease in productivity gains at the end of the "Glorious Thirties" period entailed greatest bargaining tensions. In 1973, the labor productivity felt from 5% to 2.1%, in 1995 from 2.1% to 1.1%. In this context, unions tended to focus on their core target, insiders and within insiders low-paid workers. Young entrants into the labor market, more subject to face short-term form of work contracts, were therefore less likely to be protected by unions, even more if they were skilled workers. Breda (2014) shows that unions benefit particularly to blue-collar workers, low-educated workers (under high school) and older workers (more than 45 years old). Among skilled workers, it is difficult to know who between high-skilled or medium-skilled workers suffered more from a bargaining power decline. Wage moderation may have less affected high school worker wages than university worker wages, because of the lower distance to the minimum wage. However, university workers may have more individual bargaining power, due to higher skills and a lower unemployment rate, or less short-term contract threats. The potential bias on our estimates and projections is of an ambiguous sign.

6 Concluding comments

In this paper, we document for France the existence of a skill-biased demand shift in favor of post-secondary workers with respect to high school workers, even in a context of a decrease in the relative wage. Further, we estimate its magnitude. Based on those estimates, our simulations show that wage inequalities in the two next decades will increase, due to the recent stabilization of the relative supply, and the more the relative demand will continue to increase the larger this increase in inequality will be and will continue. This increase in wage inequality will affect only cohorts who experience the stabilization of the relative supply, as workers are only partial substitutes by experience groups. The increase in wage inequality is likely to be stronger than suggested by our simulations if we under-estimate the SBTC trend. Several reasons plead for that.

Our main specification estimates suggest that SBTC effects are of 55% and 80% than what is usually found for the U.S.. This smaller SBTC may be related to the French political/societal choice to maintain a high level of low or middle-qualified employment through generous payroll-tax subsidies for low wages since the 1990s. This may in turn have lead firms to choose technologies favoring more low-or middle qualified employment than what happened in the U.S..[28] Will this choice continue in the future

[27] Collective bargaining in France was generalized by law in 1950, which established the industry as the main level for bargaining. In 1971, collective bargaining at the cross-industry level was also established. Finally, the Auroux laws of 1982 imposed an annual obligation to bargain about wages and working time at the workplace or company level for large firms and an annual obligation to bargain about wages as well as a five-year obligation to bargain on job classifications at the industry level, see Abowd, Kramarz, Lengermann, McKinney, and Roux (2012) for a precise description of those legislations.

[28] Crépon and Desplatz (2001) found that the payroll-tax subsidies for low wages enabled to create or maintain around 500 000 jobs, half unqualified.

is an opened question. Second, a smaller SBTC can also be explained by the fact that the increase in educational attainment in France is more recent than in the U.S.. If the technical change is endogenous, see $e.g.$ Acemoglu (2002), the share of highly educated workers may have been too small to encourage firms to massively invest in skill-biased technologies - at least until very recently. For instance, the French information and communication technology (ICT) investment represented in 2009 about 16% of total fixed nonresidential investment for about twice more in the U.S. (OECD, 2011). During the economic boom at the end of the 1990s, ICT sector clearly favored the employment rate growth of the more educated workers only (college graduates), see Fondeur and Minni (2004). The more numerous high-skilled workers are, the more profitable it may become for firms to invest in skill-biased technologies.

Moreover, we cannot exclude that we estimate a lower bound for SBTC. Our time trends, which we interpret as the unobserved relative technology term, may capture other demand shifters that we do not control for. We ruled out the role of the minimum wage and of selection into employment. However, changes in quality may also entail an under-estimation of the SBTC trends. Lastly, we provided evidence that controlling for changes in payroll taxation, time trend estimates predict after the mid-1990s are larger, between 82% to 102% of the ones found for the U.S..

In conclusion, France has also experienced a SBTC over the last 40 years but the strong increase in educational attainment has masked it up to now. Since the mid-1990s the rise in the relative high-skilled medium skilled supply has strongly decelerated. If the education supply keeps stabilizing, and the SBTC keeps increasing, France risks to face an increase in wage inequalities. The implications in terms of political response are important, maybe even more within the actual context of economic crisis.

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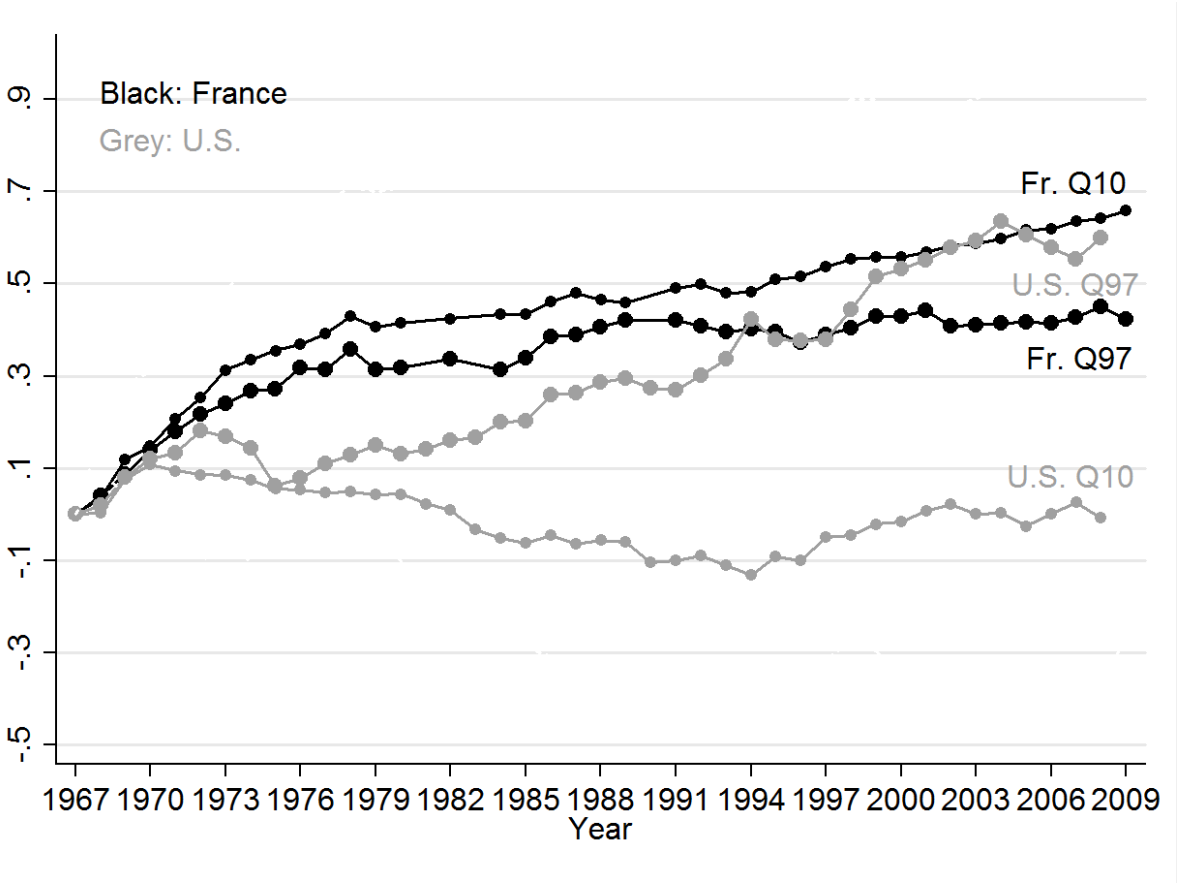
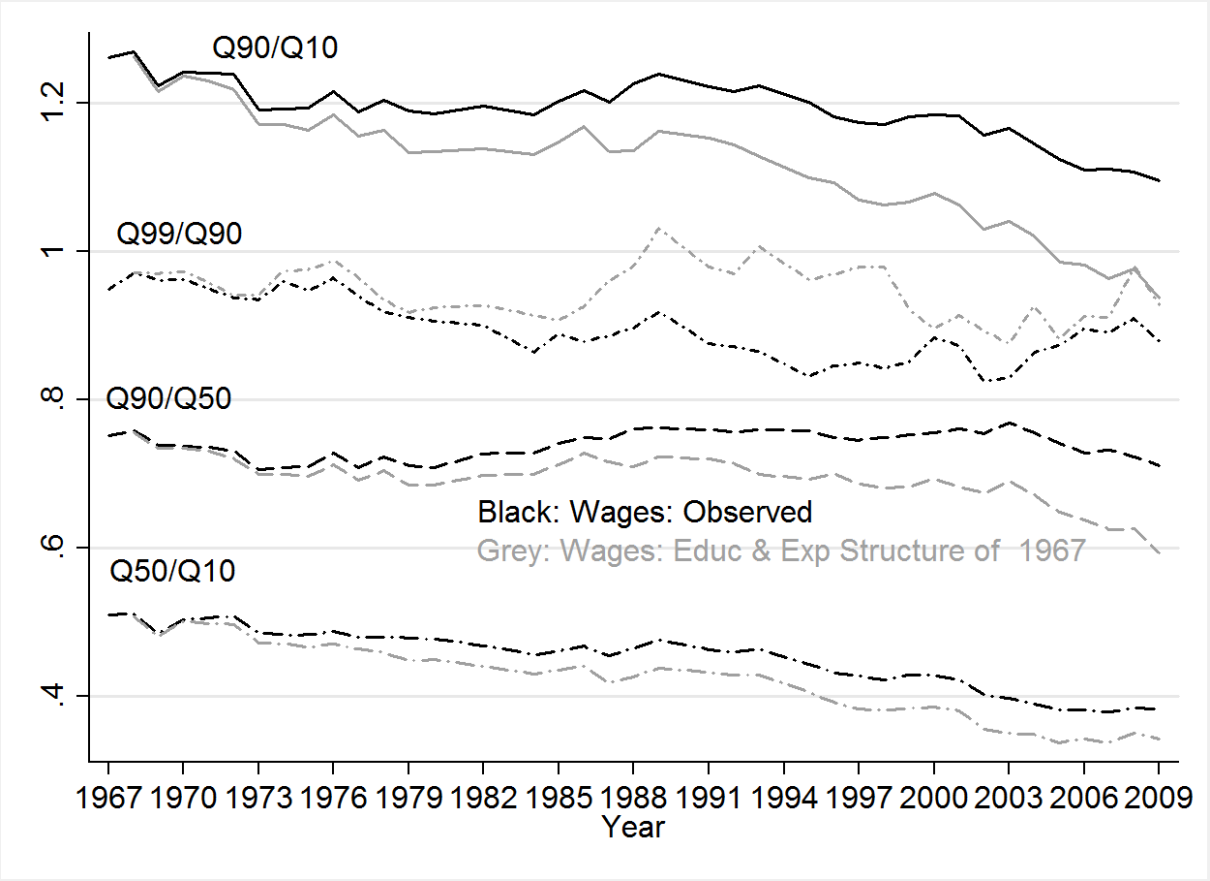
7 Tables and graphics



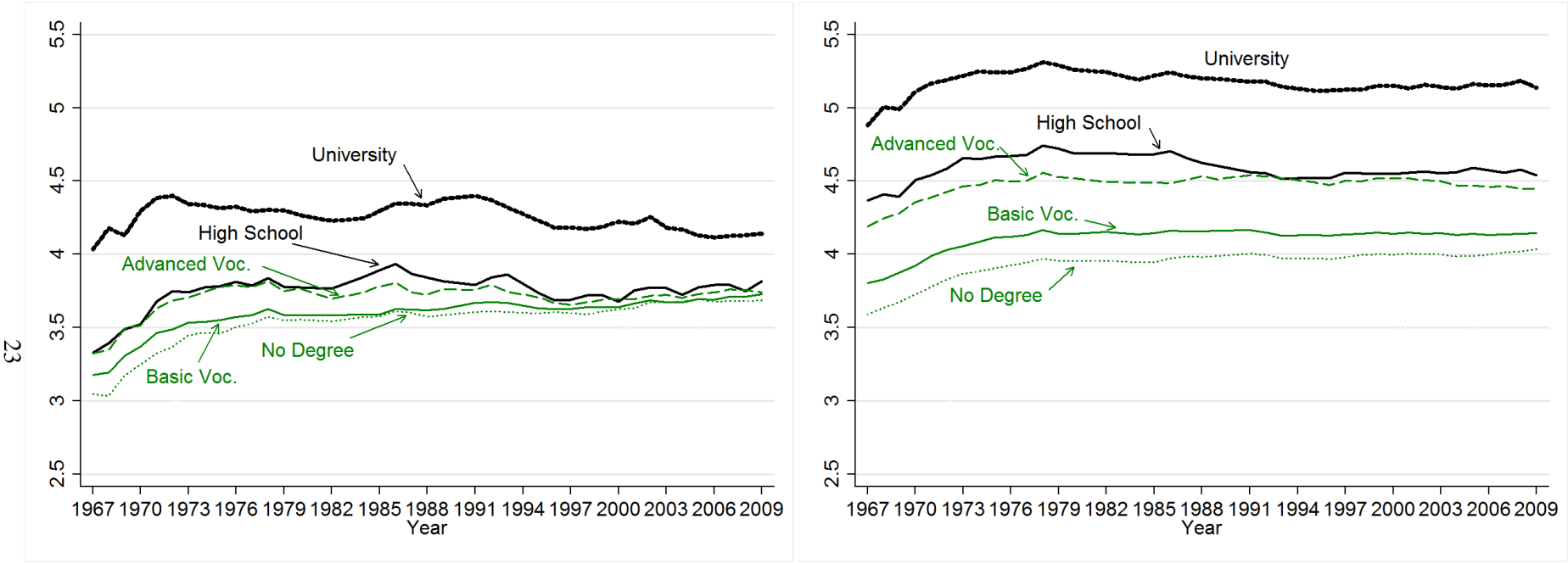
Source: France: DADS-EDP data. 15 to 64-Year-Old Full-Time Male Workers in the Private Sector, Weighted by Job Duration; U.S.: Full-Time Full-Year Male Workers, from Acemoglu and Autor (2011);

Figure 1: France/U.S. Comparison: Cumulative Log Changes in Real Weekly (U.S.) and Real Daily (Fr) Wages since 1967.



Source: DADS-EDP data, 15 to 64-Year-Old Full-Time Male Workers in the Private Sector, weighted by Job Duration. Note: Observed Differentials of Log Wage Quantiles are reported in Black. Differentials of Log Wage Quantiles with 1967 Education and Experience Structure are reported in Gray. The latter are obtained with the reweighting method of DiNardo, Fortin, and Lemieux (1996). Weights are computed with a Logit specification involving education group dummies interacted with experience, experience^2, and experience^3.

Figure 2: Raw and Education and Experience Composition-Adjusted Log Wage Inequality Trends

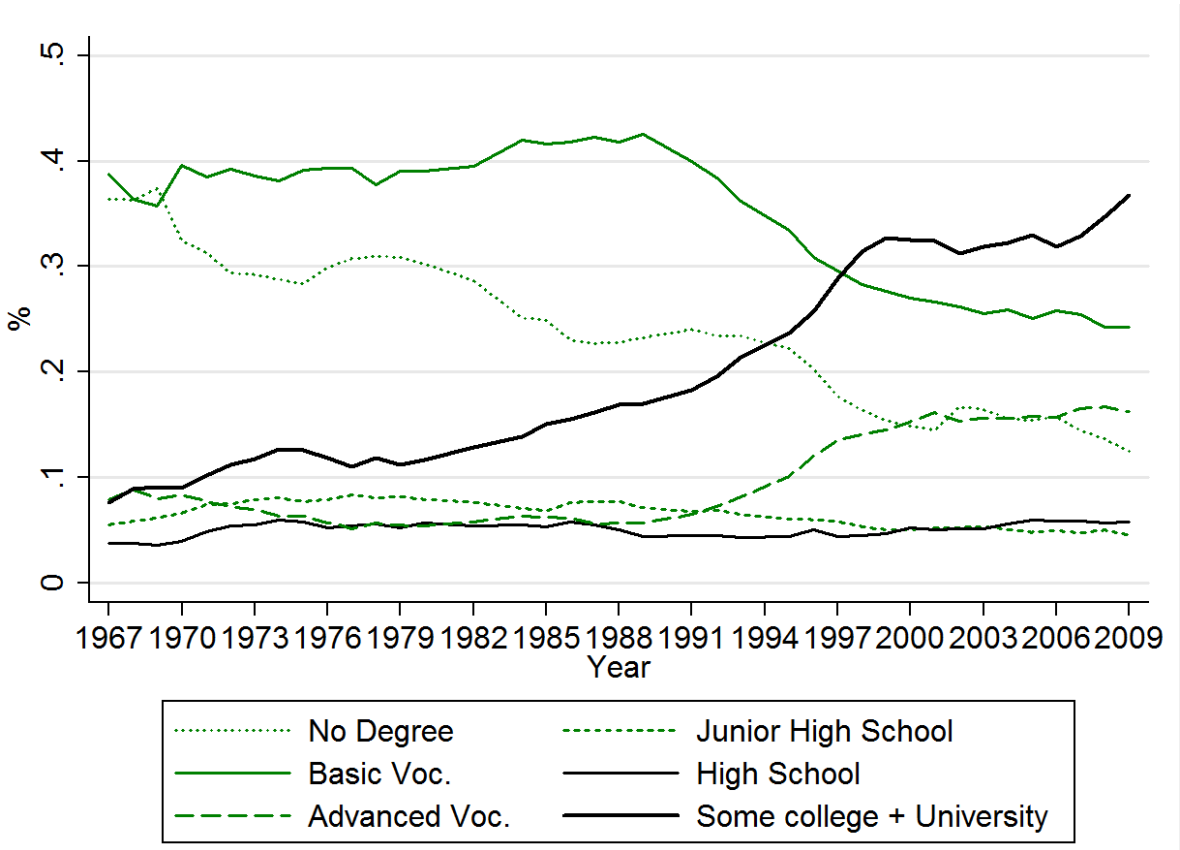


(a) One Year of Experience

(b) 25 Years of Experience

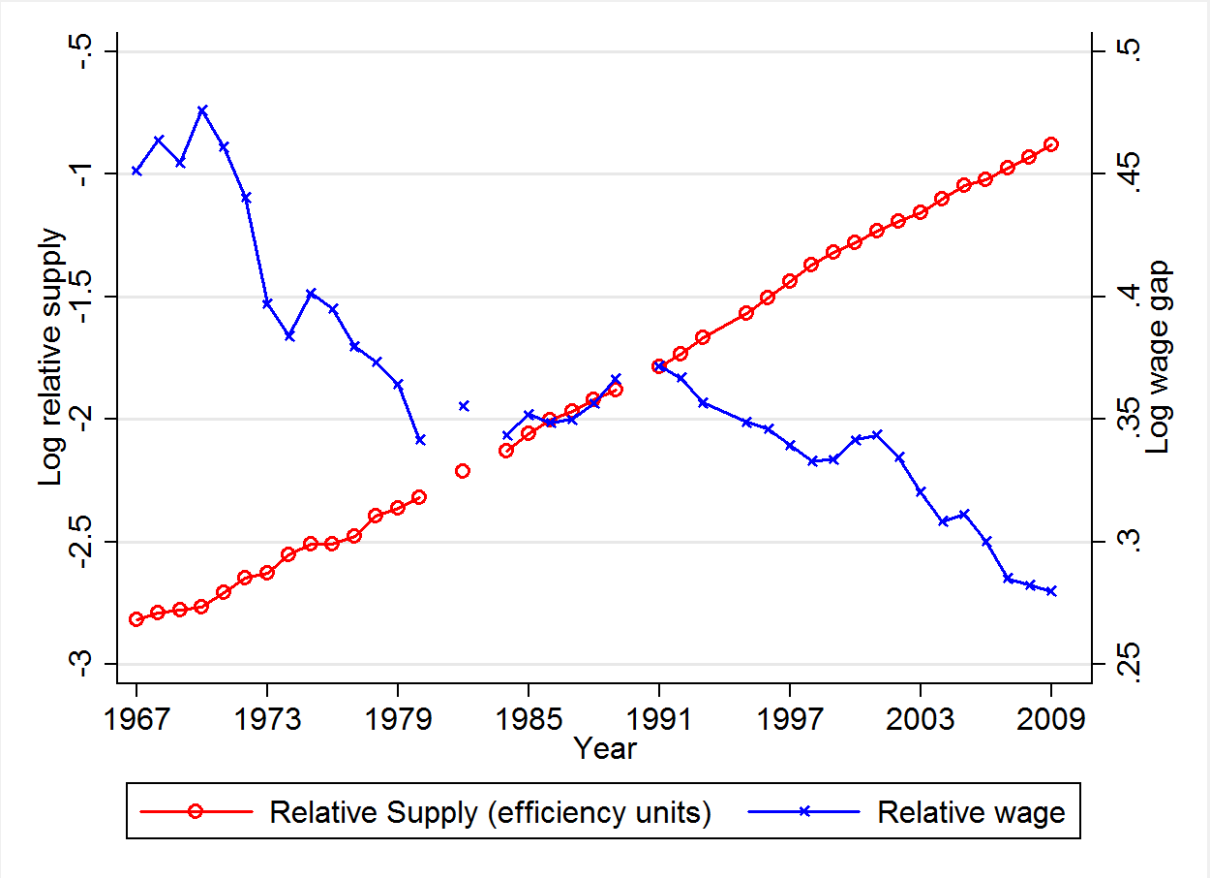
Source: DADS-EDP data, 15 to 64-Year-Old Full-Time Male Workers in the Private Sector, weighted by Job Duration. Note: Median Log Wages obtained by year-by-year-LAD regressions of Log Wages on Education Dummies interacted with Experience, Experience^2, and Experience^3..

Figure 3: Skill-Group Median Log Wages.



Source: DADS-EDP data. 15 to 64-Year-Old Full-Time Male Workers in the Private Sector with less than 5 Years of Experience, weighted by Job Duration.

Figure 4: French education trends: Shares by education of Full-Time Male Workers with less than five Years of Experience.



Note: log relative supply: ratio of the college-equivalent to non-college equivalent labor supply index in efficiency units. Log relative wage: log of a fix-weighted ratio of college to high school predicted LAD wages to adjust for composition by experience and education changes over 1967-2009.

Figure 5: Changes in college/high school relative supply and relative wage.

Table 1: Card-Lemieux model estimates for the tertiary/high school log wage gap with imperfect substitutability between experience groups, 1967-2009

	With supply indexes in days (weighted by job duration)				With supply indexes in worker units (equal weight per worker)			
	(1)	(2)	(3)	(4)	(1b)	(2b)	(3b)	(4b)
Time	-0.000	0.021*	0.010		-0.004	0.021**	0.009	
	(0.006)	(0.011)	(0.017)		(0.006)	(0.010)	(0.018)	
Time$^2/100$	0.088***	-0.011**	0.050		0.086***	-0.013**	0.038	
	(0.033)	(0.005)	(0.069)		(0.030)	(0.005)	(0.068)	
Time$^3/1000$	-0.011***		-0.007		-0.011***		-0.006	
	(0.004)		(0.008)		(0.004)		(0.008)	
Minimum wage		-0.203***	-0.091			-0.222***	-0.121	
		(0.077)	(0.148)			(0.076)	(0.153)	
Aggregate supply	-0.475**	-0.321	-0.444*		-0.372**	-0.276*	-0.346*	
	(0.238)	(0.201)	(0.244)		(0.183)	(0.161)	(0.186)	
Own minus aggregate supply	-0.192***	-0.193***	-0.192***	-0.194***	-0.215***	-0.216***	-0.216***	-0.217***
	(0.018)	(0.018)	(0.018)	(0.020)	(0.019)	(0.019)	(0.020)	(0.021)
Constant	-0.802	0.098	-0.508	0.534***	-0.510	0.268	-0.162	0.535***
	(0.697)	(0.499)	(0.846)	(0.030)	(0.539)	(0.403)	(0.697)	(0.031)
Nb obs	156	156	156	156	156	156	156	156
R^2	0.58	0.58	0.58	0.61	0.61	0.61	0.61	0.65
Experience group Dummies	Y	Y	Y	Y	Y	Y	Y	Y
Year Dummies	N	N	N	Y	N	N	N	Y
σ	2.107	3.112	2.251		2.688	3.624	2.886	
σ_E	5.205	5.178	5.196	5.159	4.644	4.623	4.633	4.604
Pval F-test of no time trend	0.053	0.058	0.090		0.033	0.028	0.053	
Partial R^2 Ag. Sup	0.026	0.017	0.022		0.027	0.020	0.023	
Partial R^2 Own	0.426	0.428	0.427		0.454	0.456	0.456	
Partial R^2 Min Wage		0.046	0.003			0.055	0.004	

Source: EDP-DADS Data. 15- to 64-Year-Old Full-Time Men working in the Private Sector.

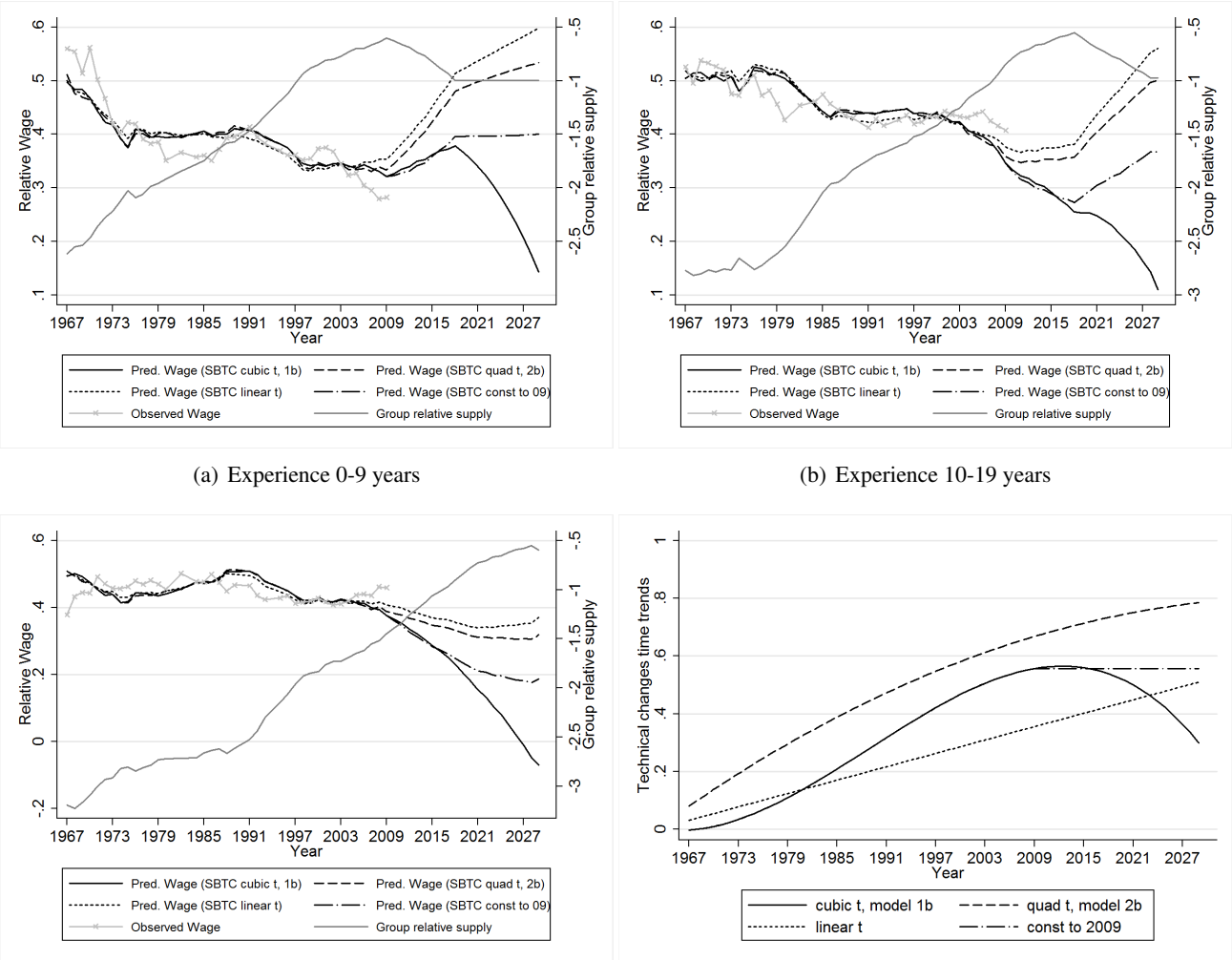
Note: Standard errors in parentheses. Significance levels: *:$p < 0.10$, **:$p < 0.05$, ***:$p < 0.01$. Each column reports OLS regression results of the fix-weighted college vs high school wage premium on indicated variables. Experience group dummies are included. Year dummies are included in columns (4) and (4b). Time, in years, equals 1 in 1964. The log relative aggregate supply is the log of the ratio between the college-equivalent labor supply index to non-college equivalent labor supply index in efficiency units, in days (columns 1-4) and worker units (columns 1b-4b). The log relative wage is the log of a fix-weighted ratio of college to high school predicted LAD wages to adjust for composition by experience and education changes over 1967-2009. LAD wages are computed weighting by the number of worked days (columns 1-4) and weighting each worker who worked at least once full time by one (columns 1b-4b). The year 1994 is not included in the computations because of poor quality data. See the Appendix for details. F tests are not corrected for the fact that relative wages are predicted.

Table 2: Katz-Murphy model estimates for the tertiary/high school log wage gap, 1967-2009

	With supply indexes in days (weighted by job duration)			With supply indexes in worker units (each worker has equal weight)		
	(1)	(2)	(3)	(1b)	(2b)	(3b)
Time	-0.016***	-0.019*	-0.014*	-0.020***	-0.020*	-0.017
	(0.003)	(0.009)	(0.008)	(0.003)	(0.010)	(0.010)
Time$^2/100$	0.121***	0.134***	0.091**	0.117***	0.116***	0.121**
	(0.018)	(0.038)	(0.035)	(0.017)	(0.039)	(0.044)
Time$^3/1000$	-0.015***	-0.016***	-0.012***	-0.014***	-0.014***	-0.016***
	(0.002)	(0.004)	(0.004)	(0.002)	(0.004)	(0.005)
Minimum wage		0.032	-0.110		-0.003	-0.102
		(0.081)	(0.096)		(0.087)	(0.111)
Aggregate supply	-0.342**	-0.352**	-0.155	-0.226**	-0.225**	-0.247**
	(0.129)	(0.133)	(0.116)	(0.101)	(0.105)	(0.117)
Unemployment rate			-0.199			-0.299
			(0.245)			(0.289)
Constant	-0.436	-0.540	0.420	-0.095	-0.086	0.151
	(0.377)	(0.462)	(0.450)	(0.300)	(0.394)	(0.440)
Nb obs	39	39	31	39	39	31
R^2	0.94	0.94	0.93	0.94	0.94	0.91
σ	2.927	2.838	6.462	4.426	4.438	4.042
Pval F-test for no time trend	0.000	0.000	0.000	0.000	0.000	0.000

Source: EDP-DADS Data. 15- to 64-Year-Old Full-Time Men working in the Private Sector.

Note: Standard errors in parentheses. Significance levels: *:$p < 0.10$, **:$p < 0.05$, ***:$p < 0.01$. Each column reports OLS regression results of the fix-weighted college vs high school wage premium on indicated variables. Time, in years, equals 1 in 1964. The log relative aggregate supply is the log of the ratio between the college-equivalent labor supply index to non-college equivalent labor supply index in efficiency units, in days (columns 1-3) and worker units (columns 1b-3b). The log relative wage is the log of a fix-weighted ratio of college to high school predicted LAD wages to adjust for composition by experience and education changes over 1967-2009. LAD wages are computed weighting observations by the job duration in columns (1) to (3), and by one each worker in columns (1b) to (4b). See the Appendix for details. F tests are not corrected for the fact that relative wages are predicted.



(a) Experience 0-9 years

(b) Experience 10-19 years

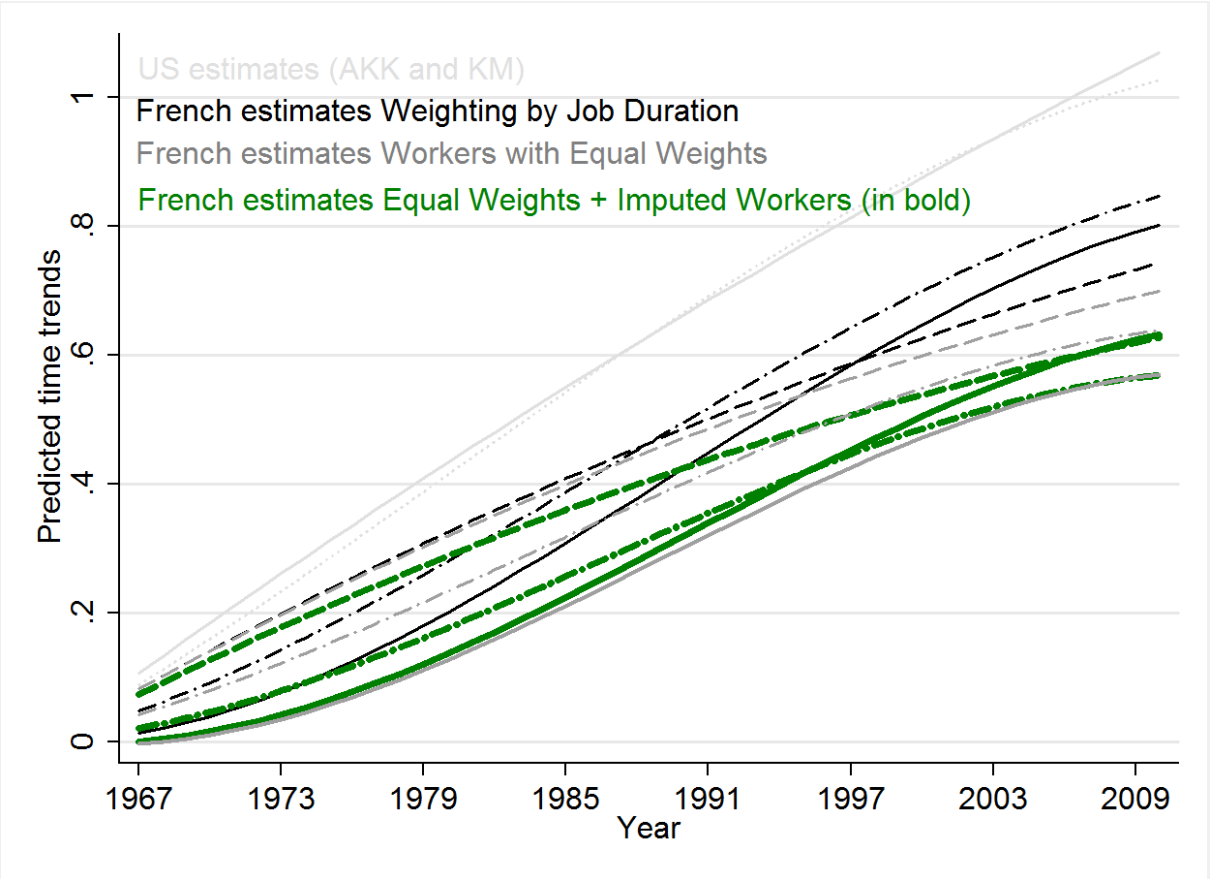
(c) Experience 20-29 years

(d) Technical changes

Source: DADS-EDP data, 15 to 64-Year-Old Full-Time Male Workers in the Private Sector.

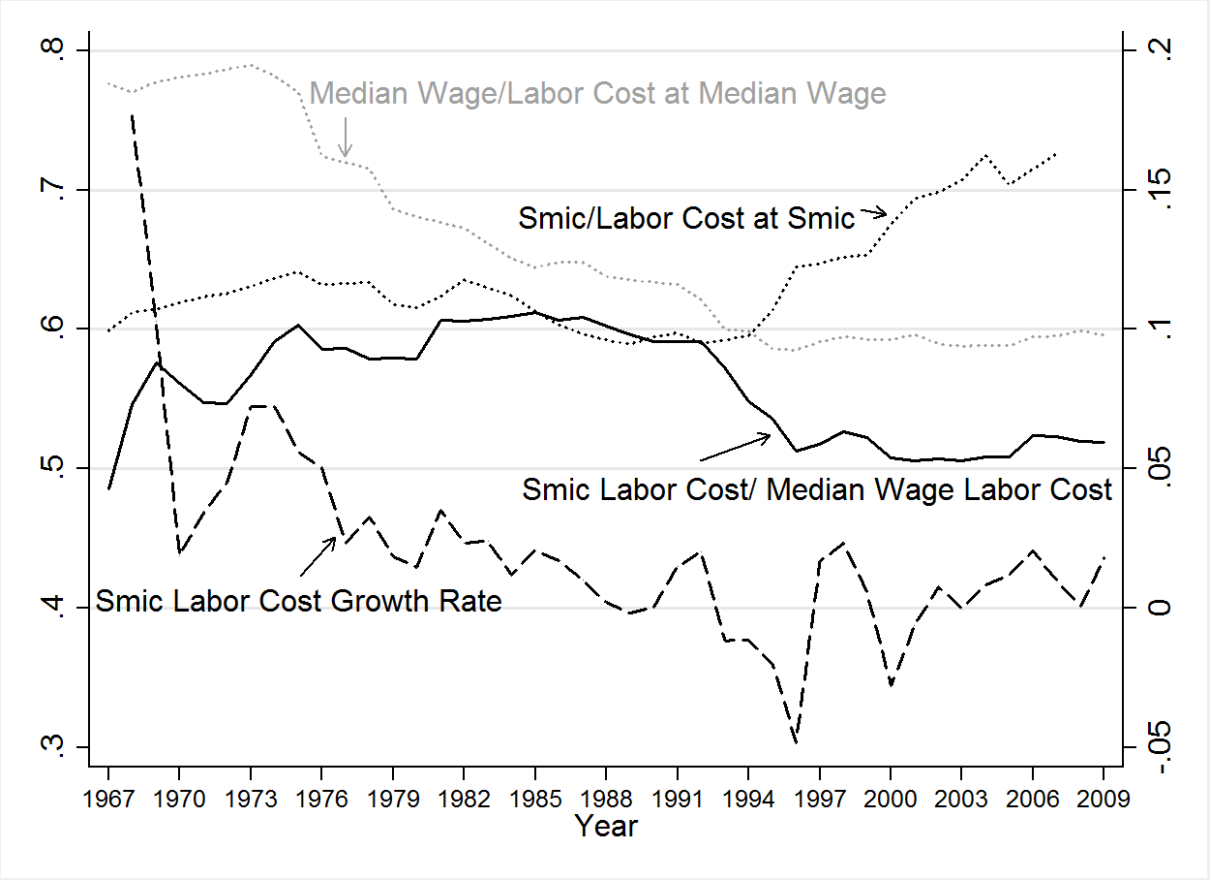
Note: For years $\geq$ 2010, supply indexes are simulated. We assume that for each year the number of workers per experience level equals the one observed in 2009. Each experience group has then an education structure equals to the structure observed the year before for the group less experienced by one year. Future new entrants in employment have the education structure observed in 2009 for the 0-experience group. Supply indexes are computed in worker efficiency units. Observed and predicted post-secondary vs high school wages are reported. Relative wages are predicted from Card-Lemieux model regressions as presented in Table 1, columns 1b-2b, with future demand shifters (minimum wage) equal to the observed level in 2009, with cubic and quadratic time trends. We also consider the case when the future time trend is constantly equal to the 2009 level (estimated with model 1b), and the case of a linear trend. Subfigure (d) reports the corresponding time trends. See the appendix for details.

Figure 6: Simulations of relative wages (supply in worker units)



Source: DADS-EDP data, 15 to 64-Year-Old Full-Time Male Workers in the Private Sector. Time trend effect estimates on relative wages are reported. The lines in pale gray are obtained using the time trend estimates found in the U.S. by Autor, Katz, and Kearney (2008) (AKK, solid line) and Katz and Murphy (1992) (KM, dotted line). The lines in black are obtained using the time trend estimates of Table 1, column 1 (solid), column 2 (dash), column 3 (dash-dot) $i.e.$ with relative wages and relative supply indexes computed by weighting by the job spell duration; the gray lines correspond to columns 1b (solid), 2b (dash), 3b (dash-dot), $i.e.$, each worker has the same weight. The green/bold lines correspond to the estimates of Table 4, columns 1 (solid), 2 (dash), 3 (dash-dot), which includes workers who are missing one year with imputed wages.

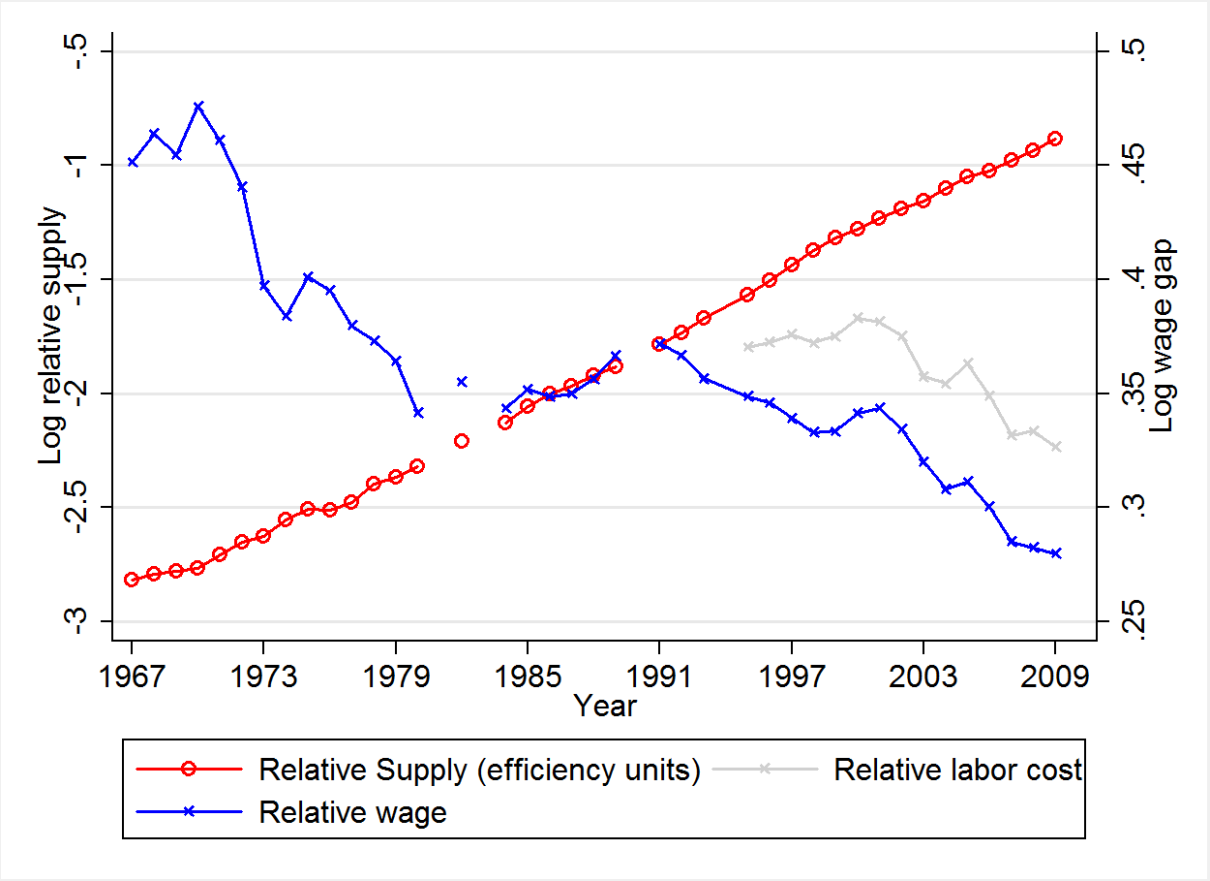
Figure 7: Predicted time trends for various data sets.



Source: Median Wage: DADS-EDP data, 15 to 64-Year-Old Full-Time Male Workers in the Private Sector, weighted by Job Duration. Minimum Wage, Labor Costs: French Ministry of Labor.

Note: Median Wage/Labor Cost at Median Wage (resp. Smic/Labor Cost at Smic) reports ratio of Daily Median Wage (resp. Daily Minimum Wage) on corresponding Daily Firm Total Labor Cost. Smic Labor Cost/Median Wage Labor cost reports the ratio of the Daily Minimum Wage Labor Cost to the Daily Median Wage Labor Cost. Series are in real terms, deflated by the French CPI. The Smic Labor Cost Growth Rate is reported on the right y-axis.

Figure 8: Labor cost trends: Minimum Wage vs Median.



Note: log relative supply: ratio of the college-equivalent to non-college equivalent labor supply index in efficiency units. Log relative wage and labor cost: log of a fix-weighted ratio of college to high school predicted LAD wages and Labor Costs to adjust for composition by experience and education changes over 1967-2009.

Figure 9: Changes in college/high school relative supply, relative wages and labor costs

8 Appendix: technicalities

8.1 Mincer-type model for wage and quantile regressions

To compute median wages and within inequalities reported in Figure 11, we use a Mincer-type model (Mincer, 1974) in which log daily wages are related to education and experience. Education-group dummies are interacted with experience, experience^2, and experience^3 to allow heterogenous effects of experience:

$$Q_{y_i}(\theta|dip_i, exp_i) = \sum_{k=1}^{7}(\beta_{k\theta} + \gamma_{1k\theta}exp_i + \gamma_{2k\theta}exp_i^2 + \gamma_{3k\theta}exp_i^3)\mathbf{1}_{dip_i=k},\ i = 1, \ldots, N, \qquad (5)$$

where $Q_y(\theta|dip, exp)$ denotes the $\theta-$order quantile of the conditional log wage distribution and θ belongs to $(0, 1)$, exp_i denotes the experience as a wage earner in the private sector and $\mathbf{1}_{dip_i=k}$ is a dummy variable equalling 1 if individual i holds the degree k, and 0 otherwise. We estimate this model year by year by quantile regressions at requested quantile orders (see Koenker and Bassett, 1978, Buchinsky, 1994, Fortin and Lemieux, 1998, Gosling, Machin, and Meghir, 2000, Autor, Katz, and Kearney, 2005).

8.2 Supply and demand: construction of the relative labor supply and the relative wage gap

The labor supply and the relative wage gap between skilled and unskilled workers are constructed following Autor, Katz, and Kearney (2008).

Relative wage gap. The relative wage gap is based on the median experience-composition-adjusted wages computed by the previous quantile regressions. 28 cells of 7 groups of education and 4 groups of experience (0-10, 10-20, 20-30, 30-40) interactions are defined. For each group of education, we predict LAD wages with 5, 15, 25 and 35 years of real experience.Then, we construct composition-adjusted wages for each group of education, by aggregating over experience groups, the predicted LAD wages, with fixed weights equalling the average over 1967-2009 of the experience group shares in the total of annual full-time working days. Finally, the aggregated composition-adjusted wages for tertiary workers is the average of the ones for University and the ones for some college workers, weighted according to the average share of worked days of both cells in the total of the tertiary group.

Relative labor supply. As usual in this literature, the labor supply is the product of a "quantity sample" and a "price sample". The "quantity sample" is the number of days worked in a given year year by the 7 education groups $\times$ 40 years of real experience, using both full-time and part-time periods. These quantities are then converted into efficiency units by multiplying them with weights fixed over the period called the "price sample". The price sample is obtained by (1) calculating for each cell and each year the median wage for full-time working periods (2) standardizing them by the ones for low-vocational

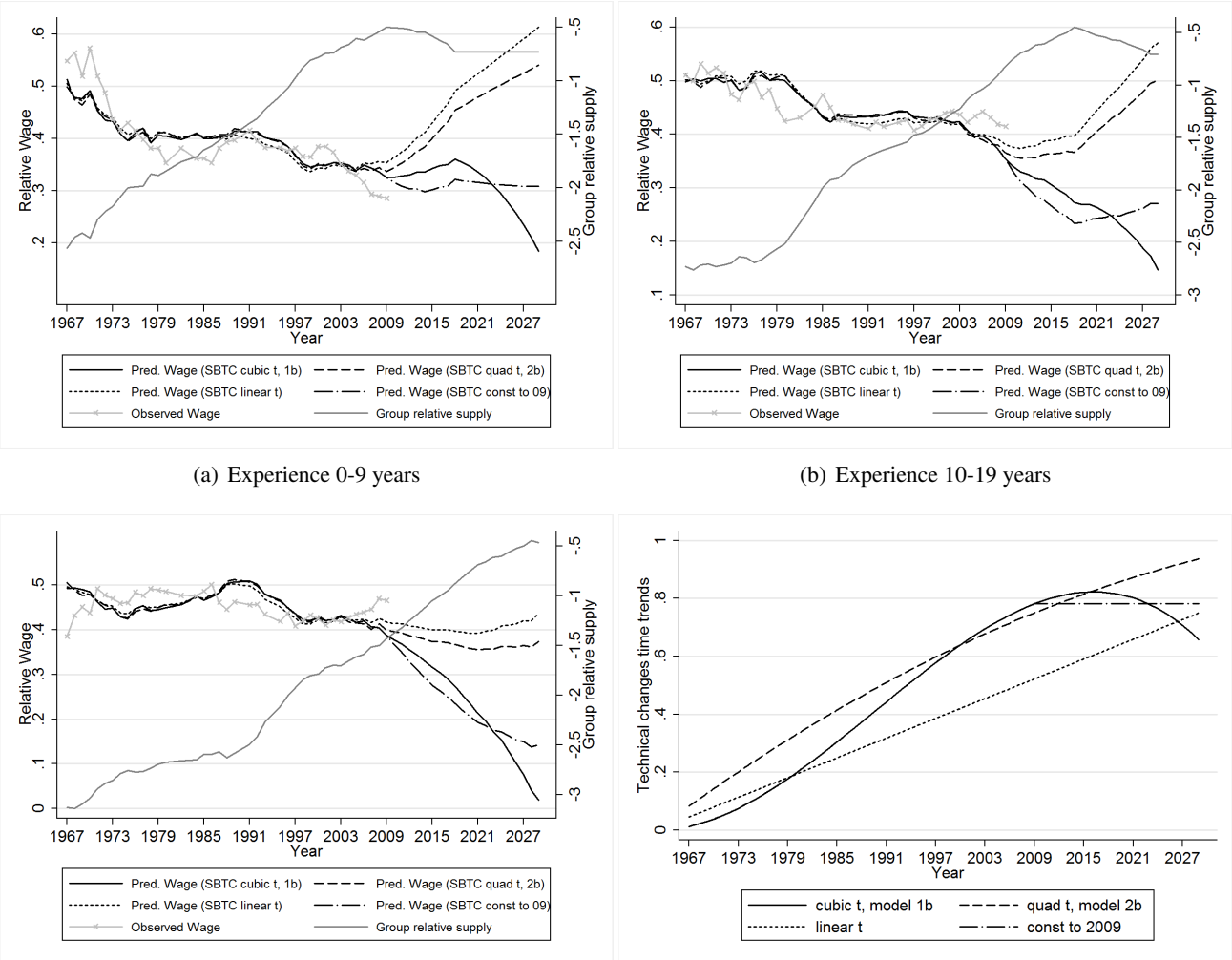
degree owners with 15 years of real experience in the same year, (3) averaging these standardized wages over the period to obtain $7\times$ 40 fixed-weights or "efficiency units". Alternatively, we compute the "quantity sample" using the number of workers having worked at least one day during the year rather than worked days. Efficiency units are then combined to obtain relative labor supplies. The aggregate college equivalent labor supply is the sum of the University and some college efficiency units, and the aggregate high school equivalent labor supply the sum of the other degree categories. The log relative labor supply is the log of the ratio between the two. This measure is both computed combining all experience groups and per experience groups.

9 Appendix: additional graphics and tables

Table 3: Education categories

French label	English label	% (pooled sample)
Aucun diplme déclaré or CEP, DFEO	no degree reported or completed elementary school	0.30
BEPC, BE, BEPS	completed junior high school	0.06
CAP, BEP, EFAA, BAA, BPA	basic vocational degree	0.37
Bac technique et professionnel, Brevet professionnel, autres brevets BEA, BEC, BEH, BEI, BES, BATA,	advanced vocational-technical degree (high vocational)	0.08
Bac général, brevet supérieur, CFES	completed high school	0.03
BTS, DUT, DEST, DEUL, DEUS, DEUG, diplme professions sociales ou de la santé	some college, college degree and technical or vocational college	0.09
Dip. universitaire de 2ème ou 3ème cycle, diplme d'ingénieur, Grandes Ecoles	university degree, engineering school, Grande Ecole	0.07

Source: EDP-DADS Data. 15- to 64-Year-Old Full-Time Men working in the Private Sector.
Note: The information on the degree may differ between Censuses. We favor the one corresponding to the Census that follows the end of studies or when the person has just passed 27. When no degree are declared in that Census or when the information is not precise enough to determine the education category, we use the information reported in the following ones. In the 1968 and the 1990 Censuses, general high school and vocational high school are not distinguished. The same occurs for "brevet de technicien" (a vocational high school degree) and BTS (a post-Bac vocational degree) in the 1968 Census. In the 1968 and the 1975 Censuses, there is no distinction between college and university degrees. In such cases, we use the following Census information when available and choose the most frequent category in the population otherwise.



(a) Experience 0-9 years

(b) Experience 10-19 years

(c) Experience 20-29 years

(d) Technical changes

Source: DADS-EDP data, 15 to 64-Year-Old Full-Time Male Workers in the Private Sector.

Note: For years $geq2010$, supply indexes are simulated. We assume that for each year the number of days worked per experience level equals the ones observed in 2009. Each experience group has then an education structure equals to the structure observed the year before for the group less experienced by one year. Future new entrants in employment have the education structure observed in 2009 for the 0-experience group. Supply indexes are computed in days efficiency units. Observed and predicted post-secondary vs high school wages are reported. Relative wages are predicted from Card-Lemieux model regressions as presented in table 1, columns 1-2, with future demand shifters (minimum wage) equal to the observed level in 2009, with cubic and quadratic time trends. We also consider the case when the future time trend is constantly equal to the 2009 level (estimate with model 1), and the case of a linear trend. Subfigure (d) reports the corresponding time trends. See the appendix for details.

Figure 10: Simulations of relative wages (supply in day units)

Table 4: Card-Lemieux model estimates for the tertiary/high school log wage gap with imperfect substitutability between experience groups, 1967-2009: imputed workers.

	With supply indexes in worker units (equal weight per worker and one-year missing imputed)			
	(1)	(2)	(3)	(4)
Time	-0.003	0.019**	0.003	
	(0.005)	(0.009)	(0.017)	
Time$^2/100$	0.082***	-0.012**	0.057	
	(0.027)	(0.005)	(0.065)	
Time$^3/1000$	-0.010***		-0.008	
	(0.003)		(0.007)	
Minimum wage		-0.202***	-0.062	
		(0.068)	(0.148)	
Aggregate supply	-0.376**	-0.270*	-0.360**	
	(0.169)	(0.151)	(0.173)	
Own minus aggregate supply	-0.221***	-0.222***	-0.221***	-0.221***
	(0.019)	(0.019)	(0.019)	(0.021)
Constant	-0.517	0.243	-0.332	0.536***
	(0.497)	(0.393)	(0.666)	(0.030)
Nb obs	156	156	156	156
R^2	0.64	0.64	0.64	0.67
Experience Dummies	Yes	Yes	Yes	Yes
Year Dummies	No	No	No	Yes
σ	2.662	3.710	2.776	
σ_E	4.520	4.504	4.516	4.515
pval F-test for no time trends	0.022	0.028	0.041	
Partial R^2 Ag. Sup	0.033	0.021	0.029	
Partial R^2 Own	0.483	0.483	0.484	
Partial R^2 Min. Wage		0.056	0.001	

Source: EDP-DADS Data. 15- to 64-Year-Old Full-Time Men working in the Private Sector, workers who are missing for one year only are also included with imputed wage equal to the average wage the year before and the year after.
Note: Standard errors in parentheses. Significance levels: *:$p < 0.10$, **:$p < 0.05$, ***:$p < 0.01$. Each column reports OLS regression results of the fix-weighted college vs high school wage premium on indicated variables. Experience group dummies are included. Year dummies are included in columns (4). Time, in years, equals 1 in 1964. The log relative aggregate supply is the log of the ratio between the college-equivalent labor supply index to non-college equivalent labor supply index in efficiency worker units. The log relative wage is the log of a fix-weighted ratio of college to high school predicted LAD wages to adjust for composition by experience and education changes over 1967-2009. LAD wages are computed weighting each worker (included those with imputed wages) by one. The year 1994 is not included in the computations because of poor quality data. See the Appendix for details. F tests are not corrected for the fact that relative wages are predicted.

Table 5: Card-Lemieux model for the tertiary/high school log wage gap: controlling for changes in payroll taxation

	With supply indexes in days (weighted by job duration)			With supply indexes in worker units (equal weight per worker)		
	(1)	(2)	(3)	(1b)	(2b)	(3b)
Time	0.001	0.025*	0.013	-0.001	0.031**	0.016
	(0.007)	(0.013)	(0.018)	(0.006)	(0.013)	(0.018)
Time$^2/100$	0.099***	-0.015*	0.056	0.118***	-0.022**	0.060
	(0.037)	(0.009)	(0.069)	(0.038)	(0.010)	(0.070)
Time$^3/1000$	-0.013***		-0.008	-0.016***		-0.010
	(0.005)		(0.008)	(0.005)		(0.008)
Minimum wage		-0.233**	-0.111		-0.294***	-0.152
		(0.092)	(0.150)		(0.099)	(0.154)
Median labor cost	-0.144	-0.123	-0.169	-0.317	-0.254	-0.350
to net wage ratio	(0.210)	(0.209)	(0.213)	(0.237)	(0.226)	(0.239)
Aggregate supply	-0.510**	-0.330	-0.479*	-0.489**	-0.330*	-0.469**
	(0.244)	(0.201)	(0.248)	(0.202)	(0.168)	(0.203)
Own minus aggregate supply	-0.191***	-0.193***	-0.192***	-0.214***	-0.216***	-0.215***
	(0.018)	(0.018)	(0.019)	(0.019)	(0.019)	(0.019)
Constant	-0.876	0.165	-0.532	-0.790	0.321	-0.382
	(0.706)	(0.513)	(0.848)	(0.577)	(0.406)	(0.710)
Observations	156	156	156	156	156	156
R^2	0.58	0.58	0.58	0.61	0.61	0.62
Experience Dummies	Y	Y	Y	Y	Y	Y
Year Dummies	N	N	N	N	N	N
σ	1.962	3.032	2.086	2.044	3.029	2.131
σ_E	5.227	5.192	5.220	4.663	4.631	4.650
pval F test for no trends	0.055	0.138	0.171	0.020	0.055	0.065

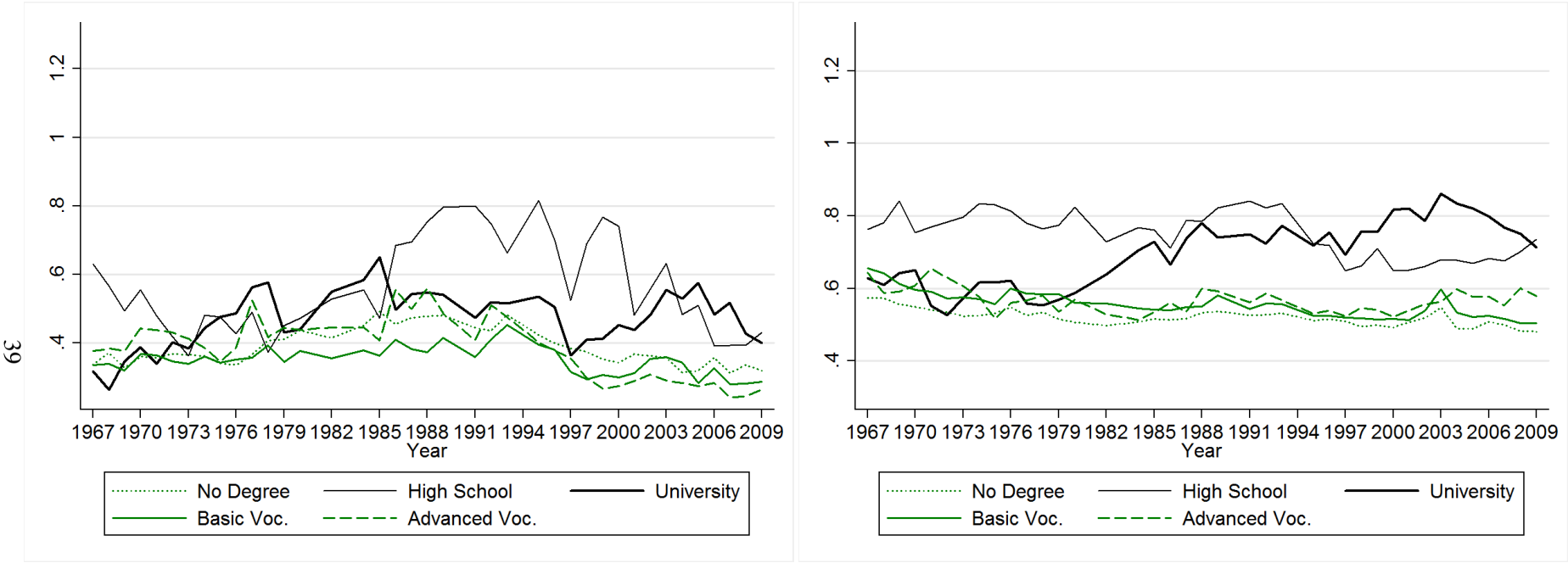
Source: EDP-DADS Data. 15- to 64-Year-Old Full-Time Men working in the Private Sector.

Note: Standard errors in parentheses. Significance levels: *:$p < 0.10$, **:$p < 0.05$, ***:$p < 0.01$. Each column reports OLS regression results of the fix-weighted college vs high school wage premium on indicated variables. Experience group dummies are included. Time, in years, equals 1 in 1964. The log relative aggregate supply is the log of the ratio between the college-equivalent labor supply index to non-college equivalent labor supply index in efficiency units, in days (columns 1-3) and worker units (columns 1b-3b). The log relative wage is the log of a fix-weighted ratio of college to high school predicted LAD wages to adjust for composition by experience and education changes over 1967-2009. LAD wages are computed weighting by the number of worked days (columns 1-4) and weighting each worker who worked at least once full time by one (columns 1b-3b). The year 1994 is not included in the computations because of poor quality data. The log of the median labor cost to net wage ratio is included in the regressions to control for changes in payroll taxation. See the Appendix for details. F tests are not corrected for the fact that relative wages are predicted.

Table 6: Explanatory power (R^2) of minimum wage evolutions relative to within-group median wage on within-group wage inequalities.

	Q50-Q10			Q90-Q50		
Experience	1 year	5	10	1 year	5	10
High School	0.25	0.11	0.00	0.01	0.03	0.02
Univ	0.00	0.02	0.06	0.05	0.02	0.03

Source: EDP-DADS Data. 15- to 64-Year-Old Full-Time Men working in the Private Sector.
Note: R^2 for OLS regressions of predicted evolutions of the difference between predicted median log wage ($Q50logw$) and Q10 log wage (resp. between Q90 and median log wage) on evolutions of $Q50logw - logsmic$. Regressions contain 34 observations.

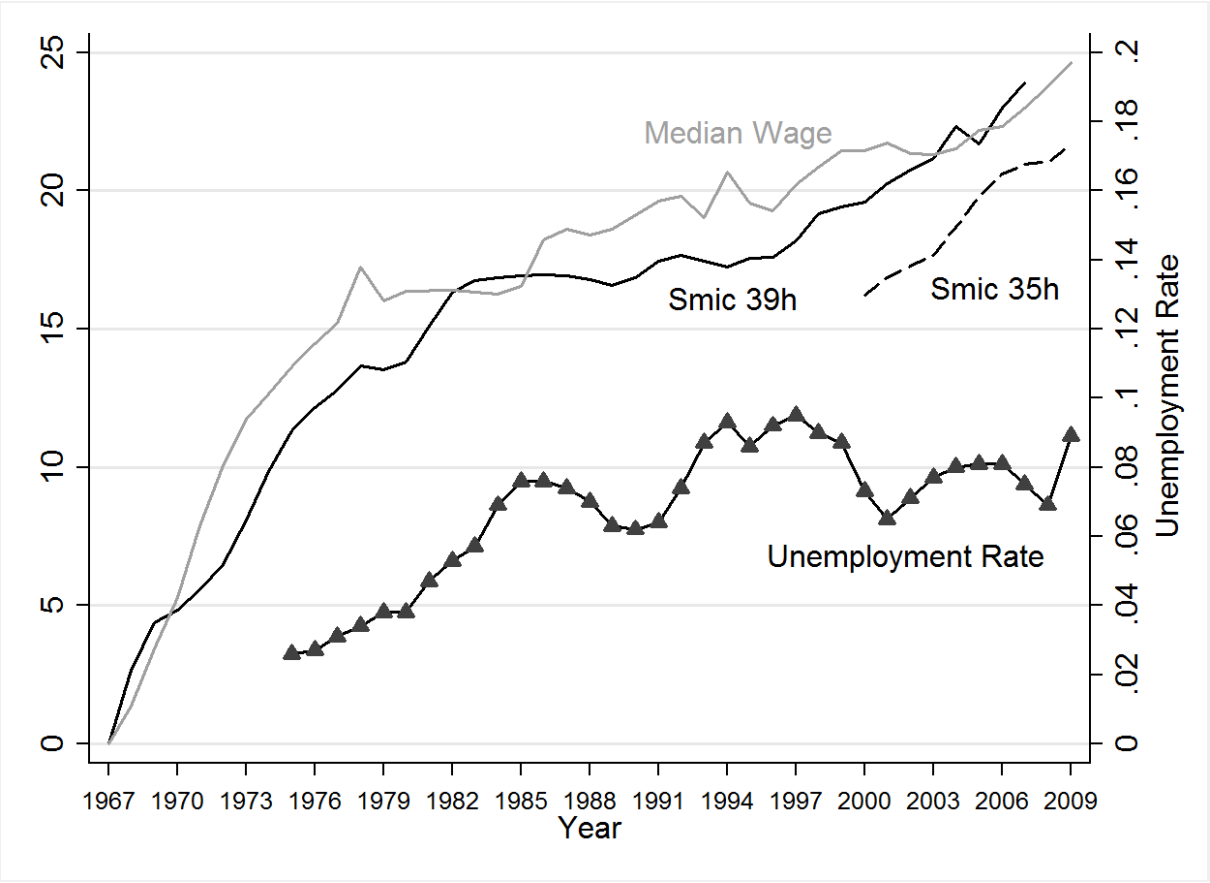


(a) One year of Experience

(b) 25 Years of Experience

Source: DADS-EDP data, 15 to 64-Year-Old Full-Time Male Workers in the Private Sector, weighted by Job Duration. Note: Fitted Q90-Q50 Log Wages Differences obtained by year by year Quantile regressions of Log Wages on Education Dummies interacted with Experience up to the third-order.

Figure 11: Within Inequalities: Intra Education and Experience Groups Q90-Q50 Log Wage Differences



Source: Median Wage: DADS-EDP data, 15 to 64-Year-Old Full-Time Male Workers in the Private Sector, weighted by Job Duration. Minimum Wages (Smic 39h and Smic 35h): French Ministry of Labor.
Note: Median Wage reports the Cumulative Changes since 1967 in Daily Median Wage of Full-Time Male Workers in the Private Sector; Smic 39h (resp. Smic 35h) reports the Cumulative Changes since 1967 in Daily Minimum Wage based on a 39-hour Workweek (resp. 35-hour Workweek). The three wages series are in real terms (en euros 2009), deflated by the French CPI. The Male Unemployment Rate is reported on the right y-axis.

Figure 12: Minimum Wage (Smic) and Unemployment Trends.