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Market vs. Institutions: The Trade-off Between Unemployment and Wage Inequality Revisited

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Abstract

The *trade-off hypothesis* suggests that high wage inequality in the US and the UK and high unemployment in countries of continental Europe are consequences of the same negative change in the demand for the low skilled under different degrees of wage rigidity. This paper uses a labor supply and labor demand model with heterogenous types of labor in order to test the trade-off hypothesis and to analyze the effect of market forces and wage rigidity on changes in the between-group variation in earnings, employment, unemployment, and inactivity in France, the UK, and the US between 1990 and 2002. The results provide clear evidence in favor of the trade-off hypothesis when France is compared to the US as well as to the UK. We also find that labor supply and labor demand are more wage elastic in the UK than in the other two countries. Counterfactual simulations based on the estimated model reveal that exogenous changes in the relative demand for skills dominated in France, while supply shifts had more impact in the US over the studied period. In the UK, the opposite effects of the supply and the demand shifts were of similar magnitude, even though the supply effects dominated for the least and the most educated.

In addition, an extended version of the trade-off hypothesis is proposed which considers not only wage inequality and unemployment but also labor supply. If labor force participation is sensitive to wages, then rising wage inequality is likely to be accompanied by an increase in the inactivity rate. We find that wage elasticity of labor force participation is positive and significant in all three countries, and suggest that depending on the institutions that affect wage rigidity, there is trade-off between unemployment on one hand, and wage inequality *and* inactivity on the other.

JEL classification: J21, J31, J64

Keywords: Unemployment and Wage Inequality Trade-off; Wage Rigidity; Inactivity;

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1 Introduction

Over the last three decades, labor markets in English-speaking countries and in continental Europe have suffered from two contrasting phenomena: while wage inequality has increased in the US and the UK, unemployment has been steadily rising in many countries of the European continent. It has been proposed (see Krugman (1994) and Blank (1997)) that the two phenomena have the same cause, namely decline in the demand for the low skilled, resulting primarily from skill-biased technological progress. The reason why the adverse shock to the demand for the low skilled has had different consequences in the various countries was suggested to be their diverse labor market institutions that affect wage flexibility. This argument has been coined as the *trade-off hypothesis*, sometimes also referred to as the Krugman hypothesis. It states that in the presence of skill-biased shift in the demand, there is a trade-off between unemployment and wage inequality, depending on the flexibility of the wage-setting mechanisms. This paper explores the empirical relevance of the trade-off hypothesis by testing whether its predictions hold when the US and the UK, two countries with relatively flexible labor markets, are compared to France, as a country with relatively rigid wages, over the 1990s.

We estimate a labor supply and labor demand model with heterogenous types of labor, using a pseudo-panel of different skill-groups constructed from the labor force surveys of the three countries (*Enquête Emploi* for France, *Labor Force Survey* for the UK, and the *March CPS* for the US) between 1990 and 2002. In the theoretical model, the demand for different types of labor is derived from a CES production function, and the labor supply varies across labor types. The model allows for wage rigidity, and consequently regards unemployment as a disequilibrium phenomenon. A system of three equations for wage, employment, and labor force participation as a function of exogenous supply and demand shifters, as implied by the structural model, is estimated by two-way fixed effects on group-level panel data. The classification of a skill-group is based on gender, age, and education. We use linear and non-linear least squares, respectively, to estimate the reduced-form parameters and the structural parameters of the model.

Both sets of parameters are used to test the trade-off hypothesis. As for the reduced-form coefficients, the hypothesis implies that wages should be more sensitive to exogenous changes in the demand than to employment in the US and the UK, countries where wages are flexible, while the opposite should hold in France. The demand-shock sensitivity of wages should also be higher in the US and the UK than in France, while the opposite should hold for the sensitivity of the employment rate. In addition, in countries where wages are fully flexible, demand shocks should affect employment in exactly the same way as labor supply, while the first effect should exceed the latter when wages are rigid. As for the structural coefficients, degree of wage rigidity is directly estimated as a parameter of the model and compared across the three countries.

There are few papers that test the trade-off hypothesis explicitly. Bertola, Blau and Kahn (2002) investigate the relationship between unemployment and wage inequality using aggregate data for a panel of OECD countries. They find a strong and significant negative relationship between the residuals from the unemployment and wage-inequality equations, but only after controlling for country and period fixed effects. However, in order to explore whether there is indeed a trade-off between wage inequality and unemployment caused by different degrees of wage flexibility in the presence of skill-biased changes in the labor demand, as the trade-off hypothesis suggests, it is necessary to look at the data disaggregated by skills. Card, Kramarz and Lemieux (1999), the closest antecedent to this work, analyze a long term change in the skill-specific wages and employment over the 1980s for France, Canada and the US. They reject the trade off hypothesis comparing France and Canada to the US. The only other work that analyzes relative wages and employment rates in order to test the trade-off hypothesis, although in a less structural framework, is Puhani (2005). Focusing on the UK, the US, and Germany, he finds evidence in favor of the trade-off hypothesis for the 1980s and 1990s when comparing Germany to the US.[2] The conclusions are therefore mixed: for different countries over different periods and using different methods, evidence is found both for and against the existence of trade-off between unemployment and wage inequality. The relevance of the trade-off hypothesis thus remains in question.

The present paper aims to add to this scarce literature not merely by providing further evidence for another set of countries over a new period but also, and primarily, by employing a novel estimation framework that we believe has several advantages over the previous work. We focus on the year-to-year changes in wage and labor-force status skill differentials using group-level panel data, comparing France, the US, and the UK over 1990s. In contrast to the more general but reduced-form approach of Puhani (2005), which is based solely on the interpretation of observed correlations between changes in the relative wages and unemployment rates of different skill-groups, we test the trade-off hypothesis using a structural model of skill-specific labor supply and labor demand with exogenous factors, in this respect following the approach of Card et al. (1999). Their model is extended here so as to include additional supply shocks as well as a new demand shifter, and the full structure of the model is utilized so as to describe not only employment but rather all three labor force states (employment, unemployment, inactivity) as well as earnings. In contrast to Card et al. (1999), the extended model is applied to panel data and estimated in the structural form (as well as reduced form).[3] Contrary to Card et al. (1999) we do find support for the trade-off hypothesis when comparing France to the US and the UK over the 1990s.

In addition to the previous discussion, we propose an extended version of the trade-off hypothesis, which focuses not only on wage inequality and unemployment but also on labor supply. If labor force participation is sensitive to wages then rising wage inequality is likely to be accompanied by an increase in the inactivity rate. If labor supply is wage elastic, it follows that depending on the institutions that affect wage rigidity there is a trade-off between unemployment on one hand, and wage inequality *and* inactivity on the other.

The estimation results are further used to construct counterfactual series that hold either the supply or the demand shifters constant at their initial levels. These simulations show what would have happened had there been no exogenous changes in the demand

[2]Among related works further belong Nickell and Bell (1995, 1996), Krueger and Pischke (1997), and Gottschalk and Joyce (1998); they focus on the determinants of the changes in relative wages but not in relative employment.

[3]Our methodological extensions of Card et al. (1999) are discussed in detail in the Appendix.

or the supply. A comparison of the actual and the simulated series reveals which factors stood behind the development in earnings and labor force status in different skill-groups in the three countries, and whether supply or demand factors dominated.

The tests based on the reduced-form estimates confirm the validity of the trade-off hypothesis and its extended version when France is compared to the US but have mixed results for the UK. Wages are more sensitive than employment to the demand shocks in the US, while the opposite is true for France as well as the UK. Cross-country comparison also shows that the demand-shock sensitivity of wages is higher, while demand-shock sensitivity of employment is lower in the US than in the other two countries. The demand shock has an equal effect on employment and labor supply in the US as well as in the UK, suggesting that there is full wage flexibility in the two countries. The mixed reduced-form results for the UK are reconciled by the structural estimation, which reveals that both labor supply and labor demand are significantly more wage elastic in the UK than in the other two countries, which explains the observed insensitivity of wages and sensitivity of employment to demand shocks in this country.

Structural results provide further evidence in favor of the trade-off hypothesis. The estimate of the wage flexibility parameter is lower in France than in the other two countries. We therefore conclude that institutions that enhance wage rigidity played an important role in the earnings and labor force status developments in France during the period under analysis. The positive and significant values of the wage elasticity of labor force participation for all three countries suggest that the high inactivity rates in the US and the UK, in particular among low-skilled men, could be a consequence of the continuing deterioration of the relative wages of the low skilled, as proposed by the extended trade-off hypothesis.

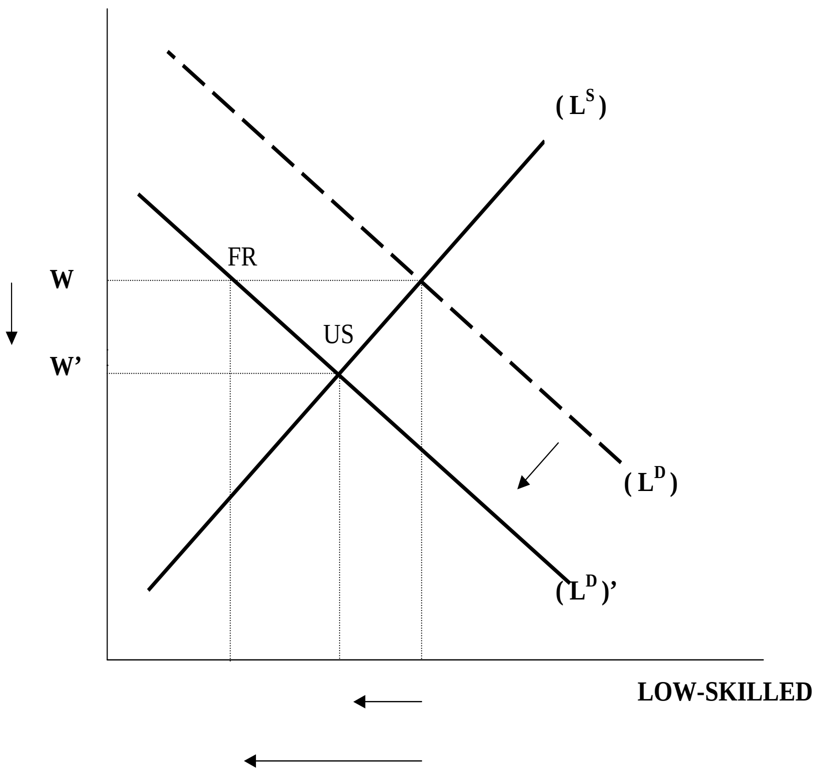
Simulations based on the estimated model show that exogenous changes in the demand dominated for the employment rates across all education groups in France, while supply shifts had more impact in the US. In the UK, the opposite effects of the supply and the demand shifts were of similar magnitude, with the supply effects dominating for the least and the most educated.

This paper has the following structure: The introduction is followed by a section that describes the trade-off hypothesis and its extended version in the context of the three countries analyzed here. The next two sections present the structural model and the estimation strategy, respectively. The subsequent section discusses the main findings. It is followed by the conclusion. The Appendix consists of six parts: data description and sources; figures; other results; model details; estimation details; and the detailed discussion of this paper's extensions of Card at al. (1999).

2 Trade-off Hypothesis and Its Extension

The trade-off hypothesis is based on a simple static model of labor supply and labor demand, as given in Figure 1. The figure shows the effect of the adverse demand shift on the *relative* earnings and employment of the low skilled (relative to the high skilled) in a country where wages are rigid, such as France, and in a country where wages are flexible, such as the US. In other words, when wages adjust, negative change in the demand for

Figure 1: The Trade-off Hypothesis



the low skilled is likely to affect their wages rather (or more) than their employment, whereas in an economy where wages are rigid the adverse demand effect will be entirely pronounced in the rise of the unemployment of the low skilled.

In the extreme case, when labor supply is wage inelastic, the adverse demand shift in flexible labor market affects only wages while employment remains at its initial level.[4] However, when labor supply is not perfectly inelastic, in countries with high wage flexibility, the deterioration of relative wages of the low skilled may reduce their incentives to work. As shown in Figure 1, although, in countries where wages fully adjust, the resulting unemployment caused by the adverse demand shift is lower (or even zero, as in this case), inactivity among the low skilled rises in response to the decline in their relative wages, leaving the gap between the employment rate in the countries with rigid and flexible wages, such as France versus the US, smaller than the original trade-off

[4] Labor supply in Figure 1 and in the context of this paper corresponds to labor force participation, and in what follows the two terms will be used interchangeably.

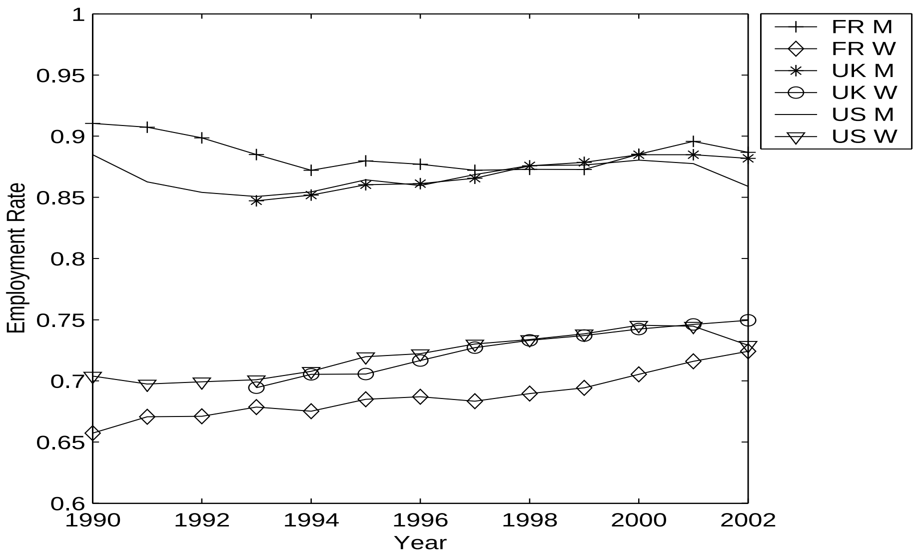
hypothesis would suggest.[5] The first point we would like to make is that if labor supply, defined as labor force participation, is not perfectly wage inelastic, then the standard trade-off hypothesis is incomplete. In what follows an *extended version of the trade-off hypothesis* is proposed that does take into account the effect of wages on inactivity. In addition to what the standard trade-off hypothesis suggests, the extended version states that if labor supply is sensitive to wages then the increase in wage inequality and the deterioration of absolute or relative wages of the low skilled in countries where wages are flexible are likely to be accompanied by an increase in inactivity. In this sense, depending on the labor market institutions, the trade-off that the policy-makers may face is the choice between rising wage inequality as well as inactivity rates on one hand and rising unemployment on the other.

France, the UK and the US, which are the focus of this analysis, represent economies with different degrees of labor market regulations and wage flexibility, with the US as the most flexible and France as the least. These two countries also seem to fit at an aggregate level into the argument of the trade-off hypothesis, as the US has experienced high and rising wage inequality and low and declining unemployment, while the opposite has been true for France. The 90th to 10th percentile of the wage distribution of men increased from 4.4 to 4.8 and that of women increased from 3.7 to 4.1 in the US between 1990 and 2000, according to the OECD statistics. In France, wage inequality declined from 3.5 to 3.3 for men and from 2.9 to 2.7 for women, using the same measure. The average overall unemployment rate during the same period was 10.8 percent in France, but only 5.5 percent in the US, and it has been rising in France, while there was a declining trend in the US. The UK seems to be somewhere in between, as its rising wage inequality was complemented by a relatively high unemployment until the mid-1990s. The rise in wage dispersion in the UK was somewhat slower than in the US – from 3.3 to 3.4 for men and from 2.9 to 3.1 for women – whereas the average unemployment rate there was 7.8 percent, and also had a tendency to decline. The observed cross-country differences in the levels of unemployment and wage dispersion seem therefore consistent with the predictions of the standard trade-off hypothesis.

The average inactivity rate among prime age men between 1990 and 2000 was only 5.1 percent in France, while it was 7.2 percent in the UK and 7.8 percent in the US. Although it had an upward trend in all three countries, it increased the least in France and the most in the US. If we add up the unemployed and the inactive, the total non-employment rate among prime age men – and this deserves to be emphasized – was similar across the three countries in the period under analysis. Thus, the average employment rate (one minus the non-employment rate) among prime age men during the 1990s was also similar in the three countries: 87.1 percent in France, 85.9 percent in the UK and 88 percent in the US. The labor force participation and inactivity of women traditionally reflects social and cultural values, as well as economic factors. The average inactivity rate of prime age women in the three countries were 23.5 percent in France, 25.6 percent in the UK and 24.5 percent in the US.

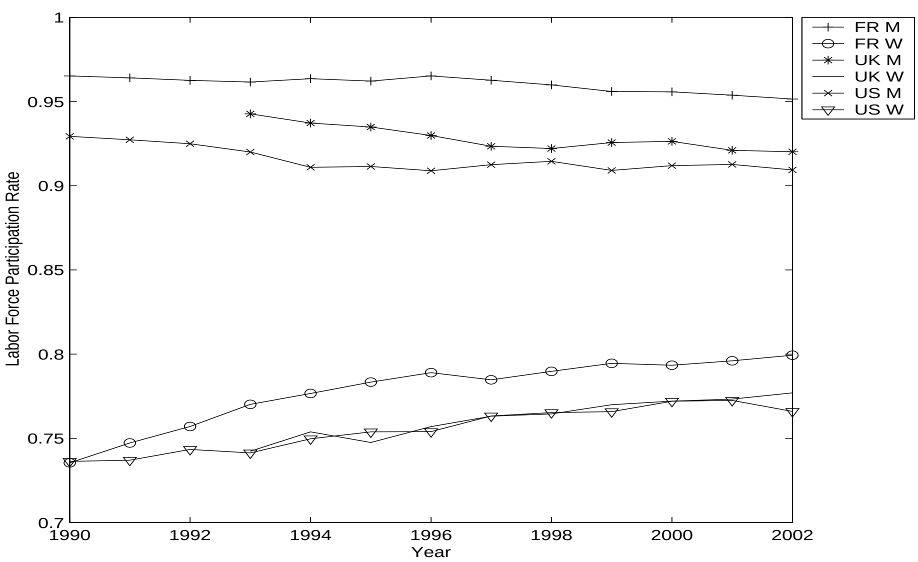
[5] In this context, inactivity is the state of voluntary non-employment, i.e. when a non-working individual declines to seek employment. This state is also often called labor force non-participation. These two terms will be used interchangeably.

Figure 2: Employment Rate



Prime age men (M) and women (W) in France, the UK and the US (out-of-school civilians of age 25-54). Source: OECD.

Figure 3: Labor Force Participation Rate



Prime age men (M) and women (W) in France, the UK and the US (out-of-school civilians of age 25-54). Source: OECD.

Employment rates for both men and women for the three countries in the studied period are shown in Figure 2. Figure 3 illustrates how the cross-country differences in inactivity versus unemployment are reflected in the three countries' labor force participation rates: we can see that labor force participation of French men and women is higher by several percentage points than the corresponding rates of men and women in the two other countries. However, the higher inactivity rates in the US and the UK "make up" for the greater proportion of unemployed in France, leaving the employment rates (in particular among men) similar, as was indicated in Figure 2. The observed cross-country differences even seem to suggest that there is a trade-off between unemployment and inactivity. The relatively high inactivity rates among prime age men in the US and the UK (i.e. countries with high wage flexibility) when compared to France, are consistent with the extended version of the trade-off hypothesis.

Although the trade-off hypothesis and its extended form seem to have some empirical relevance when looking at the aggregate data for the three countries during the studied period, in order to test the validity of these theories, it is necessary to have the labor force status data disaggregated for different earning levels and focus on the changes in the relative labor market outcomes for the different skill-groups, which is the approach we follow in this analysis.

3 Theoretical Framework

3.1 The Model

The theoretical framework of the present analysis is based on a simple model of labor supply and labor demand with heterogenous labor. The model is a variation of that in Card, Kramarz, and Lemieux (1999). It treats unemployment as a disequilibrium phenomenon caused by labor market institutions that prevent wages from being equal to their market clearing values. While Card et al. (1999) apply the model to a single long term change in wages and employment over the entire 1980s (focusing on France, Canada and the US), this paper uses an extended version of the model in order to explore the year-to-year changes observed in the panel data of different skill-groups for France, the UK, and the US over the 1990s.[6] As this is a static model, time subscripts are omitted, and the same equations are assumed to hold in every year of the analysis. The empirical application, as described in the next section, allows certain parameters to change over time through the year fixed effects.

In this model, population is composed of J labor types that differ both in skills and reservation wages.[7] A single homogenous product Y is produced in the whole economy from J labor inputs according to a constant returns CES production function, as follows

$$Y = f(L_1, L_2, ..L_J) = \Big(\sum_j (c_j\ L_j)^{\frac{\sigma-1}{\sigma}}\Big)^{\frac{\sigma}{\sigma-1}} \tag{1}$$

[6]The present work's extensions of Card at al. (1999) are discussed in detail in Section F of the Appendix.

[7]In what follows, we will refer to the groups of the different labor types as "skill-groups". The empirical analysis defines a skill-group on the basis of gender, age and education.

where σ is the elasticity of substitution between any two inputs, and c_j is the relative efficiency parameter for skill-group j. The labor demand for input j, implied by this production function, is

$$\ln(L_j^d) = \ln(Y) - \sigma \ \ln(w_j) + (\sigma - 1) \ \ln(c_j) \tag{2}$$

where w_j is the wage the economy pays on average to labor type j. Divided by the total number of individuals in the group and including the error term, the labor demand for skill-group j becomes

$$\ln(l_j^d) = \ln(y) - \sigma \ \ln(w_j) + (\sigma - 1) \ \ln(c_j) - \ln(p_j) + \nu_j^d \tag{3}$$

where $l_j^d = \frac{L_j^d}{P_j}$ is the proportion of individuals in group j who are employed, $p_j = \frac{P_j}{P}$ is the proportion of labor type j in population, $y = \frac{Y}{P}$ is the per capita output, and ν_j^d is the error term in the labor demand equation.

The labor supply of the skill-group j depends on the average wage offer w_j for the labor type j, and two exogenous factors that affect the decision to work: marital status and presence of pre-school age children. The two factors are expressed in proportions and therefore reflect the typical family characteristics of the individuals of the particular labor type.[8] An individual of the labor type j is therefore assumed to make the standard decision whether to supply her labor or not by comparing w_j (the unconditional expected wage she would receive if entering the labor market) and the reservation wage determined by her preferences and her outside options and costs given by her marital status and the presence of children. The labor supply of the labor type j is described by the participation rate l_j^S, which is the proportion of individuals in group j that are in the labor force, and has the following functional form[9]

$$l_j^s = \frac{L_j^s}{P_j} = w_j^{\varepsilon} \ \exp(\alpha_j + \beta^g \ m_j + \gamma^g \ k_j) \tag{4}$$

where ε is the wage elasticity common to all groups, α_j is the time-invariant group-specific heterogeneity in preferences, m_j is the proportion of individuals who are married, and k_j is the proportion of individuals living in households that include pre-school age children. As common knowledge and previous empirical findings suggest, marital status and the presence of pre-school children typically affect women and men in a different, and often quite opposite, ways. The coefficients of these two factors are therefore assumed to differ by gender, where $g = f$ for the skill-groups of women, and $g = m$ for the skill-groups of men. Expressed in logarithms, and including the error term ν_j^s, the labor supply is given by

$$\ln(l_j^s) = \alpha_j + \varepsilon \ \ln(w_j) + \beta^g \ m_j + \gamma^g \ k_j + \nu_j^s \tag{5}$$

[8] It can be questioned whether the two factors are truly exogenous to the model. This issue and the sensitivity of the results to their presence in the analysis will be discussed later.

[9] As the labor supply in this model is defined as the proportion of individuals in the labor force, in what follows we use the terms labor supply and labor force participation interchangeably.

The market clearing wage w_j^* for group j is defined as

$$l_j^s(w_j^*) \equiv l_j^d(w_j^*) \tag{6}$$

and equals

$$\ln(w_j^*) = \frac{1}{\varepsilon + \sigma}\left[ln(y) - \alpha_j - \beta^g\, m_j - \gamma^g\, k_j + (\sigma - 1)\, \ln(c_j) - \ln(p_j) + \nu_j^d - \nu_j^s\right] \tag{7}$$

When the market clears, the actual wage equals the market clearing wage, and as supply equals demand, there is no unemployment.[10] The labor force participation rate and the employment rate are equal in this case.

In the presence of labor market institutions that limit wage flexibility, the actual wage may differ from its market clearing value. We do not model the way the actual wage is set, but we only specify the following general (reduced-form) relationship between the actual and the market clearing wage for group j

$$\ln(w_j) = \eta + \omega_j + \rho\, \ln(w_j^*) + \nu_j^w \tag{8}$$

where $\rho \in \langle 0, 1\rangle$ is a coefficient of wage flexibility,[11] whereas ω_j and η represent the time-invariant group-specific and the time-variant overall institutional effects, respectively.[12] Equation 8 is one of the most restrictive features of the model. We discuss the assumptions that stand behind this equation, together with the other simplifications of the model, at the end of this section.

When the actual wage differs from the market-clearing wage, market doesn't clear. This means that the employment rate is determined either by the labor supply or by the labor demand, whichever of the two is smaller. If labor supply exceeds the labor demand, unemployment among individuals of labor type j is given by

$$u_j \equiv l_j^s - l_j^d \tag{9}$$

Note that u_j is defined here as the fraction of unemployed in the population of group j, rather than in their labor force, as it would be in the traditional definition of the unemployment rate. The empirical fact that at any point in time there is some unemployment observed in each skill-group, suggests within this theoretical framework that the actual wage is always above the market clearing wage, $\ln(w_j) > \ln(w_j^*)$ and the employment in group j is given by the demand

$$e_j \equiv l_{jt}^d \tag{10}$$

[10] The theoretical model assumes away frictional and other types of systemic unemployment. The empirical application however allows for additional time-invariant group-specific and year-specific group-invariant components in unemployment as well as components in other variables through two way fixed effects.

[11] Note that expressed in changes over time and assuming that $\Delta\eta = 0$ (no institutional change) and no shocks, $\Delta \ln(w_j) = \rho\, \Delta \ln(w_j^*)$. ρ also represents the proportion of the actual wage that corresponds to the market clearing wage.

[12] As many policy changes affect only some of the skill-groups, there should ideally be time-varying group-specific institutional effects as part of the resulting actual wage. Unfortunately, the present model specification and the estimation strategy does not allow the group-specific effects to vary over time. See the discussion in the text that follows.

If we define the proportion of inactive in group j as n_j, we can write down an identity relationship that states that the proportions in the three labor force states in group j must add to one

$$e_j + u_j + n_j \equiv 1 \tag{11}$$

Equations 3, 5, 6, 8, 9, 10, and 11 describe the theoretical model of the present analysis.

3.2 The Main Simplifications of the Model

The theoretical model makes several restrictive assumptions that should be kept in mind when interpreting the results.[13] Equation 8, which defines the relationship between the actual and the market-clearing wage, captures the three major simplifications. First, there are no equilibrating tendencies in this disequilibrium model. The actual wage is a function of the current market-clearing wage, but it does not depend in any way on the past gaps between the two. The choice of a static model for the present analysis rules out the possibility of incorporating any gradual adjustment towards the equilibrium. Allowing for the dynamic features would substantially change the entire set-up of the model and make its estimation in the given empirical set-up much more complex. Although the focus here is on the year to year changes, the analysis regards these as sequential point-in-time snapshots of the outcomes of the supply and demand forces on wages and labor force status.

Second, the coefficient ρ that describes the sensitivity of the actual wage to the market-clearing wage, is restricted to be the same for all the skill-groups. This assumption is required for the model to be estimable in the present form. It suggests that all the skill-groups experience a similar degree of wage rigidity. This would be violated if wages of the least skilled were affected by the labor market institutions to a greater extent than the wages of the high skilled, as for example in case of the effect of minimum wage. On the other hand, imposing ρ to be the same across groups is consistent with the fact that in several European countries, wages *at all levels* are determined by negotiations of the relevant parties (employers, unions or other employees' interest groups, and the governments) rather than by the market.[14] Industry-wide collective bargaining in France is an example of such centralized wage-setting mechanism and possibly justifies the use of this model to explore wage rigidity in this country. The responsiveness of the actual wages to the market forces (as captured by the market-clearing wage) are more likely to be similar across different skill-groups in the French labor market.

This assumption can in principle be relaxed by allowing ρ to differ for certain groups, in a similar manner as the marital-status and the presence-of-children coefficients in the labor supply equation are allowed to vary by gender. However, the choice of the variation[15] would be arbitrary, and the extension would require adding more coefficients to

[13] These are the necessary assumptions that keep the theoretical model manageable and enable us to estimate it with the available data.

[14] There are different degrees of centralization of this process in different countries, as the negotiations take place at the nation, industry or firm levels

[15] The estimation strategy does not allow group-specific ρ, so it is necessary to choose the set of the skill-groups for which it will be the same.

the model which (with the group and year effects) is already almost over-parameterized.

Third, although the gap between the actual and the market-clearing wage can change over time in aggregate (through ν_t), the skill-group variation in this gap (captured by ω_j) stays constant. Again, this assumption is likely to be violated due to the different effect of the labor market institutions across skill-groups. The main justification here is again the centralized wage negotiations that would maintain the cross-group differences the same.[16] A possible way of relaxing the last assumption is to include in equation 8 all the other time-varying exogenous factors that are in the model, without imposing any structural restrictions on their coefficients.[17] This would make the relationship of the actual and the market-clearing wage more flexible. To some extent, the presence of the other time-varying exogenous factors could also capture the adjustment process towards equilibrium and therefore relax (but only in the estimation, not structurally) the absence of the equilibrating forces discussed above. However, in this case, neither the structural parameters, nor the reduced-form coefficients describing the impact of the supply and demand shocks on wages and labor force status proportions could be identified.

In addition to the restrictions imposed by equation 8, other simplifications of the model include the same elasticity of substitution between any two of the skill-groups, the common wage elasticity of the labor force participation for all the skill-groups, and the production of one homogenous product. Again, these are the assumptions necessary to render the model estimable.

3.3 Structure and the Reduced Form

The structural model, as described by equations Equations 3, 5, 6, 8, 9, 10, and 11, leads to a reduced-form system of equations of the four endogenously determined variables (wage w_j, the proportions of employed e_j, unemployed u_j, and inactive n_j in group j), stated as functions of the exogenous factors. As the three equations for the labor force status proportions add to one, one of them is redundant. If we express the endogenous factors in logarithmic form, and use, as a left-hand-side variable, the logarithm of labor supply $\ln(l_j^s)$, that equals $\ln(e_j + u_j)$, rather than unemployment or inactivity, the model can be written as a system of three linear equations. We assume that the model describes the state of economy in each year of the analysis, with the coefficients of the key explanatory variables constant overtime. All other group-invariant parameters of the model are allowed to change. Adding the time subscripts accordingly, the model can be estimated using group-level panel data with group-specific and year-specific fixed effects in the following form

$$\begin{aligned}
\ln(w_{jt}) &= \pi_{0t}^w + \pi_{1j}^w + \pi_p^w \ln(p_{jt}) + \pi_c^w \ln(c_{jt}) + \pi_m^{g\,w} m_{jt} + \pi_k^{g\,w} k_{jt} + \xi_{jt}^w && (12)\\
\ln(e_{jt}) &= \pi_{0t}^e + \pi_{1j}^e + \pi_p^e \ln(p_{jt}) + \pi_c^e \ln(c_{jt}) + \pi_m^{g\,e} m_{jt} + \pi_k^{g\,e} k_{jt} + \xi_{jt}^e && (13)\\
\ln(l_{jt}^s) &= \pi_{0t}^s + \pi_{sj}^s + \pi_p^s \ln(p_{jt}) + \pi_c^s \ln(c_{jt}) + \pi_m^{g\,s} m_{jt} + \pi_k^{g\,s} k_{jt} + \xi_{jt}^s && (14)
\end{aligned}$$

[16] This is again violated by the specific effect of the minimum wage on the low skilled. However, the indexation of the minimum wage to the average manufacturing wage in France supports the plausibility of the constant gaps at least for certain groups at the lower half of the distribution.

[17] They already enter the equation structurally through the market clearing wage w_j^*.

where the π-s represent the reduced-form parameters. Note that, again, coefficients $\pi_m^{g\,i}$ and $\pi_k^{g\,i}$ (where $i \in w, e, s$) differ by gender ($g = f, m$). The ξ-s represent the reduced-form error terms that are functions of some of the structural parameters and the error terms ν_j^d, ν_j^s, and ν_j^w.

Similar to Card, Kramarz, and Lemieux (1999),[18] we substitute the relative efficiency parameters c_{jt}, which are not observed, with an instrument $\tilde{c}_{jt}$, assuming that the relationship between the instrument and the unobserved variable is as follows

$$\ln(c_{jt}) = \lambda_{0\,t} + \lambda\ \ln(\tilde{c}_{jt}) + \nu_{jt}^c \tag{15}$$

where $\lambda_{0\,t}$ is a time-variant parameter, λ describes the mapping from percentage changes in the instrument to percentage changes in c_{jt}, and ν_{jt}^c is the error term, which is assumed to be independent of the instrument and all other right hand side variables in the three equations. Thus, the actual reduced-form coefficients of the exogenous demand shifter that are estimated in the three equations, are $\pi_{\tilde{c}}^i = \lambda\ \pi_c^i$ and $\tilde{\pi}_{0t}^i = \pi_{0t}^i + \pi_c^i\ \lambda_{0\,t}$, and the reduced-form error terms $\tilde{\xi}_{jt}^i = \xi_{jt}^i + \pi_c^i\ \nu_{jt}^c$ where $i \in w, e, s$. The instrument used to proxy the exogenous demand shifter c_{jt} is described in the next section.

The reduced-form coefficients in the system of equations are functions of the

Table 1: Mapping of the Reduced-Form to the Structural Parameters

$i = w,\ e,\ s$	$\ln(w_j)$	$\ln(e_j)$	$\ln(l_j^s)$
$\pi_{\tilde{c}}^i$	$\left(\frac{\rho}{\sigma+\varepsilon}\right)(\sigma-1)\,\lambda$	$\left(1-\frac{\sigma\,\rho}{\sigma+\varepsilon}\right)(\sigma-1)\,\lambda$	$\frac{\varepsilon\,\rho}{\sigma+\varepsilon}(\sigma-1)\,\lambda$
π_p^i	$-\left(\frac{\rho}{\sigma+\varepsilon}\right)$	$-\left(1-\frac{\sigma\,\rho}{\sigma+\varepsilon}\right)$	$-\frac{\varepsilon\,\rho}{\sigma+\varepsilon}$
$\pi_m^{f\,i}$	$-\left(\frac{\rho}{\sigma+\varepsilon}\right)\beta^f$	$\left(\frac{\sigma\,\rho}{\sigma+\varepsilon}\right)\beta^f$	$\left(1-\frac{\varepsilon\,\rho}{\sigma+\varepsilon}\right)\beta^f$
$\pi_m^{m\,i}$	$-\left(\frac{\rho}{\sigma+\varepsilon}\right)\beta^m$	$\left(\frac{\sigma\,\rho}{\sigma+\varepsilon}\right)\beta^m$	$\left(1-\frac{\varepsilon\,\rho}{\sigma+\varepsilon}\right)\beta^m$
$\pi_k^{f\,i}$	$-\left(\frac{\rho}{\sigma+\varepsilon}\right)\gamma^f$	$\left(\frac{\sigma\,\rho}{\sigma+\varepsilon}\right)\gamma^f$	$\left(1-\frac{\varepsilon\,\rho}{\sigma+\varepsilon}\right)\gamma^f$
$\pi_k^{m\,i}$	$-\left(\frac{\rho}{\sigma+\varepsilon}\right)\gamma^m$	$\left(\frac{\sigma\,\rho}{\sigma+\varepsilon}\right)\gamma^m$	$\left(1-\frac{\varepsilon\,\rho}{\sigma+\varepsilon}\right)\gamma^m$

structural parameters: σ, ε, ρ, β^f, β^m, γ^f, γ^m, α_j, ω_j, $\ln(y_t)$, and η_t. Table 1 shows the correspondence between the reduced-form and the structural parameters for the key coefficients of the model, which are to be estimated. The three columns describe the three

[18] Card at al. (1999) write down the following relationship between the relative efficiency term and their instrument: $(\sigma - 1)\Delta\ln(c_{jt}) = \alpha + \beta\,D_j + u_j$ where D_j is either the initial wage level or the proportion of individuals using computer at work at the end of the period.

equations for wage, employment and labor supply respectively.[19] Careful inspection of Table 1 suggests that when $\rho = 1$, the last two columns become identical. In other words, if wages are flexible and the labor market clears, the changes in employment equal the changes in labor supply, as the two are the same. There is no unemployment, the population consists only of employed and inactive. In this case, the model reduces from three to two equations, the wage equation and the employment equation. It can be shown that all the key parameters (σ, ε, β^f, β^m, γ^f, γ^m) are identified from these two equations. On the other hand, when $\rho < 1$, the last two columns differ. In other words, if wages are not perfectly flexible, labor supply consists of employment and unemployment, and the third equation is needed, so that all three labor force states (employment, unemployment and inactivity) can be determined in the model. In this case, identification of all the key parameters stated above, as well as the wage flexibility parameter ρ, requires the third equation to be estimated as well.[20]

3.4 Proposed Tests of (Extended) Trade-off Hypothesis

The above presented framework allows us to test the trade-off theory as well as its extended version in several ways: The least restrictive tests are based on the estimated reduced-form coefficients from the system of equations 12, 13 and 14.[21] In general, and regardless of the particular theoretical model at hand, the trade-off theory suggests that (adverse) demand shocks work predominately through prices (wages) in the economies where wages are flexible, and through quantities (employment) in economies where wages are rigid. We should therefore expect the demand shocks to have a greater impact on wages than on employment in the first case, and a greater impact on employment than on wages in the second. If the trade-off hypothesis holds for the three countries over the 1990s, the coefficient of the demand shifter in the wage equation should be greater, both in terms of magnitude and significance, than in the employment equation in countries with flexible wages, such as the US and possibly the UK, while the opposite should be true for France.[22] If the three countries are similar in other respects (if other structural coefficients in the model have similar magnitudes), these differences should be confirmed in the cross-country comparison as well. Namely, the trade-off hypothesis would then imply that the wage coefficient of the demand shifter in the US and possibly also in the UK is greater in significance and magnitude than that in France, while the opposite holds for the coefficient of the demand shifter in the employment equation. Within-country and cross-country comparisons of the demand shifter coefficients in the two equations therefore constitute the first set of tests of the trade-off hypothesis in this analysis.

An additional test, which is still based on the reduced-form parameters but has more structural justification, is based on the property of the theoretical model as discussed at the end of the previous section, namely the identity of the employment and labor supply

[19]See Section D of the Appendix for the mapping between the structural and the reduced-form group-specific and year-specific effects, and the structural and the reduced-form error terms.

[20]Identification of the full model is shown in Section D.2 in the Appendix.

[21] The least "restrictive" in the sense that they do not necessarily impose any particular theoretical model, including the one presented here, to interpret the results.

[22]This conjecture is consistent with the structural interpretation of the coefficients, as a function of structural parameters as described in Table 1, when $\rho = 1$ and when $\rho < \frac{\sigma+\varepsilon}{\sigma+1}$.

coefficients when $\rho = 1$. It follows that the extent of wage flexibility in a given economy may be also assessed by comparing the coefficients from the two equations. To bring further evidence on trade-off hypothesis and its extended version, we therefore next test the hypothesis that the set (or subset) of the key coefficients of the employment and labor supply equations are equal. We would expect the results to reveal greater wage flexibility (i.e. smaller rejection probability) in the US and possibly in the UK than in France.

The final test is based on the structural estimation of the model and consists in the direct comparison of the magnitude of ρ, the parameter describing wage flexibility. Again, a value of ρ which is higher (closer to 1) in the US or possibly in the UK when compared to France, would support the relevance of the trade-off hypothesis.

The extended trade-off hypothesis can be also tested using both the reduced-form, as well as the structural parameters. For this hypothesis to hold, it is necessary to show that first, as before, the demand shocks affect relative wages in the US and possibly the UK more than in France, and that the labor force participation in the three countries is wage elastic. As for the reduced-form parameters, the coefficients of the demand shifter in the wage equation should be again significant and bigger in countries where wages are flexible, and the effect of the demand shifter on employment and labor supply should be identical there. In countries where wages are rigid, labor supply should be less sensitive to the demand shifter than employment. In terms of the structural parameters, the wage elasticity of labor supply ε is the parameter to look at. For the extended trade-off hypothesis to hold, it needs to be positive and significant, suggesting that the labor force participation is indeed sensitive to the changes in wages, in particular in countries where wages are flexile, such as the US or also the UK.

4 Estimation Strategy

4.1 Reduced-Form Estimation

The theoretical model presented in the previous section and described in the reduced form by the system of the three equations 12, 13 and 14, is estimated using the group-level data constructed from the individual-level datasets from the series of national labor force surveys conducted in the three countries over the 1990s. The skill-groups are based on gender, age and education. The estimation is carried out for each country separately.

To take into account the group-specific heterogeneity in preferences, and the group-specific institutional component affecting the actual wage, the model is estimated with the group fixed effects present in each of the three equations. Year fixed effects are also included in all three equations, so as to capture the aggregate development of the economy over time (changes in y_t) and the changes in institutions that affect all the skill-groups in the same way (changes in η_t). The estimated model is of the general form

$$y^i_{jt} = D^i_j + D^i_t + x^i_{jt}\beta^i + \varepsilon^i_{jt} \qquad (16)$$

where j and t indicates group and time respectively, i is an indicator for one of the three equations in the system, y-s are the three dependent variables, x-s are the supply and demand shifters, D-s are group and year fixed effects, and β-s are the reduced-form coefficients. With the group and the year fixed effects, the present analysis focuses on the within group and year variation in the wage and labor-force-status differentials rather than on their levels. It explores to what extent the relative deviations of the left-hand-side variables from their time and group averages can be explained by the relative deviations of the exogenous factors on the right-hand side.

The two-way fixed effect model is estimated in terms of these deviations by linear least squares as follows

$$y_{jt}^{*i} = x_{jt}^{*i}\beta^i + \varepsilon_{jt}^{*i} \tag{17}$$

where $y_{jt}^{*i} = y_{jt}^i - \bar{y}_j^i - \bar{y}_t^i + \bar{\bar{y}}^i$, with $\bar{y}_j^i$ and $\bar{y}_t^i$ being the time and group averages respectively, and $\bar{\bar{y}}^i$ the overall average of the dependent variable in equation i. Similar for x_{jt}^{*i} and ε_{jt}^{*i}.

The three equations form a seemingly unrelated regression equations (SURE) system with the same right-hand-side variables, so that the joint and equation-by-equation estimations give identical results. However, joint estimation is necessary for obtaining the appropriate covariance matrix for the computation of the standard errors. This is done in the following way. The system of the three equations, expressed in deviations as suggested above, is estimated jointly, with the data for the three equations stacked one above each other, allowing the coefficients to differ across the equations. Standard errors are based on the panel-robust sandwich-type covariance matrix (similar to Huber-White estimator for the cross-section) that allows for heteroskedasticity, serial correlation, as well as the cross-equation correlation of unknown forms, but assumes independence of the error terms across the groups (i.e. over j). The robust covariance matrix is calculated as follows

$$\hat{V}(\hat{\beta}) = \Big[\sum_{j=1}^{J}\sum_{t=1}^{T}\sum_{i=1}^{3} x_{jt}^{*i} x_{jt}^{*i\,\prime}\Big]^{-1} \sum_{j=1}^{J}\sum_{t=1}^{T}\sum_{s=1}^{T}\sum_{i=1}^{3}\sum_{v=1}^{3} x_{jt}^{*i} x_{js}^{*v\,\prime}\,\hat{u}_{jt}^{i}\hat{u}_{js}^{v\,\prime}\Big[\sum_{j=1}^{J}\sum_{t=1}^{T}\sum_{i=1}^{3} x_{jt}^{*i} x_{jt}^{*i\,\prime}\Big]^{-1} \tag{18}$$

where $\hat{u}_{jt}^i = y_{jt}^{*i} - x_{jt}^{*i}\hat{\beta}$.

The group-level variables are constructed from the individual-level data as means or proportions. This method builds into the model a particular type of group-wise heteroskedasticity, as the variance of the within-group-averaged individual error term varies with the sample size. In addition, the binary nature of the employment and labor force participation indicators further implies a specific form of the heteroskedasticity present in the log-linear models of the proportion data. The above defined estimator of the covariance matrix controls for the two specific types of heteroskedasticity as well.

There are two approaches employed in the way the group-specific wage is constructed. First, we use the median of the logarithm of the real hourly wages observed in each group. Second, we use the median of the logarithm of the real hourly wages predicted for individuals with missing wage information, by the standard two-equation model of Heckman.[23] The details of the specification of the selection and the wage equations in

[23] We cannot use the method of imputing the missing wages with the minimum wage or assuming

the Heckman model are given in Section E.1 in the Appendix. The second procedure is preferred, as it corrects the potential selection bias present in the previously mentioned group-specific wage estimates. We also alternate median wages with mean wages.

4.2 Choice of the Demand Shifter

The demand shifter that serves as an instrument for the unobserved relative efficiency measure is the skill-group's share in the total value added produced in the whole economy of the given country in the previous year. The information about each individual's industry is employed to map the industry-specific information to the skill-group data. The demand shifter is constructed in the following way

$$\tilde{c}_{jt} = \ln\Big(\sum_{k=1}^{K} p_{kjt-1}\ SVA_{kt-1}\Big)$$

where k is the industry identifier, $p_{kjt} = \frac{N_{kjt}}{N_{kt}}$ is the proportion of individuals from group j among the total number of individuals in industry k in year t, and SVA_{kt} is the percentage share of industry k in the total value added in the economy in year t. The information about the value added shares by industry comes from the OECD STAN database. There are 23 to 25 industry groups per country.[24] The changes in the share of the total value added are likely to be correlated with the changes in the relative efficiency of the skill-group, and in general with the labor demand for the individuals from that group.

4.3 Endogeneity Concerns: Marital Status and Children

There is a labor economic literature which suggests that marital status as well as fertility decisions may be endogenous to the labor supply decision and should be therefore instrumented in the estimation of the labor supply equation. As we work with the group-level data, the proportion of married individuals and those with pre-school age children represent a proxy for the inclinations of the different groups to marry or have children in a particular age rather than the actual micro-level evidence about them, and shouldn't therefore suffer from the endogeneity bias at the individual level. A relevant objection here, however, is that the decisions about the family structure may be endogenous to the situation in the labor market. Namely, there are papers that focus on Spain (see Mira and Ahn (2001)) and other South European countries, showing that the date of marriage as well as the date of the first-child birth are postponed due to the unfavorable conditions in the market for jobs. Individuals cannot afford to start a family if they have only a temporary job or are no job at all, and therefore postpone it till they become permanently employed. In this sense, it may not be the change in the preferences to

that they are below the overall median, as done in Card et al. (1999) and elsewhere, since in the present analysis wages are sometimes missing not only for non-workers, but also for self-employed and those employed who did not report their wage. Setting their wage to minimum wage would seriously underestimate the means, and even the medians, in cases where more than 50 % of the wages in the skill-group are missing (although these are quite rare).

[24] See Section A of the Appendix for details.

marry and have children at a later stage of life that exogenously drive the changes in the labor supply, but the postponement in the timing of marriage and children itself is an outcome of high unemployment rate and other unfavorable characteristics of the job market. Although none of the research we know of focuses on any of the three countries, and the story holds in particular for the new entrants who are, given the age restriction, most likely not part of the analysis here,[25] we keep this concern in mind and re-estimate the model without these two supply shifters. All the results go through even when the two variables are omitted and none of our conclusions qualitatively changes. The only exception is the reduced from estimation of the wage equation for the UK. This, however, seems to be a consequence of the fact that the two factors also serve as a proxy for a more detailed age categorization than captured by the group fixed effects in the UK. The sensitivity results and the discussion of this one exception can be found in the Appendix in section C.1.

4.4 Structural Estimation

We have described above the empirical strategy to estimate the reduced-form parameters of our model, as described by equations 12, 13 and 14. We next use the non-linear least squares to recover the key structural parameters.[26] The NLS estimator is applied to the same three-equation system with equation-specific two-way fixed effects, expressed in deviations and stacked together as described in equation 17. The only difference is that we now substitute the key reduced-form coefficients[27] with the respective functions of the structural parameters, as presented in Table 1.

4.5 Data Construction

The three national labor force surveys used to construct the group-level panel data are *Enquête Emploi* (1990-2002) for France, *Labor Force Survey* (1993-2002) for the UK, and the *March CPS* (1990-2002) for the US. The details are given in Section A in the Appendix. The sample selected for the empirical analysis consist of non-institutionalized individuals between the ages of 25 and 54. Individuals under 25 and over 54 years of age are not included in the analysis, as there are too many institutional issues (such as length of education and early retirement legislature) that differ across the three countries and make them not directly comparable. Although these groups have an important share in the total labor market, we choose to avoid the potential impact of these institutional differences on the present analysis and focus exclusively on prime age

[25] We exclude individuals below the age of 25.

[26] Minimum distance method with equal and optimal weighting (i.e. the method of moments and the generalized method of moments) were used to recover the structural parameters from the estimated reduced-form coefficients as a second step of the analysis in the previous version of this paper. However, the NLS estimation proved out to give more convincing (although in many respects similar) results. In addition, the direct NLS estimation is by definition more efficient than the two step method used before. I am grateful to Richard Spady for this suggestion.

[27] Only the coefficients of the demand and supply shifters get estimated in the two-way fixed-effect model with variables expressed in deviations.

individuals.[28] Students, conscripts and members of the Armed Forces are also excluded. The employment and the labor force participation rates are defined in the standard way: Employed individuals include the employed and the self-employed, as well as the unpaid family workers, and labor force participants are individuals who are either employed or unemployed (according to the ILO definition of unemployment). The wage information uses the hourly wage as the key measure. The wages are reported gross of taxes in the US and the UK, but net of employees' payroll taxes in France. The present analysis uses the same argument for the validity of the cross-country differences as in Card, Kramarz, and Lemieux (1999, p. 857): the employees' payroll taxes in France are set at a fixed rate, and therefore should not affect the relative between-group wages which are the main focus of the analysis. For a more detailed discussion of this fact and the gross versus net wages differences in France, see Section A in the Appendix.

There are 72 skill-groups (and 60 for the UK) defined in each dataset. The skill-groups are based on gender, five age ranges (25-29, 30-34, 35-39, 40-44, 45-49 and 50-54) and six education categories in France and the US, and five education categories in the UK. Their classification is chosen so as to keep a reasonable size of all the skill-groups over all the years. The group sample size is never below 150 individuals.

The group fixed-effects used in the estimation are defined in such a way, that each group is allowed to have its own fixed time-invariant component for each of the three left hand side variables. There are 72 fixed effects for the 72 skill-groups in France and the US respectively in the model. To avoid over-parametrization when using the data from the UK, which has only 5 education categories and a shorter time span, we define the group fixed effects on a broader age categories than the ones the data are stratified by. Namely, the six categories are lumped together into three age ranges (25-34, 35-44 and 45-54) for the construction of the fixed effects for the UK. There are therefore only 30 fixed effects for the 60 skill-groups in the estimation for the UK.

5 Estimation Results

5.1 Reduced-Form Estimates

The first set of tests of the trade-off hypothesis are based on the results from the estimation of the reduced-form system of equations 12, 13, and 14. They focus on sensitivity of wages and employment rates to exogenous changes in the demand in the three countries. Tables 2 and 3 show the estimated coefficients of the demand shifter in wage (W), employment (E), and labor supply (LS) equations.[29] The two sets of results differ only in the construction of the hourly wage variable: while in the first table, wage for skill-group j is constructed as median of the observed and the predicted wages of individuals from that group, in the second table, it is constructed as their mean. The coefficients in the employment and labor supply equations are therefore identical across

[28] Prime age individuals who are out of school correspond to the "population" in the theoretical model presented in Section 3.

[29] The full set of coefficients from the reduced-form estimation for these and other specifications is available in Section C in the Appendix.

the two specifications. In what follows, we refer to the results from Table 2. However, the two sets of estimates do not qualitatively differ.

The trade-off hypothesis suggests that wages should be more sensitive to exogenous changes in the demand in the US and possibly in the UK, countries where wages are flexible, than in France. The opposite should be true for the employment rate. The results show that, for France and the US, this is indeed the case: In France, the coefficient of the demand shifter in the wage equation (0.034) is only weakly significant and half the size of that in the employment equation (0.077), which is highly significant. The opposite is true for the US: the coefficient in the wage equation is highly significant and about four times bigger (0.086) than that in the employment equation (0.018), which is not significant. Table 4, which shows the F-statistics of the test of the hypothesis that the coefficients in the wage and employment equations are equal, confirms that these within-country differences between the two coefficients are significant.[30] As for the UK, the results seem contrary to what was expected: Unlike the US, and similar to France, the demand shifter coefficient in the wage equation is only weakly significant and only one third in the magnitude (0.038) than that of the employment equation (0.118), which is again highly significant. Again, the difference between the two coefficients is significant. However - going back to the theoretical model - a closer inspection of the two coefficients in terms of the functions of structural parameters they represent, as given in Table 1, suggests that the observed difference between the two coefficients may also occur due to other factors than the wage rigidity parameter ρ, namely the size of σ, and in particular ε.[31] As we will see later, this is indeed the case for the UK.

A similar test is based on the comparison of the wage and employment equation coefficients of the demand shifter across countries, assuming that the three countries are similar in all relevant respects other than wage flexibility. The results are consistent with the findings from the within-country comparison: The wage-equation coefficient in the US is more significant and twice as large in magnitude than the corresponding coefficients in the other two countries. The opposite is true for the coefficient in the employment equation, which is not significant for the US, and much smaller than that for France, which in turn is smaller than the one for the UK. Table 5 shows the t-statistics of the test of the hypothesis that the corresponding coefficients in the same equation are equal for each of the two countries. As the estimation is done separately by country, independence of the coefficients across countries is assumed. The results suggest that the differences in all the analyzed coefficients are significant (or close to) at 10 % or lower significance level, when France (and also the UK) is compared to the US. The coefficients for France and the UK, however, are not statistically different. The conclusion of the first two tests is that in the US, the demand shocks affect wages more than employment while the opposite is true for France, but also for the UK. The effect of the demand shocks on wages is also twice as big in the US than in the other two countries, while the effect on employment is much greater in the other two countries than in the US. The results are consistent with the expectations about France and the US, given the known features of the wage setting mechanisms in the two countries. The trade-off hypothesis

[30] The F-statistics are distributed $F(1,71)$ for France and the US and $F(1,29)$ for the UK.

[31] Note that $\frac{\pi_c^e}{\pi_c^s} = \frac{\varepsilon+\sigma(1-\rho)}{\varepsilon\rho}$. So that if $\rho = 1$ then $\frac{\varepsilon+\sigma(1-\rho)}{\varepsilon\rho} = 1$ and $\pi_c^e = \pi_c^s$. If $\rho < 1$ then $\pi_c^e > \pi_c^s$.

is confirmed by both within-country and cross-country comparisons, when focusing on France versus the US. The UK, however, seems to be, based on the outcomes of these two tests, more like France than the US, which is against the trade-off hypothesis and our prior expectations.

Table 2: Demand Shifter Coefficient I

	W		E		LS	
FR	$0.034^{\dagger}$	(0.018)	0.077^{**}	(0.019)	0.065^{**}	(0.016)
US	0.086^{**}	(0.019)	0.018	(0.020)	$0.036^{\dagger}$	(0.021)
UK	$0.038^{\dagger}$	(0.019)	0.118^{**}	(0.027)	0.101^{**}	(0.026)

Significance levels : $\dagger$: 10% $*$: 5% $**$: 1%
Wage constructed as the median of the observed and predicted wages.

Table 3: Demand Shifter Coefficient II

	W		E		LS	
FR	0.033^{*}	(0.016)	0.077^{**}	(0.019)	0.065^{**}	(0.016)
US	0.066^{**}	(0.014)	0.018	(0.020)	$0.036^{\dagger}$	(0.021)
UK	0.007	(0.021)	0.118^{**}	(0.027)	0.101^{**}	(0.026)

Significance levels : $\dagger$: 10% $*$: 5% $**$: 1%
Wage constructed as the mean of the observed and predicted wages.

Table 4: Comparison Across Equations (Within Country)

$\pi_c^{\cdot}$	FR		US		UK	
	I	II	I	II	I	II
W vs E	$3.46^{\dagger}$	4.53^{*}	6.12^{*}	$3.65^{\dagger}$	7.30^{*}	12.78^{**}
W vs LS	1.82	2.44	$3.87^{\dagger}$	1.54	4.26^{*}	8.35^{**}
E vs LS	4.00^{*}	4.00^{*}	2.68	2.68	2.61	2.61

Significance levels : $\dagger$: 10% $*$: 5% $**$: 1%
The F-statistics of $H_0 : \pi_c^w = \pi_c^w$.

The second test of the trade-off hypothesis is still based on the reduced-form coefficient estimates but uses a structural prediction of the theoretical model. Namely, if the actual wage changes with the equilibrium wage one to one (i.e. if $\rho = 1$), the coefficients in the employment and labor supply equations should be equal. In other words, if wages are absolutely flexible, employment and labor supply change by the same amount in response to the exogenous shocks, as they become identical in the model. Table 6 shows the F-statistic of the test of the hypothesis that the (sub)sets of coefficients of the employment and labor supply equations are equal for a given country.[32] This hypothesis is always rejected for France, whether a subset or a full set of the coefficients of the two equations are compared. However, it cannot be rejected for neither the US nor the UK when we compare the coefficients of the demand shifter in the two equations. In addition, the same conclusion holds for the UK when we focus on both the demand shifter and the coefficient of the share of the skill-group in population. Equality is rejected for the US and for the UK in other instances, when we include the coefficients of other supply shifters, such as marital status and presence of pre-school age children. However, the values of the F-statistics are always smaller than the ones for France. On the basis of this test we conclude that: there is wage rigidity ($\rho < 1$) in France which makes exogenous shocks affect employment and labor supply in different ways; full wage flexibility cannot be rejected on the basis of the comparison of the demand shifter coefficients for the US; full wage flexibility can be rejected in the UK only when all the coefficients of the two equations are compared. As for the comparison of France and the US, the test just confirms the previous findings. However, it also provides evidence for the trade-off hypothesis when France is compared to the UK. Although, this is consistent with the trade-off hypothesis and with prior expectations about the wage flexibility in the UK, it is contrary to our previous findings. As will be shown, structural estimation will help us reconcile and interpret the seemingly controversial conclusions concerning the case of the UK. We turn to the structural results next.

Table 5: Cross-country Comparisons of the Demand Shifter Coefficient

	W		E		LS	
	I	II	I	II	I	II
FR vs US	-1.99*	-1.55	2.14*	2.14*	1.10	1.10
FR vs UK	-0.15	0.98	-1.24	-1.24	-1.18	-1.18
US vs UK	1.79†	2.34**	-2.98**	-2.98**	-1.94†	-1.94†

Significance levels : $\dagger$: 10% $*$: 5% $**$: 1%

t-statistics of $H_0 : \pi_c^{\cdot A} = \pi_c^{\cdot B}$ for countries A and B, where $t = \frac{\hat{\beta}_A - \hat{\beta}_B}{\sqrt{\hat{\sigma}_A^2 + \hat{\sigma}_B^2}}$

5.2 Structural Estimates

Before computing the structural parameters, we can first check the empirical validity of the model by exploring the signs of the reduced-form coefficients from the perspective of their corresponding structural content, as described in Table 1. The reduced-form results (see Section C in the Appendix for the full estimation results for the two specifications described above) seem to be more or less consistent with the predictions of the theoretical

[32] The test compares (sub)sets of the coefficients of the two-way fixed effect model estimated in deviations. The test is $F_{(k,71)}$ for France and the US, and $F(k, 29)$ for the UK with $k = 1, 2, 6$ respectively.

Table 6: Test of Equality of Employment and Labor Supply Equation Coefficients

	FR	US	UK
$\pi_c^e = \pi_c^s$	4.00*	2.68	2.61
$\pi_c^e = \pi_c^s$ and $\pi_p^e = \pi_p^s$	23.78**	6.67**	1.75
All coefficients	11.32**	2.72*	8.42**

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

model. As σ, ε and ρ are all assumed greater than zero and the term $\frac{\sigma\rho}{\sigma+\varepsilon}$ is likely to be smaller than one,[33] the coefficient of the logarithm of the group's share in the population is expected to be negative in all three equations, and this is the case for all three countries.[34] If, in addition, σ is assumed to be greater than one (as has to be the case in order to assure a positive effect of the relative efficiency parameters on the labor demand), the coefficients of the demand shifters should be all positive, which again is true for all countries and equations under both specifications.

Projecting the structural parameters to the coefficients of other supply shifters suggests that their signs in the employment and labor force participation equation should correspond to the sign of their structural counterparts, while in the wage equation the reduced-form and the structural coefficients have an opposite sign. The structural sign of the effect of presence of pre-school children in the household on the labor force participation of women is negative, as one would empirically expect, for all three countries.[35] The implied structural effect of children on the labor force participation of men has mixed signs and it is significant only in the wage and employment equations in the US, and in the employment equations in France, where it implies a positive effect. The results for the effects of the marital status are even less clear. Although, consistently with the empirical literature, the coefficients in the employment and labor supply equations in all three countries imply that being married has a negative or insignificant effect on female labor supply, and a positive or insignificant effect on male labor supply, the coefficients in the wage equations seem to contradict the story in several cases. It is however possible, that the marital-status variables in the wage equation may be capturing other factors such as different distribution of the individual cohorts within the relatively broad age categories, and be therefore correlated with age as well. As described later in this section, structural estimates offer a more consistent picture of the effects of the two exogenous supply shifters.

The final test of the trade-off hypothesis is based on the cross-country comparison of the values of the structural parameters of the model. The structural coefficients were

[33] The reason being that ε is positive and ρ should not exceed one.

[34] The only exception is the coefficient in the employment equation in the second specification for France, which is positive but not significant.

[35] The only exception is in the wage equation for the US in the specification that uses median rather than mean for the construction of wage (Table C.1): the coefficient has a positive sign, but it is only weakly significant. It has the correct sign but is not significant in the other specification. Also, although correctly signed, the coefficient is not significant in the wage and employment equations in France.

estimated by non-linear least squares applied to the system of the three equations 12, 13, and 14, once the reduced-form coefficients where substituted by the corresponding functions of their structural counterparts, as defined in Table 1. The results for the two specifications (with wages constructed as medians and means respectively) are presented in Tables 7 and 8.

The non-linear structure of the model with linear relationships between different sets of the reduced-form coefficients both within and across equations required that one of the parameters be constrained, to achieve convergence of the model. Although, theoretically, all structural parameters are identified, the way in which λ and σ appear in the demand shifter coefficient together for all three equations make the estimation of their values unstable. For this reason, we choose λ, the parameter of the relationship between the unobserved relative productivity coefficients and the demand shifter we use, as the coefficient which is of the least interest to the present analysis, to be constrained to one in the estimation. This constraint has a straightforward interpretation and corresponds to the following assumption: if $\lambda = 1$, the relationship between the logarithm of unobserved productivity and the logarithm of the share in the value added in the previous year becomes $\ln(c_{jt}) = \lambda_{0\,t} + \ln(\tilde{c}_{jt}) + \nu^c_{jt}$. This restricts the relationship between the two variables to be linear, although changing in time, as captured by $\exp(\lambda_{0\,t})$. The interpretation of this restriction is the following: one percentage change in the group j's productivity corresponds to one percentage change in the group j's share in the value added produced in the economy in the previous year.

Table 7: Structural Results - Full I

	FR		US		UK	
ρ	0.796**	(0.011)	0.835**	(0.016)	0.842**	(0.014)
σ	1.893**	(0.033)	1.889**	(0.066)	2.249**	(0.086)
ε	0.145*	(0.060)	0.145*	(0.065)	0.282**	(0.089)
β^f	0.017	(0.130)	0.114	(0.147)	-0.024	(0.079)
β^m	0.479**	(0.098)	0.147†	(0.088)	-0.101*	(0.040)
γ^f	-0.207*	(0.090)	-0.460**	(0.168)	-0.319**	(0.051)
γ^m	-0.008	(0.067)	0.414**	(0.155)	0.063*	(0.025)

Significance levels : † : 10% $*$: 5% $**$: 1%

Wage constructed as the median of the observed and predicted wages.

Structural results bring further evidence in favor of the trade-off hypothesis, although more so for the first specification, when wages are constructed as group medians. The last test consists in comparing the estimates of the wage rigidity parameter ρ from our structural model across the three countries. First, it is clear from the size of the coefficients and their standard errors, that the hypothesis that $\rho = 1$ can be rejected for all three countries, meaning that wages are not perfectly flexible in any of them. The estimates are 0.796 for France for both specifications, 0.835 and 0.82 (median and mean wage specifications respectively) for the US, and 0.842 and 0.826 for the UK.

Table 8: Structural Results - Full II

	FR		US		UK	
ρ	0.796**	(0.010)	0.820**	(0.014)	0.826**	(0.013)
σ	1.866**	(0.033)	1.896**	(0.047)	2.208**	(0.074)
ε	0.127*	(0.058)	0.140*	(0.066)	0.280**	(0.091)
β^f	0.011	(0.136)	0.046	(0.147)	-0.026	(0.090)
β^m	0.489**	(0.099)	0.227*	(0.090)	-0.115*	(0.043)
γ^f	-0.205*	(0.091)	-0.421*	(0.170)	-0.344**	(0.051)
γ^m	-0.022	(0.067)	0.331*	(0.151)	0.065*	(0.026)

Significance levels : † : 10% $*$: 5% $**$: 1%
Wage constructed as the mean of the observed and predicted wages.

Although the differences between France and the other two countries are not huge, they are significant, in particular when we focus on the first specification. The asymptotic t-statistics for the difference between France and the US are 2.01 and 1.39 (the differences are significant at 5 % and 20 % significance level respectively). For the UK, the test statistics of the differences are 2.58 and 1.53 (the differences are significant at 1 % and 15 % significance level respectively). The differences between the coefficients for the UK and the US are not significant. The trade-off hypothesis for France versus the US and the UK is therefore confirmed in the sense that wage rigidity as modeled here affects the relative labor market outcomes for different skill-groups more in France than in the other two countries. Comparing the estimates of other parameters, namely σ and ε, helps us understand why the first test of the trade-off hypothesis, based solely on the comparison of the demand shock sensitivity in the wage and employment equations, can be misleading and imply an erroneous conclusion of high wage rigidity in the UK. The structural results show, that both σ and ε are significantly higher in the UK (2.25 and 0.28 respectively in the first specification) than in the two other countries (around 1.9 and 1.45 for both France and the US), resulting in the demand shock coefficient in the employment equation being higher than that in the wage equation. It is therefore the high labor demand and labor supply wage elasticity (and not high wage rigidity, as the first test would wrongly conclude) which makes the employment be more sensitive to the demand shocks than wages in the UK.[36] This fact, however, is only revealed in the structural estimation.

As for the other structural coefficients of the labor supply, the results confirm that in all three countries, presence of pre-school age children has a negative effect on female labor supply. The effect is the highest in the US and the lowest in France, pointing at the cross-country differences either in preferences or in the cost of child care. In accord

[36] This is consistent with the author's previous findings (see Bičáková(2005)). The values of ε estimated here are not directly comparable to the usual findings of the wage elasticity of labor supply, as this is an "averaged" estimate (across gender, age and education), common to all the skill-groups, of the wage elasticity of labor force participation (rather than labor supply of hours of work).

with this ranking, pre-school age children have positive effect on male labor supply in the US and the UK but none in France. Somewhat surprisingly, being married doesn't seem to affect female labor supply but it increases the labor supply of men in France and the US but decreases it in the UK.[37]

The extended trade-off hypothesis (the original trade-off hypothesis extended to what happens to labor supply and inactivity) finds also supporting evidence: As the trade-off hypothesis is part of the story, the same tests apply as above. In the US, wages are more sensitive to the demand shocks than in France. Demand shifter affects employment and labor supply in a statistically undistinguishable way in the US and the UK, while it has greater impact on employment than on labor supply in France. We can therefore conclude that negative demand shock works through wages and consequently increases inactivity in the US, while it primarily affects employment in France. To reconcile the insensitivity of wages to the demand shocks in the UK with its identical effect on employment and labor supply, we need again the structural results. Besides confirming the ranking of the three countries as regards their degree of wage rigidity in terms of the estimate of ρ as discussed above, the structural results also show that ε is positive and significant in all three countries. The findings therefore confirm that labor force participation is indeed wage elastic, which is a necessary condition for the extended version of the trade-off hypothesis to hold. The fact that ε is almost twice as big in the UK than in the other two countries explains the controversial reduced-form findings for the UK. High wage elasticity there leads to a flatter labor supply curve that in turn implies low sensitivity of wages to the demand shocks, which may be incorrectly interpreted as wage rigidity. We therefore conclude that the extended trade-off hypothesis also adds to the explanation of the observed patterns of relative wages and labor force status proportions across different skill-groups in the three countries. The deterioration in relative wages in countries with flexible wages such as the US and the UK seemed to have contributed to the increase in inactivity rates of the low-skilled groups affected by the adverse demand shocks.

Overall, the structural results seem to confirm that wages in France are less flexible than wages in the US and the UK, and that the wage rigidity affected the development of wages and labor force status proportions in the French economy during the analyzed period. Based on the outcomes of the tests presented in this section, we conclude that the trade-off hypothesis and its extended version has significant explanatory power when the labor market outcomes for relative skill-groups are compared between France and the US, as well as when France is compared to the UK.

5.3 Counterfactual Simulations

We next use our findings to interpret the actual developments in the relative wages and labor force status proportions observed in the three countries during the analyzed period. If the changes in the demand structure continued to favor the high skilled against the low skilled, given our findings about wage flexibility and its effects, other things being equal, we would expect the following trends: In countries with flexible wages, such as the US and the UK, the changes in the demand would increase primarily relative wages between

[37] As mentioned above, this may be caused by the fact that the group specific marital status variable also plays a proxy for other factors, such as cohort effects within the age groups.

the high skilled and the low skilled, while keeping their relative employment rates less affected. According to the extended trade-off hypothesis, we should also expect that these changes in the wage structure would lead to an increase in the inactivity rates of the low skilled relative to the high skilled. In countries where wages are rigid, such as France, the changes in the demand should affect primarily relative employment rates, while keeping the relative wages and inactivity rates unchanged. However, given our findings about the high wage elasticity of both labor supply and labor demand in the UK, we may expect smaller effect on relative wages and bigger effect on employment there as well.

Figures B.1 through B.6 present the changes in the labor force status and earnings for the six (five in the UK) educational categories. Note that the figures differ in scale, so as to capture best the between-group differences and their changes over time in each country and gender group. Any cross-country comparisons of levels or changes require looking at the actual magnitudes. Figures B.1 through B.4 that show the employment and inactivity rates highlight the difference between the least educated, i.e. education group 1 and 2 in the US (high-school dropouts: below 9th grade, and between 9th and 12th), group 1 in the UK (less than O-levels), and group 1 in France (no diploma or CEP), and the rest of the population: the least skilled have substantially lower employment rates and higher inactivity rates than everybody else in all three countries. Their employment rate is (at least in the US and France) also more sensitive to the business cycle than the employment rate of the other groups.

The changes in the levels of the observed employment rates were mostly driven by the aggregate developments in the three countries over the 1990s. While the UK and the US were in an expansionary phase of the business cycle over the 1990s (starting in 1992 in the US and 1993 in the UK), for France most of the period was recessionary, with the economic recovery starting only in 1998. Accordingly, employment rates in the US and the UK were rising in all education categories, while in France they were falling in most years.

In France, the relative employment rates of the most educated relative to the least educated increased from 1.13 to 1.9 for men, while it slightly decreased for women (from 1.61 to 1.59). Relative inactivity fell from 0.22 to 0.14 for men and from 0.32 to 0.23 for women. In the US, the relative employment rates decreased from 1.34 to 1.29 for men and from 2.23 to 1.95 for women. Relative inactivity rates have increased from 0.11 to 0.19 for men and from 0.20 to 0.26 for women. In the UK, male relative employment rates fell from 1.27 to 1.24, while female relative employment rates increased from 1.41 to 1.54. The relative inactivity rates among men fell from 0.17 to 0.15 and that of women from 0.35 to 0.24.

In the US, the real wages fanned out substantially over the entire period, with the ratio of the mean hourly wage of the highest education group to that of the lowest increasing from 2.55 to 3.5 for men and from 2.7 to 3.05 for women. It was mostly the rapid increase in the wages of the high educated that caused this rise in the between group inequality, as the wages of the least skilled stagnated (or only slightly increased for women). The between-group wage differences declined in the other two countries: the highest-lowest education group ratio decreased from 2.16 to 2.15 for men and from 2.4 to 2.21 for women in the UK, and from 2.14 to 1.93 for men and 2.34 to 2.02 for women in France.[38] The beginning of the steeper growth in the wages of the least skilled in the UK coincides with the introduction of the minimum wage in April 1999 and its subsequent increases. The automatically adjusted minimum wage in France (indexed to wage inflation) and the impact of collective bargaining is likely to account for the wage increases among the low skilled in this country.[39]

To summarize: While the between-group variation in wages has increased in the US, the employment rates of the educational groups have come closer together[40] and the male inactivity rates have continued to fan out. In the UK, the between-group differences in wages and employment have stayed more or less the same, while in France it was the wages that got closer together and the employment rates that diverged. In both countries, inactivity has fanned out for both men and women.[41]

The above described developments in the relative wages and labor force status proportions are therefore more or less consistent with what the findings of our empirical analysis would suggest to happen in consequence of the continuing skill-biased change in the demand structure.[42] However, the on-going changes in the demand has been also accompanied by an opposite supply side trend, namely the shifts in the structure of the population. With increasing investment in education and rising life expectancy, populations are becoming more educated and the average age increases, so that the proportion of the low skilled (defined by education and age) in the population is decreasing relative to the high skilled. Changes in the demand have been therefore counteracted by changes in the supply, and both have to be taken into account when explaining the observed labor market outcomes across the different skill-groups.

We next use the reduced-form results from our empirical analysis to construct counterfactual series holding the respective supply or the demand shifters constant in order to disentangle the effect of the changes in the demand and population structures on the observed developments. A comparison of the actual and the simulated series reveals what factors stood behind the development in earnings and labor force status in different skill-groups in the three countries, and which of the two factors have dominated. These

[38] The ratios might be slightly higher and the decrease smaller if the information on gross wages was available. Although the pay-roll taxes in France are a fixed proportion, there are top ceilings up to which the percentage applies. There is also a minimum wage level below which the tax does not apply. However, it is the case that majority of the population is in between the two limits. Unfortunately, all the wage inequality statistics available for France (such as the OECD measures) that I could find to compare my estimates against, were based on wages net of the payroll taxes.

[39] However, again, part of the increase may be also due to the reduction in the relative effective payroll taxes paid by the high educated versus the low educated.

[40] This might be partially due to an economy's boom which typically has higher impact on the employment of the low skilled as compared with the high skilled.

[41] The employment rate, the inactivity rate and the earnings for the six age groups (not presented in the paper) show very similar patterns across all three countries: for women, employment has increased and inactivity decreased in all age groups but most among the old; both the employment rates and the inactivity rates among different age groups of women have therefore converged together over the period. The employment rate among men for all age groups has increased in the UK, while it has decreased and followed the business cycle in France and the US. The employment of the 50-54 age old men has decreased most, while their inactivity has risen most sharply in all three countries. The wage rates have increased at a similar pace across all age groups in all three countries both for men and women, but at a higher rate for the latter.

[42] Exception are the fanning out inactivity rates for France, which will be discussed later in the text.

simulations are presented in Figures B.7 to B.15 in the Appendix.[43] First, in-sample prediction was performed where the estimated reduced-form model is used to predict the earnings and labor force status of the respective skill-groups. Second, two counterfactual series were generated to separate the effect of exogenous changes in the supply and the demand respectively. In this simulation exercise, earnings and labor force status of each skill-group are predicted using the estimated reduced-form coefficients, while holding the demand or supply shifter constant at its value at the beginning of the period. The two simulated series thus represent the counterfactual evidence suggested by the model of how earnings and labor force status of the respective groups would have evolved had there been no exogenous shifts in the demand or supply respectively.

Although the prediction and the simulation assign each particular gender-education-age-specific skill-group in each year a specific predicted or simulated value of the left-hand side variable (i.e. earnings or labor force status), for the sake of exposition the results are grouped and presented by gender and education only.[44] Each plot includes four series: the actual values, the in-sample predicted values, and the two sets of simulated values. The first simulated series shows what would have happened had the demand shifter stayed at its initial level over the entire period, the second series presents how the variable would have evolved had there been no changes in one of the supply shifters, namely the fraction of a skill-group in the population. The actual and the predicted series show that the in-sample prediction is reasonably close to what actually happened to earnings and labor force status for most of the education groups over the analyzed period.

The results suggest that both demand and supply changes were in effect over the period in all three countries. Two key trends in the exogenous changes of demand and supply are common to the three countries. The distribution of the population across the different education groups shifted from the low educated towards the most educated: the exogenous supply shifter defined as the fraction of a skill-group in a population was declining for the less educated and increased for the more educated. Other things being equal, this development would have pushed wages or employment rates, as well ass inactivity rates, across the different skill-groups together. The exogenous demand structure exhibited an opposite development: the demand shifter was falling for most of the low-educated groups, while it was rising for the more educated. Had there been no changes in the supply (i.e. no changes in the skill structure of the population) the exogenous changes in the demand would have caused the wages and employment rates, as well as the inactivity rates, across the different skill-groups to further fan out. As suggested above, the impact of the changes in the supply has been counteracted by the impact of the changes at the demand side, going in the opposite direction. The earnings and labor force status development for the respective education groups in the three countries differ only in the relative strength of the two factors.

[43] The simulation is based on the reduced-form estimates from the specification which uses the mean of the observed hourly wages. See Table C.3 in the Appendix for the estimation results. The mean of the observed wages was chosen as the wage variable to allow a direct comparison of the predicted and the simulated results with the actual series.

[44] The values by gender and education are constructed as a weighted sum of the group-specific (i.e. gender-age-education) values, using relative population shares of different age groups as weights.

Figure B.7 shows that the demand factors dominated the evolution of the group-specific employment rates in France. This is true in particular for French men. The counterfactual evidence predicted from the reduced-form model suggests that had the demand structure stayed the same, employment of the more educated men would have declined, while employment of the least-skilled men would have stayed more or less the same. The employment rates across the education groups would have converged rather than diverged. Had there been no change in the supply, the demand changes would have affected the employment rates more drastically: the employment rate of the least skilled would have declined more sharply and all the rates for the different education groups would have fanned out more broadly than they actually did. The increase in the fraction of the most educated in the population was only partially absorbed by the favorable demand changes for the high skilled. Although the results for French women are similar, the demand shifts were less harmful and the supply shifts were more favorable among low educated women, which explains why their employment rate remained at the same level most of the time and even increased at the end of the period.

In the US, as shown on Figure B.10, demand factors dominated the evolution of the employment rate of the low educated in the first half of the period, while supply shifts were more important in the second half. Among the high educated, exogenous changes in the supply more than mitigated the demand changes. The results for the US show divergent developments of two education groups, namely the high school graduates (ED3) against the high school graduates with some college or some further education other than college (ED4). It is clear that the demand shifted away from the less educated group towards individuals who had spent some time getting education after high school. The figure shows that these changes in the demand structure were almost perfectly complemented by an opposite development at the supply side: the fraction of people with some education after high school increased substantially, thus reducing the population fraction of high school graduates. It is between these two groups that the effects of the exogenous supply and demand changes reverse the sign, i.e. change the direction in between the way they affect the low educated and the way they affect the high educated.

Figure B.13 shows that the adverse effect of the demand on the employment rate of the low educated was more than mitigated by compensating changes in the supply. On the other hand, an increase in the supply shifter of the most skilled partially counteracted the favorable demand changes among these groups.

Overall, demand factors dominated the supply side effects in the development of the employment rates in France, thus favoring the high educated and harming the low educated: the employment rates among the low educated declined more than those of the high educated. In the US, it was the exogenous changes in the supply that were stronger. This resulted in a more rapid growth in employment rates among the low educated and a slower growth of the employment rates among the high educated than would have happened had there been only exogenous shifts in the demand. The impact of the supply and the demand factors on the employment rates in the UK were more or less balanced, with the supply effects dominating among the least and the most educated. The simulated decline in the employment rate of the least educated was reversed by the favorable supply changes, thus resulting in an increase of the employment rate among the least skilled. The exogenously increasing supply of the high educated slowed down the growth of their employment rates, as driven by the favorable demand changes.

Inactivity rate increased among the low educated men and stagnated among the high-educated men in France and the UK. Top panels of the Figures B.8 and B.14 show that this development was driven by changes in the demand that reversed the effect of the changes of the population's skill structure on the supply side. In the US as shown on Figure B.11 the decrease in the inactivity rate of the least educated and the slow rise in the inactivity rate among the high educated were clearly supply driven.

Figures B.12 and B.15 show that the effect of supply and demand changes on wages in the US and the UK, as represented by the simulated counterfactual series, was negligible in the face of the rise in the real hourly wage rates across all the education groups that started around 1996 in the US and around 1999 in the UK. The overall wage increase in the two countries can be attributed to the expansionary phase of the business cycle but also to institutional changes in the minimum wage. In 1996, minimum wage was increased in the US, after it had been held at the same level for a number of years. In 1999, the UK enacted national minimum wage for the first time in history. Further increases in the minimum wage followed in both countries. It seems likely that changes in the minimum wage pushed the entire wage distributions upwards, although favoring the most those with the lowest wages. Yet we can see, in particular among the high educated in the UK, that the demand changes would have increased wages of the high educated even more had it not been for the positive shifts in their supply. The opposite holds for the less educated. In France, as shown on Figure B.9, real hourly wages across all the education groups followed a much more cyclical pattern than in the other two countries. Furthermore, it was the wages of the low educated that have eventually risen the most, while the wage levels of the high educated stayed more or less the same, or even declined. The eventual rise across all education categories coincides with the adoption of the common European currency (EURO) in 1999. The effects of the exogenous demand and supply shifts are much more visible here than in the other two countries. The figure suggests that the evolution of wages in France was dominated by the changes in the supply rather than those in the demand. Had there been no exogenous changes in the supply, the wages of the low educated would have increased less, and the wages of the high educated would have first declined less and then increased more than they did. The figure also suggests that the wages of the least educated increased even more than they would have according to the model if supply changes were exclusively at play. This reflects the effect of minimum wage and, possibly, collective bargaining that pushed the wages at the bottom of the wage distribution up irrespective of the market forces.

In accord with both the reduced-form and the structural coefficient estimates, the simulation results provide some evidence for both the standard trade-off hypothesis and its extended version. The decline in the employment rate of the low educated in France at a time when their relative and absolute wages were rising was the result of negative demand shifts in the face of wages that were pushed up by institutions, rather than a consequence of a negative supply shift. The effect of the shifts in supply that caused the inactivity of the least educated in the US to decline could reflect the fact that the low educated were attracted to the labor force through the positive effect of these supply changes on their wages. However, contrary to what the extended trade-off hypothesis would suggest, the increase in the inactivity rate among the low educated in France and the UK was demand driven, as suggested by the simulated counterfactual evidence, despite the fact that the absolute and the relative wages in these groups increased. This means that demand had a direct effect on inactivity in addition to the effect through wages. As for the UK, this is in accord with the high wage elasticity of the labor supply, which may imply that employment is more sensitive to the demand shocks than wages. As for France, however, this effect cannot be explained by the simple labor supply and labor demand model estimated in the present analysis.[45] This suggests that other factors might have caused these developments, including for example the early retirement policies aimed at reducing unemployment or a discouraged worker phenomenon, features that are not part of the theoretical model presented here.

6 Conclusion

The trade-off hypothesis states that high wage inequality in the US and the UK and high unemployment in countries of continental Europe are the consequence of the same negative change in the demand for the low skilled under different degree of wage rigidity. We estimate a model of labor supply and labor demand for different skill-groups to test the validity of the trade-off hypothesis for the labor market developments in France, the US, and the UK over the 1990s. The theoretical framework builds on the model from Card et al. (1999), which is extended and estimated in its complete structural form. The results are used to analyze the effect of market forces (exogenous changes in the labor supply and labor demand) under different degree of wage rigidity on the developments in relative earnings and labor force status proportions of the different skill-groups in these three countries.

In addition, we propose an extended version of the trade-off hypothesis suggesting that, if labor force participation is not perfectly wage inelastic, wage inequality is likely to be accompanied by high inactivity rates, in particular among the low skilled. The trade-off the policy-makers face is then one between wage inequality as well as high inactivity on one hand, and high unemployment on the other.

A system of the three equations for group-specific wage, employment rate and labor supply, implied by the structural model, is estimated with two-way fixed effects, by both linear and non-linear least squares to obtain the reduced-form and the structural coefficients respectively. We propose several tests of the trade-off hypothesis and its extended version, based on both sets of coefficients.

The reduced-form results confirm the validity of the trade-off hypothesis and its extended version when France is compare to the US but have mixed results for the UK. Wages are more sensitive than employment to the demand shocks in the US, while the opposite is true for France, as well as the UK. Cross-country comparison also shows that the demand shock sensitivity of wages is higher, while sensitivity of employment is lower in the US than in the other two countries. However, the demand shock affects employment and labor supply in exactly the same way in both the US and the UK,

[45] The observed reduction in employment among the low-skilled men in France saw corresponding increases in inactivity rather than unemployment.

suggesting wages are flexible in the two countries. The contradictory reduced-form results for the UK are reconciled by the structural estimation, which shows that both labor supply and labor demand are significantly more wage elastic in the UK than in the two other countries, and explains the observed insensitivity of wages and sensitivity of employment in this country.

Structural results provide further evidence in favor of the hypothesis. The estimate of the parameter of the degree of wage rigidity seems to confirm that wages in France are less flexible than wages in the US and the UK, and that wage rigidity in France affected the development of wages and labor force status proportions in the French economy during the analyzed period. We also find positive and significant wage elasticity of labor force participation in all three countries which suggests that the high inactivity rates in the US and the UK, in particular among the low skilled, are likely to be a consequence of their decreasing relative wages, as proposed by the extended trade-off hypothesis.

The simulations based on the estimated model reveal that demand as well as supply changes were in effect in all three countries during the 1990s. The three countries saw the same overall trend in the demand and the supply structures. The distribution of the population across the different education groups shifted from the low-educated towards the high-educated, thus increasing the supply of the high skilled and reducing the supply of the low skilled. The impact of the supply shifts was counteracted by the impact of changes on the demand side that were going in the opposite direction, as the exogenous forces further shifted the demand away from the low-educated groups and towards the high-educated. The earnings and labor force status development for the respective education groups in the three countries was determined by the relative strength of these on-going shifts in the supply and the demand. The simulated counterfactual series suggest that the exogenous shifts in the demand dominated for the employment rates across the education groups in France, while in the US it was supply shifts that had more impact. The mutually opposite effects of the supply and the demand shifts in the UK were of similar magnitudes, with the supply effects dominating for the least and the most educated. Inactivity rates were driven by changes in the demand in France and the UK, while supply changes played the more substantial role in the US.

Overall, we conclude that in addition to the identified cross-country differences in the relative strength of the shifts in the supply and the demand, both the trade-off hypothesis and its extended version have substantial explanatory power when the relative labor market outcomes across the different skill-groups are compared between France and the US, as well as between France and the UK over the 1990s.

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Data Sources

- Current Population Survey, March CPS Supplement, Bureau of Census and Bureau of Labor Statistics, USA
- *Labor Force Survey*, the UK Data Archive
- *Enquête Emploi*, INSEE and LASMAS-IdL, France
- OECD Statistical Database, Statistics Portal, Labor Force Statistics Data and Indicators, http://www.oecd.org/
- STAN Indicators Database (2004), Source OECD, Paris
- Institut national de la statistique et des études économiques, Paris, France, http://www.insee.fr/
- National Statistics, UK, http://www.statistics.gov.uk/statbase/
- Bureau of Economic Analysis, USA, http://www.bea.gov/

Appendix

A Data Description and Sources

The three national labor force surveys used in the present analysis are *Enquête Emploi* (1990-2002) for France, *Labor Force Survey* (1993-2002) for the UK, and the *March CPS* (1990-2002) for the US.[46] All three datasets have a character of a short rotational panel, so that a fraction of the individuals overlaps in two consecutive years. As the present analysis utilizes a panel of grouped data with the groups based on age, the panel nature of the individual data is ignored and all the individuals are treated as newly randomly sampled in each year. The sample employed in the analysis is the non-institutionalized population between the ages of 25 and 54, excluding students, conscripts and individuals in Armed Forces. The analysis makes use of all these individuals in the datasets regardless whether they come form the same household or not. In this sense, intra-household correlations are ignored. However, for the construction of the group-level information for the skill-groups, treating all the individuals as independent seems to be rather innocuous, and substantially increases the sample size. The skill-groups are classified on the basis of gender, six age ranges (25-29, 30-34, 35-39, 40-44, 45-49 and 50-54), and six (five in the UK) education attainment categories, leading to 72 groups in total for France and the US, and 60 for the UK.

The use of the UK Labor Force Survey requires more detailed description. It is a quarterly survey that follows households for 5 consecutive quarters. In each quarter, one fifth of the households leave the sample and is replaced by a new wave. Although the questions asked in each quarter are almost the same, information about earnings is only available in the quarter when the households are in the survey for the last time (i.e. only for the outgoing wave).[47] The present analysis therefore uses the outgoing households in each quarter over a particular year to constructs a new dataset, which is than used to construct the group-level information for that year. In this sense, the UK grouped data is not directly comparable with the data from the other two countries which are more or less a point in time estimates (both surveys are conducted in Spring), whereas it is four points in time in different quarters of the year in the UK. This should be irrelevant for wage information which does not show much variation over the year, but could affect the labor force survey statistics, as employment does show some seasonality over the year. For now, this problem is neglected in the analysis. However, as the data in the UK is constructed in the same way in all years, and this analysis uses the fixed effect estimation that is based on the year-to-year differences, the problem should not have an impact on the estimation results. On the other hand, the summary statistics presented in the figures may be affected by this method of the data construction. The sample size and the size of the skill-groups is summarized in Table A.1.

Education is classified to best fit the country-specific characteristics of the education system, as well as to produce reasonably large group-sizes over the entire period. In the

[46] Missing wage information in earlier years of the LFS for the UK requires the analysis to start only in 1993 for this country.

[47] The information about earnings is asked also in the second interview starting from 1997.

Table A.1: The Sample and Skill-Group Size Statistics

country	years	individual obs (all years)	no. of skill groups	group obs (all years)	smallest group size	largest group size
FR	1990-2002	934 719	72	936	150	2704
UK	1993-2002	458 107	60	600	168	2096
USA	1990-2002	864 323	72	936	176	3196

UK the classification is as follows: 1 = "CSE below grade 1 or equivalent" (less than O-levels), 2 = "GCSE A-C or equivalent" (less than A-levels), 3 = "A level or equivalent", 4 = "higher education, below degree", 5 = "degree or higher". In France it is: 1 = "CEP or less" (primary), 2 = "BEPC" (junior high school), 3 = "CAP, BEP" (vocational or technical school) , 4 = "Baccalauréat" (academic high school), 5 = "undergraduate degree", 6 = "graduate degree". In the US, it is: 1 = "8th grade or below", 2 = "up to 12th grade, no diploma", 3 = "high-school graduate or equivalent", 4 = "some college but no degree, Associate's degree in college", 5 = "Bachelor's Degree", 6 = "Master's Degree and above".

The employment and the labor force participation rates are defined in the standard way: Employed individuals include the employed and the self-employed, as well as the unpaid family workers, and labor force participants are individuals who are either employed or unemployed (according to the ILO definition of unemployment).

The key measure the present analysis uses for earnings is the real hourly wage. In France, the hourly wage was constructed using the reported monthly wages from the previous month divided by 4.33 times the reported usual hours of work. In the UK, the hourly wage was already present in the dataset, constructed by the data providers using the reported current weekly wages and usual hours of work. In the US, hourly wage was constructed from the annual wage from the previous year, using the reported weeks worked in the previous year multiplied by the usual weekly hours of work. The reported hours of work per week were first trimmed (separately by gender and year) at the 1st and 99th percentile to avoid the outliers and top coded values, before used to construct the hourly wage. The resulting hourly wages were trimmed at the 5th and 95th percentile (separately by year and within each skill-group) for the same reason.

The consumption deflators for the period come from the official statistical sites of the three countries: Personal Consumption Expenditure Deflator from the Bureau of Economic Analysis for the US, IPC (Indice des prix à la consommation) from INSEE (French Statistical National Institute) for France, and CPI index (all items) from National Statistics in the UK. All three indices are normalized to have a base in 1995.

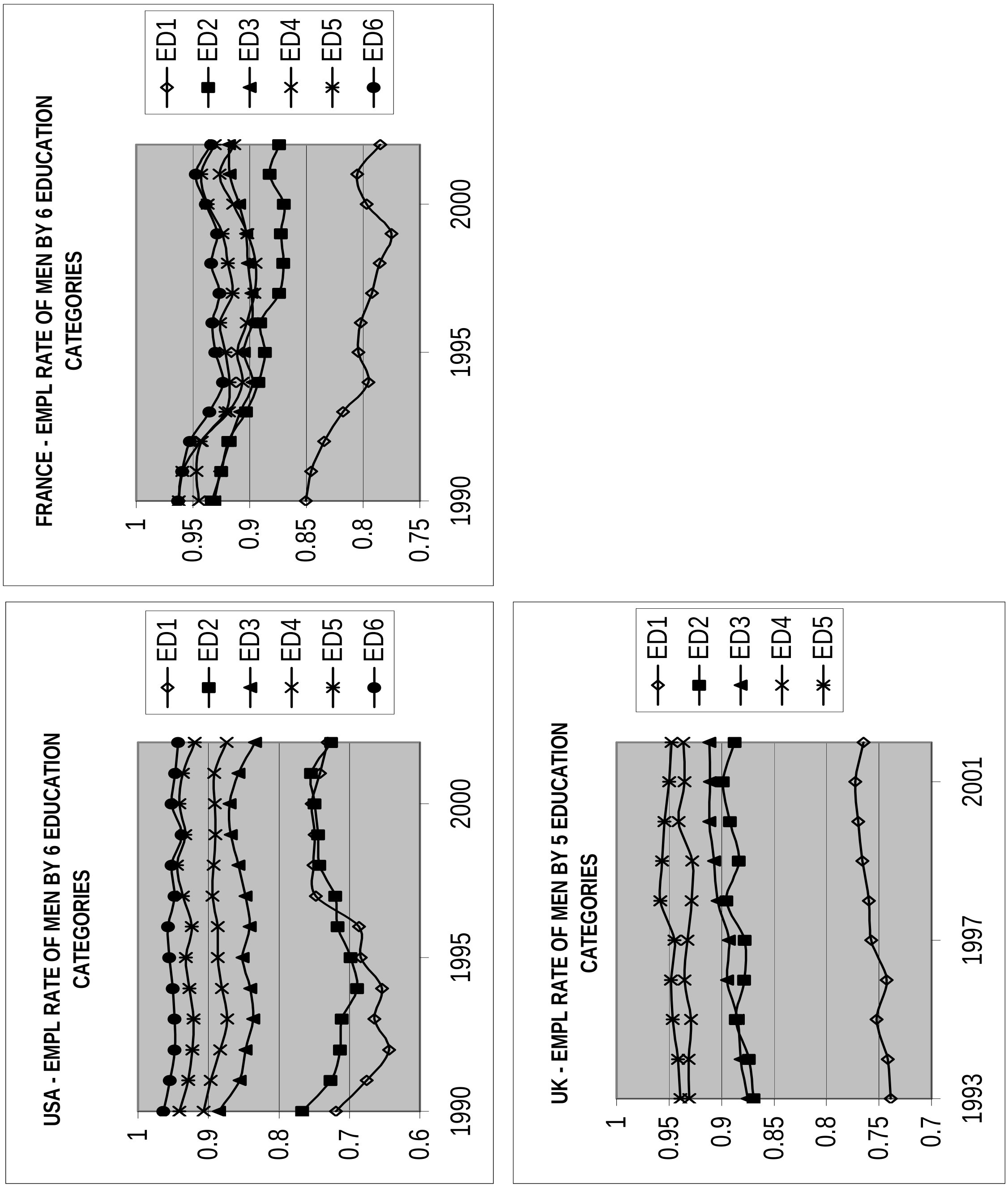
The value added shares of the individual industries used in the construction of the demand shifter come from the STAN Indicators database produced by OECD. There are 25 industry groups in the US, 24 in the UK, and 23 in France. The number of industries depends on the extent to which the national industry classifications in the individual level datasets correspond to the ISIC Rev.3 classification in the STAN database.

The exogenous supply side shifters are constructed as follows. Marital status describes the actual cohabitation (rather than the legal status), as it is assumed that cohabitation is likely to involve consumption and expenses sharing and income pooling, which are the key aspects affecting labor supply behavior. In the US, it is defined as "married with spouse present"[48], in the UK as "married with spouse present OR cohabitate" and in France as "cohabitate" (both married or not). The presence-of-children variable is defined as the presence of pre-school (less than 6 year old in the US and France, and less than 5 year old in the UK) children in the household. The information therefore does not necessarily describe individual's own children. It is not always possible to link children to their parents in the three datasets. Besides, this information may actually be preferable, as the presence children that require child-care can in principal affect labor supply behavior of any member of the household.

B Figures

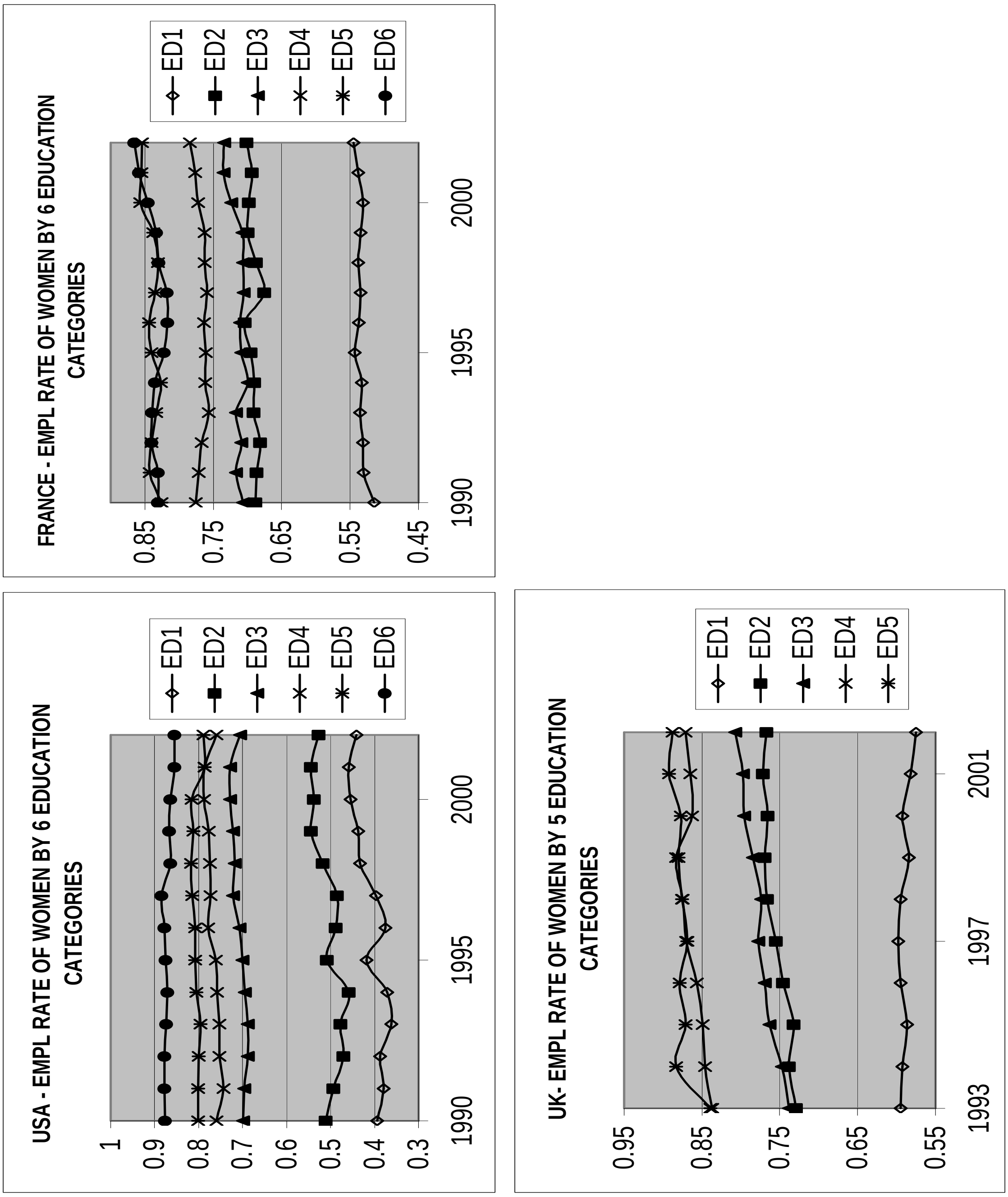
[48] Unfortunately, in the US dataset it is not possible to distinguish individuals that are not married but are living together.

Figure B.1: Employment Rate by the Educational Categories - Men



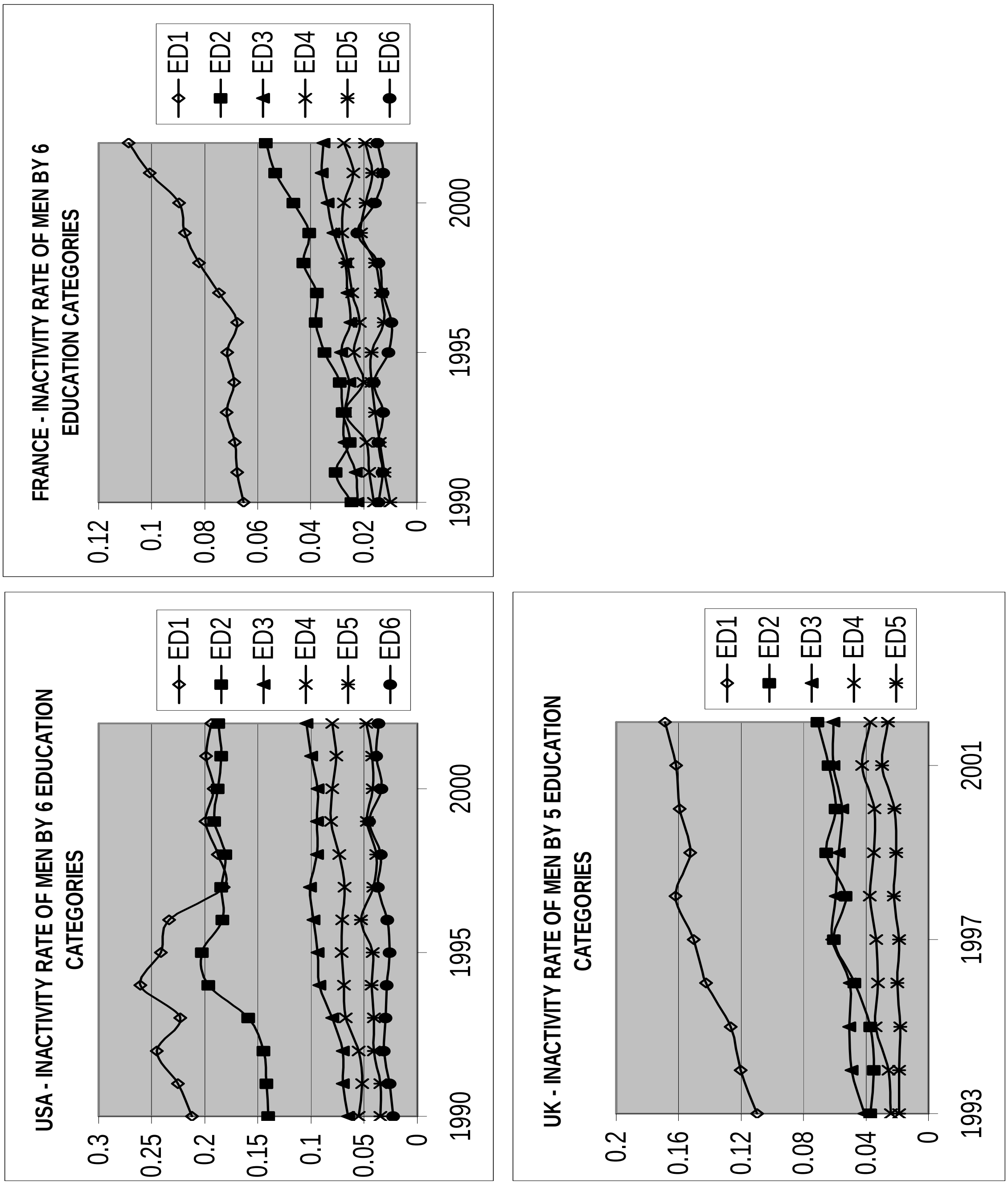
Out of school civilian prime age (24-54) population in France, the UK and the US. ED1 is the least educated group. Data is weighted by survey weights to reflect the population means.

Figure B.2: Employment Rate by the Educational Categories - Women



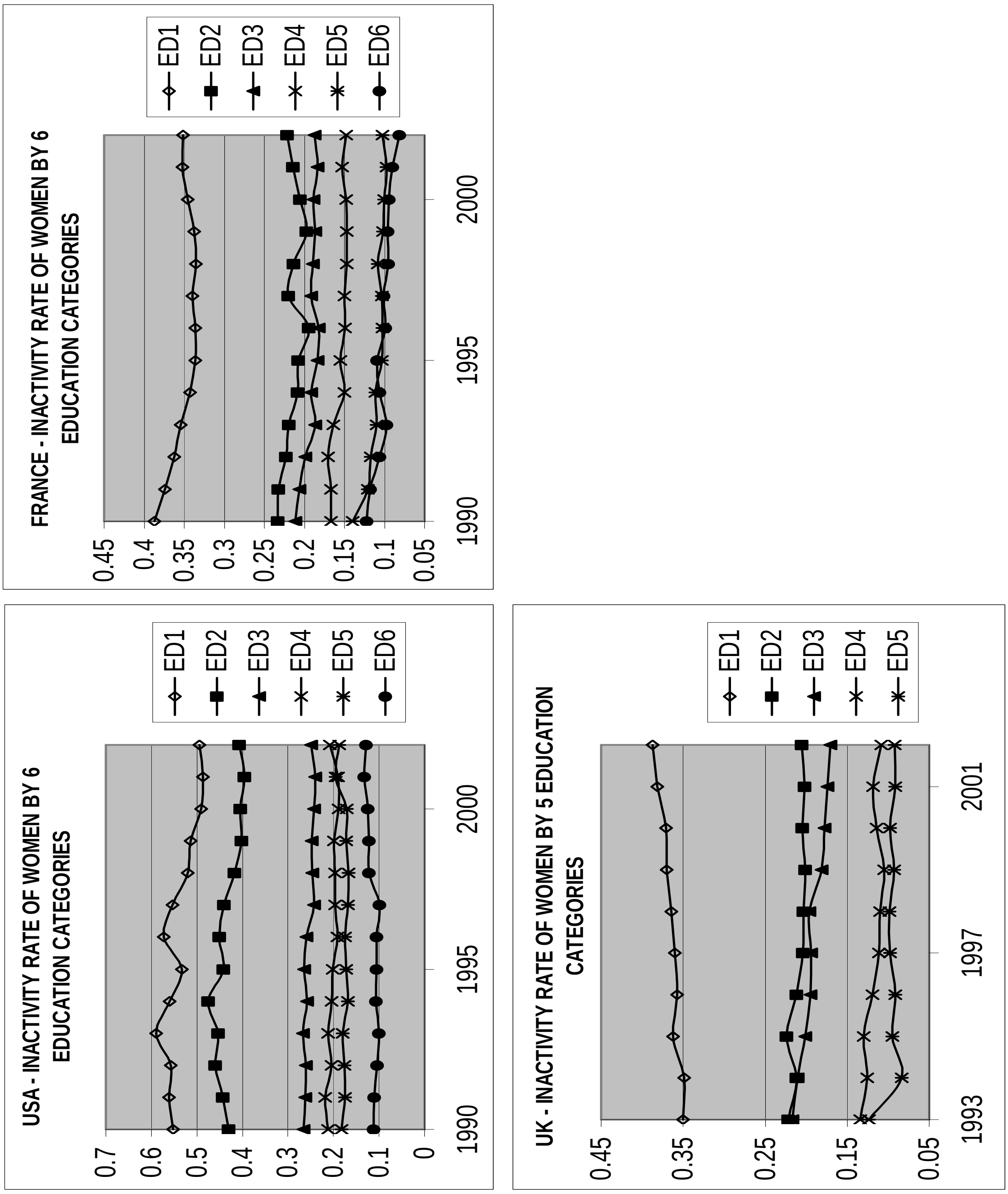
Out of school civilian prime age (24-54) population in France, the UK and the US. ED1 is the least educated group. Data is weighted by survey weights to reflect the population means.

Figure B.3: Inactivity Rate by the Educational Categories - Men



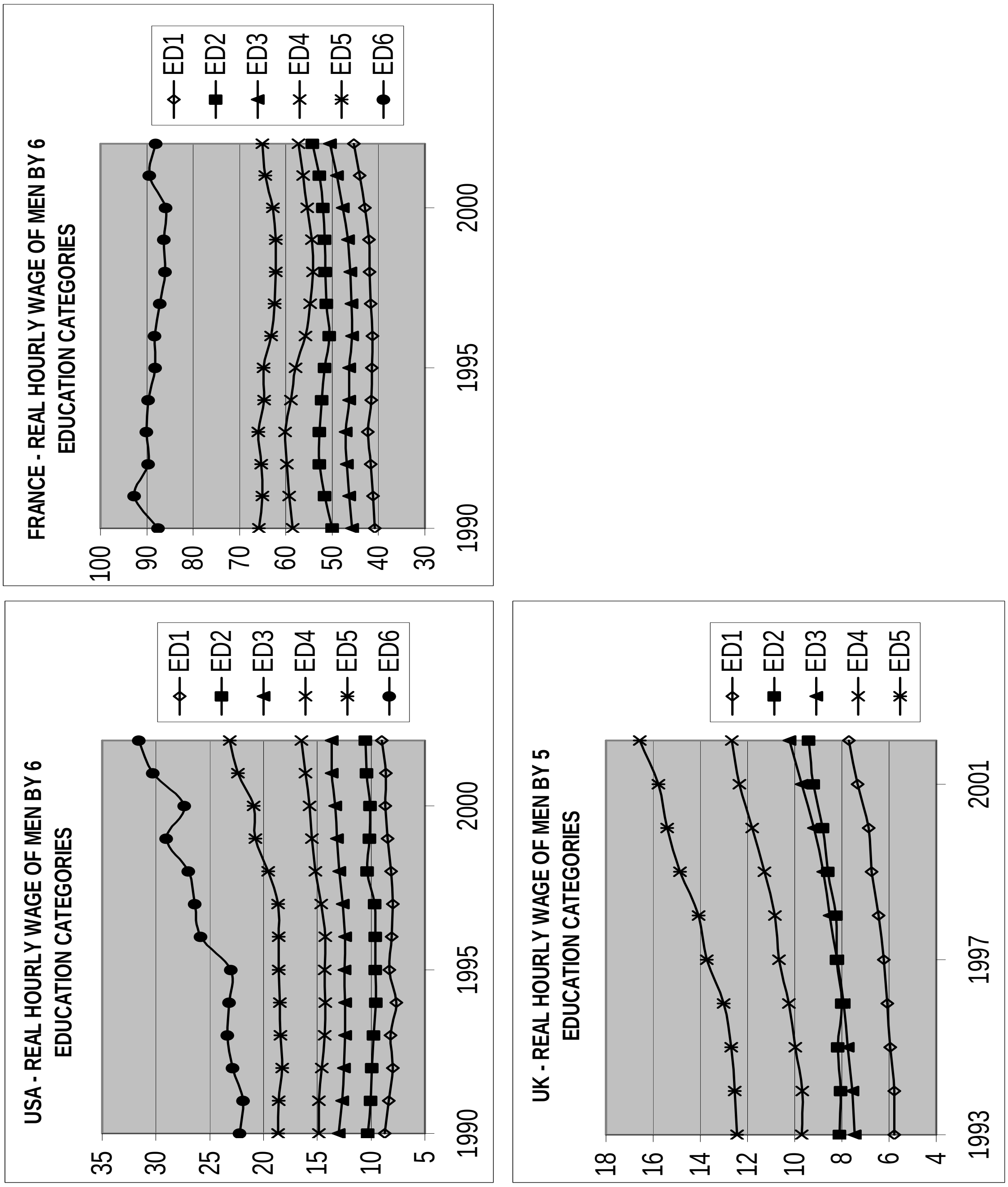
Out of school civilian prime age (24-54) population in France, the UK and the US. ED1 is the least educated group. Data is weighted by survey weights to reflect the population means.

Figure B.4: Inactivity Rate by the Educational Categories - Women



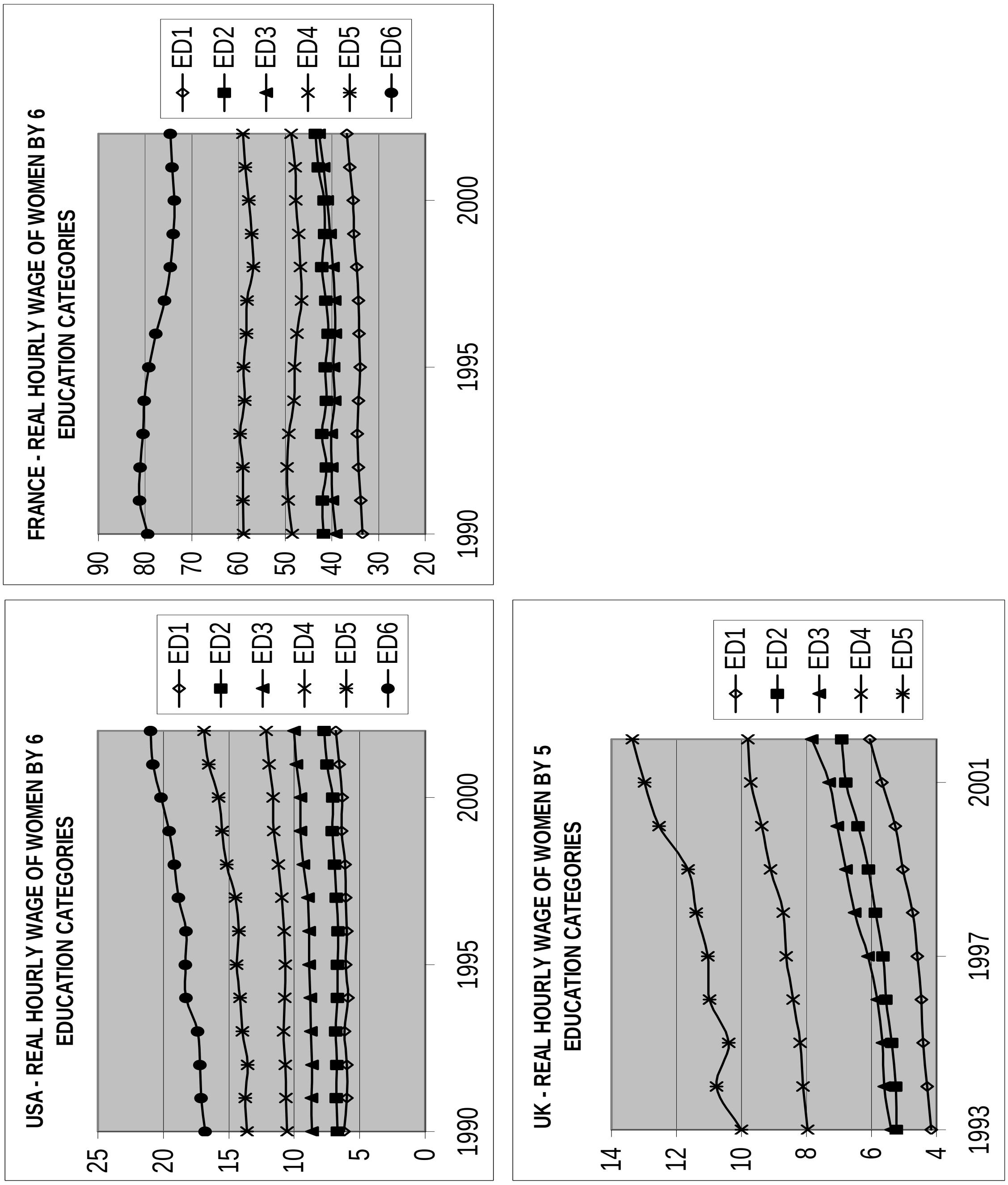
Out of school civilian prime age (24-54) population in France, the UK and the US. ED1 is the least educated group. Data is weighted by survey weights to reflect the population means.

Figure B.5: Real Hourly Wage Rate by the Educational Categories - Men



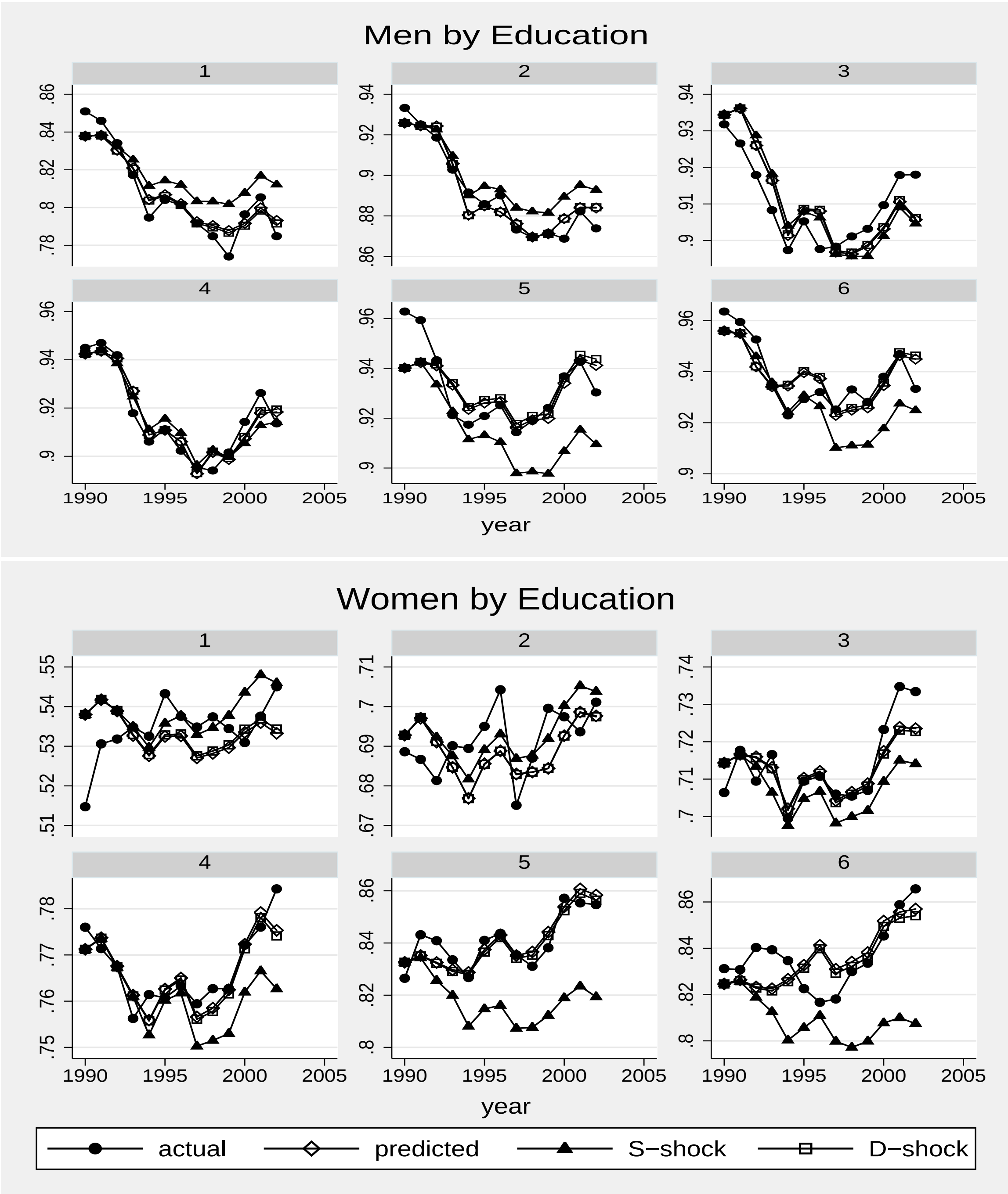
Out of school civilian prime age (24-54) population in France, the UK and the US. ED1 is the least educated group. Data is weighted by survey weights to reflect the population means.

Figure B.6: Real Hourly Wage Rate by the Educational Categories - Women



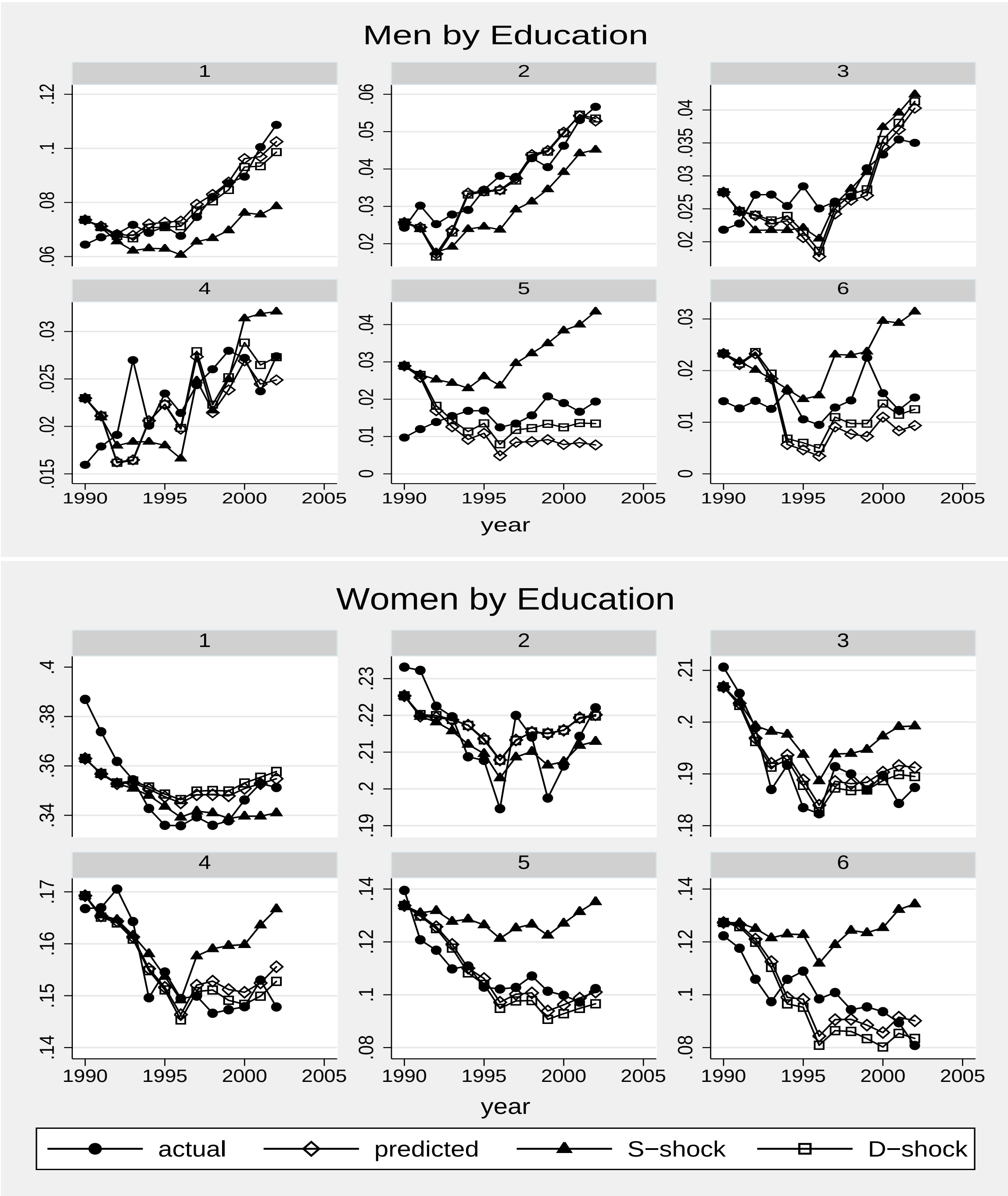
Out of school civilian prime age (24-54) population in France, the UK and the US. ED1 is the least educated group. Data is weighted by survey weights to reflect the population means.

Figure B.7: Employment by Education - France



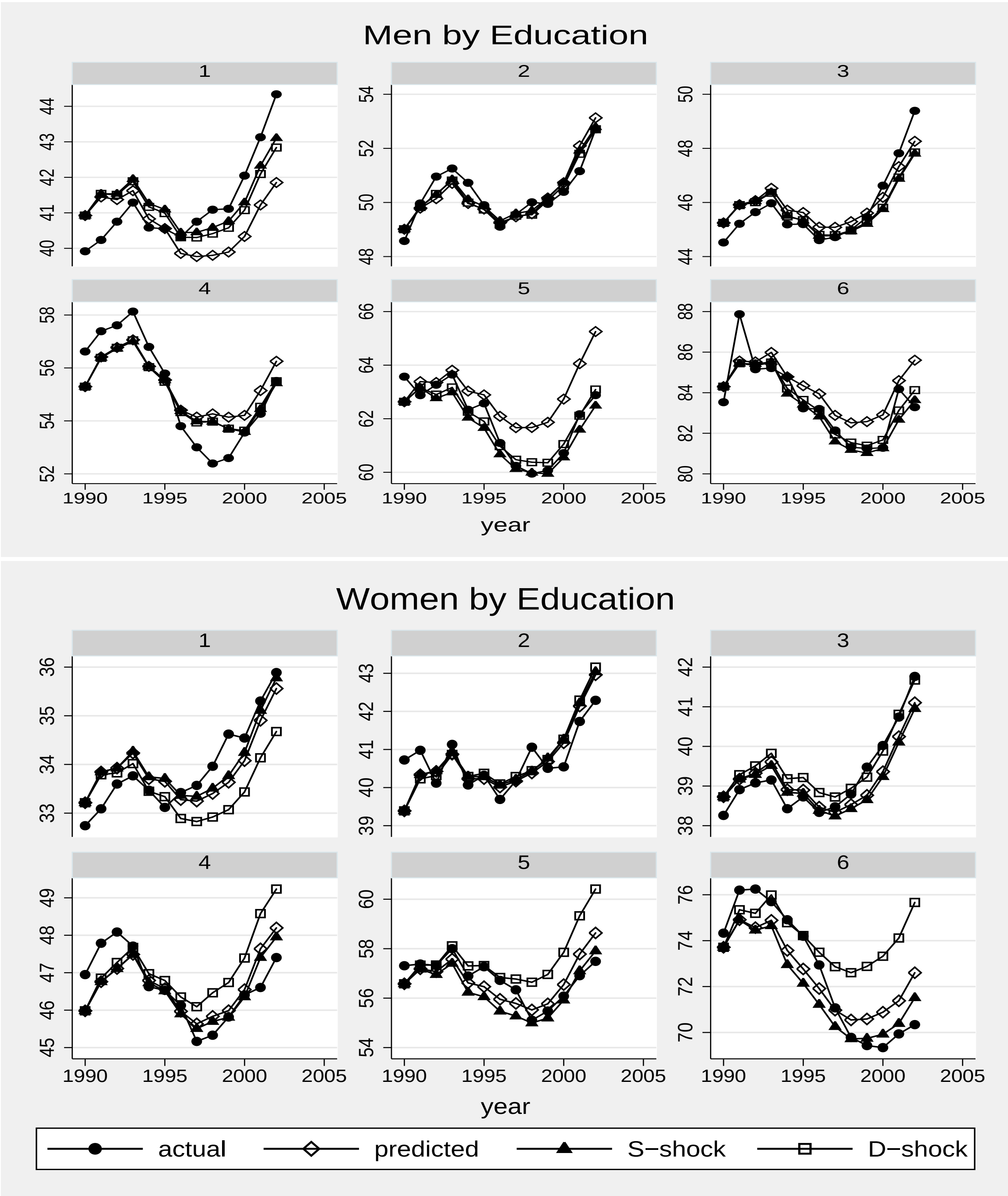
The six plots correspond to the six education groups, with ED1 being the least and ED6 the most educated. Each plot shows actual values, in-sample predicted values and two sets of simulated values. The “S-shock” and the “D-shock” series present the predicted values when the demand shifter or the first supply shifter (i.e. the fraction of the skill-group in the population) are held constant at their initial year values respectively.

Figure B.8: Inactivity by Education - France



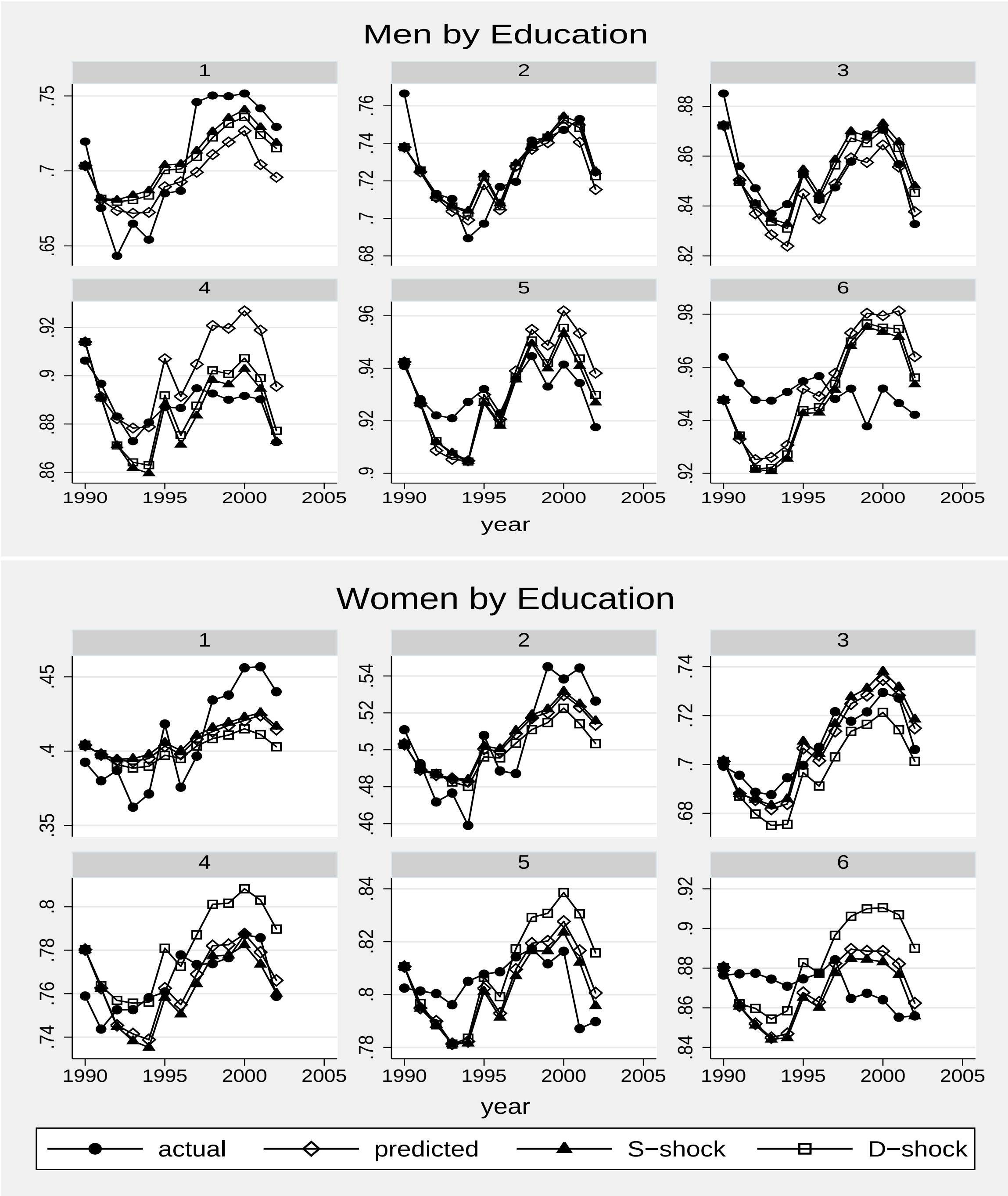
The six plots correspond to the six education groups, with ED1 being the least and ED6 the most educated. Each plot shows actual values, in-sample predicted values and two sets of simulated values. The "S-shock" and the "D-shock" series present the predicted values when the demand shifter or the first supply shifter (i.e. the fraction of the skill-group in the population) are held constant at their initial year values respectively.

Figure B.9: Hourly Wage by Education - France



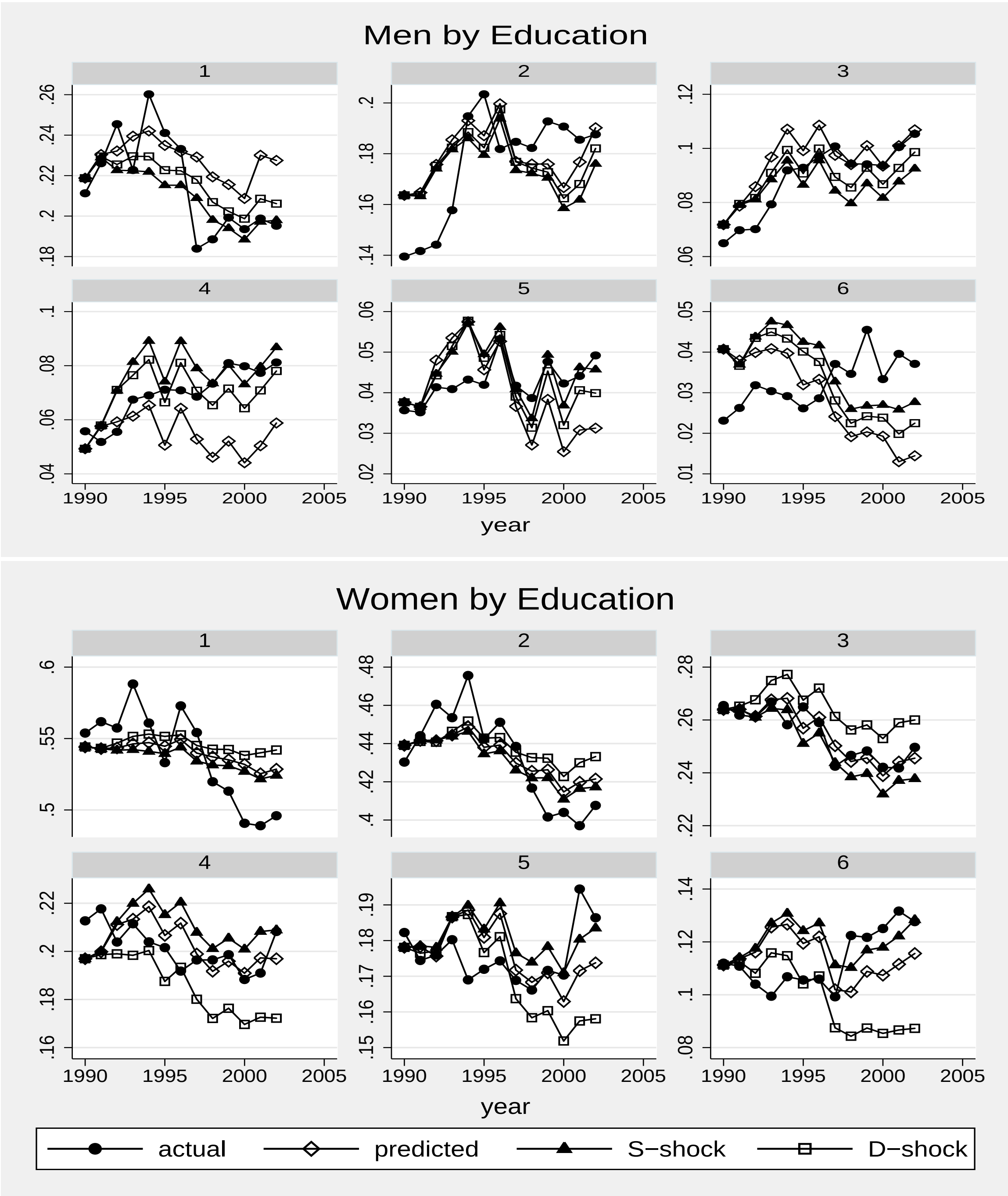
The six plots correspond to the six education groups, with ED1 being the least and ED6 the most educated. Each plot shows actual values, in-sample predicted values and two sets of simulated values. The "S-shock" and the "D-shock" series present the predicted values when the demand shifter or the first supply shifter (i.e. the fraction of the skill-group in the population) are held constant at their initial year values respectively.

Figure B.10: Employment by Education - US



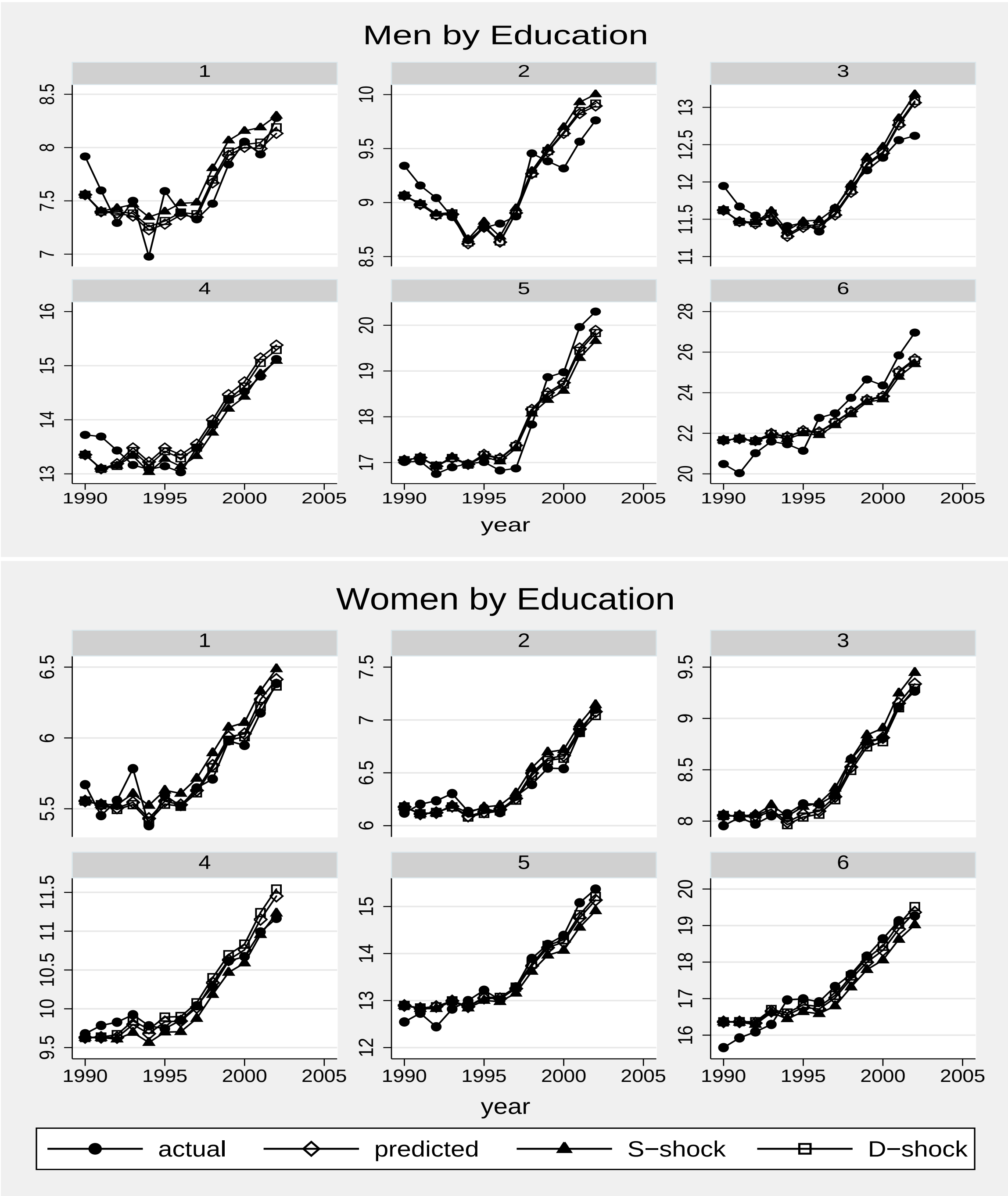
The six plots correspond to the six education groups, with ED1 being the least and ED6 the most educated. Each plot shows actual values, in-sample predicted values and two sets of simulated values. The "S-shock" and the "D-shock" series present the predicted values when the demand shifter or the first supply shifter (i.e. the fraction of the skill-group in the population) are held constant at their initial year values respectively.

Figure B.11: Inactivity by Education - US



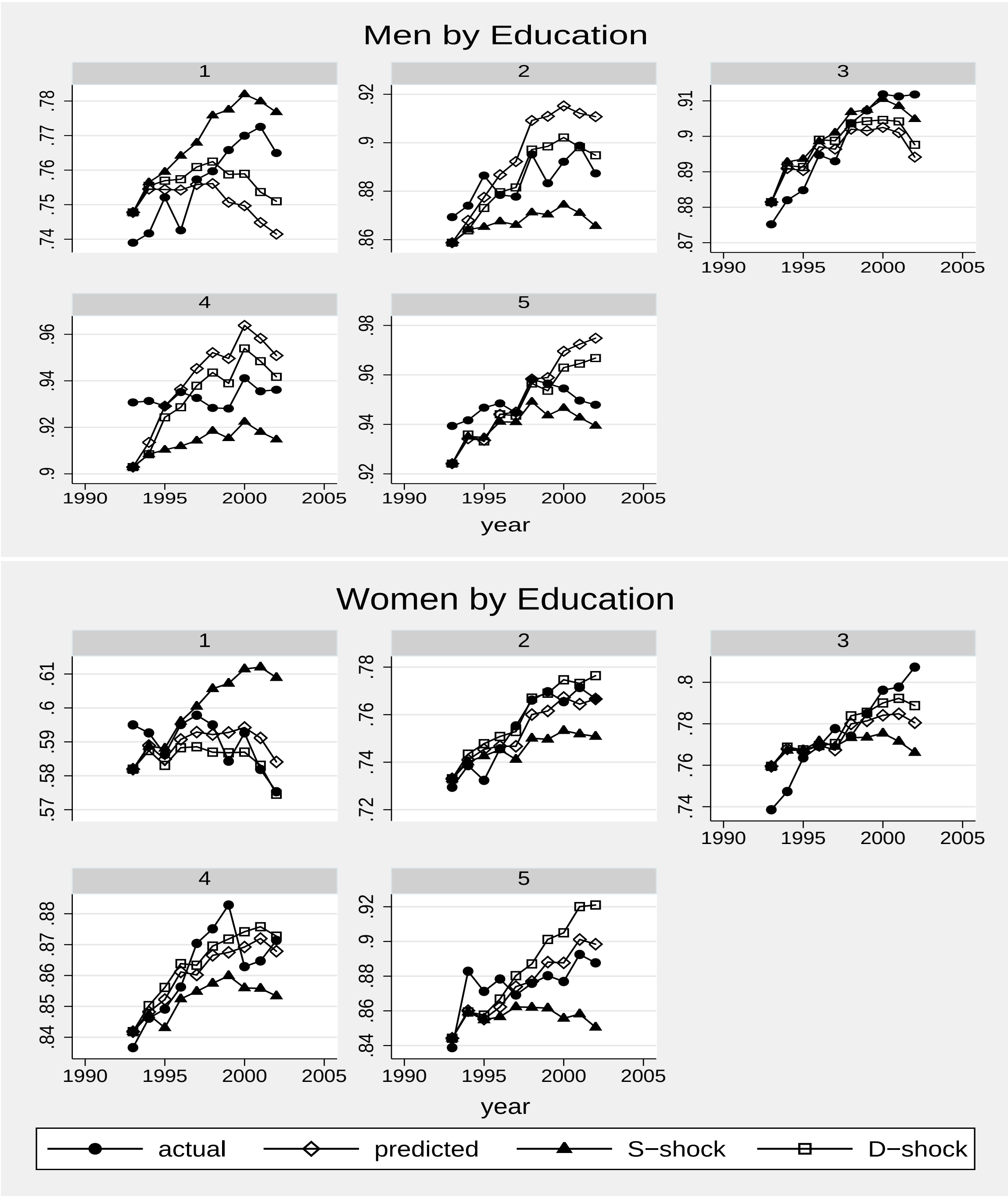
The six plots correspond to the six education groups, with ED1 being the least and ED6 the most educated. Each plot shows actual values, in-sample predicted values and two sets of simulated values. The "S-shock" and the "D-shock" series present the predicted values when the demand shifter or the first supply shifter (i.e. the fraction of the skill-group in the population) are held constant at their initial year values respectively.

Figure B.12: Hourly Wage by Education - US



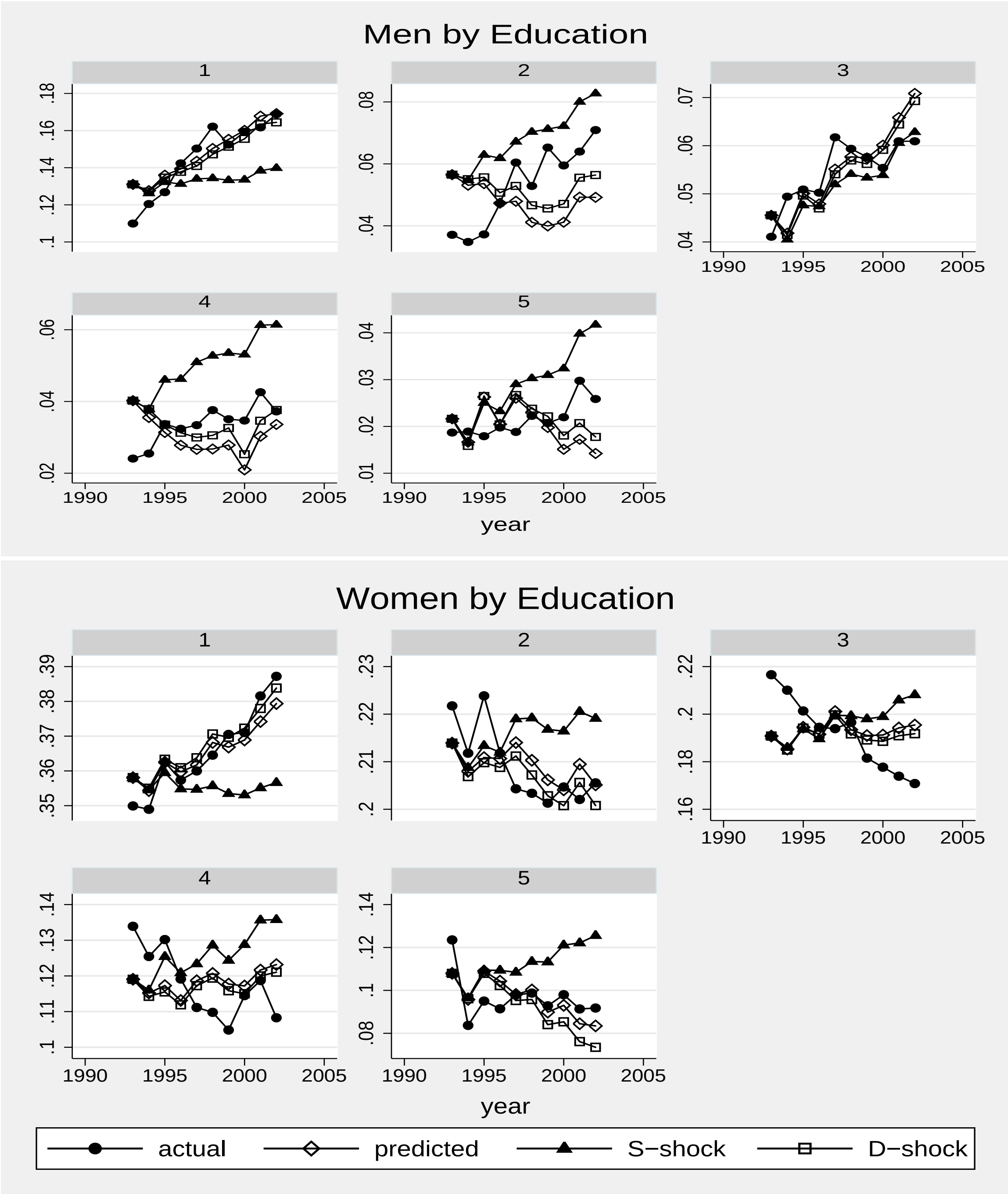
The six plots correspond to the six education groups, with ED1 being the least and ED6 the most educated. Each plot shows actual values, in-sample predicted values and two sets of simulated values. The "S-shock" and the "D-shock" series present the predicted values when the demand shifter or the first supply shifter (i.e. the fraction of the skill-group in the population) are held constant at their initial year values respectively.

Figure B.13: Employment by Education - UK



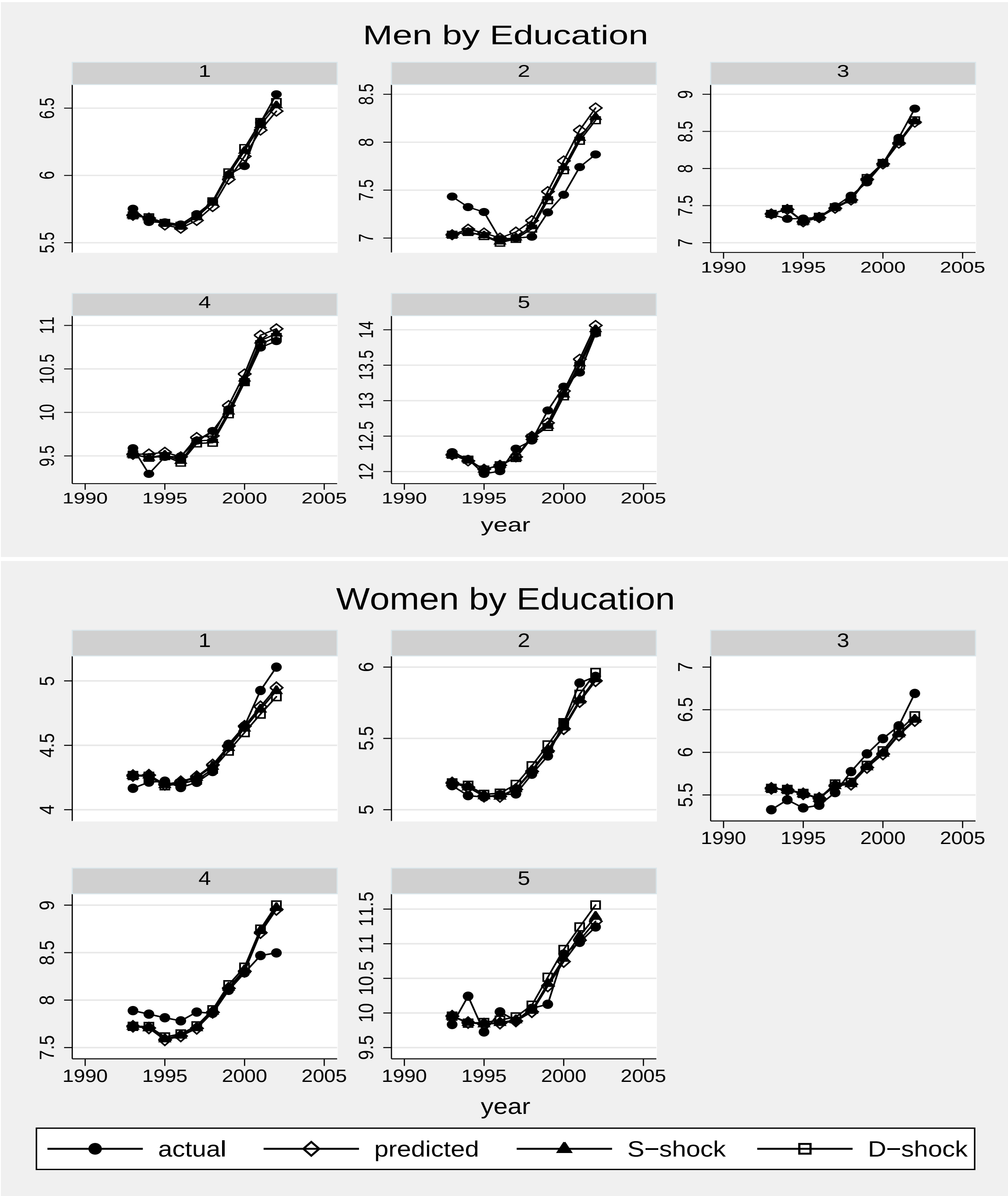
The six plots correspond to the five education groups, with ED1 being the least and ED5 the most educated. Each plot shows actual values, in-sample predicted values and two sets of simulated values. The "S-shock" and the "D-shock" series present the predicted values when the demand shifter or the first supply shifter (i.e. the fraction of the skill-group in the population) are held constant at their initial year values respectively.

Figure B.14: Inactivity by Education - UK



The six plots correspond to the five education groups, with ED1 being the least and ED5 the most educated. Each plot shows actual values, in-sample predicted values and two sets of simulated values. The "S-shock" and the "D-shock" series present the predicted values when the demand shifter or the first supply shifter (i.e. the fraction of the skill-group in the population) are held constant at their initial year values respectively.

Figure B.15: Hourly Wage by Education - UK



The six plots correspond to the five education groups, with ED1 being the least and ED5 the most educated. Each plot shows actual values, in-sample predicted values and two sets of simulated values. The “S-shock” and the “D-shock” series present the predicted values when the demand shifter or the first supply shifter (i.e. the fraction of the skill-group in the population) are held constant at their initial year values respectively.

C Other Estimation Results

Table C.1: Reduced-Form Results I

Variable		France		US		UK	
W	ln popshare	-0.033	(0.023)	-0.058*	(0.025)	-0.017	(0.023)
	D shifter	0.034†	(0.018)	0.086**	(0.019)	0.038†	(0.019)
	married F	-0.374**	(0.108)	-0.254†	(0.128)	0.548**	(0.136)
	married M	-0.260**	(0.097)	1.056**	(0.164)	0.761**	(0.060)
	child6 F	0.032	(0.111)	0.383*	(0.152)	-0.109†	(0.063)
	child6 M	0.087	(0.084)	-0.780**	(0.193)	-0.075	(0.049)
E	ln popshare	0.005	(0.019)	-0.072*	(0.028)	-0.047*	(0.021)
	D shifter	0.077**	(0.019)	0.018	(0.020)	0.118**	(0.027)
	married F	-0.263*	(0.105)	0.117	(0.146)	0.104	(0.086)
	married M	0.261**	(0.087)	0.385**	(0.103)	0.086†	(0.044)
	child6 F	-0.073	(0.090)	-0.351*	(0.175)	-0.357**	(0.044)
	child6 M	0.106*	(0.049)	0.283†	(0.148)	0.001	(0.031)
LS	ln popshare	-0.011	(0.015)	-0.072*	(0.028)	-0.020	(0.019)
	D shifter	0.065**	(0.016)	0.036†	(0.021)	0.101**	(0.026)
	married F	-0.330**	(0.070)	0.061	(0.133)	-0.062	(0.080)
	married M	0.221**	(0.074)	0.425**	(0.088)	-0.036	(0.030)
	child6 F	-0.112*	(0.055)	-0.329*	(0.145)	-0.299**	(0.045)
	child6 M	-0.030	(0.036)	0.134	(0.131)	0.030	(0.020)
N		2808		2808		1800	
R^2		0.25		0.174		0.397	
$F^{\diamond}_{(18,71)}$		14.31		10.38		68.26	

Significance levels : † : 10% $*$: 5% $**$: 1%

$\diamond$ In the case of the UK, the value of the F-statistic is for $F_{(18,29)}$.

Wage constructed as the median of the observed and predicted wages.

C.1 Omitting the Marital Status and the Presence of Pre-school Age Children

As mentioned before, it may be argued that the two supply shifters, marital status and presence of pre-school age children are not exogenous to the model. We therefore re-estimate the model without the two variables. Tables C.4 and C.5 in the Appendix present the results of this sensitivity analysis. Our main findings prove to be independent of the presence of the two variables in the model. On the contrary, they reveal even

Table C.2: Reduced-Form Results II

Variable		France		US		UK	
W	ln popshare	-0.052*	(0.022)	-0.030	(0.018)	-0.016	(0.027)
	D shifter	0.033*	(0.016)	0.066**	(0.014)	0.007	(0.021)
	married F	-0.229*	(0.098)	0.017	(0.075)	0.587**	(0.097)
	married M	-0.221*	(0.098)	0.749**	(0.106)	0.835**	(0.067)
	child6 F	0.005	(0.108)	0.217†	(0.115)	0.011	(0.061)
	child6 M	0.134†	(0.076)	-0.444**	(0.144)	-0.057	(0.055)
E	ln popshare	0.005	(0.019)	-0.072*	(0.028)	-0.047*	(0.021)
	D shifter	0.077**	(0.019)	0.018	(0.020)	0.118**	(0.027)
	married F	-0.263*	(0.105)	0.117	(0.146)	0.104	(0.086)
	married M	0.261**	(0.087)	0.385**	(0.103)	0.086†	(0.044)
	child6 F	-0.073	(0.090)	-0.351*	(0.175)	-0.357**	(0.044)
	child6 M	0.106*	(0.049)	0.283†	(0.148)	0.001	(0.031)
LS	ln popshare	-0.011	(0.015)	-0.072*	(0.028)	-0.020	(0.019)
	D shifter	0.065**	(0.016)	0.036†	(0.021)	0.101**	(0.026)
	married F	-0.330**	(0.070)	0.061	(0.133)	-0.062	(0.080)
	married M	0.221**	(0.074)	0.425**	(0.088)	-0.036	(0.030)
	child6 F	-0.112*	(0.055)	-0.329*	(0.145)	-0.299**	(0.045)
	child6 M	-0.030	(0.036)	0.134	(0.131)	0.030	(0.020)
N		2808		2808		1800	
R^2		0.272		0.137		0.451	
$F^{\diamond}_{(18,71)}$		14.05		10.1		90.85	

Significance levels : † : 10% $*$: 5% $**$: 1%

$\diamond$ In the case of the UK, the value of the F-statistic is for $F_{(18,29)}$.

Wage constructed as the mean of the observed and predicted wages.

Table C.3: Reduced-Form Results III

Variable		France		US		UK	
W	ln popshare	-0.064*	(0.026)	-0.018	(0.018)	-0.038	(0.039)
	D shifter	0.019	(0.020)	0.044*	(0.017)	-0.013	(0.026)
	married F	-0.327**	(0.108)	0.107	(0.074)	0.513**	(0.148)
	married M	0.003	(0.109)	0.585**	(0.088)	0.920**	(0.088)
	child6 F	0.004	(0.113)	0.169	(0.105)	0.188†	(0.108)
	child6 M	0.113	(0.087)	-0.203	(0.127)	-0.003	(0.069)
E	ln popshare	0.005	(0.019)	-0.072*	(0.028)	-0.047*	(0.021)
	D shifter	0.077**	(0.019)	0.018	(0.020)	0.118**	(0.027)
	married F	-0.263*	(0.105)	0.117	(0.146)	0.104	(0.086)
	married M	0.261**	(0.087)	0.385**	(0.103)	0.086†	(0.044)
	child6 F	-0.073	(0.090)	-0.351*	(0.175)	-0.357**	(0.044)
	child6 M	0.106*	(0.049)	0.283†	(0.148)	0.001	(0.031)
LS	ln popshare	-0.011	(0.015)	-0.072*	(0.028)	-0.020	(0.019)
	D shifter	0.065**	(0.016)	0.036†	(0.021)	0.101**	(0.026)
	married F	-0.330**	(0.070)	0.061	(0.133)	-0.062	(0.080)
	married M	0.221**	(0.074)	0.425**	(0.088)	-0.036	(0.030)
	child6 F	-0.112*	(0.055)	-0.329*	(0.145)	-0.299**	(0.045)
	child6 M	-0.030	(0.036)	0.134	(0.131)	0.030	(0.020)
N		2808		2808		1800	
R^2		0.273		0.108		0.444	
$F^{\diamond}_{(18,71)}$		15.11		9.2		101.2	

Significance levels : † : 10% $*$: 5% $**$: 1%

$\diamond$ In the case of the UK, the value of the F-statistic is for $F_{(18,29)}$.

Wage constructed as the mean of the observed wages.

stronger evidence for the trade-off hypothesis. The only exception are the reduced-form results for the estimation of the wage equation for the UK. The two coefficients of the group's share in the population and of the demand shifter are both significant but have opposite signs (contrary to the expectations) when marital status and presence of pre-school age children are omitted from the model. Our conjecture is that this surprising result is due to the fact that the two factors serve also as a proxy for a more detailed age categorization than captured by the group fixed effects in the case of the UK. Namely, although the stratification of the groups in the UK uses the same six age categories as in the other two countries, the fixed effects - to avoid over-parametrization of the model - vary only by three broader age categories.

Table C.4: Reduced-Form Results - - Exogenous Supply Shifters Omitted

Variable		**France**		**US**		**UK**	
W	ln popshare	-0.028	(0.023)	$-0.059^{\dagger}$	(0.031)	0.136^{**}	(0.040)
	D shifter	0.022	(0.018)	0.090^{**}	(0.021)	-0.080^{*}	(0.037)
E	ln popshare	0.001	(0.021)	-0.073^{*}	(0.030)	-0.045	(0.027)
	D shifter	0.080^{**}	(0.017)	0.020	(0.021)	0.105^{**}	(0.036)
LS	ln popshare	-0.013	(0.017)	-0.074^{*}	(0.030)	$-0.047^{\dagger}$	(0.025)
	D shifter	0.064^{**}	(0.015)	$0.038^{\dagger}$	(0.023)	0.112^{**}	(0.033)

Significance levels : † : 10% $*$: 5% $**$: 1%

Group wage is constructed as median of the observed and predicted wages.

Table C.5: Structural Results - Exogenous Supply Shifters Omitted

	France		**US**		**UK**	
ρ	0.796^{**}	(0.010)	0.833^{**}	(0.016)	0.834^{**}	(0.015)
σ	1.901^{**}	(0.033)	1.886^{**}	(0.066)	2.230^{**}	(0.086)
ϵ	0.178^{**}	(0.055)	0.150^{*}	(0.071)	0.295^{**}	(0.091)

Significance levels : † : 10% $*$: 5% $**$: 1%

Group wage is constructed as median of the observed and predicted wages.

D Model Details

D.1 Correspondences between the structure and the reduced form

This part states the other correspondences between the structure and the reduced form, in addition to the ones given in Table 1. There are J (number of groups) group-specific fixed effects in each of the three equations which correspond to the structural parameters as follows

$$\begin{aligned}
\pi^w_{1j} &= \omega_j - \frac{\rho}{\sigma+\varepsilon}\,\alpha_j \\
\pi^e_{1j} &= \frac{\sigma\,\rho}{\sigma+\varepsilon}\,\alpha_j - \sigma\,\omega_j \\
\pi^s_{1j} &= \big(1-\frac{\varepsilon\,\rho}{\sigma+\varepsilon}\big)\,\alpha_j + \varepsilon\,\omega_j
\end{aligned}$$

There are T (number of years) year-specific fixed effects in each of the three equations which correspond to the structural parameters as follows

$$\begin{aligned}
\tilde{\pi}^w_{0t} &= \eta_t + \frac{\rho}{\sigma+\varepsilon}\Big(\ln(y_t) + (\sigma-1)\,\lambda_{0\,t}\Big) \\
\tilde{\pi}^e_{0t} &= \ln(y_t) - \sigma\,\eta_t + (\sigma-1)\big(1-\frac{\sigma\,\rho}{\sigma+\varepsilon}\big)\,\lambda_{0\,t} \\
\tilde{\pi}^s_{0t} &= \varepsilon\,\eta_t + \frac{\varepsilon\,\rho}{\sigma+\varepsilon}\Big(\ln(y_t) + (\sigma-1)\,\lambda_{0\,t}\Big)
\end{aligned}$$

The reduced-form error terms map into the structural error terms as follows

$$\begin{aligned}
\xi^w_{jt} &= \frac{\rho}{\sigma+\varepsilon}\,(\nu^d_{jt} - \nu^s_{jt}) + \nu^w_{jt} \\
\xi^e_{jt} &= \frac{\sigma\,\rho}{\sigma+\varepsilon}\,\nu^s_{jt} - \sigma\,\nu^w_{jt} + \big(1-\frac{\sigma\,\rho}{\sigma+\varepsilon}\big)\,\nu^d_{jt} \\
\xi^s_{jt} &= \frac{\varepsilon\,\rho}{\sigma+\varepsilon}\,\nu^d_{jt} + \varepsilon\,\nu^w_{jt} + \big(1-\frac{\varepsilon\,\rho}{\sigma+\varepsilon}\big)\,\nu^s_{jt}
\end{aligned}$$

When the demand shifter $\tilde{c}_{jt}$ is used instead of the unobserved relative coefficient c_{jt}, the reduced-form error terms become

$$\begin{aligned}
\tilde{\xi}^w_{jt} &= \frac{\rho}{\sigma+\varepsilon}\,(\nu^d_{jt} - \nu^s_{jt}) + \nu^w_{jt} + \frac{\rho\,(\sigma-1)}{\sigma+\varepsilon}\,\nu^c_{jt} \\
\tilde{\xi}^e_{jt} &= \frac{\sigma\,\rho}{\sigma+\varepsilon}\,\nu^s_{jt} - \sigma\,\nu^w_{jt} + \big(1-\frac{\sigma\,\rho}{\sigma+\varepsilon}\big)\,\nu^d_{jt} + (\sigma-1)\big[1-\frac{\sigma\,\rho}{\sigma+\varepsilon}\big]\,\nu^c_{jt} \\
\tilde{\xi}^s_{jt} &= \frac{\varepsilon\,\rho}{\sigma+\varepsilon}\,\nu^d_{jt} + \varepsilon\,\nu^w_{jt} + \big(1-\frac{\varepsilon\,\rho}{\sigma+\varepsilon}\big)\,\nu^s_{jt} + \frac{\varepsilon\,\rho\,(\sigma-1)}{\sigma+\varepsilon}\,\nu^c_{jt}
\end{aligned}$$

D.2 Identification

The system of structural equations is given by

$$\begin{aligned}
\ln(l_{jt}^d) &= \ln(y_t) - \sigma\ \ln(w_{jt}) + (\sigma-1)\ \ln(c_{jt}) - \ln(p_{jt}) + \nu_{jt}^d \\
\ln(l_{jt}^s) &= \alpha_j + \varepsilon\ \ln(w_{jt}) + \beta^g\ m_{jt} + \gamma^g\ k_{jt} + \nu_{jt}^s \\
l_{jt}^s(w_{jt}^*) &\equiv l_{jt}^d(w_{jt}^*) \\
\ln(w_{jt}) &= \eta_t + \omega_j + \rho\ \ln(w_{jt}^*) + \nu_{jt}^w \\
u_{jt} &\equiv l_{jt}^s - l_{jt}^d \\
e_{jt} &\equiv l_{jt}^d \\
1 &\equiv e_{jt} + u_{jt} + n_{jt}
\end{aligned}$$

This system simplifies to (omitting the time subscripts)

$$\begin{aligned}
\ln(e_j) &= \ln(y) - \sigma\ \ln(w_j) + (\sigma-1)\ \ln(c_j) - \ln(p_j) + \nu_j^d \\
\ln(l_j^s) &= \alpha_j + \varepsilon\ \ln(w_j) + \beta^g\ m_j + \gamma^g\ k_j + \nu_j^s \\
\ln(w_j) &= \eta + \omega_j + \rho\ \frac{1}{\varepsilon+\sigma}\left[ln(y) - \alpha_j - \beta^g\ m_j - \gamma^g\ k_j + (\sigma-1)\ \ln(c_j) - \ln(p_j) + \nu_j^d - \nu_j^s\right] + \nu_j^w \\
1 &\equiv l_j^s + n_j
\end{aligned}$$

The way the model is set up and the substantial number of parameters (including the group and the year effects as described in the Section D.1) makes the traditional proof of identification through the rank and order conditions rather complicated. Therefore in what follows, I use an easier method of step by step description of how the key structural parameters could be recovered from particular reduced-form estimates.

The key structural parameters can be inferred for example as follows. The ratio of the coefficient of the proportion of the group in the population from the labor force participation equation to the same coefficient in the wage equation gives the wage elasticity of labor supply.[49] The ratio of the coefficient of the presence of pre-school children for women in the employment equation to the one in the wage equation can be used to calculate σ. The coefficient of the group's proportion within the population in the wage equation and the previous estimates of ε and σ enable to construct ρ. The four structural coefficients of the exogenous labor supply shifters can be recovered for example from the reduced-form estimates from the wage equation alone: They are equal to the ratio of the respective gender-specific coefficients of the variables describing marital status and children, and the coefficient of the proportion of the group in the population. The coefficient of the instrument of the relative efficiency (λ) is minus the ratio of the demand shifter and the population fraction coefficients from the wage equation, divided by $(\sigma - 1)$. We can plug in the expression for σ as derived before. All the formulas are summarized below.

[49] The same is true for the corresponding ratio of the two coefficients of the demand shifter.

$$
\begin{aligned}
\varepsilon &= \frac{\pi_p^s}{\pi_p^w} \quad ; \quad \sigma = -\frac{\pi_k^{f\,e}}{\pi_k^{f\,w}} \\
\rho &= -\,\pi_p^w\,(\sigma+\varepsilon) \quad = -\,\pi_p^w\left(-\frac{\pi_k^{f\,e}}{\pi_k^{f\,w}}+\frac{\pi_p^s}{\pi_p^w}\right) \\
\beta^f &= \frac{\pi_m^{f\,w}}{\pi_p^w} \quad ; \quad \beta^m = \frac{\pi_m^{m\,w}}{\pi_p^w} \\
\gamma^f &= \frac{\pi_k^{f\,w}}{\pi_p^w} \quad ; \quad \gamma^m = \frac{\pi_k^{m\,w}}{\pi_p^w} \\
\lambda_1 &= -\frac{\pi_{\tilde{c}}^w}{\pi_p^w}\left(\frac{1}{\sigma-1}\right) = \left(\frac{\pi_{\tilde{c}}^w}{\pi_p^w}\right)\left(\frac{\pi_k^{f\,w}}{\pi_k^{f\,w}+\pi_k^{f\,e}}\right)
\end{aligned}
$$

Alternatively, ε and ρ can be derived for example from any two of the coefficients from the wage equation, once the other parameters are derived as above. In this way, estimation of only wage and employment equations is sufficient for the identification.

E Estimation Details

E.1 Prediction of the Unobserved Wages

In the preferred specification, the group specific wage is constructed as mean or median of wages of all the individuals in the group. In this case wages for the individuals for which the wage information is missing must be imputed. The analysis predicts wages to people with missing wage information using the traditional two-equation model of Heckman. The following wage equation is estimated along with the employment equation to account for the potential selection to employment based on unobservable characteristics.

$$
\begin{aligned}
\ln(w_i) &= X_i\beta + \varepsilon_i \\
I_i &= Z_i\gamma + \upsilon_i
\end{aligned}
$$

ε_i and υ_i have a bivariate normal distribution with zero means and covariance matrix Σ, w_i is individual's i wage and I_i is a zero/one indicator function specifying whether wage is observed for the individual i or not.
The two equations are estimated jointly by maximum likelihood. Sample probability weights were used in the estimation. The right-hand-side variables in the wage equation (X_i) are age, age squared, dummy variables for the six (five in the UK) education categories, ethnicity,[50] immigration status (stating whether the individual was born in another country), and an indicator whether the individual is full-time employed. The exclusion restrictions (variables that are in the selection equation but not in the wage equation) are the marital/cohabitating status and the presence of pre-school age children

[50] This variable is not present in the French dataset and therefore is not used in the estimation for France.

in the household. The model is estimated separately for men and women, and the estimation is done by year. The model is used to predict wages to individuals for which wages are unobserved.

F Extensions of Card, Kramarz and Lemieux (1999)

The theoretical model in this paper is a variation of that in Card, Kramarz, and Lemieux (1999). However, in contrast with their application that focuses on a single long term change in wages and employment over the entire decade of 1980s (focusing on France, Canada and the US), we apply an extended version of their model to the year-to-year changes observed in the panel data of different skill-groups in France, the UK and the US over the 1990s. The key differences between the two papers, both in the model and in its application, are discussed below.

F.1 Theoretical Extensions

There are two key differences between our model and the one in Card, Kramarz, and Lemieux (1999). The first difference is the presence of the third equation. Card et al. (1999) write down only the wage and labor supply equations, and they use the employment rate for the estimation of the latter. However, the equality of employment and labor supply holds only in the case of full wage flexibility ($\rho = 1$), i.e. when the markets clear.[51] Using their theoretical framework without the assumption of full wage flexibility leads to a third equation, similar to the one presented here, that describes labor supply as observationally distinct from the employment rate due to the presence of unemployment. In addition, the estimation of the labor supply equation enables us (within the framework of the same model) to account for the observed labor force participation and inactivity rates, which is important for the extended version of the trade-off hypothesis.

The other difference between the model of Card et al. (1999) and the one presented here is the use of the "true" supply shifters, i.e. marital status and the presence of pre-school age children. Card et al. (1999) use the population share as the only proxy for exogenous shifts in the labor supply. However, this term enters the model when the labor demand equation is transformed from levels to proportions (the step from equation 2 to 3), and is therefore an "in-built" accounting feature of the model. Using the true supply shifters as well as the demand shifter, as done in this analysis, should improve the identification of the model.

Besides the above mentioned theoretical differences (including the broader set of tests of the trade-off hypothesis and the proposition and tests of its extended version), there are many other distinctive features of the estimation methodology employed in this paper which will be discussed next.

[51] In this respect it holds that if wages are not perfectly flexible, the estimated coefficients are also given an incorrect structural interpretation.

F.2 New Empirical Application

As mentioned above, while Card et al. (1999) focus on the long-term developments between two data points from the 1980s, the present analysis captures the year-to-year changes over the 1990s. The different nature of the data used in the two papers implies the diverse estimation strategies they employ: Card et al. (1999) estimate the model using a cross-section of the first differences over an entire decade, whereas here it is estimated on an annual panel of skill-groups over the period of 10 to 13 years.

The two papers use different sets of exogenous shocks in order to identify the labor supply and the labor demand: as mentioned above, while Card et al. (1999) include only the group's share in the population as the supply shifter, the present analysis also employs marital status and the presence of pre-school age children. In terms of the demand shifter, Card et al. (1999) focus specifically on the shocks that are due to technological progress and choose as their proxy the proportion of individuals who use computer at work at the end of the period. They also use initial wage level as an alternative proxy for changes in the demand. The demand shifter in the present work does not assume a particular source of the demand shock. It is constructed as a measure of the previous year productivity of each skill-group, and should therefore be closer to the actual unobserved relative efficiency parameter c_{jt} it is supposed to represent.

In contrast with Card et al.(1999) who estimate their model separately by gender, our analysis uses all the skill-groups together in the estimation. As the theoretical model (although very stylized) is designed to describe the whole economy, and as it is likely that there is a non-zero substitution between men and women in many economic areas, we prefer to use both sexes jointly in the estimation of the model.

The model does not distinguish between individuals of different ethnicity or immigration status, the reason being the absence of relevant comparable variable with this information in all three datasets.[52] The empirical analysis therefore ignores any race-based or immigration-based discrimination at the demand side as well as race or immigration heterogeneity in preferences at the supply side. We consider this approach to be preferable to the exclusive focus on Whites for the US sample (or potentially for the UK), as done in Card et al. (1999). The reason is, again, that the model is designed to describe the whole economy with all individuals and all subgroups.[53]

[52] The French dataset does not include a variable with information about ethnicity, and the US dataset lacks any immigration status information for the early years of the analysis.

[53] The ethnicity and immigration status variables are used, where available, for the prediction of wages in the Heckman procedure.