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Résumé

Dans ce papier, nous développons un modèle de croissance équilibrée intégrant des frictions d'appariement sur le marché du travail et un choix du nombre d'heures travaillées. Nous utilisons ce modèle pour étudier l'impact des politiques économiques sur les deux marges de l'offre de travail, c'est-à-dire le taux d'emploi (marge extensive) et le nombre d'heures par employé (marge intensive). Nous montrons que l'évolution de la fiscalité a un impact principalement sur les heures individuelles, alors que les institutions caractérisant un marché du travail ont une influence importante sur le taux d'emploi. Toutefois, nos résultats montrent qu'il existe une interaction entre ces deux marges, et donc ces deux types de distorsion. Le modèle est calibré sur quatre pays (les États-Unis, la France, l'Allemagne et le Royaume-Uni) qui sont caractérisés, depuis les années soixante, par des dynamiques différentes en termes de politique fiscale et d'institutions du marché du travail. En utilisant cette approche structurelle, nous réalisons des expériences contrefactuelles sur l'évolution des variables de politique économique, et ainsi évaluons les conséquences en termes de PIB et bien-être agrégé de ces différents choix.

Mots clés: taxation, institutions du marché du travail, heures travaillées, emploi, modèles d'appariement.

Codes JEL: E20, E60, J22, J60.

Abstract

In this paper we develop a balanced growth model with labor supply and search and matching frictions in the labor market, to study the impact of economic policy variables on the two margins which constitute the (total) labor input: the extensive margin (the rate of employment) and the intensive margin (the hours worked per worker). We show that the dynamics of taxes primarily have an impact on hours worked, while labor market institutions have a significant influence on the rate of employment. However, our findings emphasize that there is an interaction between the two margins. The model is tested on four countries (US, France, Germany and the UK), which have experienced different tax and labor market dynamics since the sixties. Using this structural approach, we can then perform counterfactual experiments about the evolution of the policy variables, and compare the implications of policy changes in terms of production as well as average welfare.

Keywords: Taxes, labor market institutions, hours, employment, labor market search.

JEL codes: E20, E60, J22, J60.

Non-technical summary

The objective of this paper is to study the dynamics of total hours worked over the last fifty years in some industrialized countries. Indeed, we consider the evolutions observed in the US in relation to the performances of France, Germany and the UK. France and Germany experienced a steady decline of total hours worked, while in the US hours slightly increased. The experience of the UK is somehow in the middle, with the country approaching the performance of the US at the end of the sample. It can surely be argued that the US and France, for example, do not share the same preferences and attitude towards labor supply; however, we want to study the impact of different policy choices on the evolution of total hours worked. We claim that the different choices in terms of, on the one hand, tax rates, and on the other, labor markets arrangements, have some explanatory power with respect to the long run evolution of total hours. Our results are based on a model which is able to reproduce the dynamics of labor supply. This model is especially used in order to evaluate the costs or gains of alternative policies.

The effects of tax rates, in particular the taxes on labor income, in explaining cross country differences in hours worked, have been widely studied in the literature: Prescott (2004) considers different countries at two dates in time, and claims that the variations in the tax wedge (the tax rates on labor income and on consumption) account for most of the observed changes in hours. With his structural model, he evaluates the welfare gain of decreasing the tax wedge in France to the level of the US to an amount of 19% of lifetime consumption. Ohanian et al. (2008) extend the work of Prescott (2004), by considering a set of OECD countries during the last fifty years: they claim that the tax wedge on labor supply can reasonably explain the evolutions of hours, across countries and across time.

Ljungqvist and Sargent (2007) criticize Prescott's findings, by arguing that Prescott's model relies on a very high elasticity of labor supply. If he had to add non-employment income, as the benefits generously provided by European countries, the model would predict extremely low level of hours for the countries of the old continent. Ljungqvist and Sargent (2007) consider that employment is primarily affected by social insurance[1], intended as a source of income in non-employment states, and not by taxes.

Taxes are considered as important determinants also by the strand of literature which concentrated on the role of "institutions" in shaping hours of work. For example, Layard and Nickell (1999) or Blanchard and Wolfers (2000) consider the effects of a wide set of institutions, including the generosity of unemployment benefits, employment protection legislation, union indicators and so on, but also labor taxes, on the unemployment rate. The conclusions of this type of studies are often ambiguous, but it can be retained that the generosity

[1]The term social insurance includes unemployment benefits, retirement incentives and disability compensations.

of unemployment compensation seems to affect negatively the unemployment rate, while the effect of the power of unions is often negative, in a context of decentralized bargaining. We report the conclusions on these two particular institutions, as they are those which we choose to adopt in our model set-up.

Considering the empirical evidence about the importance of both taxes and institutional variables, in explaining the evolution of total hours, an attempt to model at the same time the two margins of labor supply seems necessary and useful for policy analysis. Based on Langot and Quintero Rojas (2008) findings, we consider a general equilibrium model with a balanced growth path, search and matching frictions and individual labor supply, to account for the evolution of both the employment rate and hours per worker. We focus on the impacts of two types of labor market institutions (the non-employment income and the bargaining power of workers), as well as taxes, in explaining the evolution of total labor input. Langot and Quintero Rojas (2008) develop a model with frictional labor markets and individual hours of work. However, they do not look at the whole long run dynamics of the two variables, but consider static comparisons, in line with the methodology of Ohanian et al. (2008). Moreover, their model suffers the same critics that Ljungqvist and Sargent (2007) move to Prescott (2004), for what it regards the high level of labor supply elasticity which is retained. We extend the work by Langot and Quintero Rojas (2008) by applying the methodology of McDaniel (2011), who looks at the long run evolution of hours devoted to market and domestic work.

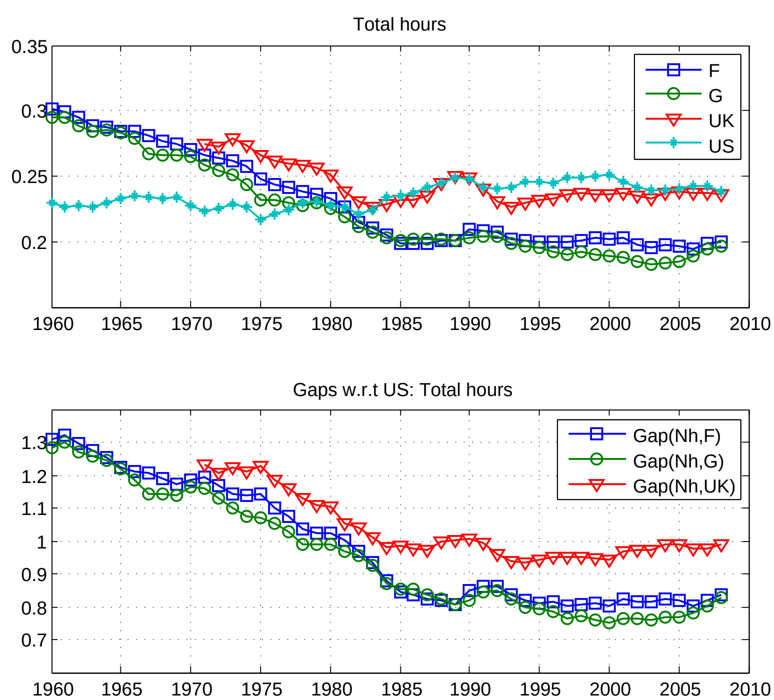
Our steady state analysis builds on Fang and Rogerson (2009), who highlight the fact that the two margins (the hours per worker and the number of workers) are considered as substitutes by the households and the firms. Their analysis, however, remains a qualitative one, while we add a quantitative exercise about the whole dynamics of hours and employment during the last fifty years. In addition, our model is able to replicate the long run evolutions of the two margins of labor supply for the four considered countries: the quantitative predictions of the model allow to interpret, ex post, the consequences of some structural reforms implemented in the different countries (for example the policy changes during the Thatcher Government in the UK, the Hartz reforms in Germany, the modifications to the generosity of non-employment income during the Mitterand period in France). It also allows us to perform some counterfactual experiments and to evaluate the costs in terms of output loss, as well as welfare, of alternative policy settings.

We have decided to focus on France, to make a comparison with the US economy, because it showed the most different policy choices, with respect to those observed in the US, and the data are available for the whole time spell. Thus, we evaluate the cost of a high tax wedge as being more important than the one coming from the labor market institutions (often qualified as “rigid”). The losses in terms of output amount to around 3 percentage points (pp) of GDP per year, during the last ten years. Our evaluation of the welfare costs of the high tax wedge observed in France, in terms of lifetime consumption, is lower than the result highlighted by Prescott (2004): on average, it amounts to 9 pp, with respect to a theoretical first best, obtained with lump sum taxes. Our different evaluation is connected to firstly, the lower labor supply elasticity we adopt (in line with micro and macro estimates), and secondly, the choice to consider a part of government consumption as not substitutable by private goods.

1 Introduction

The evolution of total hours of work during the post WWII period was characterized by sharp differences across developed economies: if we look at the evolution of this aggregate, by analyzing in particular the US and three selected European countries[2] (France, Germany and the UK), we can observe a sharp decline in hours in the two continental European countries, at least until the mid-eighties, while in the UK the decline was less significant and in the US total hours marginally increased (see Figure 1, top panel). Moreover, the gaps between the US and the selected European countries have continuously increased since the mid-seventies: whereas in the 1960s, a European employee worked 15% more than an American worker, his descendant works 30%, 20%, or 10% less than his American counterpart, if he lives, respectively, in France, Germany or the UK (see Figure 1, bottom panel).

Figure 1: **Total hours 1960-2010**



The heterogeneity in the evolution of aggregate hours of work has already been highlighted in the literature[3]. The main finding of these contributions can be summarised as follows, using the words of Prescott (2004): "[...] I determine the importance of tax rates in

[2]These countries are also among those retained by Prescott (2004) in his seminal paper on the labor wedge and taxes.

[3]See for example Prescott (2004), Ohanian et al. (2008) or McDaniel (2011).

accounting for these differences in labor supply for the major advanced industrial countries and find that tax rates alone account for most of these differences in labor supply". According to his view, the welfare impact of a tax reform in France could therefore be considerable: if France were to adopt American tax rates on labor income (i.e. reduce the effective tax rate on labor by 20 percentage points) "the welfare of the French people would increase by 19 percent in terms of lifetime consumption equivalents"[4] .

A simple neoclassical growth model with endogenous labor supply, as that adopted by Prescott (2004) or McDaniel (2011), can be considered as a parsimonious approach to quantitatively evaluate the impact of a tax reform on the level of aggregate hours of work at general equilibrium: in this case, the labor wedge is reduced to the tax wedge. However, this approach does not allow a distinction to be made between hours worked per employee and the number of employees, whereas in fact these two margins experienced different evolutions (see Figure 2): while the American "jobs miracle", characterized by an increase in the chance of being employed and a marginal decline in the hours worked per employee, seems to be a peculiar feature of only the US, until the end of the 2000s, Germany[5] and the UK show comparable evolutions to each other. In particular, it seems possible to observe the effects on the employment rate of the reforms implemented in Germany from the mid-nineties (the Schröder and Hartz reforms), as well as the Thatcher reforms, applied in UK from the end of the seventies. By contrast, France performs particularly bad. France shares Germany's substantial decline in hours worked per employee (the gap between a French and an American worker is equal to -10% at the end of the sample). However, in France the chance of being employed falls from 65% to 60% (leading to a gap in the chance of being employed equal to 20 percentage points compared to an American worker), following the Mitterrand reforms.

An important strand of literature focused on the low employment rate in Europe.

These studies encompass those that focus on unemployment[6] and those that analyze non-participation[7]. The main result of these studies is that incomes received during inactivity create a large distortion to the employment rate: unemployment benefits, pensions or subsidized education induce an implicit tax on labor supply. Hence, beyond the unemployment gap, the European countries are characterized by a large employment gap. This leads us to focus on the employment rate, rather than on the restrictive measure of the unemployment

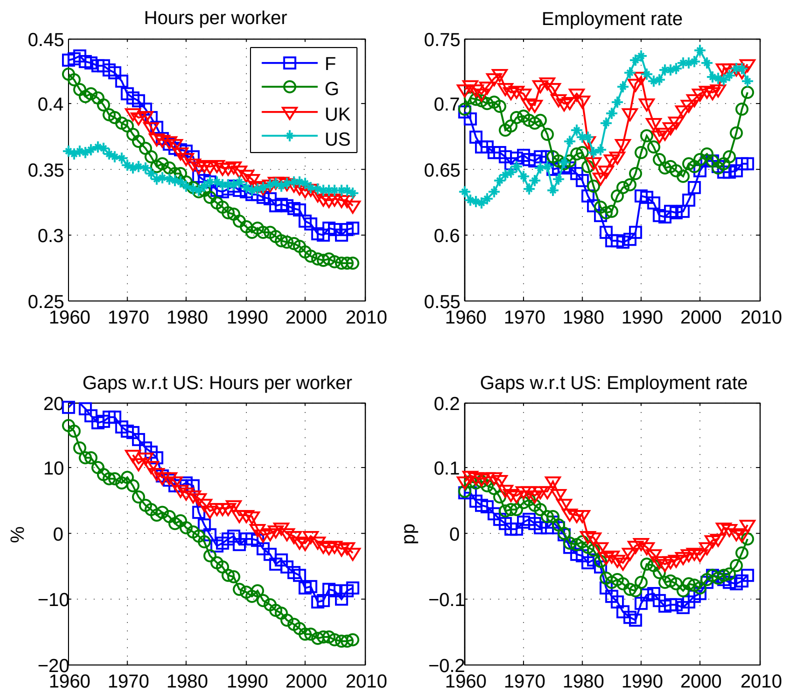
[4]Such large welfare gains would undoubtedly call for cutting European taxes down to US levels. At general equilibrium, the corollary of such a policy would naturally be to reduce government expenditures and transfers, as it done in Prescott (2004).

[5]Data for Germany refer to the actual country as it exists from 1990; the series for the years which precede the reunification are reconstructed using data from West and East Germany.

[6]See e.g. Mortensen and Pissarides (1999), Blanchard and Wolfers (2000) or Ljungqvist and Sargent (2007).

[7]See e.g. Gruber and Wise (2005) and Hairault et al. (2014).

Figure 2: **The decomposition of total hours 1960-2010**



rate[8], and on the impact of the distortions implied by the shifts in labor market institutions.

The objective of this paper is to develop a dynamic general equilibrium model with search and matching frictions, in order to decompose the labor wedges into two components: the "hours worked per employee wedge" and the "employment wedge". From a theoretical point of view, the originality of our paper is that it proposes a theory for the allocation of time that makes it possible to identify the relative contribution of taxes and changes to labor market institutions, by distinguishing the elasticities of the intensive and extensive margins[9]. We

[8]In this respect, we agree with the view presented in Rogerson (2006): the unemployment rate alone cannot be the only factor to explain the gap between Europe and the US. Given the institutional arrangements, only the employment rate can account for this gap.

[9]Ohanian et al. (2008) show that the labor wedge computed with a model that merges hours worked per employee and the employment rate is not independent from the labor market institutions, such as the unemployment benefit system or the type of wage bargaining arrangements. Nevertheless, these authors shows that such shifts in labor market institutions do not have strong explanatory power in relation to the dynamics of their measures of the labor wedge. However, this weak relationship can be explained: *(i)* there is a break in the data showing that the differences across countries in aggregate hours are mainly due since the end of the seventies to quantitatively significant differences along the extensive margin, and *(ii)* the measure of their labor wedge are based on the assumption of an homogenous elasticity of hours per worker and employment to policy variables. It is then necessary to distinguish the elasticities of the two margins (extensive and intensive) in order to account for the time-varying relative importance of taxes and labor market institutions to the dynamics of the aggregate hours.

then propose to analyze the decentralized allocation of a general equilibrium model with matching frictions, wage bargaining and efficient bargaining on the number of hours worked per employee[10].

The decision to work or not is not governed by the same arbitrations than the one of the hour supply. Hence, our approach consists of distinguishing the elasticities of the hours worked per worker and of the employment rates with respect to long-run changes in taxation and labor market institutions: as is suggested by Ljungqvist and Sargent (2007), the standard neoclassical growth model used by Prescott (2004) cannot account for the observed impact of both taxes and labor market institutions. Given that our data provide evidence for large change in the labor market institutions, we also overcome the doubts expressed by Nickell (1997) about the puzzling fact that, while in Europe labor market institutions remained almost unchanged between the sixties and the nineties, the performance of countries in terms of unemployment was often reversed at the end of this period, with respect to the beginning of it[11]. Our model highlights how to reconcile the long-run evolution of the employment rate with the observed evolution of the labor market institutions.

From a methodological point of view, we depart from Prescott (2004) and Ohanian et al. (2008): they only compute wedges in the static first-order condition governing labor supply, in a calibrated version of the growth model[12]. In our paper, we instead follow McDaniel (2011): rather than simply focusing on the static first-order conditions, we solve for the time series of choice variables given country-specific tax rates, labor market institutions and productivity series, with perfect foresight[13].

Given the size of these shifts and their large persistence, its seems reasonable to incorporate these long-run changes in the expectations of the agents, who perceived them as deterministic modifications in their environment[14]. What is interesting about this approach is that it provides a test to the theory, given the restrictions it implies on agents' expectations. This point is particularly important from a long-run perspective, where the objective is to explain the structural shifts on labor market allocation, linked to permanent drifts in taxation and institutions. From an "econometric" point of view, this type of test is more demanding with respect to the theory, because the complete resolution of the model leads to an

[10]The model is close to the first contributions of Langot (1995), Merz (1995) and Andolfatto (1996).

[11]We are grateful to Alexandre Janiak for bringing this to our attention.

[12]Prescott (2004) computes this static wedge at two points (the early seventies and the mid-nineties), whereas Ohanian et al. (2008) compute this wedge with an annual frequency, on a much larger set of OECD countries.

[13]In this last point, we depart from Langot and Quintero Rojas (2008) who propose a search and matching model, but only account for the static wedges of FOCs.

[14]Hence, we depart from an analysis that focuses on the short run impacts of policy changes, as it is done in the New Keynesian literature: indeed, the size and the persistence of the observed gaps in Europe suggest that they largely overcome the keynesian "Okun" gap, that can be stabilized by transitory policy.

accumulation of the forecast errors of the static first-order conditions. With this method, we then include measures based on static wedges, such as the one proposed by Pissarides (2007), where the steady state equilibrium variables depend on the growth rate of the exogenous variables.

With this general equilibrium approach, we also take into account the dynamics of the Solow residual and of taxes on capital: these two components cannot be disregarded in an analysis of the long-run evolutions of the input factors. It is important to remark that in our approach, the agents share the same preferences for leisure and have access to the same technology across countries. Hence, we abstract from the "cultural" interpretation in explaining differences in hours worked across countries[15].

Finally, we also depart from Prescott (2004) when it comes to the choice of modeling of government expenditure. Indeed, Prescott's evaluation is performed under the simplifying extreme assumption that all government expenditure can be substituted by private consumption: hence, in Prescott's view, the government size is "excessive" by definition, because its optimal size is zero. This view is contestable: one can distinguish between public expenditure in individual goods (education, health, etc.) and in those which are intrinsically collective (army, justice, collective equipment). Unlike the first category, the optimal size of collective public spending cannot be zero, because it does not constitute a perfect substitute to private consumption, since it cannot be provided by the household herself[16]. Hence, in our evaluation of a tax-cut reform, we will only reduce the individual government spending, which induces a misallocation of consumption. In the model, we then distinguish between these two types of government spending, by postulating that the optimal size of the collective good is strictly positive.

What do we learn from our methodology? Firstly, from a theoretical point of view, we show that:

(i) there is a non-trivial interaction between the two labor margins, leading to a substitution between hours per worker and employment, and

(ii) taxes and labor market institutions do not have the same impact on these substitutions.

A change in the labor market institution has a direct impact solely on the extensive margin: lowering wage pressures (by reducing the bargaining power of workers or their non-employment benefits) increases the level of hirings. This is perceived as a positive wealth

[15]See Alesina et al. (2006), where externalities in the utility from leisure at a society level can generate a "social multiplier".

[16]This view finds some empirical support in Ragan (2013) and Rogerson (2007). They show that it is necessary to introduce this "collective" public spending in the utility function of the agent to account for labor market outcomes heterogeneity among OECD countries.

effect, leading households to reduce their hours worked by employee. Hence, the magnitude of such a change in institutions can be significant for the two labor margins[17]. This is not the case for a reduction in tax rates. Indeed, this policy provides incentives to increase effort at work (intensive margin), with the side effect being to raise disutility at work, and thus the reservation wage. This last effect counteracts the positive impact of the tax decrease on the labor costs. Thus, the employment rate is less sensitive to tax reforms, whereas the hours per worker rate is highly sensitive to them.

Secondly, from a quantitative point of view, several points must be stressed:

(i) the choice of these countries allows us to control for certain factors: the US workers constitute the "non-treated" group because the tax wedge and the labor market institutions are stable over the whole period, whereas the French workers constitute the group experiencing different treatment. In France, the taxes increase over the period, and the labor market institutions shift in favor of the worker, at the beginning of the first socialist government (the beginning of the 1980s). We also use German and UK data in order to check that contrasting reforms in Europe produce different model predictions. In particular, in Germany the taxes increase over the period, and the labor market institutions shift in favor of firms, during the nineties, with the Kohl and Schröder governments and with the Hartz reforms (after 2003). In the UK, taxes remain generally low, and the labor market reforms implemented by the Thatcher government, at the beginning of the eighties, shift power in favor of firms.

(ii) Given our calibration strategy, which only restricts the averages of the simulated series of hours per worker and employment to match their empirical counterparts, we show that the model enables to predict the slope of the continuous decline in hours per worker in all European countries, and the considerable changes in employment rates. France, Germany and the UK exhibit contrasting evolutions, since these countries did not implement the same reforms at the same time.

(iii) Finally, we can compute the welfare gains associated with a change in policy. The size of the distortions induced by the high tax wedge in France overcomes that one induced by the distortions on the labor market. Moreover, a complementarity exists between the two sets of reforms, originating from the fact that each reform affects, at the same time, both the intensive and the extensive margin: the sum of the gains coming from each reform is lower than the overall gains coming from implementing both reforms at the same time.

[17] Our analysis then extends the one by Fang and Rogerson (2009) who study, from a qualitative point of view, the implications of a model of labor supply and search and matching frictions (without capital accumulation) on the interactions between the two margins of labor input at steady state.

This paper is organized as follows. Section 2 documents the data used. In Section 3, the search and matching model is outlined. Section 4 applies the model to the data, after calibrating the key parameters of the model. In Section 5 we perform counterfactual experiments. Section 6 sets out our conclusion.

2 The basic facts

In this section, we describe the data we use for the US, France, Germany and the UK. We consider the UK to be an "intermediate" case, lying somewhere in between the US and the continental cases. With respect to Germany, it is important to remember that most of the data have been reconstructed, so as to correspond to the reunified country after 1989. However, the variables which measure labor market arrangements are typically not comparable between the two economies of West and East Germany: we therefore decided to perform a "check" of the explanatory power of our model, by looking at its predictions for Germany only for the last 20 years (i.e. starting from 1990).

We can therefore demonstrate why the choice of these countries is interesting, from the perspective of a test of the theory: since the time series of the exogenous variables (taxes, labor market institutions and technological progress) do not have the same dynamics, we expect that the same will apply for the endogenous variables, which are the hours per worker and the employment rate.

2.1 Hours per worker and employment rates

In this section, we present the basic facts we want to take into account in our model[18]. Figures 1 and 2 give a complete description of the dynamics of hours worked and employment in the selected countries. Table 1 summarizes these data[19].

Table 1: **Ratios**

Ratios in 2008 relative to 1960	US	FR	UK	GE
$\frac{Nh}{Pop*365*14}$	1.00	0.66	0.85	0.70
$\frac{N}{Pop}$	1.10	0.95	1.03	1.06
$\frac{h}{365*14}$	0.91	0.70	0.82	0.66

For the UK we report the ratios in 2008 relative to 1971

[18] We use the dataset constructed by Ohanian and Raffo (2012). We are extremely grateful to A. Raffo for sharing the latest version of this dataset with us. A version of it can be found at: http://www.sciencedirect.com/science/article/pii/S0304393211001139.

[19] We choose 2008 as the terminal point of the sample in order to remove the effect of the last recession from our basic statistics.

The evolution of total hours worked differs widely over the last fifty years in the selected countries: while hours remained flat in the US, we observe a considerable decline in the European continental countries (France and Germany), with the evolution in the UK being in between that of the US and its continental neighbors. This evolution is in fact caused, as we have seen, by the path of the two margins which compose total labor input: the intensive margin and the extensive margin. In the US, the employment rate showed an increasing trend between the mid-eighties and the end of the nineties, while in France the employment rate decreased between the eighties and the mid-nineties. The German performance is markedly better than that of France, with a continuously increasing employment rate starting from the mid-nineties. As we can see in the bottom right panel of Figure 2, the UK recently closed the "employment gap" with respect to the US that started to be observed in the mid-seventies.

If we look at the intensive margin, in the top left panel of Figure 2, we observe a sharp decline in France and Germany, while in the US hours per worker declined only marginally. The UK seems to share the evolution of its continental neighbor, but only until the mid-eighties, when the decline slowed down.

From the mid-nineties, with the Kohl reforms, the employment rate continuously increases in Germany. This feature is magnified from the beginning of the implementation of the Hartz reforms[20]. In the UK, the reforms implemented by the Thatcher governments seem to have a significant impact on the probability of being employed: the employment rate has been rising since the mid-eighties, with a current level equal to the one observed in 1960. From the beginning of the eighties, the number of hours worked per employee is also stable and equal to that of an American worker. We can measure the total-hours-worked gap with the US, and the contribution of employment rates and hours per worker to this gap. We then replicate the counterfactual exercise proposed by Rogerson (2006) to assess the explanatory role of both the hours worked per employee and the employment rate in the dynamic of total employment. The procedure used is as follows:

1. Consider a reference year t_0, say 1981.

2. Consider a different year t. For each country $i = \{\text{France}, \text{Germany}, \text{UK}, \text{US}\}$, compute the change in the employment rate between t_0 and t: $\Delta_{i,t}^N = N_{i,t} - N_{i,t_0}$.

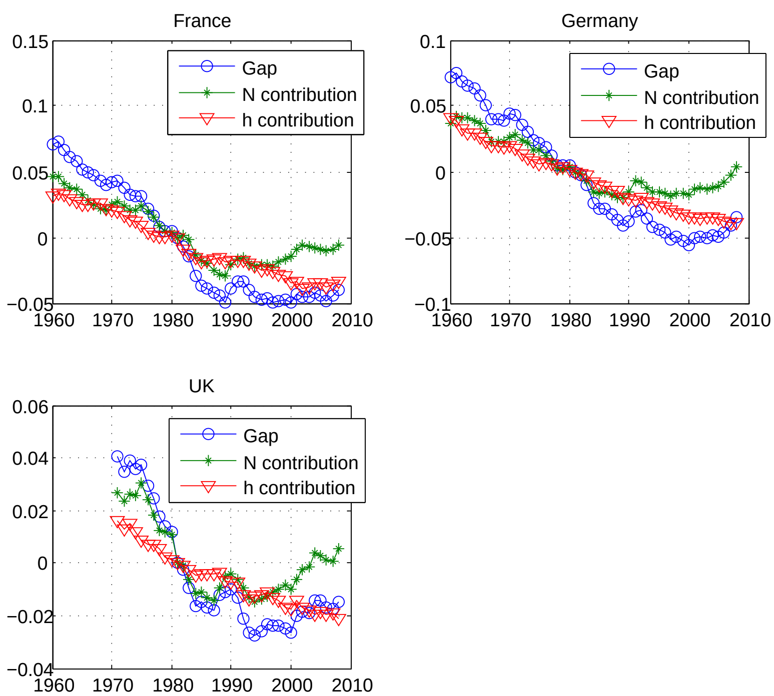
3. Compute the change for country $i \neq$ US minus the change for the US: $r\Delta_{i,t}^N = \Delta_{i,t}^N - \Delta_{US,t}^N$. $r\Delta_{i,t}^N$ denotes the differential in country $i \neq$ US's employment rate relative to the US (and to the reference year t_0).

[20] These new laws on the labor market make part-time work easier, and also reduce the labor costs. Thus, the hours per worker do not increase, whereas at the end of the sample, the employment rate is greater than the one observed in the US, for the first time since the end of WWII.

4. Consider the hypothetical case in which the change in country $i \neq$ US's relative employment did not happen: the chance of being employed evolves as in the US. Instead, assume that the $r\Delta^N_{i\neq US,t}$ (%) individuals were employed in t and worked the same number of hours as an individual in country $i \neq$ US, that is $h_{i,t}$. This would raise total hours in country $i \neq$ US by an amount equal to $\Delta^{Nh,N}_{i,t} = -r\Delta^N_{i,t} \times h_{i,t}$. The series $\Delta^{Nh,N}_{i,t}$ are the number of additional hours worked that economy i would have at date t if its employment rate were the same as in the US.

5. The comparison of $\Delta^{Nh,N}_{i,t}$ with the observed differential in relative total hours gives us a measure of the employment rate contribution. The observed differential is computed as $\Delta^{obs}_{i,t} = N_{i,t}h_{i,t} - N_{US,t}h_{US,t}$. If the contribution of employment to the total hours gap is significant, we expect a series of hypothetical hours ($\Delta^{Nh,N}_{i,t}$) close to the actual hours($\Delta^{obs}_{i,t}$).

Figure 3: **A decomposition of total hours gaps**



In each panel of Figure 3, for each country, the "gap" is $\Delta^{obs}_{i,t}$. The time series "N contribution" and "h contribution" are computed respectively using $\Delta^{Nh,N}_{i,t}$ and $\Delta^{Nh,h}_{i,t}$. The reference year (t_0) is 1981. Total hours Nh are multiplied by 365*14: the gaps are then the differences between the US and European countries for one year.

We also assess how much of the gap between each country and the US, in total hours worked, is due to the intensive margin. To this end, we compare the contribution of the additional hours that European countries would have if all employed workers were working as much as American workers ($\Delta_{i,t}^{Nh,h}$). Given that $\Delta_{i,t}^{Nh,N}$ measures the additional hours that European countries would have if the employment rates were the same as in the US, we have $\Delta_{i,t}^{Nh,N} + \Delta_{i,t}^{Nh,h} = \Delta_{i,t}^{obs}$, where $\Delta_{i,t}^{Nh,N}$ and $\Delta_{i,t}^{Nh,h}$ are the relative contribution of extensive and intensive margins in the observed gap ($\Delta_{i,t}^{obs}$).

In Figure 3 we report the results for France, Germany and the UK, where the reference year is $t_0 = 1981$. As expected, the size of the gap is smaller in the UK than in France and Germany. From the beginning of the 1980s, the three European countries exhibit differing experiences. In Germany, the contribution of the employment rate is minimal, showing that this country provides the same chance of being employed as the US. This dynamics, in terms of the relative influence of the employment rate on the hours gap, is shared by the UK. Thus, for these two countries, the gap with the US comes from a smaller number of hours worked per employee: the losses, in Germany and in the UK, are 200 hours and 100 hours respectively. In France, the experience is different: from 1985 to 2000, the most significant contribution to the hours gap is the low chance of employment provided by the French economy. During this period, the losses due to this "under-employment" are equal to 150 hours per year and per participant. At the same time, we also observe in France, that the hours per worker make a strong contribution to the hours gap (approximately 150 hours per worker on average since 1980). Thus, both gaps in France are significant and of similar magnitude.

2.2 Taxes, labor market institutions and technological progress

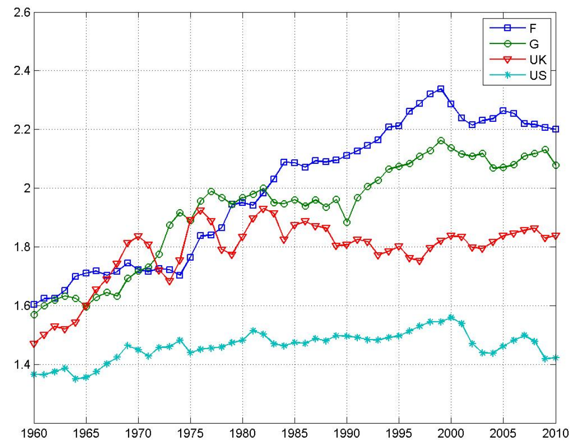
In our model we have three sets of exogenous variables: the set of tax rates (on labor income, on consumption, on capital revenues and on investment), a set of variables summing up the labor market institutions (the replacement rate and an indicator of the level of unionization, representing the bargaining power of the worker), and finally the Solow residual of the production function, representing the technological progress in labor productivity.

2.2.1 Taxes on labor

In terms of data sources, the tax rates are taken from McDaniel (2007)[21]. In Figure 4, we report the evolution of this first exogenous variable. We observe that the tax wedge is stable over the total period in the US. In 1960, it was necessary to produce \$1.4 in order to consume \$1. In 2010, the situation is unchanged. By contrast, in France, these tax wedges

[21] latest update: 2012; http://www.caramcdaniel.com/researchpapers.

Figure 4: **Tax wedge** $\frac{1+\tau_c}{1-\tau_w}$



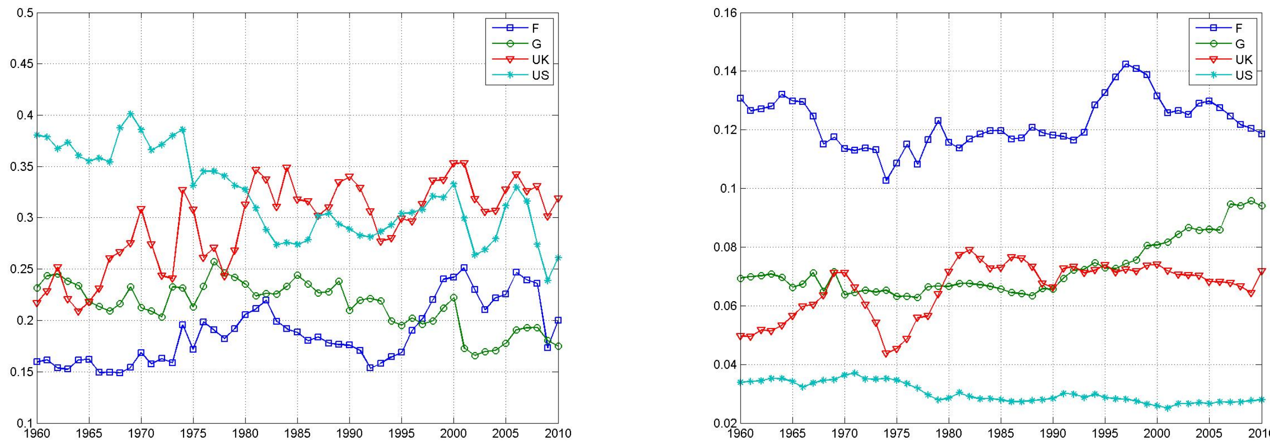
increase rapidly between 1960 and 1985, and continue to grow afterwards, but at a lower rate. Whereas in 1960 it was necessary to earn \$1.6 in order to consume \$1, in 2010, it would be necessary to earn for a amount of \$2.2 in order to obtain \$1 of consumption. In the UK, the evolution of the tax wedge is comparable to what happened in France until the mid-seventies, while after that date it ceases to grow, and its level today remains in between that of the US and France. In Germany the tax wedge increased through the seventies, while a lower growth in the tax rate is observed in the sub-sample 1980-2010.

2.2.2 Taxes on capital

Given that our model is a general equilibrium one, it is important not to omit taxes on capital. These taxes modify the relative demand between capital and employment. There are two type of taxes: those on the revenues of existing capital, and those on investment goods. The tax rates on capital revenues and on investment are taken from McDaniel (2007)[22]. In Figures 5 we report the evolution of this set of exogenous variables. The policy choices are not the same on the two sides of the Atlantic. In the US and the UK, the taxes are based largely on capital incomes, whereas in France and Germany taxes are heavier on investment. Note that the gaps in the capital income taxes decline over the entire sample, whereas the gaps in the investment taxes are persistent.

[22]latest update: 2012; http://www.caramcdaniel.com/researchpapers.

Figure 5: **Taxes on capital and investment 1960-2010**



Tax rate on capital revenues   Tax rate on investment

2.2.3 Labor market institutions

The data on bargaining power are taken from the Database on Institutional Characteristics of Trade Unions, Wage Settings, State Intervention and Social Pact (ICTWSS).[23] The bargaining power of the worker is considered as an average of two indicators, the union density and the union coverage. The replacement rate is taken from the OECD. Since it is available only for uneven years, we linearly interpolated the missing values.

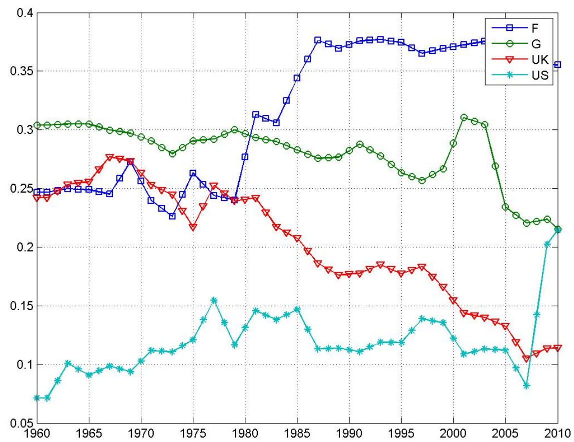
Two statistical indicators are available, to give an indirect measure of the bargaining power of the employee during the wage bargaining process: the union coverage and the union density. These two indicators are closely linked to the bargaining power: a wide union coverage or a high union density enable the worker to make counter-offers during the bargaining process. We choose to evaluate the worker bargaining power by the average of the union coverage and the union density. Indeed, even if we observe a decline in union density, the institutional agreements can conserve an "historical" coverage (the memory effect). It should be remembered that for Germany, the data prior to the reunification correspond only to West Germany.

We report the evolution of these exogenous variables in Figure 6. A brief look at these data suggests that the influence of the labor market institutions is very different in our selected countries.

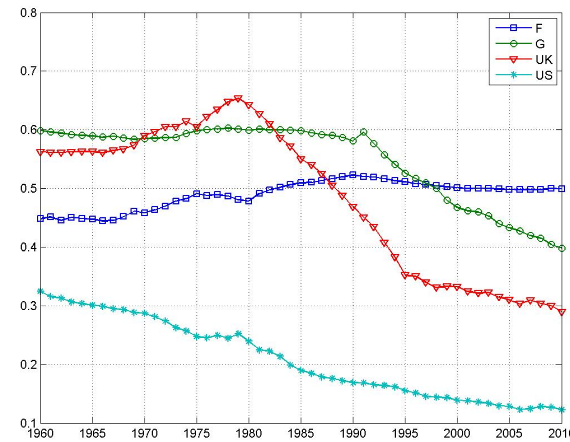
In terms of the bargaining power of workers, we observe a continuous decline in the US, while the UK and Germany show a significant decline in the eighties and in the nighties

[23]The database is compiled by the Amsterdam Institute for Advanced Labour Studies (AIAS).

Figure 6: **Labor market institutions 1960-2010**



Replacement rate



Bargaining power of the workers

respectively. At the opposite, France is characterized by continuous small increase during the sample period. These facts are mainly explained by the decline of the union density, a phenomenon which is common to all countries. In France it is overcompensated by the increase of the union coverage, promoted by the French governments during the eighties. The breaks in the UK and Germany data are due to the labor market reforms promoted by the first Thatcher government in UK and by the Schröder governments in Germany, aimed at limiting the role of unions to achieve more flexibility.

Concerning the non-employment benefits, the dynamics of the replacement rate are also markedly different across countries. After a slight increase before the mid-seventies, the replacement rate in the US remained constant. In the UK, while at the beginning of the sample the replacement rate was similar to the one observed in France, after the Thatcher government its value was halved. Similarly, at the beginning of the nineties, with the Kohl government, Germany experienced a decline in the replacement rate. Between 1993 and 1997, three laws led to a reduction in the eligibility of unemployment insurance, and in the replacement rate. The first Schröder government chose to backtrack on these labor market reforms, but the labor market outcomes led the second Schröder government to re-introduce more flexibility. After 2002 and the implementation of the Hartz reforms, the decline of the replacement rate was even greater. The French experience has been highly different: the first socialist government (elected at the beginning of the 1980s) decided to increase by more than 50% the unemployment benefits.

Since our model includes only two possible states (employed or non-employed) for each member of the representative family, the non-employment incomes must be in accordance with all programs available to agents in the working age (i.e. agents who are 16-65 years old). Hence, the measure of the replacement rate must represent the ratio of all alternative incomes over the wage[24]. If we restrict ourself to the unemployment benefits, this measure corresponds to the average gain during an unemployment spell, given the rule of the insurance scheme. Hence, we consider that in each family there exists a representative group of unemployed workers who gain the "average" unemployment benefits.

The degression and the loss of eligibility explain the low level of the replacement rate of a "representative" unemployed worker. But, beyond the heterogeneity between the unemployed workers, there exists also an heterogeneity between the insurance possibilities, which are contingent to the worker age. In particular, this is the case for the pensions schemes or the early retirement benefits, which are available, when they exist, to the workers before the age of 65 years: for what it concerns the older workers (55-64 years old), our modeling assumption is equivalent to say that the revenue of a retiree (till 65 years old) is equivalent to that of an unemployed *stricto sensu*. Is this hypothesis acceptable? The largest bias can come from the country which is the more generous with the older workers, namely France. If we look at the evolution of the replacement rate in France (left panel of Figure 6), we can see that the biggest change occurred between the end of 1970s till 1982/1983: the synthetic measure of the replacement rate passed from 0.25 to around 0.35. Behind this change, we find from the one hand, the increase in the generosity of the support to the unemployed, from the other the generosity of compensation of the old.

Let us consider the data provided by Blöndal and Scarpetta (1999) in their study: in 1975 the official age of retirement was 65 years old, but the average age to leave the labor market was 63 years old[25]. For the remaining years until 65, the authors report an "expected old-age pension gross replacement rate" of 62.5%[26]. In 1995, the normal age of retirement was 60 years old, the estimated age of transition of inactivity was 59.2 years and the gross old-age pension replacement rate was 64.8%. The overall pension replacement rates in 1975 and in 1995 can therefore be computed as following: $p_{1975} = 0.625 \times (2/10) = 0.13$ and $p_{1995} = 0.65 \times (5/10) = 0.33$, where 2/10 and 5/10 represent the average number of years between 55 and 65 during which the worker perceives a pension (respectively (65-63)/(65-55) and (65-60)/(65-55)). The measures are thus not far from the overall replacement rate: this suggests that the simplifying assumption of one representative non-employed worker in each family, paid at the replacement rate, is acceptable.

Another interesting point that deserves to be underlined is that the reforms of the labor

[24]If we follow the definition provided by the OECD, the "replacement rate" for non-employment income is a comprehensive measure, that refers to an average 40 years old person; it can be found at http://www.oecd.org/els/benefits-and-wages-statistics.htm.

[25]Blöndal and Scarpetta (1999), Table II.1.

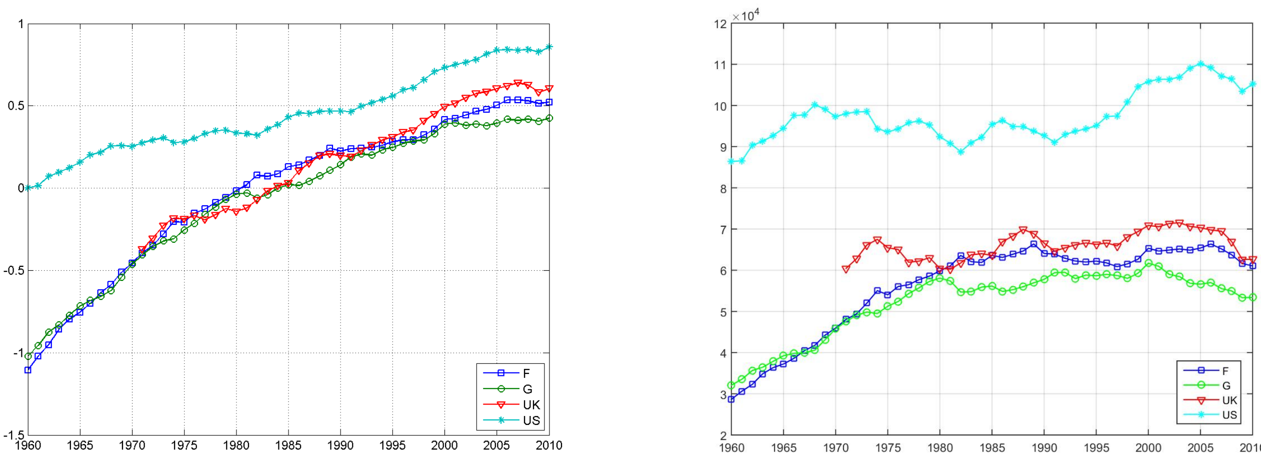
[26]Blöndal and Scarpetta (1999), Table III.3.

market, such as the change in the replacement ratios, have been decided at the same time that the changes in generosity in the pension system. It is particularly true for the large changes observe in France at the beginning of the eighties, and in Germany with the Schröder governments. Hence, in addition to a level that can be applied to all non-employed people, the changes in the replacement ratio of the UB corresponds approximately to the same changes in the specific programs where only older worker are eligible.

2.2.4 Technological progress

We recover the Solow residuals, measuring the labor augmenting technological process, from the production function, as $A = \left(\frac{Y}{K^{1-\alpha}}\right)^{1/\alpha} \frac{1}{Nh}$. Figure 7 shows the logarithm of total factor productivity (TFP) time series, the raw series (left panel) and the deflated series (right panel). The left panel suggests that there are some "breaks" in these time series.

Figure 7: **Solow residuals in log**



Productivity in log

Deflated productivity in log

It is well known that the European experienced a period of technological "catching-up", after the material destructions of the WWII period. In order to capture this feature, we proceed in a very simplistic manner: we identify a linear trend for the TFP using only data starting from the mid-eighties (for France and Germany) or from the end of the eighties (for the UK), and then use it to deflate the whole sample data. In this way, our deflated TFP can track the trajectory of the technological "catch-up". Our approach consists therefore in setting the growth rate of technological progress at its long-run value, with the catch-up phase being a transitory period, during which the level of technological progress is under its long-run value. The convergence toward this long-run trend is effective in the mid-eighties. For the US, we observe a break in 1990: the TFP seems to be higher after this year. Hence, similarly to the case for the catch-up phenomenon in the European countries, we assume that the TFP rate of growth, in the very long run, is not affected by this episode. The growth rate is estimated thus over the period 1960-1990 and we then identify the decades 1990-2010 as a transitory period when the level of the TFP is above its long-run value.

3 Employment rates and hours per worker: a theoretical model

The model we use is a neoclassical growth model with search and matching frictions in the labor market. It is composed of a representative household, a representative firm and a government that runs a balanced budget every period. A distinction is made between roughly two different types of government expenditure (G_t): collective services expenditure and individual services expenditure. We consider then that the part of consumption that government uses for individual services (G_t^{ind}) is a perfect substitute for private consumption, while the part that is offered to collective services (G_t^{col}) enters in the utility function of a household, but in a separate way. We present the equilibrium under the assumption of dynamic perfect foresight.

3.1 Labor market

In the labor market the evolution of the stock of employment is given by the new matches M_t which add to the "non-destroyed" jobs $(1-s)N_t$: $N_{t+1} = (1-s)N_t + M_t$, where the matching function is $M_t = \Upsilon V_t^{\psi}(1-N_t)^{1-\psi}$. We highlight here that the separation rate s is fixed and differs from country to country. The labor market tightness is given by $\theta_t = \frac{V_t}{1-N_t}$, while $f_t = \Upsilon\theta_t^{\psi}$ and $q_t = \Upsilon\theta_t^{\psi-1}$ indicate respectively the job finding and the job filling probability.

3.2 Households

The economy is populated by a large number of households, and each of them consists of a continuum of identical infinitely-lived agents. Each agent can be either employed or non-employed (thus free to occupy a job). Agents pool their incomes inside the household, so that they are fully insured against non-employment idiosyncratic risk. Agents consume and save by accumulating physical capital, that they rent to firms. Agents pay taxes on their wage income, capital income, investment decisions and consumption. When they are non-employed, they receive benefits from the government. In accordance with the representative agent model, each household is composed by the same proportion of each type of agents aged from 16 to 65 years old than the total population: hence, there are employed persons perceiving a wage, unemployed workers characterized by all the possible unemployment duration spells, with the specific unemployment benefits attached to these states, and early or fully retired individuals. Investment is subject to capital adjustment costs[27]. The term $\bar{c}$ indicates the presence of a "subsistence" term in consumption: this term is important to match the "catching-up" of the European countries, compared to the development levels of the US in the aftermath of WWII[28]. The benefits received during periods of non-employment are expressed as a fraction (given by the replacement rate ρ) of the wage bill. The program of a household is given by:

$$W^h(N_t, K_t) = \max_{c_t, K_{t+1}} \left\{ \begin{array}{l} \log(c_t + \gamma G_t^{ind} - \bar{c}) + \chi \log(G_t^{col}) + N_t(-\sigma_l \frac{h^{1+\eta}}{1+\eta}) + (1-N_t)\Gamma^u \\ +\beta W^h(N_{t+1}, K_{t+1}) \end{array} \right\}$$

$$\begin{aligned} \text{s.t.} \quad I_t(1+\tau_{i,t}) + c_t(1+\tau_{c,t}) + \frac{\Phi}{2}\left(K_{t+1} - (1+g)K_t\right)^2 &= (1-\tau_{w,t})\left[w_t h_t N_t + (1-N_t)\widetilde{b}_t\right] \\ &\quad +\pi_t + (1-\tau_{k,t}) r_t K_t \\ K_{t+1} &= K_t(1-\delta) + I_t \\ N_{t+1} &= (1-s)N_t + f_t(1-N_t) \end{aligned}$$

where, at the symmetric equilibrium, we have $\widetilde{b}_t = \rho_t w_t h_t$. The "subsistence" term changes the individual choices: it reduces the wealth effect when the economy is above its long run steady state. Indeed, with exogenous growth, this component disappears, because $C_t \to \infty$ when $t \to \infty$, whereas $\bar{c}$ is constant.

3.3 Firms

The representative firm produces using a Cobb-Douglas technology combining capital K_t and labor input $N_t h_t$: $Y_t = K_t^{1-\alpha}(A_t N_t h_t)^{\alpha}$. The technological progress A_t is labor augmenting, according to a balanced growth path. In order to hire workers the firm posts vacancies V_t, and the unit cost of keeping a vacancy open is given by ω, so that the total costs paid by the firm are given by the wage bill, the rental cost of capital and the vacancy

[27]While the presence of these costs helps to smooth the reaction of the variable physical capital, the results of the model remain even if the costs are not present.

[28]See for example Rogerson (2006).

posting costs. The firm's program is given by

$$\begin{aligned} V^f(N_t) &= \max_{V_t,K_t} \left\{ K_t^{1-\alpha}(A_tN_th_t)^\alpha - w_th_tN_t - r_tK_t - \omega_tV_t + \beta\frac{\lambda_{t+1}}{\lambda_t}V^f(N_{t+1}) \right\} \\ & \quad \text{s.t.} \quad N_{t+1} = N_t(1-s) + q_tV_t \end{aligned}$$

3.4 Wage bargaining

Wages and hours are set by the firm and the worker simultaneously, according to a Nash bargaining scheme: $\max_{w_t,h_t}\left(\frac{\partial W^h}{\partial N_t}\right)^{1-\epsilon_t}\left(\frac{\partial V^f}{\partial N_t}\lambda_t\right)^{\epsilon_t}$.

In contrast to most models, we allow for a time-varying bargaining power of the firm (ϵ_t). The result of the bargaining process is given by the wage and hour equations:

$$\begin{aligned} w_th_t &= (1-\epsilon_t)\underbrace{\left[\alpha\frac{Y_t}{N_t} + \omega_t\left\{\frac{(1-s)}{q_t}\left(1-\frac{\phi_{t+1}}{\phi_t}\frac{(1-\tau_{w,t+1})}{(1-\tau_{w,t})}\right) + \frac{\phi_{t+1}}{\phi_t}\frac{(1-\tau_{w,t+1})}{(1-\tau_{w,t})}\theta_t\right\}\right]}_{BS} \\ &\quad +\epsilon_t\underbrace{\left[\frac{(1+\tau_{c,t})}{(1-\tau_{w,t})}(C_t-\overline{c})\left(\Gamma^u + \sigma_l\frac{h_t^{1+\eta}}{1+\eta}\right) + \rho_tw_th_t\right]}_{RW} \qquad (3.1) \\ \sigma_lh_t^\eta &= \alpha\frac{Y_t}{N_th_t}\frac{(1-\tau_{w,t})}{(1+\tau_{c,t})}\frac{1}{C_t-\overline{c}} \qquad (3.2) \end{aligned}$$

where $\phi_t = \frac{1-\epsilon_t}{\epsilon_t}$. The marginal labor cost per employee (w_th_t) expresses the opportunity cost of working as the sum of the bargained surplus (BS) and the reservation wage (RW). The BS is made up of two components: the marginal productivity of the employee and the cost of the search activity[29]. During the bargaining process, the firm-worker pair shares the returns on the search process. For the worker, this is equal to the discounted time necessary to find a job offer, while for the firm, returns are instead equivalent to the discounted time necessary to find a worker. These relative time spans cannot be proxied by the ratio of the average duration for these two search processes ($\theta_t = \frac{f_t}{q_t}$) as would be the case if bargaining power and taxes were constant[30]. Indeed, if workers expect that tomorrow their bargaining powers are close to zero ($\phi_{t+1} \approx 0$), the evaluation of the current match surplus is only driven by the search costs saved by the firm if the job is not destroyed: $(1-s)\frac{\omega}{q_t}$. On the contrary, when the bargaining power of the worker increases ($\phi_{t+1} > \phi_t$), the match value

[29]Note that in the simple case where bargaining power and taxes are constant over time, we simply have $BS = \alpha\frac{Y_t}{N_t} + \omega\theta_t$.

[30]See for example Burda and Weder (2010) for a discussion about the implications for business cycle fluctuations of the presence of a time-varying tax wedge in the wage equation.

must be depreciated by the firm (it expects a decrease of its bargaining power), whereas the relative time spans must be over-evaluated by the worker because her bargaining power increases. Thus, the value of the search cost is a function of the bargaining power, which itself changes over time, and is affected by the time-varying distortions induced by taxes: this explains why BS is a function of dynamics of ϵ and τ. The RW is given by the sum of the marginal rate of substitution of consumption for employment $(C_t - \bar{c})\left(\Gamma^u + \sigma_l \frac{h_t^{1+\eta}}{1+\eta}\right)$ and the non-employment benefits $\rho_t w_t h_t$. In the basic case, where the bargaining power of the workers is nil ($\epsilon_t = 1$, $\forall t$), a gap remains, equal to $\frac{1}{1-\rho_t}$, between the real wage and the marginal rate of substitution of consumption for employment, because the non-employment benefits are proportional to the average wage. By raising the labor costs, this gap reduces the equilibrium employment rate.

Since we are assuming an efficient bargaining process, the equilibrium number of hours (the intensive labor supply) is determined jointly with wages. Equation (3.2) shows that, at the symmetric equilibrium, the solution is such that the marginal rate of substitution of consumption for an hour worked is equal to the marginal product of an hour worked, net of the tax wedge. This expression does not introduce any labor market institutions, because we assume an efficient bargaining process over the hours worked, so that the hours contracts are only directly affected by the taxes.

3.5 Equilibrium

To complete the model, the market clearing conditions on the goods market must be satisfied:

$$Y_t = C_t + G_t^{col} + I_t + \omega_t V_t + \frac{\Phi}{2}\left(K_{t+1} - (1+g)K_t\right)^2 \quad \text{with } C_t = c_t + G_t^{ind}$$

whereas the government budget constraint is balanced at each date through lump-sum transfers given to the agents:

$$TR_t = \tau_{c,t} c_t + \tau_{w,t}(w_t h_t N_t + \rho_t w_t h_t (1 - N_t)) + \tau_{i,t} I_t + \tau_{k,t} r_t K_t - \rho_t w_t h_t (1 - N_t) - G_t^{col} - G_t^{ind}$$

The model we described is a neoclassical growth model which allows for a balanced growth path. We have two sources of growth in the economy: population, which is growing at rate g_n, and technological progress, which is growing at the constant rate g_A. Each of the three countries is characterized by a different growth rate, but here we simply stress that in order to have a stationary model, we deflate all growing variables by the total growth rate $g = g_A + g_n$[31].

[31] See Appendix A for a complete description of the equation of the stationarized model.

4 Quantitative results

The model is solved with perfect foresight: the path of all exogenous variables is known to agents from the beginning[32]. First of all, we present our calibration strategy. Secondly, once the model is simulated with the identified parameters, and the exogenous variables are specific to each country, we plot the simulated series and the actual series for the four countries[33]. We then choose to focus mainly on the two countries whose policies differ the most: the US and France. We give some intuition of the functioning of the model by considering a steady state version, in order to study the impact of a permanent change in policy variable on both the intensive margin (hours per worker) and the extensive margin (in this case represented by labor market tightness).

4.1 Identification of parameters

In order to solve the model, we need to identify some parameters. The set of all parameters is given by $\Theta = \{\beta, \delta, \sigma_l, \eta, \alpha, g_A, \overline{c}, \Upsilon, \psi, \omega, \Gamma^u, s, g_n, \Phi, \frac{G^{col}}{Y}\}$.

We choose to calibrate the following subset of parameters $\Theta_1 = \{\beta, \delta, \alpha, \eta, \psi, s, g_A, g_n, \frac{G^{col}}{Y}, \Phi\}$. We set $\beta = 0.98$, $\delta = 0.05$ and $\alpha = 0.3$ according to standard values in the literature, when the period of reference is one year. In particular, for evidence about the depreciation rate we follow Gomme and Rupert (2007). In the long run, we have the following restrictions: *i)* $1 = \frac{\beta}{1+g}\left[1 - \delta + \frac{1-\tau_k}{1+\tau_i} r\right]$, *ii)* $r = (1-\alpha)\frac{Y}{K}$ and *iii)* $I = (\delta + g)K$. For an observed value of $E[I/Y] \approx 0.17$ in the US, we obtain a gross interest rate $r \approx 12.35\%$, and thus $r - \delta \approx 7.35\%$, using *ii)* and *iii)* (the demand of capital). Note that our value of α is such that the first equation (the supply of capital) is also satisfied, for the average values of the tax rates on capital and investment. Nevertheless, this standard calibration leads, as usual, to an over-estimation of the interest rate[34]. We therefore choose to reduce the interest rate by an amount which corresponds to the risk premium ($\kappa = 20\%$), which is paid by the firm when the uncertainty on its investment projects is taken into account by the financing contract. This leads us to $r(1-\kappa) - \delta \approx 4.88\%$, which is closer to the long-run value of the asset returns.

Our parameter η is set to a value of 2, which implies a Frisch labor supply elasticity of 0.5, a widely adopted value in the literature, in range with the estimates derived from microdata reported by, for example, Chetty et al. (2011). The parameter ψ, which represents the elasticity of the matching function with respect to vacancies, is set to a value of 0.5, which

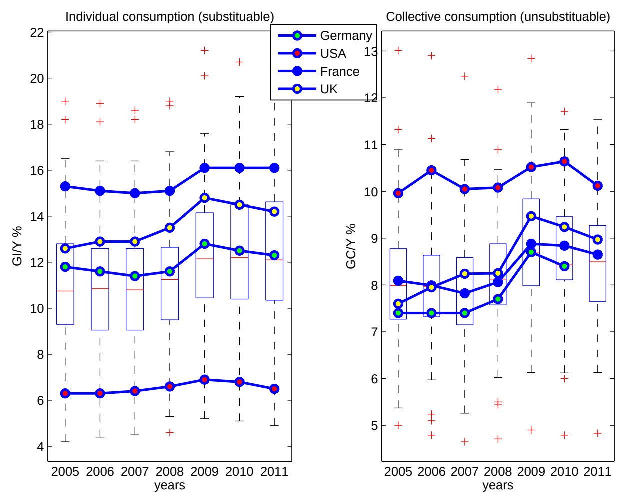
[32] In appendix D we show that the paths are not greatly modified when the policy changes are unexpected. Given this robustness check, we prefer to present the results based on perfect forecasts because they avoid introducing the arbitrary timing of the market participants' "knowledge" of the reforms.

[33] As noted earlier, for Germany we will use our model to simulate only the period starting from 1990.

[34] See Gomme and Rupert (2007) for a more complete discussion on this point.

is an average of the range of possible values identified by Pissarides and Petrongolo (2001), and is widely adopted in literature. In terms of the country-specific separation rate s, we use the estimation results in Elsby et al. (2008). We then use information from our data to give a value to g_A and g_n. Using our computation of the Solow residual for each country (see Section 2.2.4), we fit a linear trend which is our g_A. Similarly, we fit a linear trend to the population 15-64 and call it g_n. The total rate of growth of all non-stationary variables will therefore be $g = g_A + g_n$.

Figure 8: **A decomposition of government expenditure (OECD data)**



In each panel of Figure 8, for each year, the central mark is the median value over a sample of 32 OECD countries. The edges of the box are the 25^{th} and 75^{th} percentiles, the whiskers extend to the most extreme data points not considered outliers, and outliers are plotted individually.

Data for the ratio of government expenditure in collective goods are taken from the OECD.[35] As documented in Figure 8, France, Germany and the UK feature collective public spending (in proportion to GDP) comparable to other OECD countries[36], while the US is characterized by a higher share of collective public spending (in which defense is included). This leads us to calibrate Φ as a common parameter by assuming that these collective goods are chosen by the government in accordance to the households preferences. By contrast, individual government spending in France, Germany and the UK is much larger than the average of the OECD countries, while in the US the share of individual government expenditure is minimal.

[35]Table COFOG, government expenditure by function.
[36]Data come from Langot et al. (2014).

Table 2: **Calibrated parameters I**

	β	δ	η	α	ψ	Φ
Common	0.98	0.05	2	0.3	0.5	10
	s	g_A	g_n	$\frac{G^{col}}{Y}$		
US	0.12	0.017	0.0136	0.098		
FR	0.15	0.019	0.0069	0.085		
UK	0.17	0.024	0.0033	0.090		
GE	0.12	0.018	0.004	0.069		

We are then left with the following set of parameters to identify: $\Theta_2 = \{\sigma_l, \Gamma^u, \bar{c}_i, \Upsilon_i, \omega_i\}$ for $i = US, FR, UK, GER$, with $dim(\Theta_2) = 13$. Our restrictions are that the asymptotic preferences (represented by σ_l and Γ^u) are common to all countries, whereas two sets of parameters are country-specific: the scale parameters of the matching functions (Υ) and the vacancy posting cost (ω). The value of $\bar{c}$ should be different from zero only for countries which are not the US: as in Rogerson (2006), Ohanian et al. (2008) and McDaniel (2011), we introduce a consumption subsistence term, in order to capture the fact that the level of hours worked was higher, at the beginning of the sample, in the countries that experienced a lower level of productivity compared to the US[37].

The calibration procedure is the solution of $\min_{\Theta_2} ||\Psi^{theo}(\Theta_2) - \Psi||$. The targeted moments are $\Psi = \{\overline{N}_i, \overline{h}_i, \theta_i, \overline{\Delta h}_j\}$, for $i = US, FR, UK, GER$ and $j = FR, UK, GER$, where $\overline{X} = \frac{1}{T-t_0}\sum_{t=t_0}^{T} X_t$, with $T = 2007$ $\forall X = N, h$ and $\overline{\Delta h} = h_{1975} - h_{1960}$. Given that $dim(\Psi) = 14$, there are over-identifying restrictions[38]. To build the times series of θ for the the US we use the Composite Help-Wanted Index developed by Barnichon (2010)[39]. For France the data used to compute the average value of tightness over the period come from DARES[40]. Because of data issues for the UK , we prefer to consider for the average labor market tightness the same target as for the US.[41] The targets of $\theta = \frac{V}{1-N}$ are 0.7, 0.5 and 0.7 for the US, France and the UK respectively.[42] In Table 3 we report the values of the identified parameters.

With these restrictions, any difference in the behavior of the economic variables predicted

[37]The presence of the term $\bar{c}$ is important from a quantitative point of view to match the fact that in countries which were relatively poorer compared to the US, hours worked were much higher at the beginning of the sample period and decreased strongly in the catching-up period; see Appendix E for a more detailed discussion.

[38]Because θ_{GER} is unobserved, we assume that $\omega_{GER} = \omega_{FR}$, implying $dim(\Theta_2) = 12$.

[39]Available through the author's website https://sites.google.com/site/regisbarnichon/research.

[40]Direction de l'Animation de la Recherche, des Etudes et des Statistiques, which is attached to the French Ministry of Labor, www.emploi.gouv.fr.

[41]We consider that the official number of vacancies is underestimated, because according to the data provided by the OECD, under the denomination "Registered unemployed and job vacancies", the resulting

Table 3: **Identified parameters**

parameter	US	FR	UK	GE
σ_l	31.1	31.1	31.1	31.1
Γ^u	0.03	0.03	0.03	0.03
Υ	0.36	0.39	0.48	0.42
$\bar{c}$	0	0.36	0.15	0.24

by the model will therefore be guided by differences in policy variables or "technological" conditions (namely the Solow' residuals, the matching technology efficiency and the search costs). Given that our objective is to match the overall dynamics of the observed time series with our model simulations, we report as well as the graphical analysis, the value of the Mean Square Errors (MSEs) of each time series in order to have a statistical measure of the fit.

4.2 The fit of the model

Given that the parameters are set in order to match certain average values $\{h; N\}$ and the variation over the first years of h in France, Germany and the UK, the ability of the model to fit the observed data must be tested using additional information: we check that the model correctly predicts the long run evolution of the variables of interest (the intensive and extensive margins). We report additional information in Appendix G: in Section G.1, the simulated values of the investment/output ratio and of total hours, and, in Section G.2, a decomposition of the contribution of each exogenous set of variables in the model outcomes.

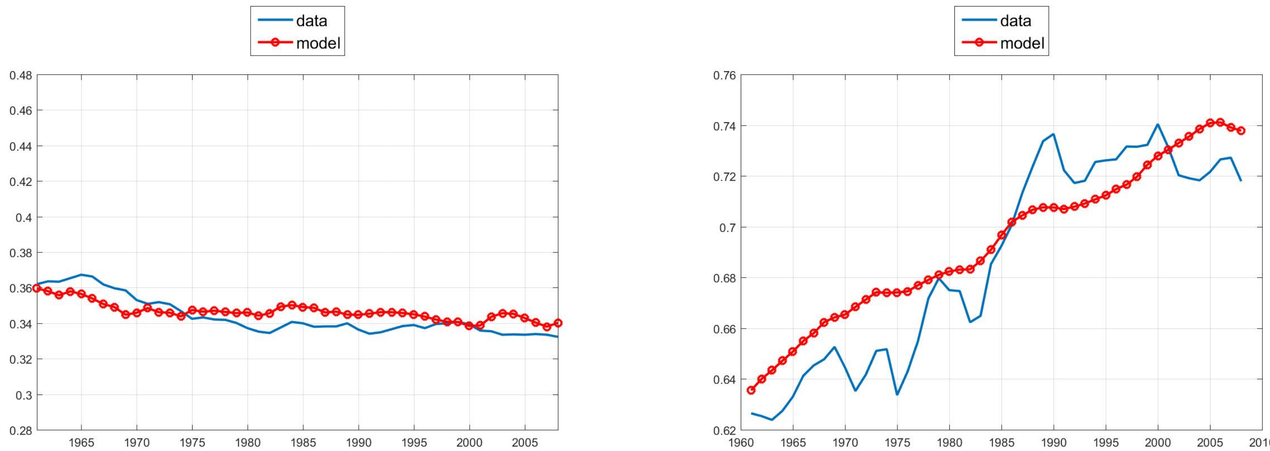
Initially, for the US, taxes remain stable, whereas the labor market institutions (LMI) shift slowly in favor of firms. When the simulation is performed using these country-specific policy variables, the model then predicts an increase in the employment rate and a small decline in the hours per worker. The composition of these adjustments of the two labor market margins leads to predicted total hours that marginally increase during the period. These results for the US economy are reported in Figure 9 and are compared to the observed data. Given that there is no break point in the time series of taxes and LMI in the US, the model reproduces the small and continuous changes observed simultaneously in the hours per worker and employment rate. The MSEs for the hours worked and for employment are respectively equal to $6.3686 \cdot 10^{-5}$ and $3.1536 \cdot 10^{-4}$.

In France, the tax wedge experienced at least three regimes. At the beginning of the sample, until 1985, it increases rapidly. Between 1985 and 2000, its increase is less marked,

average of tightness would be of 0.3, even lower than the value for France.

[42]Our actual implied values of tightness are, respectively, $\theta = 0.8, 0.5$ and 0.8.

Figure 9: **The US economy**



Hours per worker

Employment rate

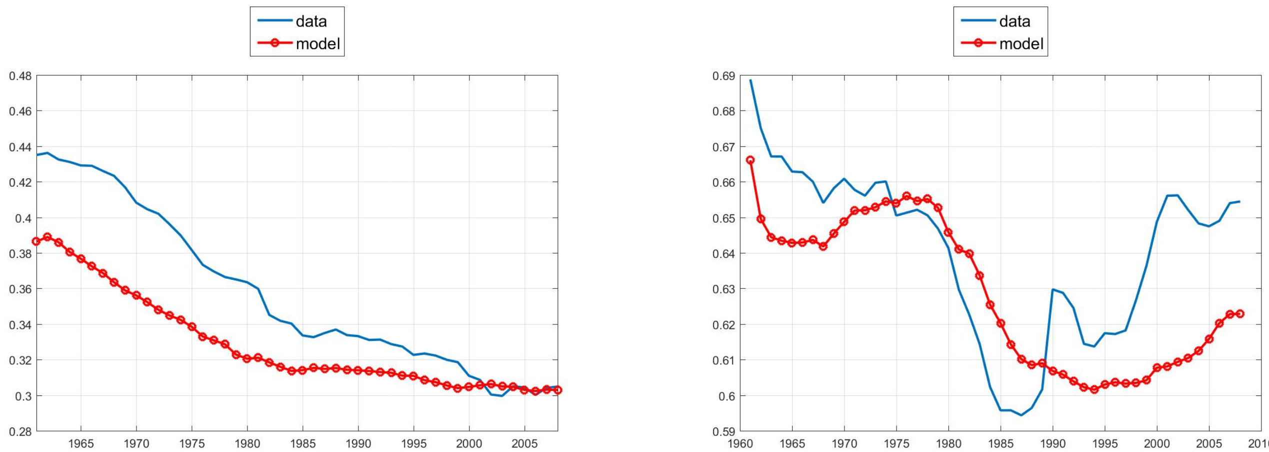
whereas after 2000, we observe a significant decline (see Figure 4). In response to these tax rates, the model predicts that each French employee works fewer hours, with a small recovery after 2000. This prediction is not contradicted by the data (see Figure 10).

In the French labor market, while the bargaining power of the workers remains stable over the total sample, this is not the case for the replacement rate: it largely increases in 1981 and 1985, then it remains stable, before beginning to decline from 2002 (see Figure 6). In response to these substantial changes in the LMI, the employment rate predicted by the model largely declines at the beginning of the eighties, and increases at the end of the sample. These predictions are consistent with the data (see Figure 10), even if the elasticity of the model slightly under-estimates the changes in the employment rate in France. The MSEs for hours worked and for employment are equal to 0.0012 and $4.9340 \cdot 10^{-4}$, respectively.

The overall fit for the UK is worse than for the previous two economies: the MSEs for the hours worked and for employment are equal to $6.0647 \cdot 10^{-4}$ and 0.0032, respectively. We can see that the model does a relatively good job of reproducing the dynamics for hours, but only starting from the mid eighties, once the tax wedge on consumption and labor income stabilizes. In terms of the employment rate, the model captures its tendency to decrease until the end of the seventies, and a recovery afterwards, mirroring the change in the evolution of labor market institutions. However, it overestimates the elasticity of the employment rate to these changes, and it does not capture the evolutions of the nineties.

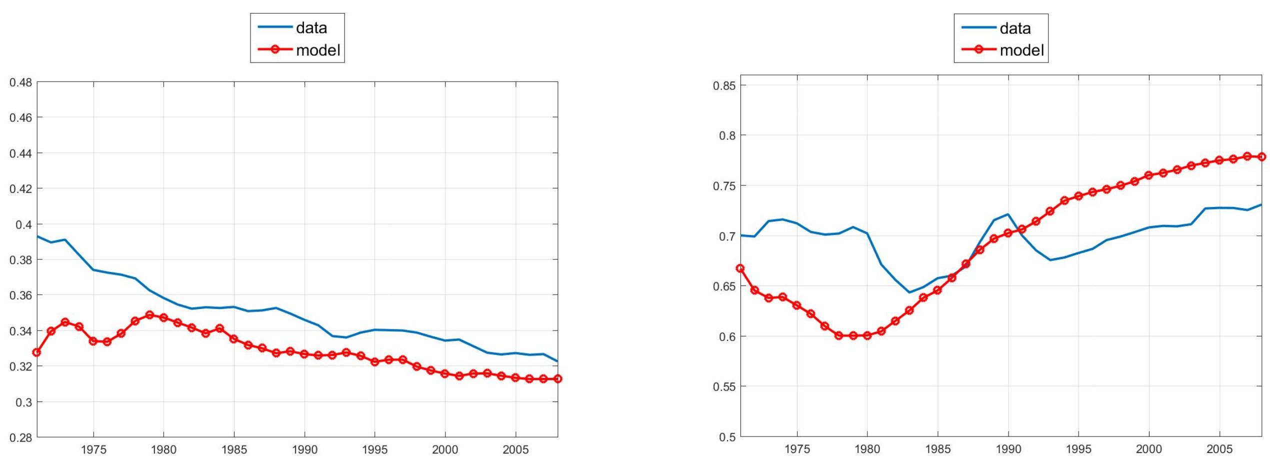
With respect to Germany, the simulation (starting from the reunification period) does capture the decrease in the intensive margin which continues during the nineties and the positive trend in the employment rate. The overall fit of the model in terms of MSEs, for

Figure 10: **The French economy**



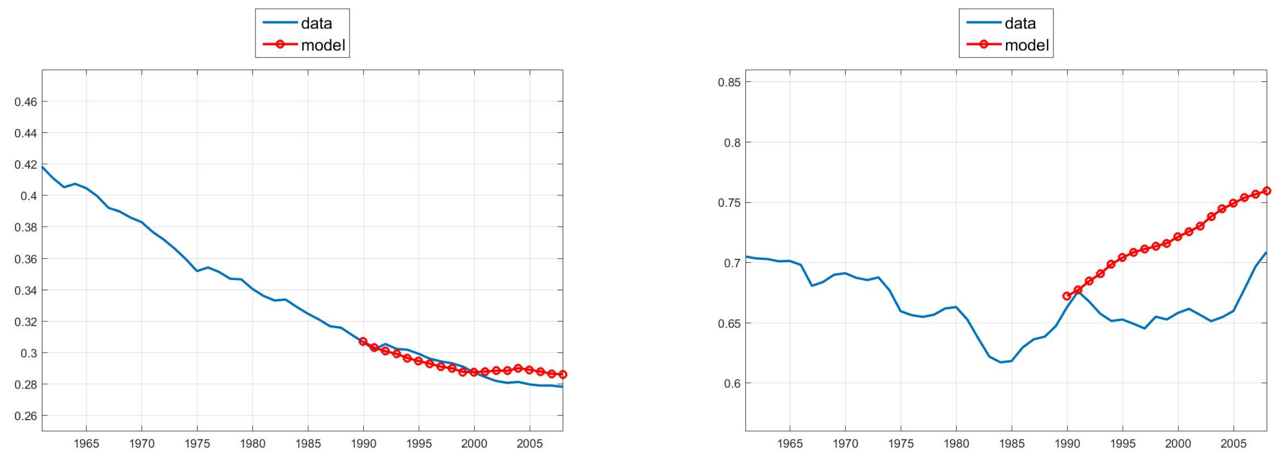
Hours per worker   Employment rate

Figure 11: **The UK economy**



Hours per worker   Employment rate hours and employment is respectively $3.3486 \cdot 10^{-5}$ and 0.0039.

Figure 12: **The German economy**



Hours per worker

Employment rate

4.3 Analyzing the mechanisms of the model

In this subsection, we propose to analyse the mechanisms of the model by focusing on a steady state analysis[43].

4.3.1 Steady state analysis

Before considering the counterfactual experiments in the fully dynamic model, we look at the final steady state and study the comparative static effects of a change in a policy variable (tax rates, replacement rate or bargaining power). In doing this, we follow Fang and Rogerson (2009), but, in contrast to their exercise, our model includes capital, as well as the replacement rate. Our general equilibrium analysis implies that labor supply (intensive and extensive margins) depends on equilibrium consumption through the marginal rate of substitution between consumption and leisure. We add the resource constraint to provide the link between consumption and labor market variable through the net output (total consumption, $C(\theta, h)$, is a function of θ and h[44]), and thus integrate this general equilibrium

[43]In Appendix F, we analyze the dynamics of the outside value of employment, which is usually presented as a key variable of the Shimer (2005) puzzle. It is shown that the general equilibrium approach puts this "puzzle" into perspective.

[44]See the appendix C for a complete description of the system equations.

restriction in our labor market analysis. Hence, at the steady state, we can reduce the system equations for two unknowns $\{h,\theta\}$[45].

$$\sigma_l h^{1+\eta} C(\theta,h) \quad = \quad \alpha A h \frac{(1-\tau_w)}{(1+\tau_c)} \left(\frac{r}{1-\alpha}\right)^{-\frac{(1-\alpha)}{\alpha}} \qquad (Ls)$$

$$\frac{\omega\theta^{1-\psi}}{\Upsilon}\left[\frac{1}{\beta}-(1-s)\right]+\left(\frac{1-\epsilon}{1-\rho\epsilon}\right)\omega\theta \quad = \quad \left(\frac{\epsilon}{1-\rho\epsilon}\right)\left\{\begin{array}{c} (1-\rho)\alpha A h\left(\frac{r}{1-\alpha}\right)^{-\frac{(1-\alpha)}{\alpha}} \\ -\left(\Gamma^u+\sigma_l\frac{h^{1+\eta}}{1+\eta}\right)\frac{(1+\tau_c)}{(1-\tau_w)}C(\theta,h) \end{array}\right\} \qquad (JC)+(WC)$$

The (Ls) equation can be interpreted as the locus where the "intensive margin" is at equilibrium, whereas the second is the locus where the "extensive margin" is at equilibrium. As usually, this last locus merges the Job Creation curve (JC) and the Wage Curve (WC). These two relationships can be interpreted as showing a trade-off between the two margins of labor input for households as well as firms, at general equilibrium.

Proposition 1 *For an equilibrium employment rate greater than 1/3, the resource constraint defining $C(h,\theta)$ always implies that $\epsilon_{C|h}>0$ and $\epsilon_{C|\theta}>0$*

Proof. See Appendix C.1. ■ Given that an employment rate equal to 1/3 is largely below what has been observed for all countries along the total time span, we can confidently say that in our model an increase in tightness or in hours per worker implies an increase in consumption.

Proposition 2 *If $C(h,\theta)$ leads to $\epsilon_{C|h}>0$ and $\epsilon_{C|\theta}>0$, then the equilibrium intensive margin (equation (Ls)) defines a negative relationship between hours worked h and the labor market tightness θ.*

Proof. See appendix C.2. ■ The optimal choice of the intensive margin shows that the labor market tightness acts as a wealth effect or agent decisions: a high θ implies a high employment rate, therefore a lower incentives for each individual in the household to work.

Proposition 3 *For $\frac{\eta}{1+\eta}>\rho$, there exists a value for $\Gamma^u<0$ such that the equilibrium extensive margin (equation $(JC)+(WC)$) defines a negative relationship between hours worked h and the labor market tightness θ.*

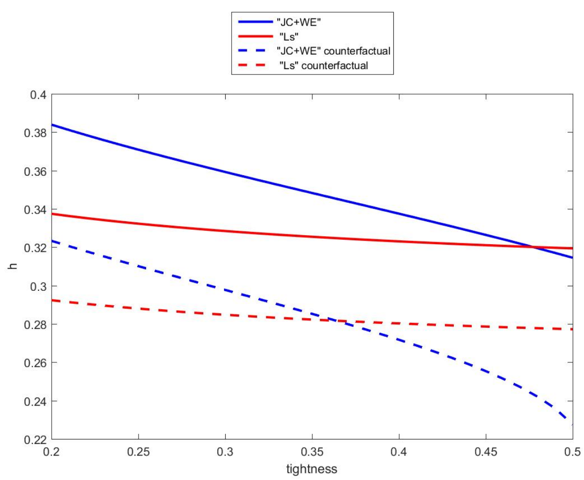
Proof. See Appendix C.3. ■ The optimal choice of the extensive margin shows that a high h implies a higher gap between disutility at work and at home, leading to lower incentives for an additional worker in the household to work. This can be viewed as an increase of the wage reservation due to the scarcity of leisure when h increases.

[45] When we consider the steady state of the model, we refer to an "asymptotic" steady state, which is obtained when the subsistence consumption term is null, so that in the following $\bar{c}=0$.

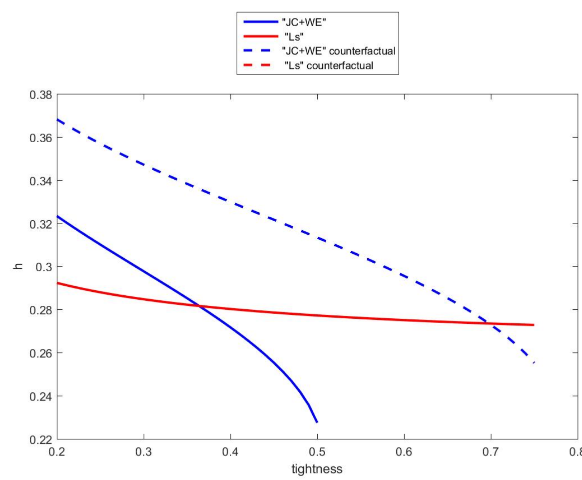
Comparative statics: counterfactual experiments. Let us now perform a comparative statics analysis: what would the impact be of a reduction in tax rates on the final steady state (SS)? We can, for example, apply the US tax rates (on consumption and labor income) to France, and check the functioning of the model.

In Figure **??** we represent the relations between hours per worker (h) and labor market tightness (θ) given by the equations (Ls) and ($JC + WE$). We expect both the labor supply and the labor market equilibrium curves to shift upward; since tax rates affect directly both relations. The overall effect on hours per worker is unequivocally positive, while the effect on the extensive margin depends on the relative movements of the curves. We can see this mechanism graphically in the left panel of Figure 13. Indeed, for our calibration, the tax reduction gives incentives to work longer and at the same time it also reduce the labor costs, inducing a rise in tightness.

Figure 13: **SS comparative statics - France**



Change in the tax wedge



Change in the replacement rate

What if we simulate the French economy with the unemployment benefits system of the US? In the graphical representation in the right panel of Figure 13 we see that a change in the replacement rate does not affect the labor supply curve, but that it does affect the labor market equilibrium curve: the latter shifts towards the right so that the effect on tightness is strongly positive. When the proportion of the employed in the representative family increases, the generated wealth effect leads to reduce the individual effort at work. Thus, the reservation wage is reduced, and then the impact of the reduction of the replacement rate is amplified. Considering that the "intensive margin" curve, as resulting from our calibration, is very flat, the effect on hours per worker (which decrease overall) is quantitatively less significant.

5 Counterfactual experiments: alternative policies

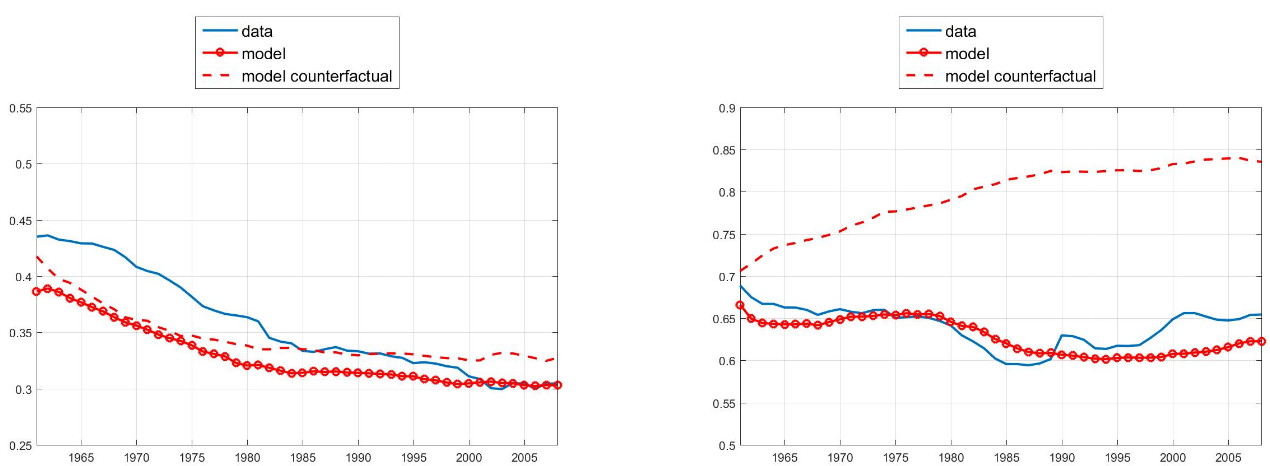
Once we described the forces at work at steady state, we can perform a counterfactual experiment with the fully fledged dynamic version of the model. We focus on the two countries which lie at the extremes of the spectrum in terms of the evolution of policy variables, the US and France: what would the evolution have been of the two margins of labor input in France with the path of policy variables which characterized the post WWII history of the US?

5.1 The impact of policies on the two margins

Let us start by comparing the evolution of the simulated variables for France, when the economy is fed with the complete set of policy variables which characterized the US. This means that in our first experiment the two economies differ only with respect to the path of technological progress and a few parameters: the separation rate, the population growth rate and the matching efficiency. In Figure 14, we see the results of the simulations of the French economy with both US taxes and labor market institutions.

On average, the fictive French employee works longer and has a higher chance of being employed. If we look at the evolution of the employment rate, it seems that with the labor market institutional arrangements which characterize the US, France would have observed a spectacularly high employment rate: at the end of the simulation, the employment is 85% in this “fictive” France, whereas it is equal to 62.5% in the “actual” economy.

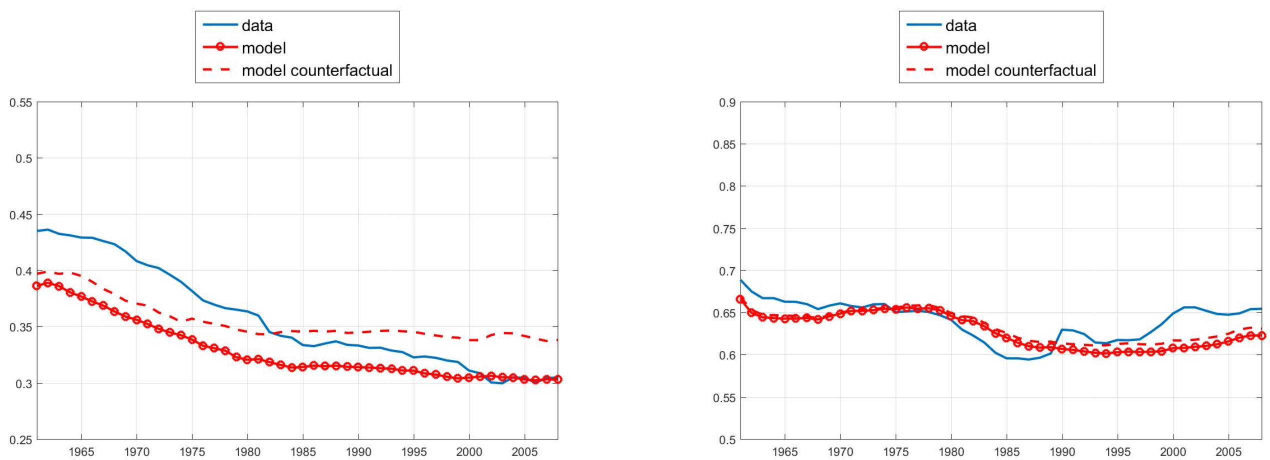
Figure 14: **Counterfactual: US taxes and LMI in France**



Hours per worker (h) Employment rate (N)

Let us consider a situation in which we insert the tax rate evolution observed in the US in France, while keeping the labor market arrangements as they are. We see in Figure 15 that the amount of hours worked would have been higher. The important point here is that a simple reduction of the tax rates does not have a very significant impact on employment: the decline of the labor cost they induce is compensated by the rise in reservation wage of the workers, who now work longer. These results are the counterparts, in a dynamic framework, of the comparative static results summarised in Propositions 2 and 3.

Figure 15: **Counterfactual: France with US taxes**



Hours per worker (h)

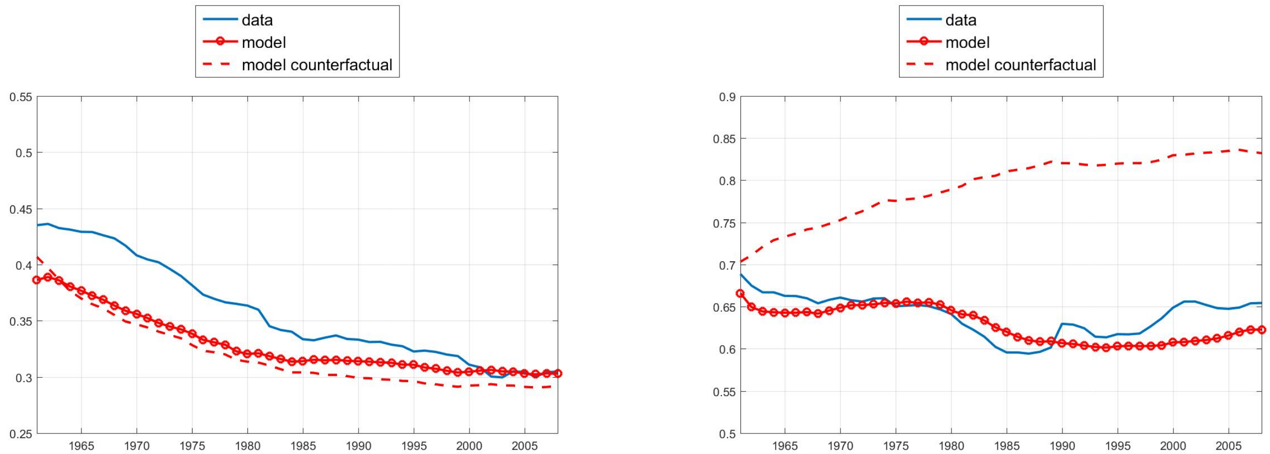
Employment rate (N)

If we look at Figure 16, which shows the hypothetical case of France applying US labor market institutions, but its own taxation system, we see that in this instance we would have observed a very high employment level, with a contemporaneous decrease in hours worked. Agents in France, when strongly taxed, choose to work less than an American worker. The general equilibrium effects magnify these two direct effects. Firstly, the large "chance" of employment is perceived by the agent as a wealth effect, that reduces his incentive to work longer. Secondly, when a worker reduces his hours worked, his reservation wage decreases, leading to a magnification of the rise in the employment rate. This also echoes the results obtained with the comparative statics analysis in Propositions 2 and 3.

5.2 Do the French work less to be happier?

To evaluate the impact of policies on welfare, we compute the welfare gap in Frances induced by the "distortive" taxes and labor market institutions, with respect to a "reference" value of welfare that would be chosen by a benevolent social planner. In this case,

Figure 16: **Counterfactual: France with US LMI**



Hours per worker (h) Employment rate (N)

the government consumption expenditure in collective goods would be financed in a non-distortive way through lump-sum taxes[46]. The planner observes the same dynamics of the technological shocks as the private agents do. The two counterfactual experiments which are performed are the following: in one case, we set the proportional taxes rates as null, government expenditure in collective goods being financed by lump-sum transfers; in the other, we eliminate instead the distortions on the labor market institutions.

We then compute the rate at which we should "tax" the social planner in order to have an equivalent welfare level to that of the market economy, at each date. We define a factor λ_t entering the social welfare function as the following:

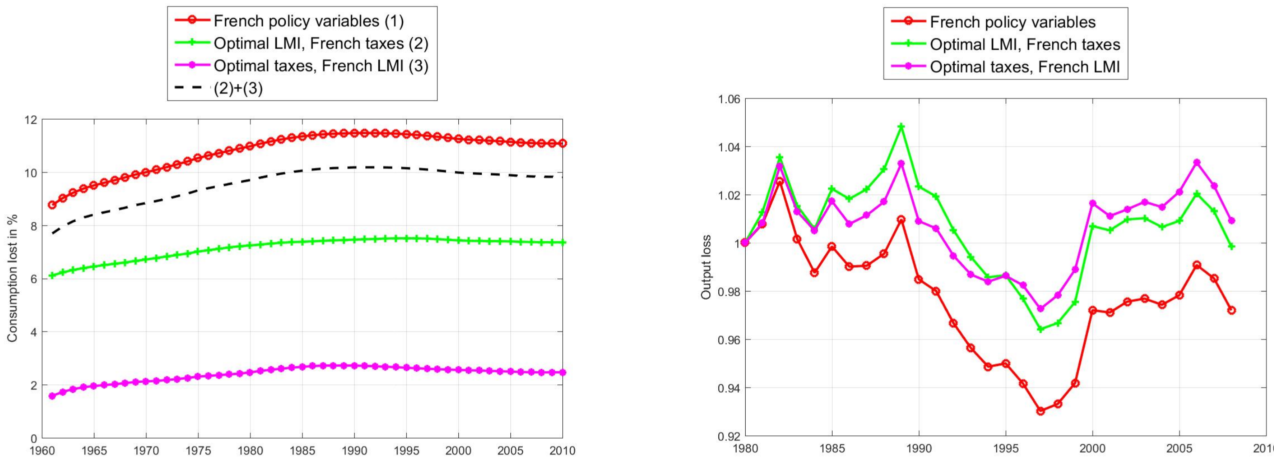
$$\left.\begin{array}{c} W_t{}^{actual} \\ W_t{}^{cf} \end{array}\right\} = \log((1-\lambda_t)C_t) + \zeta \log(G_t^{col}) + N_t \left(-\sigma_l \frac{h_t^{1+\eta}}{1+\eta} \right) + (1-N_t)\Gamma^u + \beta W_{t+1}$$

The factor λ_t gives the losses in consumption units implied by the market allocations (*actual* or *cf* as counterfactual). The value of ζ is derived by considering the choice that a social planner would make, i.e. considering the first order conditions (FOCs) with respect to privately consumed goods and collective goods: $\zeta = \frac{G_t^{col}}{C_t}$. In order to find the value of ζ we consider the time series for G_t^{col} and we compute the mean value over the period, i.e. $\zeta = \frac{\overline{G}^{col}}{\overline{C}}$ [47], obtaining 0.139 for France.

[46]In the labor market, the bargaining power of workers would be constant and equal to the elasticity of the matching function with respect to unemployment, while the unemployment benefit would be null.

[47]Given that this ratio is not constant over the period, our calibration procedure ensures that the first

Figure 17: **Factor λ_t and output loss for France**



Factor λ_t | Output loss in efficiency units

If we look at the left panel of Figure 17, we can see that the gains originated by a tax reform are higher than those coming from a labor market reform (around 9 percentage points of life-time consumption would be gained at the end of the period in the first case, in contrast to around 4 percentage points in the second case). The intuition can come from the analysis of the steady state in Figure 13: starting from a situation in which hours and the employment rate are lower than the optimal level, a fiscal reform which reduces the tax burden, contributes in helping the employment rate too (left panel of Figure 13), while a reform of labor market institution worsens the performance in hours (right panel of Figure 13), even if in this case the overall elasticity of hours is quite low. This first result suggests that a French worker is not better off than an American, even if he works less.

In comparison to Prescott (2004), our evaluation of the welfare losses is lower[48]. This mainly results from *(i)* the assumption that government expenditures are not a pure waste and *(ii)* a much lower elasticity of the labor supply[49].

Another interesting point regards the complementarities that can arise in a general equilibrium framework in which the intensive and the extensive margin of labor supply interact: if we simply sum up the gains of implementing one reform at a time we obtain the dashed

best allocation matches the observed time series of the collective government expenditures.

[48]In his paper Prescott evaluates the welfare gains for France of shifting to a "US style" tax system to 19% of life-time consumption.

[49]Prescott (2004) estimates the labor supply elasticity and find it "[...] large, nearly 3 when the fraction of time allocated to the market is in the neighborhood of the current U.S. level.", Prescott (2004), p. 11, but it is important to remember that in his model there is no unemployment, so his elasticity refers at the same time to both the intensive and the extensive margin.

black line in the left panel of Figure 17: we can see that the sum of the costs of the two distortions is lower than the actual cost experienced in the economy, or in other words the gains of implementing both reforms at the same time are higher.

Finally, we can also consider the percentage points of output (in efficiency units) that have been "lost" in France, compared to what could have happened with a set of policy variables such as those chosen by the planner: in the right panel of Figure 17, we plot the history of output in the actual French economy and in the two counterfactual experiments, normalized at their respective level in 1980. Given the size of these "structural" losses each year, measuring the losses in the potential output, it seems that the Keynesian "Okun gap" is negligible for France: all the efforts of policy-makers should be devoted to the reduction of the Harberger triangles, which are increasing, representing today between 3 and 4 percentage points of the output per year.

6 Conclusions

In this paper, we developed a dynamic perfect foresight model of neoclassical growth with labor market frictions, that can account for the long run evolutions of both the extensive and the intensive margin of labor supply. We calibrated it to reproduce the evolutions of these two margins for four representative countries, namely the United States, France, the United Kingdom and Germany.

We then focused on the differences between the two countries which represent the "polar" cases in terms of policy choices: the US and France. These two countries in fact showed extremely different evolutions with respect to the aggregate labor supply. We highlighted that there are non-trivial interactions between the two margins, and we confirmed that quantitatively the evolution of the tax wedge can explain the path of hours worked per worker, while labor market institutions[50] must be taken into account if we want to explain the evolution of employment.

The appeal of the model lies in the fact that it allows us to perform counterfactual experiments and to evaluate the welfare losses or gains of implementing certain reforms: in this instance the country of interest is France, and we ask ourselves what the welfare gains would be of switching towards an optimal system for taxes and institutions. One of the potential policy implications of our exercise is that it seems pointless to advocate a "liberalization" of labor market institutions if we do not consider diminishing the tax wedge at the same time.

[50] We remind that we limit ourselves to consider only the bargaining power of workers and the replacement rate.

References

Alberto F. Alesina, Edward L. Glaeser, and Bruce Sacerdote. Work and Leisure in the U.S. and Europe: Why So Different? In *NBER Macroeconomics Annual 2005, Volume 20*, NBER Chapters, pages 1–100. National Bureau of Economic Research, Inc, June 2006.

David Andolfatto. Business cycles and labor market search. *American Economic Review*, 86(1): 112–32, March 1996.

Regis Barnichon. Building a composite help-wanted index. *Economics Letters*, 109(3):175 – 178, 2010.

Olivier Blanchard and Justin Wolfers. The Role of shocks and institutions in the rise of European unemployment: The aggregate evidence. *The Economic Journal*, 110(462):C1–C33, March 2000.

Sveinbjörn Blöndal and Stefano Scarpetta. The retirement decision in oecd countries. OECD Economics Department Working Papers 202, OECD Publishing, 1999.

Michael Burda and Mark Weder. Payroll Taxes, Social Insurance and Business Cycles. 2010.

Raj Chetty, Adam Guren, Day Manoli, and Andrea Weber. Are Micro and Macro Labor Supply Elasticities Consistent? A Review of Evidence on the Intensive and Extensive Margins. *American Economic Review*, 101(3):471–75, May 2011.

Gabriel Chodorow-Reich and Loukas Karabarbounis. The cyclicality of the opportunity cost of employment. Working Paper 19678, National Bureau of Economic Research, November 2013.

Michael Elsby, Bart Hobijn, and Aysegul Sahin. Unemployment dynamics in the oecd. Working Paper 14617, National Bureau of Economic Research, December 2008.

Lei Fang and Richard Rogerson. Policy Analysis In A Matching Model With Intensive And Extensive Margins. *International Economic Review*, 50(4):1153–1168, November 2009.

Paul Gomme and Peter Rupert. Theory, measurement and calibration of macroeconomic models. *Journal of Monetary Economics*, 54(2):460–497, March 2007.

Jonathan Gruber and David Wise. Social security programs and retirement around the world: Fiscal implications, introduction and summary. Working Paper 11290, National Bureau of Economic Research, May 2005.

Marcus Hagedorn and Iourii Manovskii. The Cyclical Behavior of Equilibrium Unemployment and Vacancies Revisited. *American Economic Review*, 98(4):1692–1706, September 2008.

Jean-Olivier Hairault, François Langot, and Thepthida Sopraseuth. Why is Old Workers' Labor Market More Volatile? Unemployment Fluctuations over the Life-Cycle. IZA Discussion Papers 8076, Institute for the Study of Labor (IZA), March 2014.

Robert E. Hall. Employment Fluctuations with Equilibrium Wage Stickiness. *American Economic Review*, 95(1):50–65, March 2005.

François Langot. Unemployment and Real Business Cycle : A Matching Model. In P.Y. Henin, editor, *Advances in Economic Business Cycles Theory*. Springer Verlag, 1995.

François Langot and Coralia Quintero Rojas. Explaining the Evolution of Hours Worked and Employment across OECD Countries: An Equilibrium Search Approach. IZA Discussion Papers 3364, Institute for the Study of Labor (IZA), February 2008.

François Langot, Lise Patureau, and Thepthida Sopraseuth. Optimal Fiscal Devaluation. Banque de france working papers, Banque de France, 2014.

Richard Layard and Stephen Nickell. Labor market institutions and economic performance. In O. Ashenfelter and D. Card, editors, *Handbook of Labor Economics*, volume 3 of *Handbook of Labor Economics*, chapter 46, pages 3029–3084. Elsevier, 1999.

Lars Ljungqvist and Thomas J. Sargent. Do taxes explain European employment? Indivisible labor, human capital, lotteries, and savings. In *NBER Macroeconomics Annual 2006, Volume 21*, NBER Chapters, pages 181–246. National Bureau of Economic Research, Inc, 2007.

Cara McDaniel. Average tax rates on consumption, investment, labor and capital in the OECD 1950-2003. Working papers, Arizona State University, December 2007.

Cara McDaniel. Forces shaping hours worked in the OECD, 1960-2004. *American Economic Journal: Macroeconomics*, 3(4):27–52, October 2011.

Monika Merz. Search in the labor market and the real business cycle. *Journal of Monetary Economics*, 36(2):269–300, November 1995.

Dale T. Mortensen and Christopher A. Pissarides. New developments in models of search in the labor market. In O. Ashenfelter and D. Card, editors, *Handbook of Labor Economics*, volume 3 of *Handbook of Labor Economics*, chapter 39, pages 2567–2627. Elsevier, 1999.

Stephen Nickell. Unemployment and labor market rigidities: Europe versus North America. *Journal of Economic Perspectives*, 11(3):55–74, Summer 1997.

Lee Ohanian, Andrea Raffo, and Richard Rogerson. Long-term changes in labor supply and taxes: Evidence from OECD countries, 1956-2004. *Journal of Monetary Economics*, 55(8):1353–1362, November 2008.

Lee E. Ohanian and Andrea Raffo. Aggregate hours worked in OECD countries: New measurement and implications for business cycles. *Journal of Monetary Economics*, 59(1):40–56, 2012.

Christopher A. Pissarides. Unemployment And Hours Of Work: The North Atlantic Divide Revisited. *International Economic Review*, 48(1):1–36, 02 2007.

Christopher A. Pissarides and Barbara Petrongolo. Looking into the Black Box: A Survey of the Matching Function. *Journal of Economic Literature*, 39(2):390–431, June 2001.

Edward C. Prescott. Why do Americans work so much more than Europeans? *Quarterly Review*, (Jul):2–13, 2004.

Kelly S. Ragan. Taxes and Time Use:Fiscal Policy in a Household Production Model. *American Economic Journal: Macroeconomics*, 1(5):168–92, 2013.

Richard Rogerson. Understanding differences in hours worked. *Review of Economic Dynamics*, 9 (3):365–409, July 2006.

Richard Rogerson. Taxation and Market Work: Is Scandinavia an Outlier? Nber working papers, National Bureau of Economic Research, Inc, February 2007.

Robert Shimer. The Cyclical Behavior of Equilibrium Unemployment and Vacancies. *American Economic Review*, 95(1):25–49, March 2005.

Appendix

A Stationarized FOCs

We report the equations that compose the model, where the convention adopted is to indicate with $\widehat{X}$ a variable X, for $X \in \{A, C, Y, K, I, w, \omega\}$ which is deflated by the rate of growth, ie. $\widehat{X_t} = X_t/(1+g)^t$. The set of equations used to solve the dynamic paths of the model is the following:

$$
\begin{aligned}
(1+n)N_{t+1} &= (1-s)N_t + \min\left[\min(V_t, 1-N_t), \Upsilon V_t^{\psi}(1-N_t)^{1-\psi}\right] \\
(1+g)\widehat{K}_{t+1} &= (1-\delta)\widehat{K}_t + \widehat{I}_t \\
\widehat{Y}_t &= \widehat{K}_t^{1-\alpha}(\widehat{A}_t N_t h_t)^{\alpha} \\
\widehat{Y}_t &= \widehat{C}_t + \widehat{I}_t + \widehat{G_t^{col}} + \widehat{\omega} V_t \\
\frac{(\widehat{C}_{t+1} - \overline{c})}{(\widehat{C}_t - \overline{c})} &= \frac{\beta}{(1+g)} \frac{(1+\tau_{c,t})}{(1+\tau_{c,t+1})(1+\tau_{i,t+1})} [r_{t+1}(1-\tau_{k,t+1}) + (1-\delta)(1+\tau_{i,t+1})] \\
r_t &= (1-\alpha)\widehat{K}_t^{-\alpha}(\widehat{A}_t N_t h_t)^{\alpha} \\
\frac{\widehat{\omega}\theta_t}{f_t} &= \frac{\beta}{(1+g)} \frac{(\widehat{C}_t - \overline{c})(1+\tau_{c,t})}{(\widehat{C}_{t+1} - \overline{c})(1+\tau_{c,t+1})} \left[\alpha \frac{\widehat{Y}_{t+1}}{N_{t+1}} - \widehat{w}_{t+1} h_{t+1} + (1-s)\frac{\widehat{\omega}\theta_{t+1}}{f_{t+1}}\right] \\
\widehat{w}_t h_t &= \frac{(1-\epsilon_t)}{(1-\rho_t\epsilon_t)} \left[\alpha \frac{\widehat{Y}_t}{N_t} + \widehat{\omega}\left(\frac{1-s}{q_t}\left(1 - \left(\frac{\phi_{t+1}}{\phi_t}\frac{(1-\tau_{w,t+1})}{(1-\tau_{w,t})}\right) + \frac{\phi_{t+1}}{\phi_t}\frac{(1-\tau_{w,t+1})}{(1-\tau_{w,t})}\theta_t\right)\right)\right] \\
&\quad + \frac{\epsilon_t}{1-\rho_t\epsilon_t} \frac{(1+\tau_{c,t})}{(1-\tau_{w,t})} (\widehat{C}_t - \overline{c}) \left(\Gamma^u + \sigma_l \frac{h_t^{(1+\eta)}}{(1+\eta)}\right) \\
f_t &= \min\left(\frac{\Upsilon V_t^{\psi}(1-N_t)^{1-\psi}}{1-N_t}, 1\right) \\
q_t &= \min\left(\frac{\Upsilon V_t^{\psi}(1-N_t)^{1-\psi}}{V_t}, 1\right) \\
\theta_t &= \frac{V_t}{U_t}
\end{aligned}
$$

In order to ensure that the job finding rate and the job filling rate are in $[0, 1]$, we take the minimum between the unconstrained definition of these rates and 1. In accordance with these constraints, the matching function is also redefined.

B Steady state analysis

We firstly report all the equations which compose the model:

$$
\begin{aligned}
(n+s)N &= q(\theta)V \\
(g+\delta)K &= I \\
Y &= K^{1-\alpha}(ANh)^{\alpha} \\
Y &= C+I+G^{col}+\omega V \\
1 &= \frac{\beta}{1+g}\left[r\frac{(1-\tau_k)}{(1+\tau_i)}+1-\delta\right] \\
r &= (1-\alpha)\left(\frac{K}{ANh}\right)^{-\alpha} \\
\frac{\omega\theta}{f(\theta)} &= \beta\left[\alpha\frac{Y}{N}-wh+(1-s)\frac{\omega\theta}{f(\theta)}\right] \\
wh &= \frac{1-\epsilon}{1-\rho\epsilon}\left(\alpha\frac{Y}{N}+\omega\theta\right)+\frac{\epsilon}{1-\rho\epsilon}\frac{1+\tau_c}{1-\tau_w}(C-\overline{c})\left(\Gamma^u+\sigma_l\frac{h^{1+\eta}}{1+\eta}\right) \\
\theta &= \frac{V}{U} \\
f(\theta) &= \Upsilon\theta^{\psi} \\
q(\theta) &= \frac{\Upsilon}{\theta^{1-\psi}} \\
\sigma_l h^{1+\eta} &= \alpha\frac{Y}{N}\frac{1-\tau_w}{1+\tau_c}\frac{1}{C-\overline{c}}
\end{aligned}
$$

We then report for clarity an intermediate step in the substitution. Let us define the two following values:

$$
\begin{aligned}
r &= \left[\frac{1+g}{\beta}-(1-\delta)\right]\frac{1+\tau_{inv}}{1-\tau_k} \\
K &= \left(\frac{r}{1-\alpha}\right)^{-\frac{1}{\alpha}}ANh
\end{aligned}
$$

We can therefore reduce the system of steady state equations to the following one [51]:

$$\begin{aligned}
N(\theta) &= \left(\frac{n+s}{\Upsilon\theta^{\psi}}+1\right)^{-1} \\
Y(\theta,h) &= \left(\frac{r}{1-\alpha}\right)^{-\frac{(1-\alpha)}{\alpha}} AN(\theta)h \\
K(\theta,h) &= \left(\frac{r}{1-\alpha}\right)^{-\frac{1}{\alpha}} AN(\theta)h \\
I(\theta,h) &= (g+\delta)K(\theta,h) \\
C(\theta,h) &= \frac{Y(\theta,h)}{N(\theta)}\frac{\alpha}{\sigma_l}\frac{(1-\tau_w)}{(1+\tau_c)}\frac{1}{h^{1+\eta}} \\
\frac{\omega\theta}{\Upsilon\theta^{\psi}}\left[\frac{1}{\beta}-(1-s)\right]+\frac{1-\epsilon}{1-\rho\epsilon}\omega\theta &= \frac{\epsilon}{1-\rho\epsilon}\left[\begin{array}{c} (1-\rho)\alpha\frac{Y(\theta,h)}{N(\theta,h)} \\ -\left(\frac{1+\tau_c}{1-\tau_w}\right)C(\theta,h)\left(\Gamma^u+\sigma_l\frac{h^{1+\eta}}{1+\eta}\right) \end{array}\right] \\
Y(\theta,h) &= C(\theta,h)+I(\theta,h)+\omega\theta(1-N(\theta))
\end{aligned}$$

By continuing in substituting, we arrive to the following three equations which represent the labor supply equation, the combination of the wage equation and the job opening condition and the aggregate market clearing, respectively.

$$\begin{aligned}
Ch^{1+\eta} &= \frac{\alpha}{\sigma_l}\frac{(1-\tau_w)}{(1+\tau_c)}\left(\frac{r}{1-\alpha}\right)^{-\frac{(1-\alpha)}{\alpha}} Ah \\
\frac{\omega\theta^{1-\psi}}{\Upsilon}\left[\frac{1}{\beta}-(1-s)\right]+\left(\frac{1-\epsilon}{1-\rho\epsilon}\right)\omega\theta &= \frac{\epsilon}{1-\rho\epsilon}\left[\begin{array}{c} (1-\rho)\alpha Ah\left(\frac{r}{1-\alpha}\right)^{-\frac{(1-\alpha)}{\alpha}} \\ -C\left(\frac{1+\tau_c}{1-\tau_w}\right)\left(\Gamma^u+\sigma_l\frac{h^{1+\eta}}{1+\eta}\right) \end{array}\right] \\
C+\omega\theta\left(1-\left(\frac{n+s}{\Upsilon\theta^{\psi}}+1\right)^{-1}\right) &= Ah\left(\frac{r}{1-\alpha}\right)^{-\frac{(1-\alpha)}{\alpha}}\left(\frac{n+s}{\Upsilon\theta^{\psi}}+1\right)^{-1}\left(\left(\frac{r}{1-\alpha}\right)-(g+\delta)\right)
\end{aligned}$$

[51] When we consider the steady state of the model, we refer to an "asymptotic" steady state, which is obtained when the subsistence consumption term is null, so that in the following $\bar{c}=0$.

C Proofs of proposition

The equation (C.3) implicitly defines the consumption $C(\theta,h)$ as a function of θ and h, which can be integrated into the two other relationships.

$$
\begin{aligned}
Ch^{1+\eta} &= \frac{\alpha}{\sigma_l}\frac{(1-\tau_w)}{(1+\tau_c)}\left(\frac{r}{1-\alpha}\right)^{-\frac{(1-\alpha)}{\alpha}} Ah & \text{(C.1)}\\
\frac{\omega\theta^{1-\psi}}{\Upsilon}\left[\frac{1}{\beta}-(1-s)\right]+\left(\frac{1-\epsilon}{1-\rho\epsilon}\right)\omega\theta &= \frac{\epsilon}{1-\rho\epsilon}\left[\begin{array}{c}(1-\rho)\alpha Ah\left(\frac{r}{1-\alpha}\right)^{-\frac{(1-\alpha)}{\alpha}}\\ -C\left(\frac{1+\tau_c}{1-\tau_w}\right)\left(\Gamma^u+\sigma_l\frac{h^{1+\eta}}{1+\eta}\right)\end{array}\right] & \text{(C.2)}\\
C+\omega\theta\left(1-\frac{1}{1+\frac{n+s}{\Upsilon\theta^{\psi}}}\right) &= Ah\left(\frac{r}{1-\alpha}\right)^{-\frac{(1-\alpha)}{\alpha}}\left(\frac{\left(\frac{r}{1-\alpha}\right)-(g+\delta)}{1+\frac{n+s}{\Upsilon\theta^{\psi}}}\right) & \text{(C.3)}
\end{aligned}
$$

We therefore obtain the following system $(Ls)-(JC)+(WC)$ presented in the text.

C.1 Proof of proposition 1

Let $\epsilon_{C|h}=C'_h\frac{h}{C(\theta,h)}$ and $\epsilon_{C|\theta}=C'_\theta\frac{\theta}{C(\theta,h)}$ where $C(\theta,h)$ is the consumption compatible with the resource constraint. Differentiating equation (C.3) with respect to h, we obtain $dC=\frac{-A\left(\delta+g-\frac{r}{1-\alpha}\right)}{\left(\frac{n+s}{\Upsilon\theta^{\psi}}+1\right)\left(\frac{r}{1-\alpha}\right)^{\frac{1}{\alpha}}}dh$. Let us substitute the expression of the equilibrium real interest rate, which is given by $r=\left(\frac{1+\tau_{inv}}{1-\tau_k}\right)\left(\frac{1+g}{\beta}-(1-\delta)\right)$, to obtain that

$$
C'_h\frac{h}{C(\theta,h)}=\frac{-A\left[\delta+g-\left(\frac{1+\tau_{inv}}{1-\tau_k}\right)\left(\frac{1+g}{\beta}-(1-\delta)\right)\left(\frac{1}{1-\alpha}\right)\right]}{\left(\frac{n+s}{\Upsilon\theta^{\psi}}+1\right)\left(\frac{r}{1-\alpha}\right)^{\frac{1}{\alpha}}}\frac{h}{C(\theta,h)}>0
$$

because the term inside parenthesis in the numerator is always negative.[52] If we now check the derivative with respect to tightness, we find the following expression:

$$
\frac{\partial C}{\partial\theta} = \omega\left[\frac{\Upsilon\theta^{\psi}}{n+s}(1+\psi)-1\right]+\left[\frac{-Ah\psi(n+s)(\delta+g-\frac{r}{1-\alpha})}{\Upsilon\theta^{1+\psi}\left(\frac{n+s}{\Upsilon\theta^{\psi}}+1\right)^2\left(\frac{r}{1-\alpha}\right)^{\frac{1}{\alpha}}}\right]
$$

[52]This can be seen more easily if we re-arrange it as following

$$
\delta\left(1-\frac{1}{1-\alpha}\left(\frac{1+\tau_{inv}}{1-\tau_k}\right)\right)+\frac{1}{1-\alpha}\left(\frac{1+\tau_{inv}}{1-\tau_k}\right)\left(1-\frac{1}{\beta}\right)+g\left(1-\frac{1}{\beta(1-\alpha)\left(\frac{1+\tau_{inv}}{1-\tau_k}\right)}\right)<0
$$

The second term in square brackets is always positive, so that the overall sign depends on the conditions on the first term in square bracket; we find that a sufficient condition to have an overall positive sign at the numerator is that the first term in square brackets is positive too, which is satisfied if $\frac{\Upsilon\theta^{\psi}}{n+s}(1+\psi)>1$. Since we know that in steady state $\frac{f}{n+s}=\frac{N}{1-N}$, the previous condition reduces to $\frac{N}{1-N}(1+\psi)>1$, i.e. $N>\frac{1}{2+\psi}$. In the most "restrictive" case ($\psi=1$), the condition would be satisfied for an employment rate at least equal to 1/3.

C.2 Proof of proposition 2

Differentiating the equations (C.1) and (C.3) leads to $\left(\eta+\epsilon_{C|h}\right)\frac{dh}{h}=-\epsilon_{C|\theta}\frac{d\theta}{\theta}$, where $\epsilon_{C|h}=C'_h\frac{h}{C(\theta,h)}$ and $\epsilon_{C|\theta}=C'_\theta\frac{\theta}{C(\theta,h)}$ where $C(\theta,h)$ is the consumption compatible with the resource constraint.

C.3 Proof of proposition 3

Differentiating equation (C.2) leads to

$$\left\{\begin{array}{l}(1-\psi)\frac{\omega\theta^{1-\psi}}{\Upsilon}\left[\frac{1}{\beta}-(1-s)\right]\\ +\left(\frac{1-\epsilon}{1-\rho\epsilon}\right)\omega\theta+\left(\frac{\epsilon}{1-\rho\epsilon}\right)\Gamma^u\frac{(1+\tau_c)}{(1-\tau_w)}C\epsilon_{C|\theta}\end{array}\right\}\frac{d\theta}{\theta}=\left(\frac{\epsilon}{1-\rho\epsilon}\right)\left\{\begin{array}{c}\frac{\eta-\rho(1+\eta)}{1+\eta}\alpha Ah\left(\frac{r}{1-\alpha}\right)^{-\frac{(1-\alpha)}{\alpha}}\\ -\Gamma^u\frac{(1+\tau_c)}{(1-\tau_w)}C\epsilon_{C|h}\end{array}\right\}\frac{dh}{h}$$

With $\Gamma_u<0$ and $\eta-\rho(1+\eta)>0$, the RHS is positive whereas the sign of the LHS is undermined. Its sign is negative iff

$$(1-\psi)\frac{\omega\theta^{1-\psi}}{\Upsilon}\left[\frac{1}{\beta}-(1-s)\right]+\left(\frac{1-\epsilon}{1-\rho\epsilon}\right)\omega\theta+\left(\frac{\epsilon}{1-\rho\epsilon}\right)\Gamma^u\frac{(1+\tau_c)}{(1-\tau_w)}C\epsilon_{C|\theta}<0$$

If we assume that $\Gamma_u=-\sigma_l\frac{e^{1+\eta}}{1+\eta}$ with $e<h$, we then have $\Gamma_u=-\mu\sigma_l\frac{h^{1+\eta}}{1+\eta}$ with $\mu<1$. Using (C.1), we deduce that $\Gamma^u\frac{(1+\tau_c)}{(1-\tau_w)}C=-\mu\frac{\alpha}{1+\eta}\frac{Y}{N}$. Hence the previous restriction can be rewritten as follows:

$$(1-\psi)\frac{\omega\theta^{1-\psi}}{\Upsilon}\left[\frac{1}{\beta}-(1-s)\right]+\left(\frac{1-\epsilon}{1-\rho\epsilon}\right)\omega\theta<\left(\frac{\epsilon}{1-\rho\epsilon}\right)\mu\frac{\alpha}{1+\eta}\frac{Y}{N}\epsilon_{C|\theta}$$

Which is, when we assume for simplicity that $n\to0$ and $\beta\to1$

$$\frac{\omega\theta(1-N)}{Y}\left[1-\psi+\frac{1-\epsilon}{1-\rho\epsilon}\frac{N}{1-N}\right]<\left(\frac{\epsilon}{1-\rho\epsilon}\right)\mu\frac{\alpha}{1+\eta}\frac{\frac{\alpha}{1-\alpha}(g+\delta)}{\frac{\alpha}{1-\alpha}(g+\delta)-\frac{\omega\theta(1-N)}{Y}}$$

given that

$$\begin{aligned}\frac{dC}{dh}\frac{h}{C} &= Ah\left(\frac{r}{1-\alpha}\right)^{-\frac{(1-\alpha)}{\alpha}}\frac{1}{C}\left(\frac{\left(\frac{r}{1-\alpha}\right)-(g+\delta)}{1+\frac{n+s}{\Upsilon\theta^{\psi}}}\right)\\ \Leftrightarrow \epsilon_{C|h} &= \frac{Y}{C}\left[\frac{r}{1-\alpha}-(g+\delta)\right] = \frac{Y\left[\frac{r}{1-\alpha}-(g+\delta)\right]}{Y\left[\frac{r}{1-\alpha}-(g+\delta)\right]-\omega\theta(1-N)}\end{aligned}$$

Assume that $x=\frac{\omega\theta(1-N)}{Y}<1$ is given, we have

$$x\left[1-\psi+\frac{1-\epsilon}{1-\rho\epsilon}\frac{N}{1-N}\right]<\left(\frac{\epsilon}{1-\rho\epsilon}\right)\mu\frac{\alpha}{1+\eta}\frac{\frac{\alpha}{1-\alpha}(g+\delta)}{\frac{\alpha}{1-\alpha}(g+\delta)-x}$$

where the largest value of the LHS is obtained for $N=1/2$. Hence a sufficient condition is

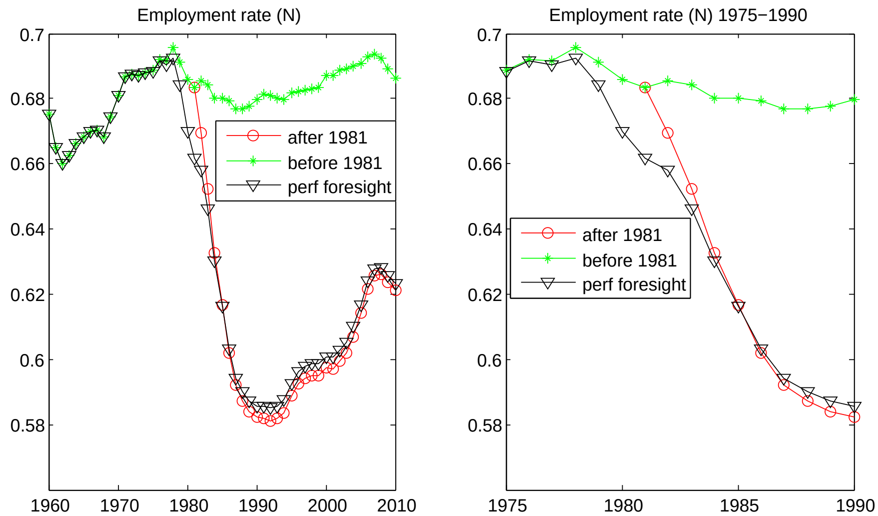
$$x\left[1-\psi+\frac{1-\epsilon}{1-\rho\epsilon}\right]\left(\frac{1-\rho\epsilon}{\epsilon}\right)\frac{1+\eta}{\alpha}\frac{\frac{\alpha}{1-\alpha}(g+\delta)-x}{\frac{\alpha}{1-\alpha}(g+\delta)}<\mu$$

D Unexpected policy change

In order to check the impact of the perfect foresight hypothesis, we perform the following experiment: we suppose that at the beginning of the sample (in 1960), agents in France correctly anticipated the path of all exogenous variables, but the replacement rate (we choose this policy change because the break in the evolution of the replacement rate is the largest among all changes of exogenous variables). The agents therefore consider that the replacement rate evolves till 1980, and then remains constant at its 1981 level. When the new government enters in function in 1981 and it changes the policy about the replacement rate, agents are surprised. At this point, the full new path of the replacement rate is revealed. The results of this experiment are shown in Figure 18.

Until 1978, both scenarii, under perfect forecast (black line with triangles) or with unexpected change (green line with stars), produce the same results. After 1979, the firms begin to reduce their vacancies if the policy change is correctly anticipated. Thus, the reduction of the employment rate is slightly smoothed until 1984, year after which the employment rate becomes again the same, as we can see looking at the lines which represent the perfect foresight case (black line with triangles) and the reaction of agents when they are surprised (red line with circles). Nevertheless, the gap between the two scenarii does never exceed 1.5 percentage point, which can be considered small, given the size of the policy change.

Figure 18: **Surprise in 1981 for replacement rate**



E The role of the subsistence term of consumption $\bar{c}$

In this section we provide a discussion about the role of the term $\bar{c}$: as already highlighted in the main text, the term $\bar{c}$ captures the "exceptionality" of the period between 1960s and 1970s for the economies which undertook a "reconstruction" period after WWII. In order to check the importance of this hypothesis, we consider an alternative version of the model in which $\bar{c}$ is set equal to zero: the model would require therefore another set of parameters for both countries to be found by matching the same four moments as in Section 4.1.

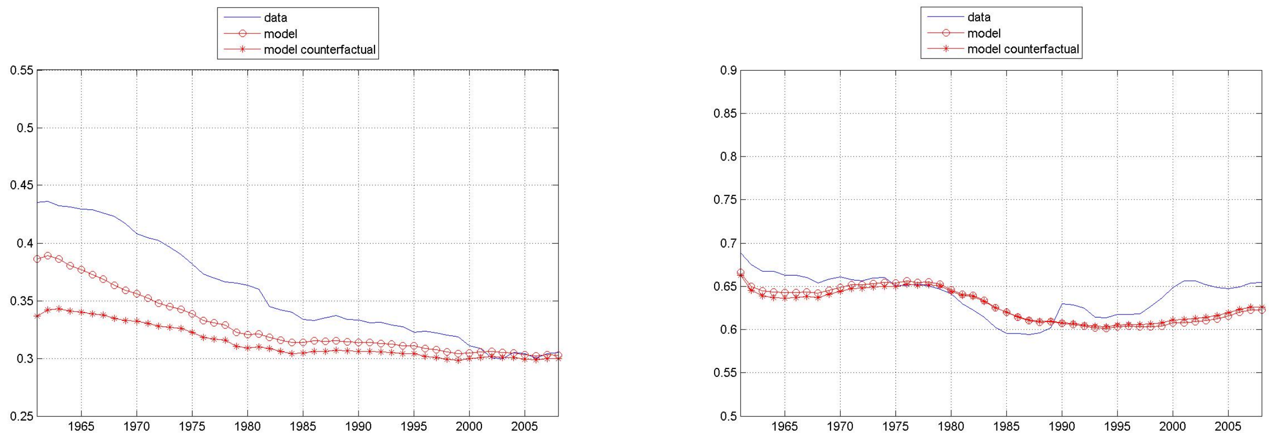
Table 4: **Identified parameters**

parameter	US	FR
σ_l	29.2	29.2
Γ^u	0.01	0.01
Υ	0.35	0.38
$\bar{c}$	0	0

With this alternative calibration, we show the performance of the model in replicating the variables of interest for France. As we can see in Figure 19, without the subsistence term $\bar{c}$ the model underestimates the level of hours till the mid-eighties; the important point is that it predicts a decrease in hours worked, even if with a lower "speed".

We can also compute a simple measure of the "lost" in the fit of the model by considering the Mean Squared Errors (MSEs) for hours for the two models: the MSEs for hours with

Figure 19: **The French economy**



Hours per worker

Employment rate

the alternative model is 2.33 times higher than that one of the benchmark model (the values are respectively 0.0028 and 0.0012).

F The flow value of non-employment

As it has been pointed out by Shimer (2005) and Hall (2005), the performance of the search and matching model in reproducing the variability of employment is tightly linked to the mechanisms underlying the wage process, in particular the evolution of the so called "flow value of non-employment"[53]. We thus check the evolution over time of the implied flow value of non-employment produced by our model. We report for the reader's convenience the term entering the wage equation which represents the flow value of non-employment (or reservation wage):

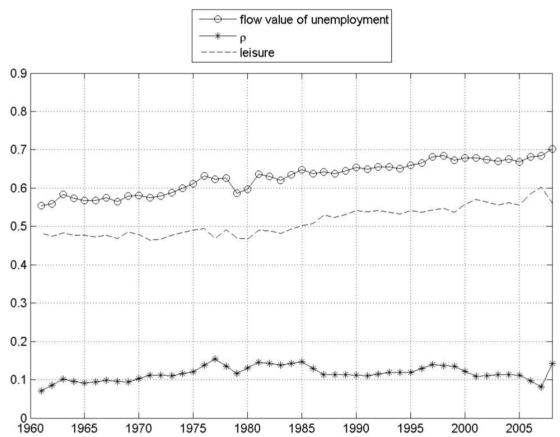
$$RW_t = \underbrace{\left(\Gamma^u + \sigma_l \frac{h_t^{1+\eta}}{1+\eta}\right)(C_t - \bar{c})\left(\frac{1+\tau_c}{1-\tau_w}\right)}_{\substack{\text{Value of leisure} \\ \text{in consumption goods}}} + \underbrace{\rho_t w_t h_t}_{\substack{\text{Non-employment} \\ \text{benefits}}}$$

We plot the results implied by our model[54] in Figure 20.

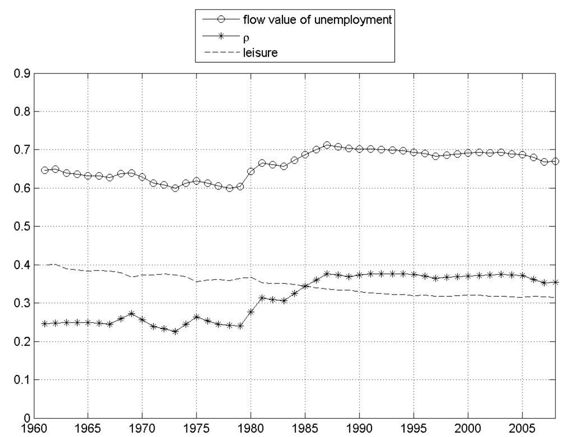
[53] Chodorow-Reich and Karabarbounis (2013) focus on the empirical counterparts of the elements we found in the flow value of non-employment when wages are set through a Nash bargaining mechanism.

[54] We plot the measure of the reservation wage normalized with respect to the wage bill $w_t h_t$.

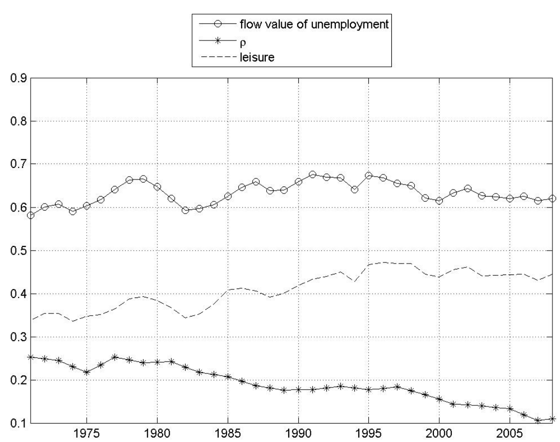
Figure 20: **Flow value of non-employment**



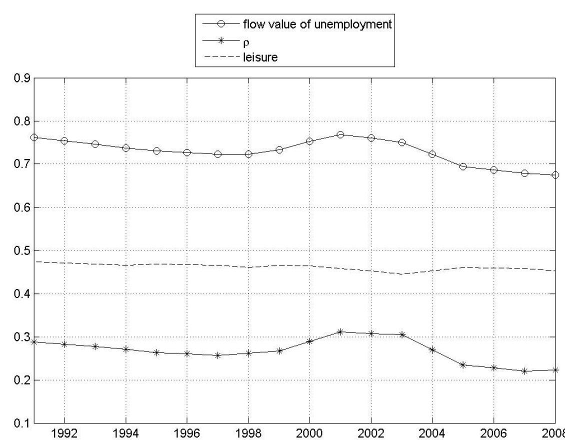
US



France



UK



Germany

Figure 20 puts in evidence two things. First of all, the implied flow value of non-employment remains inside some range which is widely accepted in the literature which is $[0.4; 0.943]$, the highest value being provided by Hagedorn and Manovskii (2008) whereas the lowest being the one proposed by Shimer (2005). Nevertheless, it seems that the general equilibrium value of this flow value of non-employment is closer to the one proposed by Hagedorn and Manovskii (2008): this is not surprising because our model does not restrict this value to the replacement rate, as it is suggested in Shimer (2005).

Firstly, remark that the levels of flow value of non-employment are quite similar among countries. But it is important to have in mind that in the US and in the UK, the bargaining power of the workers is very low, leading the real wage to be close to this flow value of non-employment [55], whereas in France, the bargaining power of the workers is large, implying that the real wage is larger than this flow value of non-employment.

Secondly we remark that the evolution of the flow value of non-employment for our countries is driven by different forces: in France the weight of the non-employment benefit is much more significant while the the value of "home staying" decreased (market hours decreased). In the US, the flow value of non-employment increases because the number of hours worked per employee rises over the sample: this endogenously increases the reservation wage of the US workers. In the UK the overall flow value of non-employment started to decrease after the Thatcher reforms (the beginning of the 1980s), mainly driven by the decrease of the non-employment benefit. In Germany, the dynamics of the overall reservation wage are mainly driven by the replacement rate, which increased temporarily during the first Schröder government (between the end 1990s and the mid-2000s), whereas it had decreased during the Kohl government and has decreased during the second Schröder government (Hartz reforms). At the opposite, in France, the flow value of non-employment decreases over the whole sample: before the large increase of the replacement ratio at the beginning and at the end of the 1980s (the Mitterrand reforms), this decline of the reservation wage explains the small increase of the employment rate. After the 1980s, this component of the flow value of the non-employment is dominated by the dynamics of the replacement rate: the employment rate declines after the beginning of the 1980s. It is only during the 2000s that the large decline of the reservation wage, due to the dynamics of the hours worked, explains the small increase of the employment rate. It is interesting to remark that the decline of the hours worked per employee en France and in Germany has not the same impact on the reservation wage in these two countries: in Germany, the high level of the employment rate allows families to have a higher wealth, that maintains the relative value between the consumption and the leisure, whereas in France, the decline of the employment rate reduces

[55] The observation of low bargaining power also supports the views of Hagedorn and Manovskii (2008) who calibrate this parameter at a value equals to 0.061.

the consumption and thus, reduces the relative leisure value. Thus, the endogeneity of the reservation wage, and more precisely its strong link with the number of hours worked, underline the interest of our general equilibrium approach.

G The fit of the model

G.1 Additional model predictions

We report the complete set of information about the fit of the model: Figures 21-24 show for each country not only the hours per worker and the employment rate as in the main text, but also total hours and the investment/output ratio.

G.2 The driving forces of the model

In this section we analyze the impact of the different driving forces of the model. In order to disentangle the effect of the evolution of the exogenous variables, we proceed as in McDaniel (2011) by "switching off" the effects caused by the different variables: we compare the outcome of the "full" benchmark model with that of

(i) a model in which only taxes vary, but labor market institutions and TFP do not;

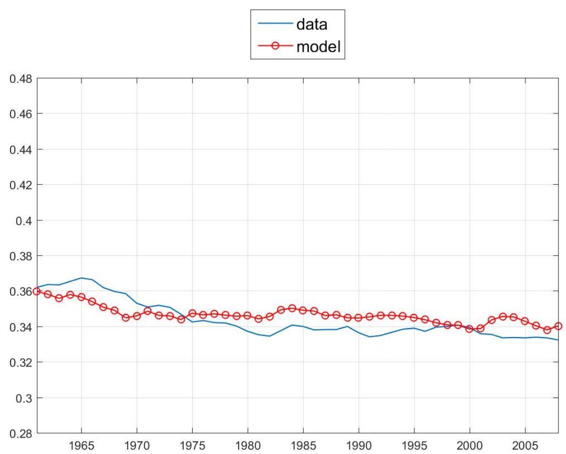
(ii) a model in which only labor market institutions evolve, but taxes and TFP do not.

In particular we fix the level of the constant exogenous variables to that one they attain in 2010, so that all the versions of the model share the same final steady state.

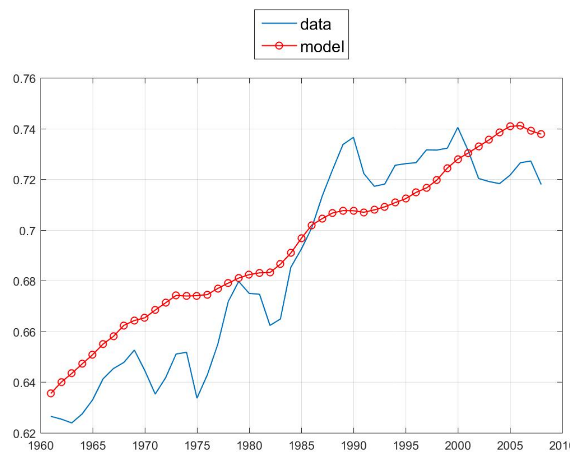
If we look at the evolution of hours for France in the top left panel of Figure 25, we see clearly the explicative power of the tax wedge: hours remain flat till 1975 and then they start to decrease, reflecting the evolution of the tax wedge that we can see in Figure 4. On the other hand, the evolution of employment is not at all explained in this case.

If we look at labor market institutions as the driving force of the model, we confirm the insight coming from the steady state analysis that they explain the evolution of the employment rate while the overall effect of hours worked is very limited, due to the low elasticity of the labor supply locus (see the right panel of Figure 13).

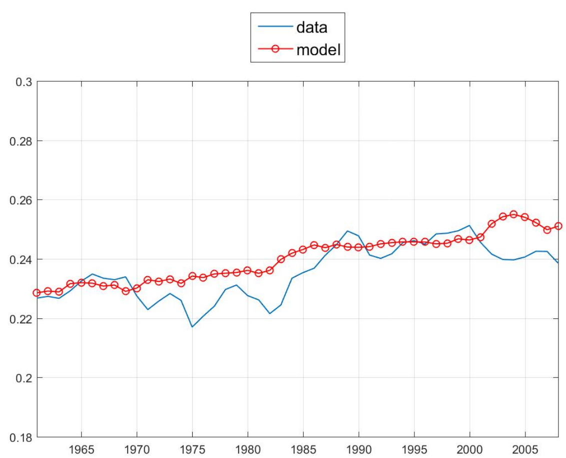
Figure 21: **The US economy**



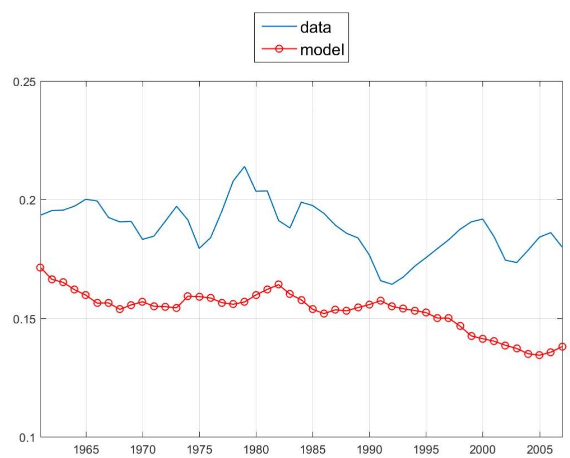
Hours per worker



Employment rate



Total hours



I/Y

Figure 22: **The French economy**

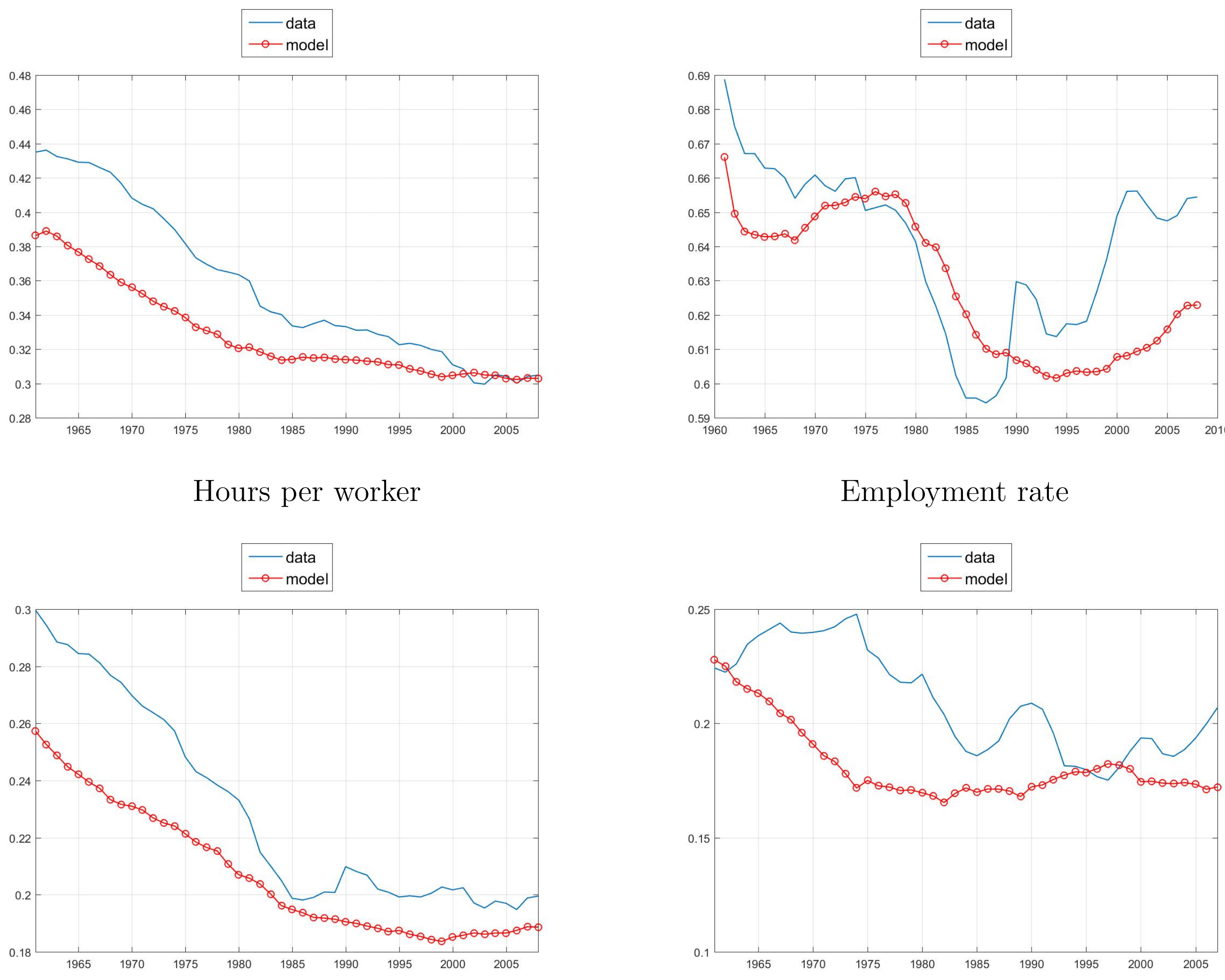
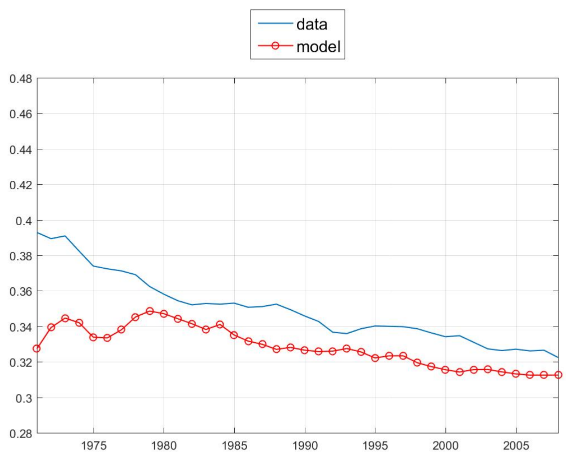
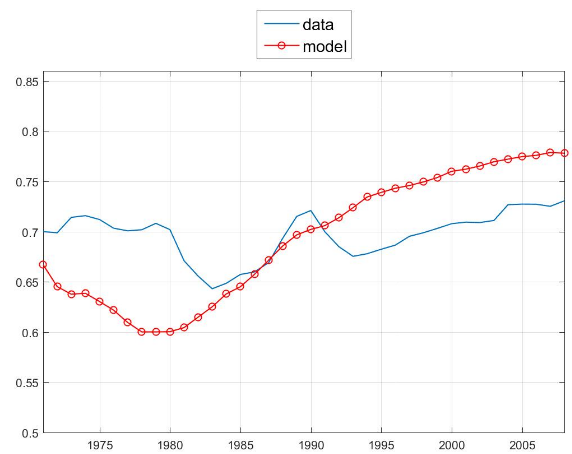


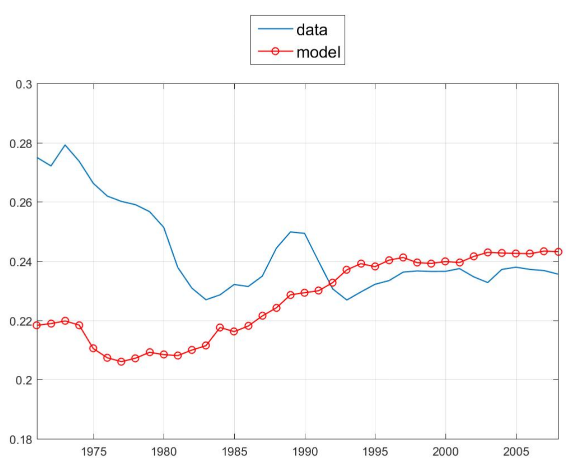
Figure 23: **The UK economy**



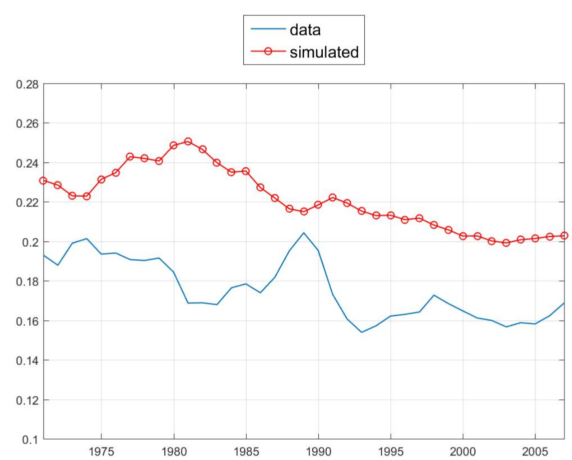
Hours per worker



Employment rate

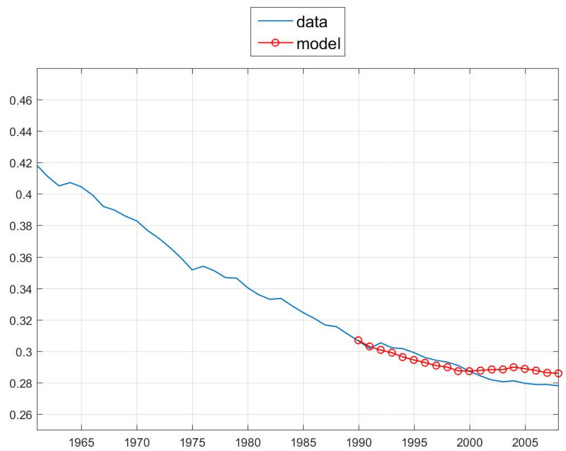


Total hours

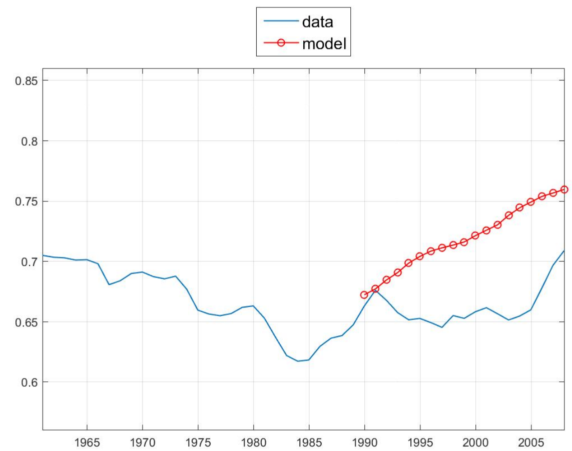


I/Y

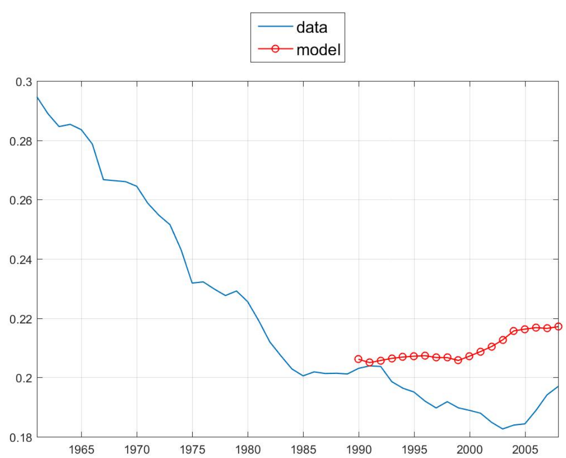
Figure 24: **The German economy**



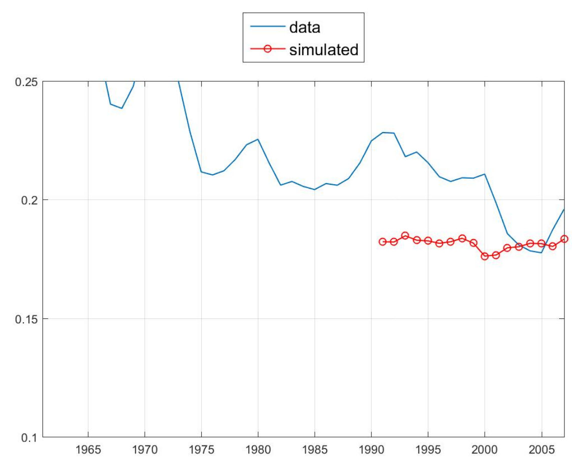
Hours per worker



Employment rate

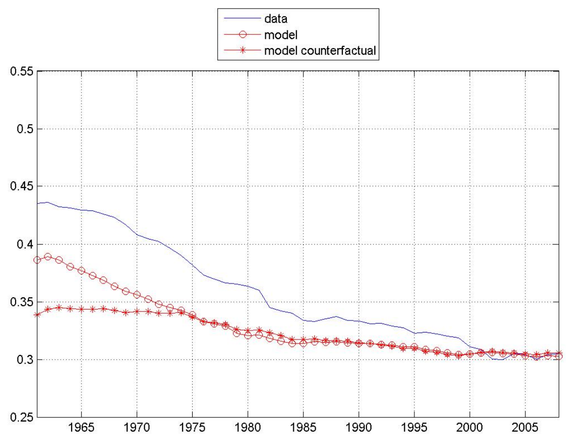


Total hours

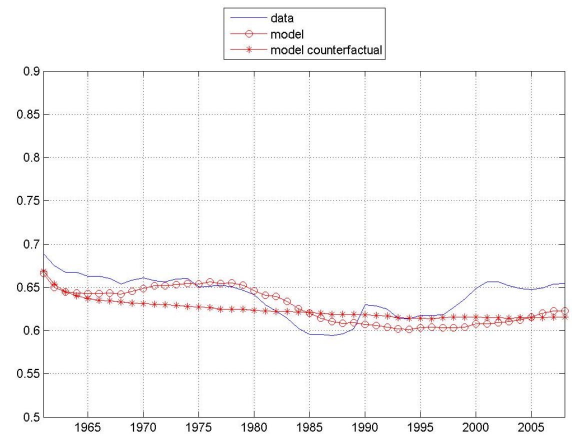


I/Y

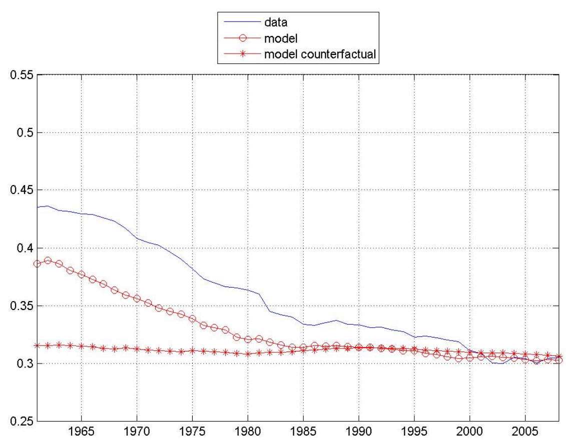
Figure 25: **Disentangling the contribution of exogenous variables (France)**



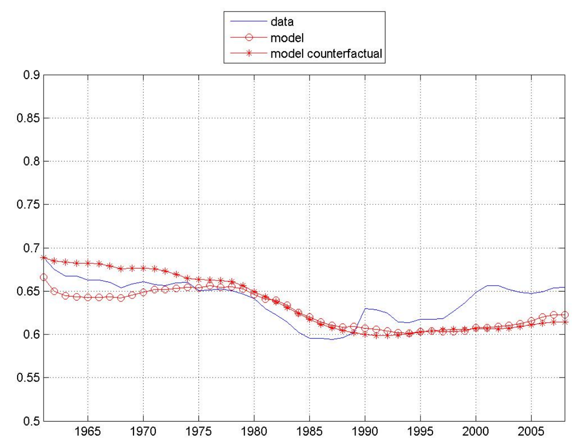
Hours if only taxes vary



Employment if only taxes vary



Hours if only LMI vary



Employment if only LMI vary

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