



**HAL**  
open science

## Accounting for Labor Gaps

Francois Langot, Alessandra Pizzo

► **To cite this version:**

| Francois Langot, Alessandra Pizzo. Accounting for Labor Gaps. 2018. halshs-01922697

**HAL Id: halshs-01922697**

**<https://shs.hal.science/halshs-01922697v1>**

Preprint submitted on 14 Nov 2018

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



**ACCOUNTING FOR LABOR GAPS**

---

FRANÇOIS LANGOT, ALESSANDRA PIZZO

[www.tepp.eu](http://www.tepp.eu)

TEPP - Institute for Labor Studies and Public Policies  
TEPP - Travail, Emploi et Politiques Publiques - FR CNRS 3435



# Accounting for Labor Gaps

FRANCOIS LANGOT \*

Le Mans Université (GAINS-TEPP-IRA), Paris School of Economics, Cepremap & IZA

ALESSANDRA PIZZO

Universidad de Chile & SMAUG †‡

First draft: January 2014

This version: August 2018

## Abstract

We develop a balanced growth model with matching frictions in the labor market to study the long run impact of changes in taxes and labor market institutions on total labor input, distinguishing between the extensive margin and the intensive margin. At a theoretical level, we show that there are significant benefits to simultaneously reforming these two wedges, due to positive complementarity. The model is tested on four countries (the US, France, Germany, and the UK). Using this structural approach, we can then perform counterfactual experiments about the evolution of the policy variables and compare the welfare levels implied by policy changes.

**JEL Classification :** E20, E60, J22, J60

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

---

\*Corresponding author. Email: [flangot@univ-lemans.fr](mailto:flangot@univ-lemans.fr)

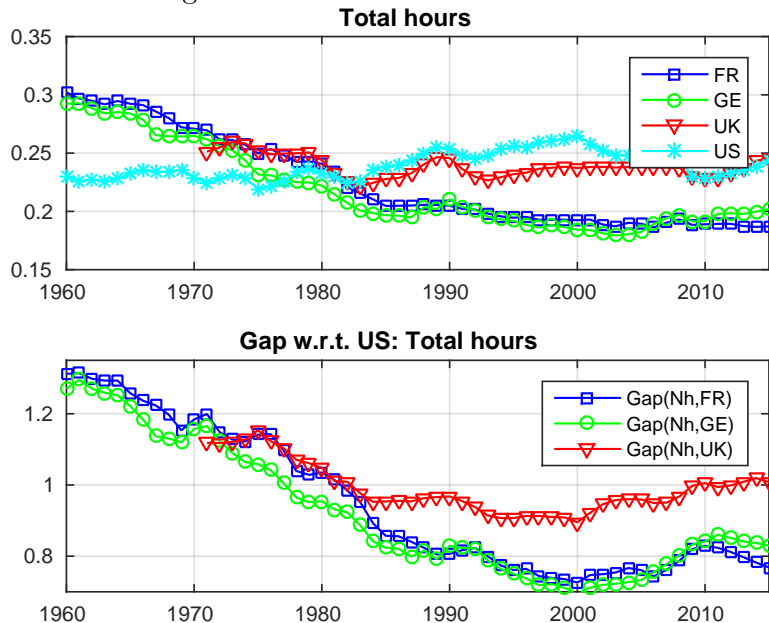
†Email: [ale.pizzo@gmail.com](mailto:ale.pizzo@gmail.com)

‡The paper is issued from the second chapter of my PhD thesis: financial support from the Banque de France as well as from the Anillo Project SOC 1403 (CONICYT) and Institute Millennium MIPP (IS130002) is gratefully acknowledged. We would like to thank Regis Barnichon, Florin Bilbiie, Gilbert Cette, François Fontaine, Jean-Olivier Hairault, Alexandre Janiak, Xavier Ragot, and Etienne Wasmer for their helpful comments. We also thank seminar participants at Banque de France, PSE, Banco Central de Chile, University of Chile, and T2M (Berlin) seminars. Any omissions and mistakes are our own.

# 1 Introduction

As it is well known, the evolution of total hours worked during the post-WWII period is characterized by sharp differences across developed economies. If we look in particular at the US and three selected European countries (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 is less significant. At the opposite, total hours increased in the US (see Figure 1, top panel). The “gaps” in terms of total labor supply between the US and the European continental countries have evolved over time until the 1990s, when they stabilized: whereas in the 1960s, total hours were 15% higher in Europe than in the US, today they are 20% lower (see Figure 1, bottom panel). In this long term perspective, the last crisis has had a large impact in the US, whereas structural changes seem to be the main drivers of the total hour changes in European countries.

Figure 1: **Total hours 1960-2015**



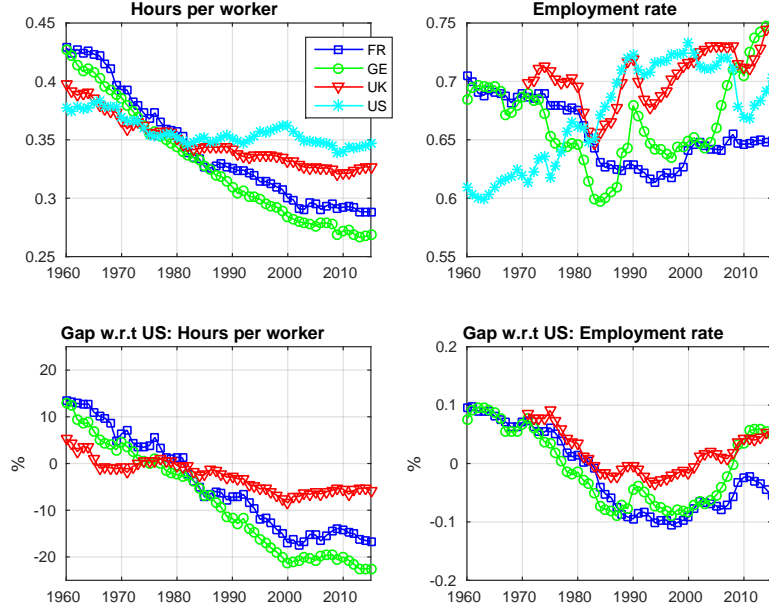
Total hours are given by the number of hours per year per worker, multiplied by the number of employed. We normalize the amount of total hours dividing by the working age population and a measure of total workable hours, so the measure we report is  $(\frac{N \cdot h}{14 \cdot 365})$ .

The evolution of total hours of work has been the object of attention of many studies.<sup>1</sup> There is wide agreement nowadays that both taxes and labor market institutions affect total hours of work. However, not many studies have focused on the simultaneous adjustments of the two margins that compose total hours: the hours per worker (the intensive margin) and the number of employees (the extensive margin). If we look at Figure 2, it is evident that these two margins experienced very different evolutions: some interactions exist (in terms of substitution or complementarity), and the sensitivities of each margin

<sup>1</sup>Without the pretension to be exhaustive, a short list of papers in the literature include Blanchard and Wolfers [2000], Prescott [2004], Alesina et al. [2006], Ohanian et al. [2008], and McDaniel [2011].

to policy changes are specific, i.e. there is a distinction between the elasticity of the hours worked by employee and the elasticity of the employment rate. In this paper, we propose to fill this gap by using information on both the intensive and extensive margins to measure the labor market allocation’s sensitivity to changing trends in taxes and institutions along the last 50 years.

Figure 2: **The decomposition of total hours 1960-2015**



Since Prescott [2004]’s study, it has emerged that we need a labor supply elasticity equal to or higher than 2, in order to explain the changes in total hours as a function of the heterogeneity of tax increases. However, since Blundell and MaCurdy [1999], studies based on micro data suggest values for this elasticity that are lower than 1. For many years, there has been a broad agreement in the literature that Frisch elasticity is important for the behavior of the labor market (see Shimer [2009]). Keane and Rogerson [2015] suggest that structural models that distinguish the intensive margin (hours worked by employee) and the extensive margin (number of employees) would be useful in understanding the interactions between these two components of the aggregate hours, allowing macro models to reproduce the dynamics of the aggregates on the labor market despite low Frisch elasticity at the individual level.<sup>2</sup>

Our model is able to distinguish the elasticities of the intensive and extensive margins but also allows us to identify the type of shocks and their dynamics that affect the labor market equilibrium, and in particular the changes in taxes 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

<sup>2</sup>The works of Chetty et al. [2011] and Chang et al. [2012] also underscore the necessity of reconciling micro and macro estimates of both intensive and extensive margins in response to permanent changes in tax rules.

market institutions.<sup>3</sup> We then 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.<sup>4</sup> This class of macroeconomic models provides a simple way to analyze labor market adjustments on both margins.<sup>5</sup>

Fang and Rogerson [2009], in a partial equilibrium framework, analyze from a theoretical point of view the effects of different policies (taxation and changes in job creation costs) on the two margins of labor supply. At the steady state, they show that the two margins, in terms of output production, can be considered as “substitutes”: policies that imply increases in the cost of creating jobs have a direct (negative) impact on the employment rate; through a negative wealth effect, however, these policies lead to an increases in hours worked per employee.

From a methodological point of view, we depart from the static analysis of the impacts of tax and LMI changes by following McDaniel [2011]: we solve for the equilibrium paths of the model, given the country-specific tax rates, labor market institutions, and productivity series, with perfect foresight. Hence, we go beyond the steady state analysis proposed by Fang and Rogerson [2009] and Prescott [2004]. By solving the model, and thus checking if the equilibrium saddle path exists, we also depart from Ohanian et al. [2008]: these authors consider a calibrated version of the growth model and compute the wedges affecting the static first-order condition governing labor supply.<sup>6</sup> The main interest of our approach is to provide the fit of the model for each variable, not only the residuals of FOCs that are combinations of several time series.

In our approach, agents share the same preferences for leisure across countries. Hence, we abstain from using a “cultural” interpretation to explain differences in hours worked

---

<sup>3</sup>The neoclassical growth model, as adopted by Prescott [2004] or McDaniel [2011], can be considered as a parsimonious approach to evaluate the impact of observed tax changes on aggregate worked hours. But in this model, the labor wedge is reduced to the tax wedge. 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 labor market institutions such as the unemployment benefit system or the type of wage bargaining arrangements. Nevertheless, these authors show that such shifts in labor market institutions do not have strong explanatory power. Our analysis shows that 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 in explaining the dynamics of aggregate hours.

<sup>4</sup>The model is close to the first contributions of Langot [1995], Merz [1995], and Andolfatto [1996] in the context of business cycle analysis.

<sup>5</sup>Thus, we depart from Prescott et al. [2009], Rogerson and Wallenius [2009], and Chang et al. [2012], who use the standard neoclassical growth model to account for labor adjustments along both margins. In these papers, the distinction between the elasticities of the two margins come from nonconvexity in the mapping between time devoted to work and labor services, as well as from the addition of idiosyncratic productivity shocks.

<sup>6</sup>Prescott [2004] computes this static wedge at two points (the early seventies and the mid-nineties), whereas Ohanian et al. [2008] compute the wedges of FOCs of the neoclassical growth model with annual frequency data, for a large set of OECD countries. Quintero Rojas and Langot [2016] measure the static wedges of FOCs of a matching model.

across countries.<sup>7</sup>

Finally, we also depart from Prescott [2004] when it comes to the choice of modeling government expenditure. Indeed, Prescott's evaluation is performed under the extreme assumption that all government expenditure can be substituted by private consumption. Hence, in Prescott's view, the optimal government size is zero. This view is contestable: one can distinguish between public expenditure on individual goods (education, health, etc.) and intrinsically collective goods (army, justice, collective equipment, etc.). Unlike the first category, the optimal size of collective public spending cannot be zero, because there is no perfect substitute in private consumption.<sup>8</sup> Hence, in our evaluation of a tax-cut reform, we then distinguish between these two types of government spending and we will reduce only the individual government spending, which is the type that induces a misallocation of consumption.

What do we learn from our methodology?

First, there is a non-trivial interaction between the two labor margins, leading to a substitution between hours per worker and employment. Moreover, taxes and labor market institutions do not have the same impact on these substitutions. A change in labor market institutions 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, and this leads households to reduce their hours worked by employee. A reduction in tax provides incentives to increase effort at work (intensive margin), with the side effect of raising 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. The responses of the two margins interact, supporting the idea that the changes of extensive and intensive margins are not independent.<sup>9</sup>

Second, from a quantitative point of view, two points must be stressed:

- (i) Given our calibration strategy, which only restricts the averages of the simulated series of hours per worker and employment to match their empirical counterparts, our model enables us to predict both 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.

---

<sup>7</sup>See Alesina et al. [2006], where externalities in the utility from leisure at a society level can generate a "social multiplier".

<sup>8</sup>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.

<sup>9</sup>This point is also underlined by Chang et al. [2012]. These authors, however, use a model without labor market frictions where the shift of labor market institutions can not be analyzed.



- (ii) We can compute the welfare gains associated with a change in policy. The size of the distortions induced by the high tax wedge overcomes the one induced by changes in the labor market institutional setting. Moreover, a complementarity exists between the two sets of reform. This implies that each reform simultaneously affects both the intensive and the extensive margin: The sum of the gains from each reform is lower than the overall gains coming from implementing both reforms at the same time.

This paper is organized as follows. Section 2 documents the data used. In Section 3, the search and matching model is outlined. Section 4 calibrates the model's key parameters and applies it to the data. 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 European continental cases. With respect to Germany, it is important to remember that most of the data (GDP, hours, etc.) have been reconstructed so as to correspond to the reunified country after 1989. However, the variables that measure labor market arrangements are typically not comparable between the two economies of West and East Germany<sup>10</sup>. We therefore decided to perform a “check” of the explanatory power of our model by looking at its predictions for Germany for only the last 20 years (i.e., starting from 1990). We can therefore show why our choice of countries is interesting, from the perspective of testing the theory: Since the exogenous variables (taxes, labor market institutions, and technological progress) do not have the same dynamics over this time period, 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.<sup>11</sup> 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.

The evolution of total hours worked differs widely over the last fifty years in the selected

---

<sup>10</sup>For the years before reunification, data on LMI, in our case unemployment benefits generosity and workers' bargaining power, refer only to West Germany.

<sup>11</sup>Appendix A contains a description of data sources.

Table 1: **Ratios**

Ratios in 2015 relative to 1960	US	FR	UK	GE
Total hours ( $\frac{Nh}{Pop \cdot 365 \cdot 14}$ )	1.06	0.62	0.98	0.69
Employment rate ( $\frac{N}{Pop}$ )	1.15	0.92	1.08	1.10
Hours per worker ( $\frac{h}{365 \cdot 14}$ )	0.92	0.67	0.91	0.63

For the UK, we report the ratios in 2015 relative to 1971

countries: While they slightly increased in the US, they declines considerably in the European continental countries (France and Germany), with their evolution in the UK being somewhere in between. This evolution is in fact caused, as we have seen, by the path of the two margins that compose total labor input: the intensive margin and the extensive margin.

The American “jobs miracle” that began in the sixties was characterized by an increase in the chance of being employed and a small decline in the hours worked per employee. Germany and the UK show comparable evolutions in the employment rate, but only after the eighties; in the UK the employment rate recovered after the crisis of the early 1980s, while the break in Germany seems to correspond the reforms implemented by Schröder and Hartz<sup>12</sup> in the early 2000s. As we can see in the bottom right panel of Figure 2, just before the Great Recession the UK and Germany closed the “employment gap” with respect to the US and then suffered a lower decrease during the crisis, so that today they show a higher employment rate than the US. By contrast, France performs particularly poorly: The chance of being employed falls from 70% to 65%, following the presidential election of Mitterrand, elected in 1981, and therefore used as a break date in the following.

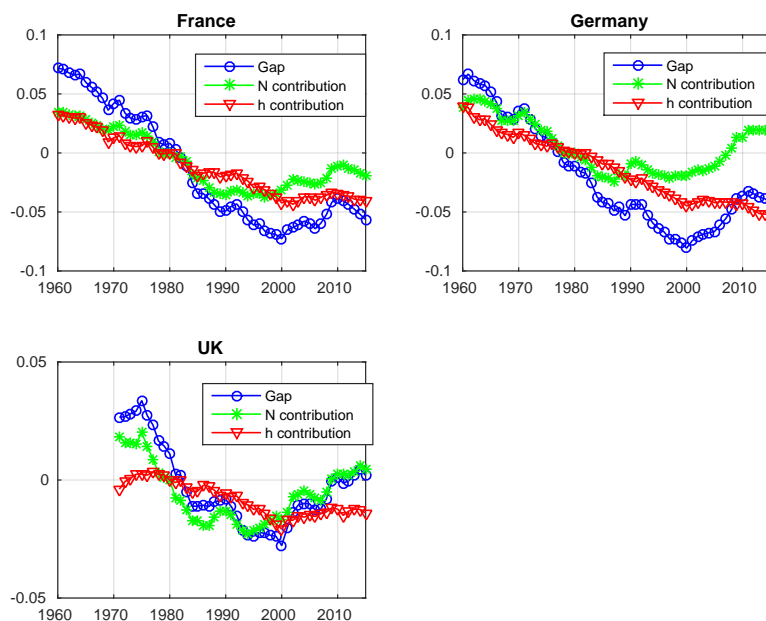
If we look at the intensive margin, in the top left panel of Figure 2, we observe a sharp decline in France and Germany, while in the US hours per worker declined only marginally. The UK seems to share the evolution of its continental neighbor, but only until the beginning of the eighties, when the decline slowed down. Since then, the number of hours worked per employee is stable and only slightly lower than that of an American worker.

We can measure the total-hours-worked gap between a countries  $i$  and the US, ie.  $Gap_{i,t} = N_{i,t}h_{i,t} - N_{US,t}h_{US,t}$ , as well as the contribution of employment rates and hours per worker to this gap. To measure these two contributions, we follow Rogerson [2006]. We consider two hypothetical cases: in the first, the relative employment changes in country  $i \neq US$  did not happen, and the chance of being employed evolves as in the US, whereas in the second, the relative changes of hours worked by employee in country  $i \neq US$  did not happen, and the effort at work evolves as in the US. Hence, the series “ $N$  contribution” are the number of additional hours worked that economy  $i$  would have at date  $t$  if its

<sup>12</sup>These new laws regulating the labor market make part-time work easier and reduce labor costs. Thus, the hours per worker do not increase, whereas by the end of the sample, the employment rate has surpassed the one observed in the US for the first time since the end of WWII.

employment rate were the same as in the US: The comparison of these series with the observed differential in relative total hours ( $Gap_{i,t}$ ) gives us a measure of the employment rate contribution. If the contribution of employment to the total hours gap is significant, we expect a series of hypothetical total hours close to the gaps in actual hours. We replicate the same computation for the contribution of the hours worked by employee ("*h contribution*").<sup>13</sup>

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



In each panel of Figure 3, for each country, the reference year ( $t_0$ ) is 1981. Total hours  $Nh$  are multiplied by  $365 \cdot 14$ . In 1960, a French worked 7% more than an American in comparison with 1981, the reference year for this gap. At this time, the contributions of employment rate and hours worked by employee on this gap were equal (3.5%), meaning that a French had more chance to be employed and worked longer than a American.

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 small and even positive at the end of the period, showing that this country provides the same chance of being employed as the US. This dynamic, 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 is the result of a smaller number of hours worked per employee: The losses, in Germany and in the UK, are 270 hours and 75 hours per year respectively. In France, the experience is different: From 1985 to 2000, the most significant contribution

<sup>13</sup>See appendix B for more details on this decomposition.

to the hours gap is the low chance of employment for workers in 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 that the hours per French 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 order to account for these country specific patterns in total hours, we introduce three groups of exogenous variables in our model: the set of tax rates that defines the tax wedge (tax on labor income and consumption), 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. Detailed data description and data sources are available in Appendix A.

We also introduce the time varying tax rates on capital revenues and investment (see Appendix D.1), as well as the government expenditures (collective and individual, see Appendix D.2) specific to each country.

### 2.2.1 Taxes on labor and consumption

In terms of data sources, all tax rates are taken from McDaniel [2007].<sup>14</sup>

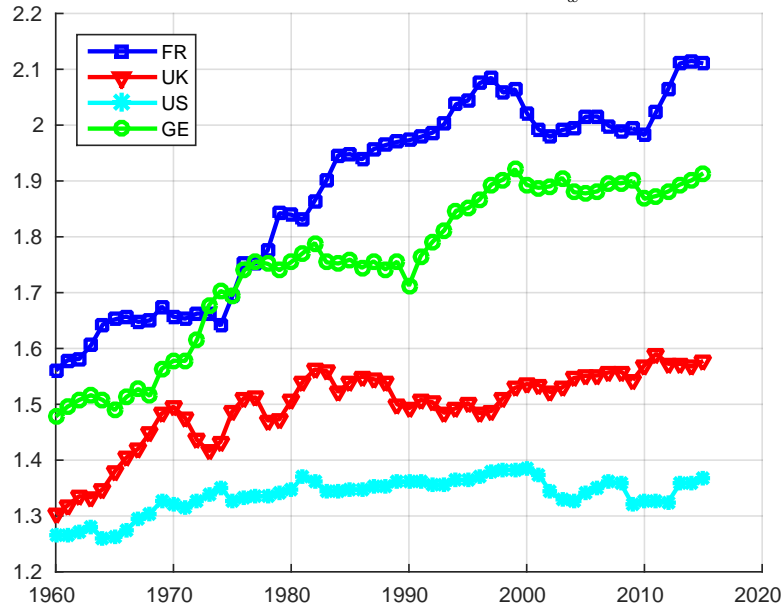
In Figure 4, we report the evolution of the consumption and income taxes. We observe that the tax wedge is stable over the total period in the US. In 1960, it was necessary to produce \$1.27 in order to consume \$1. In 2015, the situation is not very different: It is necessary to earn \$1.37 in order to consume \$1. By contrast, in France, the tax wedge increases rapidly between 1960 and 1985, and continues to grow afterwards at a lower rate. Whereas in 1960 it was necessary to earn \$1.56 in order to consume \$1, in 2015 it is necessary to earn \$2.11 to do so. In Germany the tax wedge increased through the seventies and then in the nineties, and today it is very similar to the level observed in France. In the UK, the tax wedge increased until 1980 and then remained stable at a level closer to the one observed in the US than in the European continental countries.

These data suggest two things, in a world where all employees have a job ( $N = 1$ ). Firstly, the "static" effect of the taxes can reduce the levels of hours worked by employee. Secondly, the "dynamic" effect induced by the intertemporal substitution can lead to a

---

<sup>14</sup>Latest update: 2015; data are available at <http://www.caramcdaniel.com/researchpapers>.

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



reduction of hours worked when the taxes increase.

## 2.2.2 Labor market institutions

We consider two different labor market institutions: a measure of the bargaining power of the worker and the unemployment benefits replacement rate.

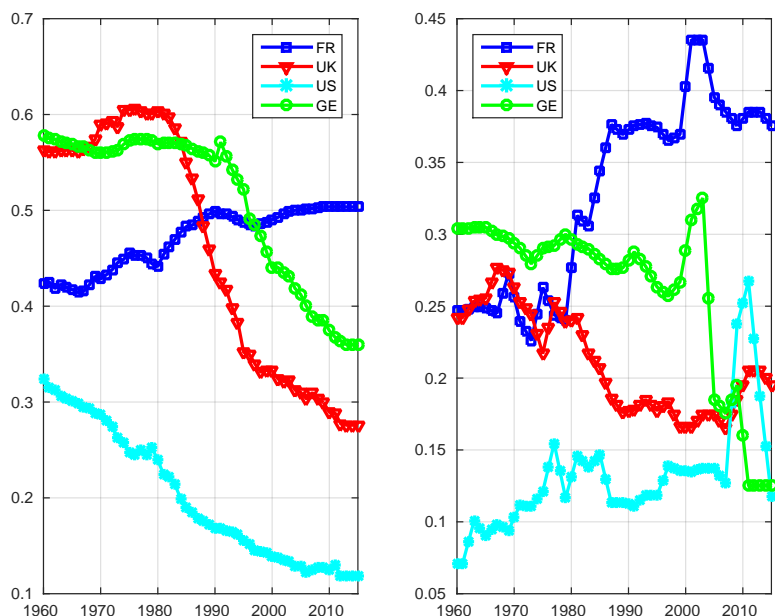
The data on bargaining power are taken from the Database on Institutional Characteristics of Trade Unions, Wage Settings, State Intervention and Social Pact (ICTWSS).<sup>15</sup>

Two statistical indicators can 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 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 averaging the union coverage and union density.

In the left panel of Figure 5 we report the evolution of the bargaining power of the workers. A brief look at these data suggests that the influence of these institutions is very different across our selected countries. We observe a continuous decline in the US, while the UK and Germany show a significant decline in the eighties and in the nineties, respectively (it should be remembered that for Germany, the data prior to the reunification correspond only to West Germany.). At the opposite end of the spectrum, France is characterized by a continuous small increase over the sample.

<sup>15</sup>J. Visser, ICTWSS Data base. version 5.1. Amsterdam: Amsterdam Institute for Advanced Labour Studies (AIAS), University of Amsterdam. September 2016.

Figure 5: LMI: bargaining power of the workers (left) and replacement rate (right)



These trajectories are mainly explained by the fact that unions declined in density across all countries, but France overcompensated for these losses by increasing the union coverage, promoted by the French governments during the eighties. The break in the data for the UK is due to the labor market reforms promoted by the first Thatcher government. In Germany, after a brief surge in union membership after the reunification, the unions lost force during the 1990s.<sup>16</sup> The additional decline in the 2000s is linked to the role of the Schröder governments, which limited the role of unions to achieve more flexibility in hiring and firing rules.

The indicator of the replacement rate is provided by the OECD. It is a measure of gross non-employment income over an unemployment period of five years. Since it is available only for uneven years, we linearly interpolated the missing values.

Concerning the non-employment benefits, the dynamics of the replacement rate are also highly different across countries, as it can be seen in the right panel of Figure 5.

After a slight increase before the middle of the seventies, the replacement rate in the US has remained constant. The spike in recent years is due to an increase in the length of

<sup>16</sup>According to the European Foundation for the Improvement of Living and Working Conditions (<https://www.eurofound.europa.eu/observatories/eurwork/articles/industrial-relations/trade-union-membership-and-density-in-the-1990s>), “After German unification, West German trade unions expanded into East Germany, taking over East German trade unions and most of their members. As a consequence, total union membership rose to more than 13.7 million in 1991. Since then, however, total membership has fallen every year [...]. From 1991 to 1998, German trade unions lost almost 3.5 million members. A large share of these losses seem to stem from eastern German workers leaving the unions because of unemployment and disillusion with the western-type unionism, but since not all unions provide separate figures for eastern and western Germany, it is hard to draw definite conclusions. Membership is also falling because unions have severe problems in recruiting younger workers and employees in the growing private service sector”.

the period in which workers can collect unemployment benefits, a measure adopted after the 2008 crisis.<sup>17</sup> While at the beginning of the sample the replacement rate in the UK was similar to that in France, it has been reduced during the Thatcher government. 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 number of people eligible for unemployment insurance, and a reduction 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 is greater. The French experience has been very different: The first socialist government (the beginning of the eighties) increased unemployment benefits by more than 50%.<sup>18</sup>

The basic DMP model, with constant hours worked by employee, suggests that a high bargaining power or a large replacement rate reduce employment rate ("static" effect obtained at the steady state). By decreasing the capitalization effect, the increases in bargaining power or replacement rate lead to decrease the employment rate over time.

### 2.2.3 Technological progress

We recover the Solow residuals, which measure the labor augmenting technological process, from the production function, as  $A = \left(\frac{Y}{K^{1-\alpha}}\right)^{1/\alpha} \frac{1}{Nh}$ .

Figure 6 shows the logarithm of technological process time series. It suggests that there are some "breaks" in these time series.<sup>19</sup> As far as the European economies are concerned, there is a great deal of literature asserting that there was a period of technological "catching up" after the material destructions of the WWII period. We suppose a break in the linear trend for productivity in the mid eighties for France and the UK, and in 1981 for Germany; for the US, we suppose a break in the mid 90s, when productivity seems to accelerate: in all four cases, the Chow test confirms our hypothesis (for the details, see Appendix E).

We then choose to consider the rate of growth of productivity estimated in the second half of the sample as the "long run" value to deflate all macroeconomic series, while the higher rates of growth experienced in the first half of the sample correspond to a transitory period of exceptionally high growth.

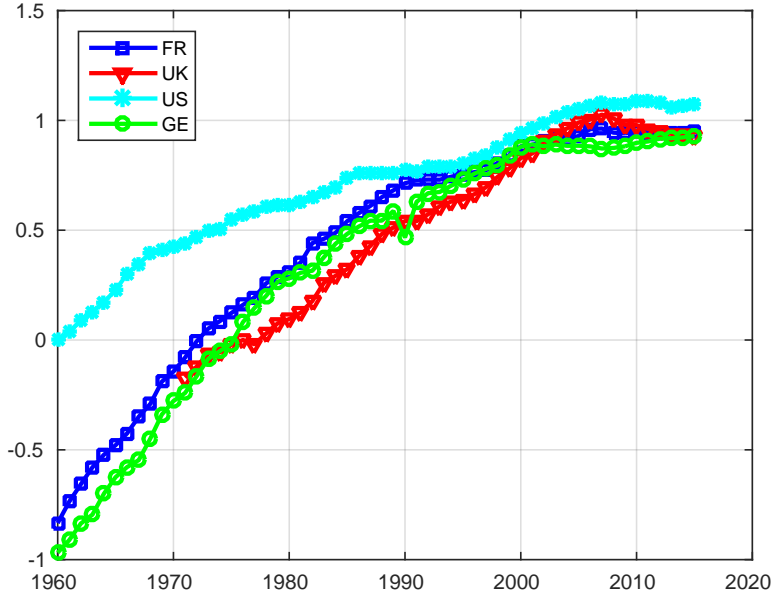
---

<sup>17</sup>Starting from March 2009, President Obama extended unemployment benefits from the original 26 weeks to a maximum of 99 weeks, as part of the American Recovery and Reinvestment Act. Starting from 2013, these extensions were phased out.

<sup>18</sup>See Appendix C for a discussion on the measure of the non-employment incomes.

<sup>19</sup>Since our model considers a balanced growth path, all macroeconomic series are deflated by the total growth rate of GDP and population.

Figure 6: Solow residuals in log



### 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. 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 has a standard Cobb-Douglas form  $M_t = \Upsilon V_t^\psi (1 - N_t)^{1-\psi}$  and  $V_t$  indicates the number of vacancies. We highlight here that the separation rate  $s$  is fixed across time 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 the job finding and job filling probability respectively .

#### 3.2 Households

The economy is populated by a representative households, consisting of a continuum of identical infinite lived agents. Each agent can be either employed or non-employed (and thus free to occupy a job). Agents pool their incomes inside the household, so that they are fully insured against non-employment idiosyncratic risk. The income of



an unemployed agent is indicated by  $\tilde{b}_t$ , and it consists in a proportion  $\rho_t$  of the wage income. Agents consume and save by accumulating physical capital, that they rent to firms. Investment is subject to capital adjustment costs.<sup>20</sup> Agents pay taxes on their wage income, capital income, investment, and consumption spending. The revenues of these taxes are used by the government to finance (i) non-employment benefits and (ii) public expenditures. 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. The program of a household is given by:

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

$$\text{s.t. } I_t(1 + \tau_{i,t}) + c_t(1 + \tau_{c,t}) + \frac{\Phi}{2}(K_{t+1} - (1 + g)K_t)^2 = (1 - \tau_{w,t}) \left[ w_t h_t N_t + (1 - N_t)\tilde{b}_t \right]$$

$$+ \pi_t + (1 - \tau_{k,t})r_t K_t$$

$$K_{t+1} = K_t(1 - \delta) + I_t$$

$$N_{t+1} = (1 - s)N_t + f_t(1 - N_t)$$

where, at the symmetric equilibrium, we have  $\tilde{b}_t = \rho_t w_t h_t$ . The term  $\bar{c}$  indicates the presence of a “subsistence” term in consumption. It changes the individual choices by reducing the wealth effect mostly when, at the beginning of the period, the European economies are off the balanced growth path. Indeed, with exogenous growth, this component disappears, because  $C_t \rightarrow \infty$  when  $t \rightarrow \infty$ , whereas  $\bar{c}$  is constant. By reducing the wealth effect at the beginning of the sample, this term is important to account for the “catching up” of the European countries, compared to the development levels of the US, in the aftermath of WWII.<sup>21</sup>

### 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  $\omega_t$ . So the

<sup>20</sup>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.

<sup>21</sup>See for example Rogerson [2006].

total costs paid by the firm are given by the wage bill, the rental cost of capital, and the vacancy posting costs. Since the firm is owned by the household, the discount factor used to evaluate the future flow of profits includes the marginal value of wealth  $\lambda_t$ . The firm's program is given by

$$V^f(N_t) = \max_{V_t, K_t} \left\{ K_t^{1-\alpha} (A_t N_t h_t)^\alpha - w_t h_t N_t - r_t K_t - \omega_t V_t + \beta \frac{\lambda_{t+1}}{\lambda_t} V^f(N_{t+1}) \right\}$$

$$\text{s.t. } N_{t+1} = N_t(1-s) + q_t V_t$$

### 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 ( $\epsilon_t$ ). The result of the bargaining process is given by the wage and hour equations:

$$w_t h_t = (1 - \epsilon_t) \underbrace{\left[ \alpha \frac{Y_t}{N_t} + \omega_t \left\{ \frac{(1-s)}{q_t} \left( 1 - \frac{\phi_{t+1} (1 - \tau_{w,t+1})}{\phi_t (1 - \tau_{w,t})} \right) + \frac{\phi_{t+1} (1 - \tau_{w,t+1})}{\phi_t (1 - \tau_{w,t})} \theta_t \right\} \right]}_{BS}$$

$$+ \epsilon_t \underbrace{\left[ \frac{(1 + \tau_{c,t})}{(1 - \tau_{w,t})} (C_t - \bar{c}) \left( \Gamma^u + \sigma_l \frac{h_t^{1+\eta}}{1 + \eta} \right) + \rho_t w_t h_t \right]}_{RW} \quad (1)$$

$$\sigma_l h_t^\eta = \alpha \frac{Y_t}{N_t h_t} \frac{(1 - \tau_{w,t})}{(1 + \tau_{c,t})} \frac{1}{C_t - \bar{c}} \quad (2)$$

where  $\phi_t = \frac{1-\epsilon_t}{\epsilon_t}$ . The marginal labor cost per employee ( $w_t h_t$ ) 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<sup>22</sup>. 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<sup>23</sup>. Indeed, if workers expect that tomorrow their bargaining power will be 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

<sup>22</sup>Note that in the simple case where bargaining power and taxes are constant over time, we simply have  $BS = \alpha \frac{Y_t}{N_t} + \omega \theta_t$ .

<sup>23</sup>See for example Burda and Weder [2016] for a discussion about the implications for business cycle fluctuations of the presence of a time-varying tax wedge in the wage equation.

( $\phi_{t+1} > \phi_t$ ), the match value 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  $\epsilon$  and  $\tau$ . The  $RW$  is given by the sum of the marginal rate of substitution of consumption for employment  $(C_t - \bar{c}) \left( \Gamma^u + \sigma_t \frac{h_t^{1+\eta}}{1+\eta} \right)$  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 (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:

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

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

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

We use a neoclassical growth model that 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  $g = g_A + g_n$ .<sup>24</sup>

---

<sup>24</sup>See Appendix F for a complete description of the equation of the stationarized model.

## 4 Quantitative results

The model is solved with perfect foresight using the software Dynare (see Adjemian et al. [2011]): the path of all exogenous variables is known to agents from the beginning.<sup>25</sup>

The model is simulated for a finite number of periods ( $T = 1000$ ), starting from the year 1960. The exogenous time series that are fed to the model (the technological progress, the vacancy posting costs and the policy variables- taxes and LMI) are given by actual data till 2015: our hypothesis about the long run steady state values is that there is no change after 2015, i.e. all exogenous time series keep the values they have in 2015 until the end of the simulation.

First, we present our calibration strategy. Second, once the model is simulated with the identified parameters, and the country-specific exogenous variables, we plot the simulated series and the actual series for the four countries.<sup>26</sup> We then focus mainly on the two countries at the ends of the spectrum, the US and France, and perform some counterfactual experiments. We give some intuition of the functioning of the model by considering a steady state version 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 for each country, we need to identify some parameters. The first identifying restriction is the choice of the common calibrated parameters:  $\Theta_1 = \{\beta, \delta, \alpha, \Phi, \eta, \psi\}$ . 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*)  $1 = \frac{\beta}{1+g} \left[ 1 - \delta + \frac{1-\tau_k}{1+\tau_{inv}} r \right]$ , *ii*)  $r = (1-\alpha)\frac{Y}{K}$  and *iii*)  $I = (\delta+g)K$ , where the values of  $g$ ,  $\tau_k$ ,  $\tau_{inv}$  are country-specific. For the US, for example, the model implies an average value of the investment-output ratio, over the whole simulation period, of  $\approx 0.18$ , so that we obtain a gross interest rate  $r \approx 13.39\%$ , and thus  $r-\delta \approx 8.39\%$ , using *ii*) and *iii*). Note that our value of  $\alpha$  is such that the first equation 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.<sup>27</sup> We therefore choose to reduce the interest rate by an amount which corresponds to the risk premium

---

<sup>25</sup>In Appendix G 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.

<sup>26</sup>As noted earlier, for Germany we will use our model to simulate only the period starting from 1990.

<sup>27</sup>See Gomme and Rupert [2007] for a more complete discussion on this point.

( $\kappa = 20\%$ ), 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  $r(1 - \kappa) - \delta \approx 5.7\%$ , which is closer to the long-run value of the asset returns. Following Kollmann [2004], we set the scale parameter of the capital adjustment cost function  $\Phi = 10$ . Our parameter  $\eta$  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 micro-data reported by, for example, Chetty et al. [2011]. The parameter  $\psi$ , which represents the elasticity of the matching function with respect to vacancies, is set to a value of 0.5, which is an average of the range of possible values identified by Pissarides and Petrongolo [2001], and is widely adopted in literature.

The country-specific calibrated parameters are  $\Theta_2 = \{s_i, g_{A,i}, g_{n,i}, \chi_i\}_{i=US,FR,UK,GER}$ . For the separation rate  $s$ , we use the estimation results in Elsby et al. [2013]. 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 2.2.3), we fit a linear trend, which is our  $g_A$ . Similarly, we fit a linear trend to the population aged 15-64 and call it  $g_n$ . The total rate of growth of all non-stationary variables will therefore be  $g = g_A + g_n$ .

As we have seen in Section D.2, the ratio of government expenditures on collective goods to GDP differs across countries. This leads us to calibrate  $\chi_i$  as a parameter, allowing the model to match these collective goods as if they were chosen by the government in accordance to the households' preferences.<sup>28</sup>

Table 2: **Calibrated parameters**

	$\beta$	$\delta$	$\eta$	$\alpha$	$\psi$	$\Phi$
Common	0.98	0.05	2	0.3	0.5	10
Country	$s_i$	$g_{A,i}$	$g_{n,i}$	$\frac{G^{col}}{Y} \rightarrow \chi_i$		
US	0.12	0.013	0.0104	0.098		
FR	0.15	0.013	0.0056	0.085		
UK	0.17	0.024	0.0033	0.090		
GE	0.12	0.017	0.0017	0.069		

The parameters left to identify are the following:  $\Theta_3 = \{\sigma_l, \Gamma^u, \bar{c}_i, \omega_i, \Upsilon_i\}_{i=US,FR,UK,GER}$ .

Our restrictions are that the asymptotic preferences (represented by  $\sigma_l$  and  $\Gamma^u$ ) are common to all countries, whereas two sets of parameters are country specific: the scale parameters of the matching functions ( $\Upsilon$ ), as well as the vacancy posting cost ( $\omega$ ) and the subsistence term of consumption  $\bar{c}$ .

In order to calibrate the vacancy posting costs, we consider the information in Barron

<sup>28</sup>We know that optimally the marginal utility of a unit of private consumption has equalize that one of a collective public consumption good, i.e.  $1/C = \chi/G^{col}$ . Since we have data for all these series for each country, under the assumption that actual collective good expenditure is optimal we can recover the value of the parameter  $\chi$ , by using the historical average values.

et al. [1997] (which has been adopted also by Fujita and Ramey [2012]) where  $\omega$  amounts to 17% of the average labor productivity. We calibrate the parameter using the data for the four countries to meet the target for the beginning of the period. We then allow the vacancy posting costs to grow at a rate that can be different from the rate of growth of other macro variables, during the transition period. Thus, while we calibrate the first value  $\omega_{1960}$ , we need to estimate the final value  $\omega_{2015}$ . In order to do so, we proceed by estimating a rate of growth of  $\omega$ ,  $g_{\omega,i}$  for each country  $i$ , so that we obtain a whole series of values of the vacancy posting costs as  $\omega_{i,t} = \omega_{i,1960} * (1 + g_{\omega,i})^t$ .

The value of  $\bar{c}$  should be different from zero only for countries that 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.<sup>29</sup>

The calibration procedure is the solution of  $\min_{\Theta_3} \|\Psi^{theo}(\Theta_3) - \Psi\|$ . The targeted moments are  $\Psi = \{\bar{N}_i, \bar{h}_i, \bar{I}_i/\bar{Y}_i, \bar{\Delta h}_j\}$ , for  $i = US, FR, UK, GER$  and  $j = FR, UK, GER$ , where  $\bar{X} = \frac{1}{T-t_0} \sum_{t=t_0}^T X_t$ , with  $T = 2015 \forall X = N, h$  and  $\bar{\Delta h} = h_{1975} - h_{1960}$ . Given that  $dim(\Psi) = 15$ , there are over-identifying restrictions.<sup>30</sup> In Table 3 we report the values of the identified parameters.

Table 3: **Identified parameters**

parameter	US	FR	UK	GE
$\sigma_l$	31.1	31.1	31.1	31.1
$\Gamma^u$	0.03	0.03	0.03	0.03
$\Upsilon_i$	0.29	0.50	0.55	0.37
$g_{\omega,i}(\%)$	0.04	1.38	0.33	1.36
$\bar{c}_i/C_i$	0	0.62	0.15	0.48

We report the value of  $\bar{c}$  in terms of the consumption per capita of each country in 1960.

With these restrictions, any difference in the behavior of the economic variables predicted by the model will therefore be guided by differences in “policy” variables (namely taxes and LMI) or “technological” conditions (namely the Solow’ residuals, the matching technology efficiency, and the search costs).<sup>31</sup> Given that our objective is to match the overall dynamics of the observed time series with our model simulations, we report in addition

<sup>29</sup>The presence of the term  $\bar{c}$  is important from a quantitative point. McDaniel [2011] obtains values of  $\bar{c}$ , in terms of consumption in 1960, equal to 27%, 40% , 52 % and 54% for the US, UK, France, and Germany respectively. In countries that 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 H for a more detailed discussion.

<sup>30</sup>As noted above,  $dim(\Theta_3) = 13$ .

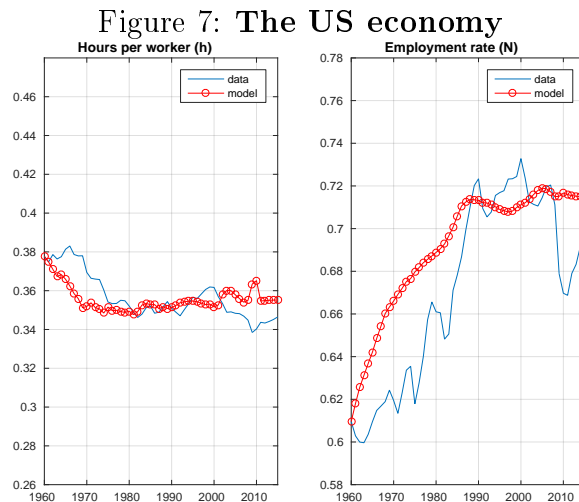
<sup>31</sup>In Appendix I, we analyze the dynamics of the outside value of employment, which is usually presented as a key variable of the Shimer [2005] puzzle. It is shown that the general equilibrium approach puts this “puzzle” into perspective.

to the graphical analysis, the value of the MSE 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 slope over the first years of  $h$  in France, Germany, and the UK, the model's ability to fit the observed data must be tested using additional information: We check that it correctly predicts the long-run evolution of the variables of interest (the intensive and extensive margins).<sup>32</sup>

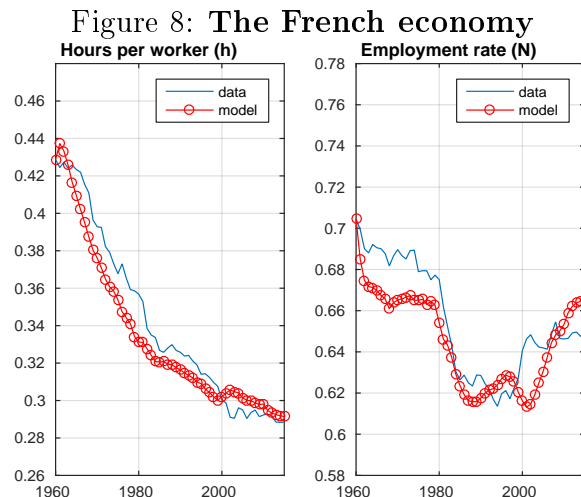
Initially, for the US, taxes remain stable, whereas the labor market institutions (LMI) shift slowly in favor of firms. The model then predicts an increase in the employment rate and a small decline in the hours per worker. The composition of these adjustments of the two labor market margins leads to a marginal increase in predicted total hours during the period. These results for the US economy are reported and compared to the observed data in Figure 7. Given that there is no break point in the time series of the taxes and the LMI in the US, the model reproduces the small and continuous changes observed simultaneously in the hours per worker and employment rate. The Mean Square Errors (MSEs) for the hours worked and for employment are respectively equal to  $1.1756 \cdot 10^{-4}$  and  $9.0145 \cdot 10^{-4}$ . The ratio of the vacancy posting costs to labor productivity ( $\frac{\omega}{Y/Nh}$ ) averages 16.2% over the period.



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

<sup>32</sup>In Appendix J, Section J.1, we show the individual contribution of each of the two groups of policy variables to the overall outcome of the model: we “shut down” taxes or LMI and simulate the model. In Section J.2, we report the simulated values of additional variables, such as the investment/output ratio and total hours.

marked, and 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 8). 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 between 1981 and 1985, then it remains stable, before beginning to decline from 2002 (see Figure 5). 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 8), even if the elasticity of the model slightly over-estimates the changes in the employment rate in France. The MSEs for hours worked and for employment are equal to  $1.6992 \cdot 10^{-4}$  and  $2.5152 \cdot 10^{-4}$ , respectively. The ratio of the vacancy posting costs in terms of labor productivity ( $\frac{\omega}{Y/Nh}$ ) averages 10.8% over the period.

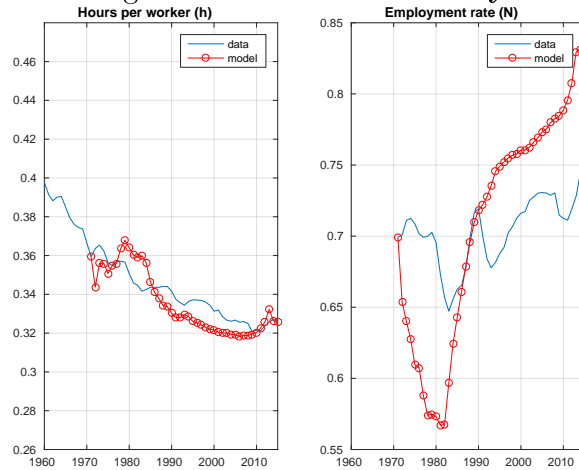


The fit for the employment rate in the UK is worse than for the previous two economies: The MSEs for the hours worked and for employment are equal to  $8.7333 \cdot 10^{-5}$  and 0.0047, respectively. The ratio of the vacancy posting costs in terms of labor productivity ( $\frac{\omega}{Y/Nh}$ ) averages 11.5% over the period. We can see that the model does a relatively good job of reproducing the dynamics for hours. In terms of the employment rate, the model captures its tendency to decrease until the end of the seventies and its 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 that continues during the nineties, as well as the positive trend in the employment rate. The overall fit of the model in terms of MSEs, for hours and employment, is  $1.3177 \cdot 10^{-4}$  and 0.0028 respectively. The ratio of the vacancy posting costs in terms of labor productivity ( $\frac{\omega}{Y/Nh}$ ) averages 9% over the

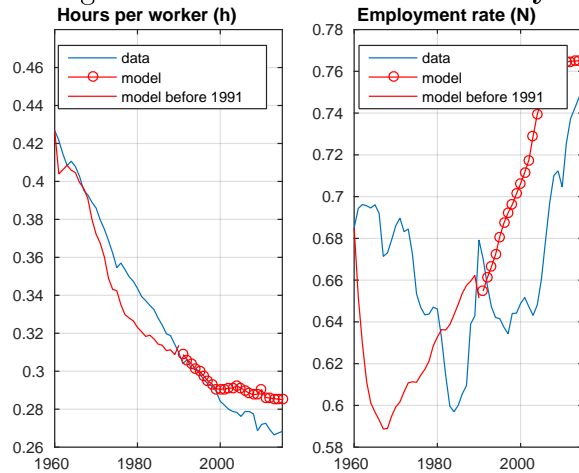


Figure 9: The UK economy



period.

Figure 10: The German economy



### 4.3 Analyzing the mechanisms of the model

In this subsection, we analyze the mechanisms of the model by focusing on a steady state analysis.

#### 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). To do this, we follow Fang and Rogerson [2009], but in contrast to their exercise, our model includes capital as well as replacement rate. Hence, our general equilibrium analysis implies that labor supply (intensive and extensive margins) depends on equilibrium consumption through the MRS. To capture this, we add the resource constraint to provide the link between

consumption and labor market variable through the net output (the consumption  $C(\theta, h)$  is a function of  $\theta$  and  $h$ ),<sup>33</sup> and thus integrate this general equilibrium restriction into our labor market analysis. At the steady state, hence, we can reduce the system equations for two unknowns  $\{h, \theta\}$ <sup>34</sup>.

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

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 usual, 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 L.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  $\theta$ .*

*Proof.* See appendix L.2. □

The optimal choice of the intensive margin shows that the labor market tightness acts as a wealth effect on agent decisions: A high  $\theta$  implies a high employment rate and therefore a lower incentive for each individual in the household to work.

<sup>33</sup>See the appendix K for a complete description of the system equations.

<sup>34</sup>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  $\bar{c} = 0$ .

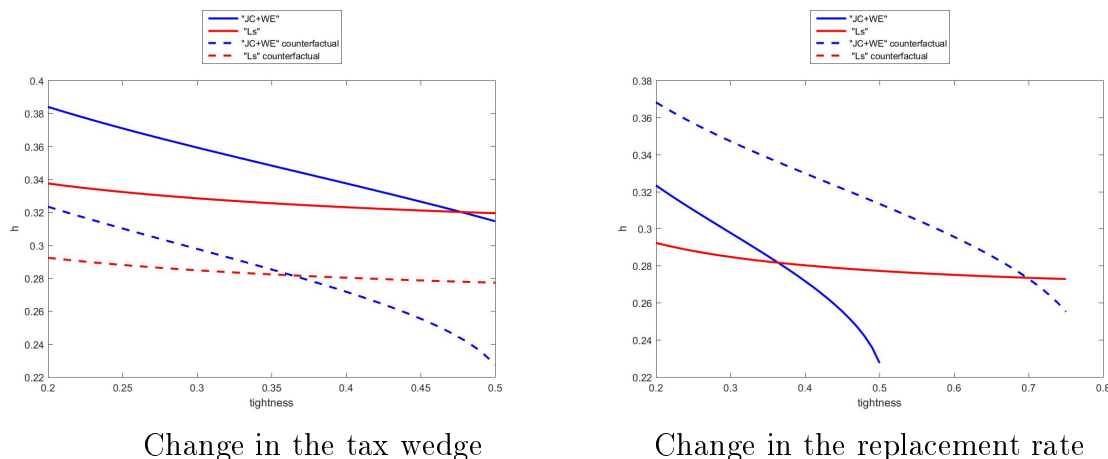
**Proposition 3.** For  $\frac{\eta}{1+\eta} > \rho$ , there exists a value for  $\Gamma^u < 0$  such that the equilibrium extensive margin (equation (JC) + (WC)) defines a negative relationship between hours worked  $h$  and the labor market tightness  $\theta$ .

*Proof.* See Appendix L.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.

**Comparative statics: counterfactual experiments.** Let us now perform a comparative statics analysis: How would a reduction in tax rates impact 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. We expect both the labor supply and the labor market equilibrium curves to shift upward. 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 11. Indeed, for our calibration, the tax reduction gives workers an incentive to work longer while at the same time reducing labor costs (this effect overcompensates the increase in the reservation wage of the worker, who now wants to work longer), inducing a rise in labor market tightness.

Figure 11: SS comparative statics - France



What if we simulate the French economy with the unemployment benefits system of the US? We see in the right panel of Figure 11 that a change in the replacement rate does not affect the labor supply curve, but it does affect the labor market equilibrium curve: The latter shifts toward the right, so that the effect on tightness is strongly positive. Note that when the workers are more numerous, the generated wealth effect leads them

to reduce their 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 is very flat, the effect on hours per worker (which decrease overall) is quantitatively less significant.

## 5 Counterfactual experiments: alternative policies

Once we have understood the forces at work at steady state, we can perform a counterfactual experiment with the fully fledged dynamic version. 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. How would the two margins of labor input in France have evolved, with the path of policy variables that characterized the post-WWII US?

### 5.1 The impact of policies on the two margins

Let us start by looking at how the simulated variables for France would evolve, if policy variables are those that characterized the US. In particular, we suppose that the tax wedge and the labor market institutions (the bargaining power of the workers and the replacement rate) in France are in fact given by what we observed in the US. The two economies differ, therefore, in the tax rates applied on capital and investment. We note that, in addition, the two countries are characterized by their specific technological and population evolution, as well their own matching technology (in terms of matching efficiency and vacancy posting costs) and separation rates. In Figure 12, we see the results of the simulations of the French economy with US taxes and labor market institutions.

On average, the fictive French employee works longer hours and has a much higher chance of being employed. If we look at the evolution of the employment rate, with the labor market institutional arrangements that characterize the wage negotiation in the US, France would have observed a spectacularly high employment rate. At the end of the simulation, the employment is 86% in this fictive France, whereas it is 65% in the actual economy.

Let us consider a situation in which we have the US tax wedge evolution in France, while keeping the labor market arrangements as they are. Figure 13 shows that the amount of hours worked would be higher. The important point here is that a simple reduction of the consumption and labor income tax rates does not significantly impact employment, because the decline of the labor cost they induce is compensated by the rise in reservation wage of the workers, who now work longer hours. These results are the counterparts, in a dynamic framework, of the comparative static results summarized in Propositions 2 and 3.

Figure 12: **Counterfactual: France with US tax wedge and LMI**

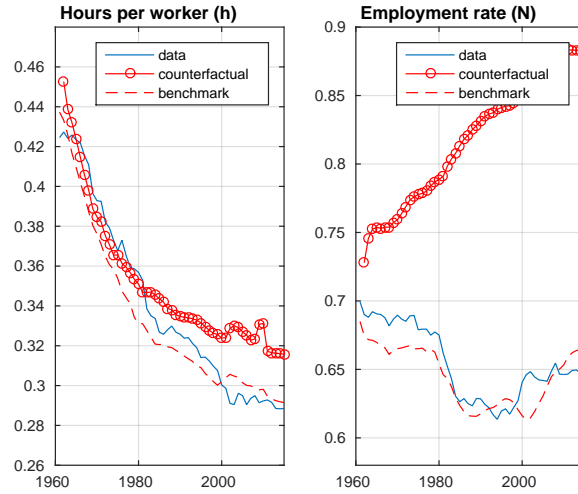
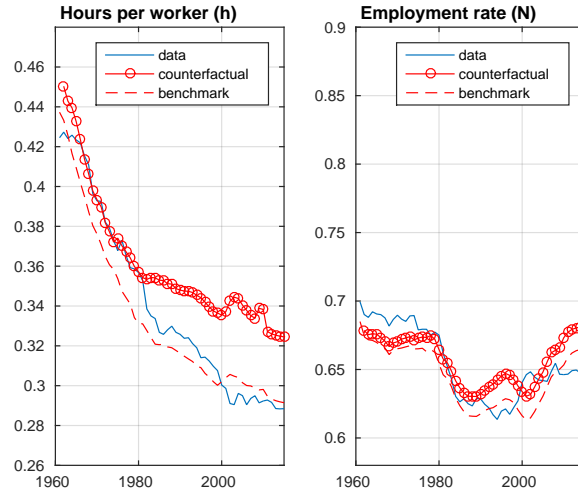


Figure 13: **Counterfactual: France with US tax wedge**



If we look at Figure 14, which shows the hypothetical case of France characterized by the US LMI but with its own taxation system, we observe 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. First, the large “chance” of employment is perceived by the agent as a wealth effect that reduces his incentive to work longer. Second, when a worker reduces his hours, his reservation wage decreases, leading to a magnification of the rise in 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 induced by the “distortive” taxes and labor market institutions in France, with respect to a reference welfare value that would be chosen by a benevolent social planner. In this case, the

Figure 14: Counterfactual: France with US LMI



government consumption expenditures on collective goods would be financed in a non-distortive way through lump-sum taxes.<sup>35</sup> The planner observes the same dynamics of the technological process as the private agents do.

We perform the following two counterfactual experiments: In one case, we set the proportional taxes rates as null, government expenditure in collective goods being financed by lump-sum transfers (Optimal taxes); in the other, we eliminate instead the distortions on the labor market institutions (Optimal LMI).

We then compute the rate at which we should “tax” consumption in the social planner allocation, in order to have a welfare level equivalent to that of the market economy at each date. We define a factor  $\lambda_t$ , entering the social welfare function as the following:

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

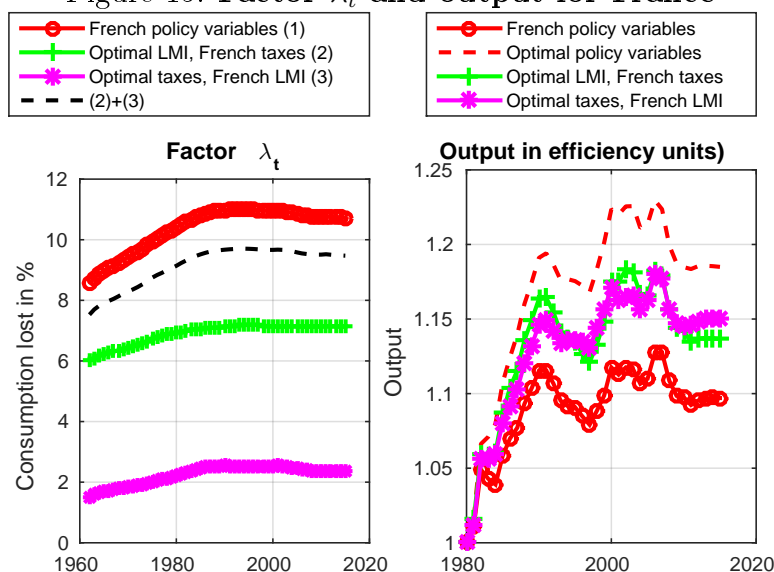
The factor  $\lambda_t$  gives the losses in consumption units implied by the market allocations (*actual* or *cf* as counterfactual). The value of  $\zeta$  is derived by considering the choice that a social planner would make—i.e., considering the first-order conditions (FOCs) with respect to privately consumed goods and collective goods:  $\zeta = \frac{G_t^{col}}{C_t}$ . In order to find the value of  $\zeta$ , we consider the time series for  $G_t^{col}$  and compute the mean value over the period<sup>36</sup> (i.e.,  $\zeta = \frac{\bar{G}^{col}}{\bar{C}}$ ), obtaining 0.139 for France.

The left panel of Figure 15 gives the welfare losses induced by a set of distortion. For example, the counterfactual simulation with “optimal taxes” and “French LMI” provides the welfare losses induced by LMI distortions, whereas the counterfactual entitled “French policy variables” mixes the impacts of both tax and LMI distortions. Hence, the left panel

<sup>35</sup>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.

<sup>36</sup>Given that this ratio is not constant over the period, our calibration procedure ensures that the first best allocation matches the observed time series of the collective government expenditures.

Figure 15: Factor  $\lambda_t$  and output for France



of Figure 15 shows that the gains spurred on by a tax reform are higher than those coming from a labor market reform (around 7 percentage points of lifetime consumption would be gained at the end of the period in the first case, in contrast to around 2 percentage points in the second case).

This idea comes from the analysis of the steady state in Figure 11. Starting from a situation in which hours and the employment rate are lower than the optimal level, a fiscal reform that reduces the tax burden also contributes to raising the employment rate (left panel of Figure 11), while a reform of labor market institution “worsens” the performance in hours (right panel of Figure 11), 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 she works less.

In comparison to Prescott [2004], we calculate a lower amount of welfare loss<sup>37</sup>. 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.<sup>38</sup>

Another interesting point is 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 black line in the left panel of Figure 15. We can see that the sum of the costs of the two distortions is lower than the actual cost experienced in the economy; in other words, the gains are higher when implementing both reforms at the same time.

<sup>37</sup>In his paper Prescott evaluates the welfare gains for France of shifting to a “US style” tax system to 19% of life-time consumption.

<sup>38</sup>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.

Finally, we can 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 15, we plot the history of output in the actual French economy and in the three counterfactual experiments (the case with optimal policy variables, the case with only optimal taxes, and the one with only optimal LMI), normalized at their respective level in 1980. The output in France could have been 17% higher than its 1980 level; this growth comes from the TFP rise, inducing capital and employment accumulation processes. But, with the trends in French policy variables, the output today is only 10% higher than its 1980 level. Hence, the output losses are 7%. The contributions of the tax distortions and LMI distortions on these losses have the same order of magnitude. 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 reducing the steadily increasing Harberger triangles, which represent today approximately 7 percentage points of the output per year in 2015.

## 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 intensive margins 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 that represent the “extreme” cases in terms of policy choices: the US and France. These two countries showed very 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 the evolution of the tax wedge can explain the path of hours worked per worker, while labor market institutions<sup>39</sup> must be taken into account if we want to explain the evolution of employment.

The appeal of the model is 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 predict the welfare gains of switching toward 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.

---

<sup>39</sup>We limit ourselves to consider only the bargaining power of workers and the replacement rate.



## References

- Stephane Adjemian, Houtan Bastani, Michel Juillard, Frederic Karame, Junior Maih, Ferhat Mihoubi, George Perendia, Johannes Pfeifer, Marco Ratto, and Sébastien Villemot. Dynare: Reference Manual Version 4. Dynare working papers, CEPREMAP, April 2011.
- 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.
- John M. Barron, Mark C. Berger, and Dan A. Black. *On-the-Job Training*. Books from Upjohn Press. W.E. Upjohn Institute for Employment Research, 1997.
- 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.
- Richard Blundell and Thomas MaCurdy. Labor Supply: A Review of Alternative Approaches. In O. Ashenfelter and D. Card, editors, *Handbook of Labor Economics*, volume 3 of *Handbook of Labor Economics*, pages 1559–1695. Elsevier, 1999.
- Michael Burda and Mark Weder. Payroll Taxes, Social Insurance and Business Cycles. *Journal of the European Economic Association*, 14(2):438–467, April 2016.
- Yongsung Chang, Sun-Bin Kim, and Richard Rogerson. Hours and Employment in the Cross-Section and Over the Cycle. Technical report, 2012.
- 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 cyclicity of the opportunity cost of employment. Working Paper 19678, National Bureau of Economic Research, November 2013.
- Michael Elsby, Bart Hobijn, and Aysegül Sahin. Unemployment dynamics in the oecd. *Review of Economics and Statistics*, 95(2):530–548, 2013.
- 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.
- Shigeru Fujita and Garey Ramey. Exogenous versus endogenous separation. *American Economic Journal: Macroeconomics*, 4(4):68–93, May 2012.
- Paul Gomme and Peter Rupert. Theory, measurement and calibration of macroeconomic models. *Journal of Monetary Economics*, 54(2):460–497, March 2007.
- Marcus Hagedorn and Iourii Manovskii. The Cyclical Behavior of Equilibrium Unemployment and Vacancies Revisited. *American Economic Review*, 98(4):1692–1706, September 2008.

- Robert E. Hall. Employment Fluctuations with Equilibrium Wage Stickiness. *American Economic Review*, 95(1):50–65, March 2005.
- Michael Keane and Richard Rogerson. Reconciling micro and macro labor supply elasticities: A structural perspective. *Annual Review of Economics*, 7(1):89–117, 2015.
- Robert Kollmann. Welfare effects of a monetary union: the role of trade openness. *Journal of the European Economic Association*, 2(2-3):289–301, 2004.
- Francois Langot. Unemployment and Real Business Cycle : A Matching Model. In P.Y. Henin, editor, *Advances in Economic Business Cycles Theory*. Springer Verlag, 1995.
- Francois Langot, Lise Patureau, and Thepthida Sopraseuth. Optimal Fiscal Devaluation. Banque de France working papers, Banque de France, 2014.
- 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.
- 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.
- 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.
- Edward C. Prescott, Richard Rogerson, and Johanna Wallenius. Lifetime aggregate labor supply with endogenous workweek length. *Review of Economic Dynamics*, 12(1):23 – 36, 2009.
- Coralia Quintero Rojas and Francois Langot. Explaining labor wedge trends: An equilibrium search approach. *European Journal of Comparative Economics*, 13(1):3–35, 2016.
- 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.
- Richard Rogerson and Johanna Wallenius. Micro and macro elasticities in a life cycle model with taxes. *Journal of Economic Theory*, 144(6):2277 – 2292, 2009.

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

Robert Shimer. Convergence in macroeconomics: The labor wedge. *American Economic Journal: Macroeconomics*, 1(1):280–297, 2009.

# Appendix

## A Data sources and definitions

The data used can be distinguished into two categories: policy variables and economic variables. The policy variables are the average tax rates, replacement rates, and bargaining power of the workers.

The average tax rates are computed by McDaniel [2007] and are available on her website at the following address: <http://www.caramcdaniel.com/researchpapers>.

The replacement rates for unemployment benefits are computed by the OECD. To be consistent with our model, we need the gross replacement rate, which is available from 1963 until 2005; from 2005 onward we use information on the net replacement rate in order to reconstruct the gross one. Both measures refer to the average replacement rate of income during unemployment over a five-year period (for details, see the OECD website <http://www.oecd.org/els/benefits-and-wages-statistics.htm>).

The bargaining power is computed as the average between union coverage and union density. Both measures are contained in the ICTWSS Database (Database on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts), provided by the AIAS<sup>40</sup> and available at <http://www.uva-aias.net/en/ictwss>.

Regarding the economic variables, we make use of the hours worked per worker, the employment rate, and some GDP components (private consumption, investment, and government expenditures). Hours are taken from the Total Economy Database of The Conference Board, available at <https://www.conference-board.org/data/economydatabase/index.cfm?id=2776>

All other macroeconomic series are taken from the OECD Economic Outlook editions. We consider in particular: the private final consumption expenditure ( $c$ ), Government final consumption ( $G$ ), and the private non-residential and government fixed capital formation, ( $I$ ). Our GDP is then reconstructed as the sum of the demand components ( $Y = c + I + G$ ). All series are expressed in real terms (in 2010 USD at PPP).

## B Total hours decomposition

The procedure used is as follows:

1. Consider a reference year  $t_0$ , say 1981.

---

<sup>40</sup>J. Visser, ICTWSS Data base. version 5.1. Amsterdam: Amsterdam Institute for Advanced Labour Studies (AIAS), University of Amsterdam. September 2016

2. Consider a different year  $t$ . For each country  $i = \{\text{France, Germany, UK, US}\}$ , 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  $i \neq \text{US}$  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  $i \neq \text{US}$ 's employment rate relative to the US (and to the reference year  $t_0$ ).
4. Consider the hypothetical case in which the change in country  $i \neq \text{US}$ 's relative employment did not happen, and the chance of being employed evolves as in the US. Instead, assume that the  $r\Delta_{i \neq US,t}^N$  (%) individuals were employed in  $t$  and worked the same number of hours as an individual in country  $i \neq \text{US}$ , that is  $h_{i,t}$ . This would raise total hours in country  $i \neq \text{US}$  by an amount equal to  $\Delta_{i,t}^{Nh,N} = -r\Delta_{i,t}^N \times h_{i,t}$ . The series  $\Delta_{i,t}^{Nh,N}$  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  $\Delta_{i,t}^{Nh,N}$  with the observed differential in relative total hours gives us a measure of the employment rate contribution. The observed differential is computed as  $\Delta_{i,t}^{obs} = N_{i,t}h_{i,t} - N_{US,t}h_{US,t}$ . If the contribution of employment to the total hours gap is significant, we expect a series of hypothetical hours ( $\Delta_{i,t}^{Nh,N}$ ) close to the actual hours ( $\Delta_{i,t}^{obs}$ ).

We also assess how much of the gap in total hours worked between each country and the US 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 ( $\Delta_{i,t}^{obs}$ ).

## C The measure of the non-employment incomes

In accordance with the idea that 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 for agents aged from 16-65 years old. Hence, the measure of the replacement rate must represent the ratio of all alternative incomes over the wage.<sup>41</sup> If we restrict ourselves to the unemployment benefits, this measure corresponds to the average gains during an unemployment spell, given

---

<sup>41</sup>If we follow the definition provided by the OECD, the “replacement rate” for non-employment income is a comprehensive measure, referring to a person that is 40 years old on average. This definition can be found at <http://www.oecd.org/els/benefits-and-wages-statistics.htm>.

the rule of the insurance scheme. Hence, we consider that in each family there exists a representative group of unemployed workers that gains the “average” unemployment benefits. The degression and 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 also exists a heterogeneity between the insurance possibilities, which are contingent on the worker ages. In particular, this is the case for the pension schemes or early retirement benefits, if they exist for those under 65 years old; concerning the older workers (55-64 years old), our modelling assumption is the equivalent of saying that the revenue of a retiree (until 65 years old) is equivalent to that of an unemployed *stricto sensu*. Is this hypothesis acceptable? The largest bias can come from the country that is more generous with older workers namely, France. If we look at the evolution of the replacement rate in France (left panel of Figure 5), we can see that the biggest change occurred between the end of 1970s and 1982/1983: The synthetic measure of the replacement rate rose from 0.25 to around 0.35. We find that behind this change was on the one hand the increase in the generosity of the support to the unemployed, and on the other the generosity in 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.<sup>42</sup> For the remaining years until 65, the authors report an "expected old-age pension gross replacement rate" of 62.5%.<sup>43</sup> 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 ( $((65-63)/(65-55))$  and  $((65-60)/(65-55))$  respectively). 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 mentioned is that the reforms of the labor market, such as the change in the replacement ratios, were implemented at the same time as the changes in generosity in the pension system. This is particularly true for the large changes observed 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 for which only older workers are eligible.

---

<sup>42</sup>Blöndal and Scarpetta [1999], Table II.1.

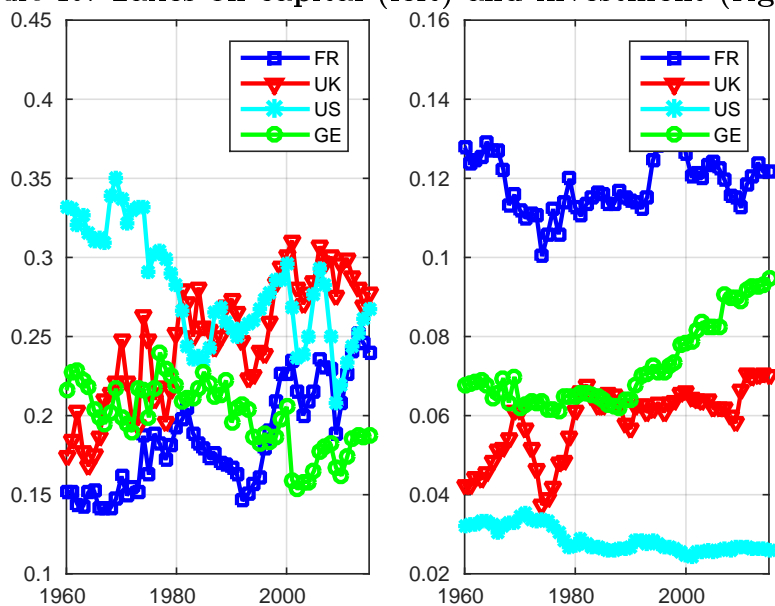
<sup>43</sup>Blöndal and Scarpetta [1999], Table III.3.

## D Tax on capital and government expenditures

### D.1 Taxes on capital and investment

Given that ours is a general equilibrium model, it is important not to omit taxes on capital. These taxes modify the relative demand between capital and employment. There are two types of taxes: those on the revenues of existing capital, and those on investment goods.

Figure 16: Taxes on capital (left) and investment (right)



In Figure 16 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, the taxes are largely based on capital incomes, whereas France and Germany, and to a lesser degree the UK, also have a tax on investment. Note that the gaps in the capital income taxes decline over the entire sample, whereas the gaps in investment taxes are persistent.

### D.2 Government expenditure in collective goods

Data for the ratio of government expenditures on collective goods to GDP are taken from the OECD.<sup>44</sup> As documented in Figure 17, France, Germany and the UK feature a rate of collective public spending in proportion to GDP comparable to other OECD countries,<sup>45</sup> while the US is characterized by a higher share of collective public spending, in which defense is included.

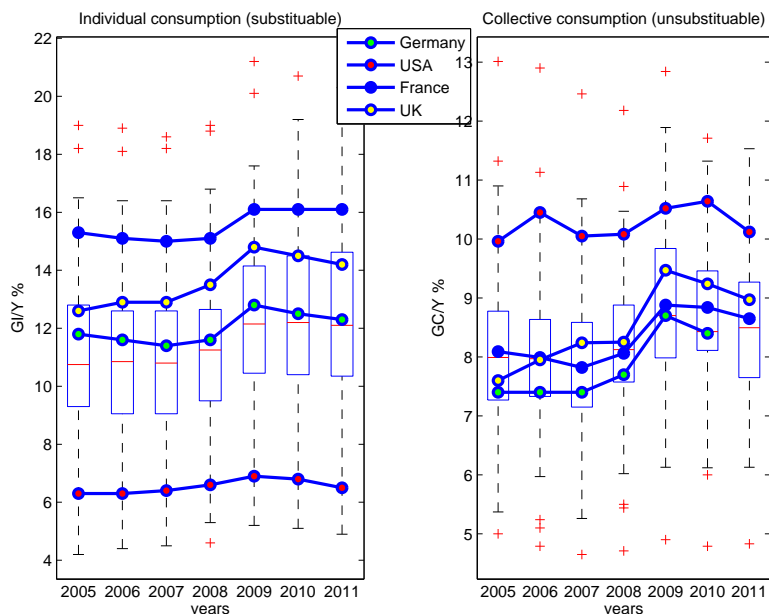
By contrast, individual government spending in France, Germany, and the UK is much

<sup>44</sup>Table COFOG, government expenditure by function.

<sup>45</sup>Data come from Langot et al. [2014].

larger than the average of the OECD countries, while in the US the share of individual government expenditure is minimal.

Figure 17: A decomposition of government expenditure (OECD data)



In both the individual and collective panels of Figure 17, 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<sup>th</sup> and 75<sup>th</sup> percentiles, the whiskers extend to the most extreme data points not considered outliers, and the outliers are plotted individually.

## E Solow's residuals

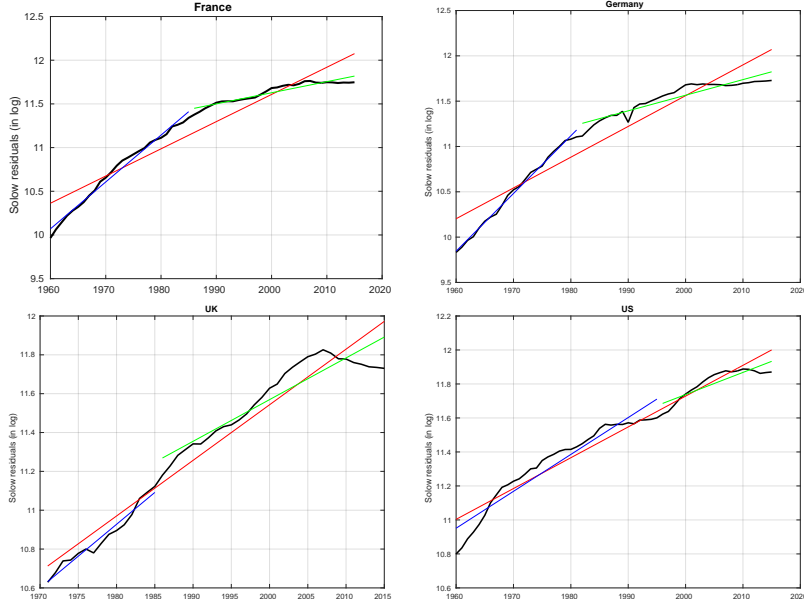
In figure 18 we show the presence of a break in the linear trend of the Solow residuals. For the European economies, the presence of a break in productivity is linked with the “catching up” period of reconstruction after WWII. In particular, we identify a break in 1985 for France and UK, and in 1982 for Germany. For each country, the Chow test tells us to reject the null hypothesis of a unique time trend. For the US, we consider a break in the mid 90s, when we can observe an acceleration of productivity: our hypothesis is confirmed by the Chow test, which tells us to reject the null hypothesis of a unique linear trend.

## F Stationarized FOCs

Below are the equations that compose the model, in which the convention adopted is to indicate with  $\hat{X}$  a variable  $X$ , for  $X \in \{A, C, Y, K, I, w, \omega\}$  which is deflated by the rate



Figure 18: Linear trends in productivity



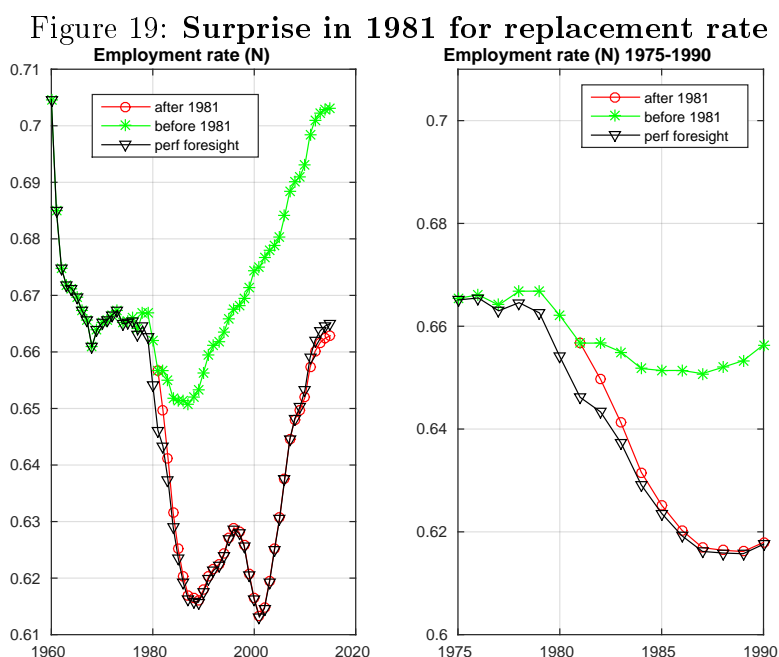
of growth i.e.,  $\widehat{X}_t = X_t/(1+g)^t$ . The set of equations used to solve the dynamic paths of the model is as follows:

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

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

## G 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 its evolution is the largest among all changes of exogenous variables). The agents consider that the replacement rate evolves until 1980 and then remains constant at its 1981 level. When the government changes in 1981, and the new one changes the replacement rate policy, agents are surprised. At this point, the new path of the replacement rate is revealed. The results of this experiment are shown in Figure 19.



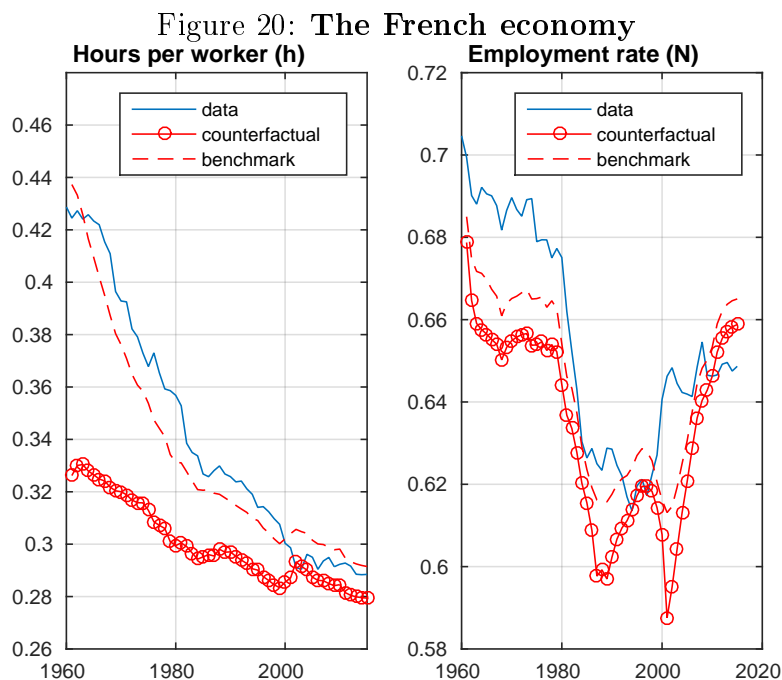
Until 1978 both scenarii, under the hypothesis of perfect forecast (black line with triangles) or with unexpected change (green line with stars), produce the same results. After 1979, the firms begin to reduce their vacancies if the policy change is correctly anticipated. Thus, the reduction of employment rate is slightly smoothed until 1985, the year after which the employment rate again becomes 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 never exceeds 1.5 percentage points, which is small, given the size of the

policy change.

## H 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,  $\bar{c}$  captures the “exceptionality” of the period between the 1960s and 1970s for the economies that 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 while all other parameters are set equal to the benchmark version (this implies, in particular, that the two versions of the model share the same final steady state).

We show the performance of the model in replicating the variables of interest for France. As we can see in Figure 20, without the subsistence term  $\bar{c}$  the model underestimates the level of hours; 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 and the employment rate with the alternative model are  $0.0027$  and  $4.1051 \cdot 10^{-4}$  respectively.

# I The flow value of non-employment

As 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”.<sup>46</sup> 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<sup>47</sup> in Figure 21.

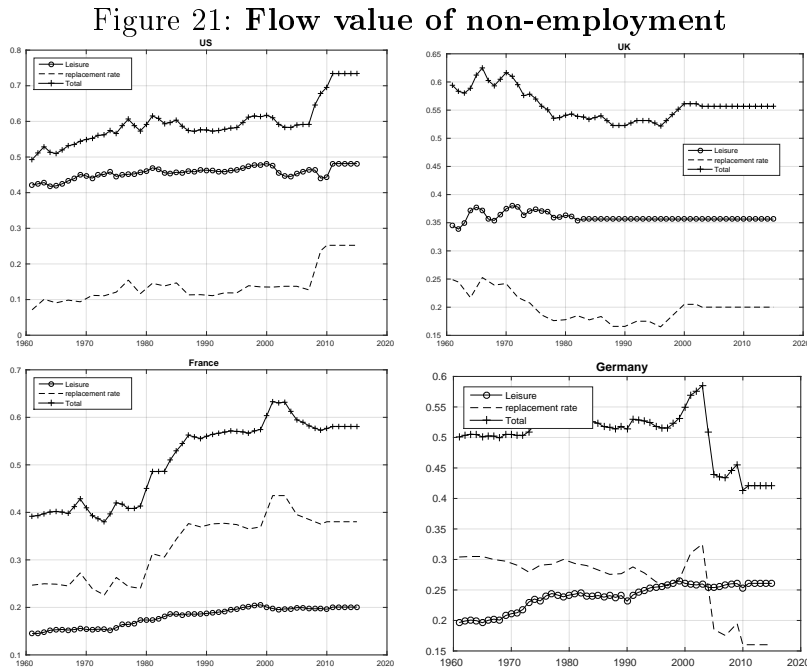


Figure 21 highlights two facts. Note that the implied flow value of non-employment remains within a range that is widely accepted in the literature, which is  $[0.4; 0.943]$ , the highest value being provided by Hagedorn and Manovskii [2008] and the lowest proposed by Shimer [2005].

First, note that the levels of flow value of non-employment are quite similar among

<sup>46</sup>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.

<sup>47</sup>We plot the measure of the reservation wage normalized with respect to the wage bill  $w_t h_t$ .

countries. But it is important to bear 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<sup>48</sup> 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.

Second, we note 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 value of staying at home is stable and less important (because of the low amount of worked hours). In the US, the flow value of non-employment is driven mainly by the number of hours worked per employee. In the UK, the overall flow value of non-employment started to decrease after the Thatcher reforms (the beginning of the eighties), mainly driven by the decrease of the non-employment benefit. In France, the flow value of non-employment increases over the whole sample: Before the large increase in the replacement ratio at the beginning and at the end of the 1980s (the Mitterrand reforms) it remains stable, but after the 1980s, its dynamic is driven by the dynamics of the replacement rate. In Germany too 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 of the nineties and the mid-2000s). In contrast, it decreased during the Kohl government and has decreased during the second Schröder government (Hartz reforms).

## J The fit of the model

### J.1 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 two counterfactuals:

- (i) a model in which only taxes vary, but labor market institutions and labor productivity do not;
- (ii) a model in which only labor market institutions evolve, but taxes and labor productivity do not.

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

---

<sup>48</sup>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.

Figure 22: The contribution of exogenous variables (France): taxes

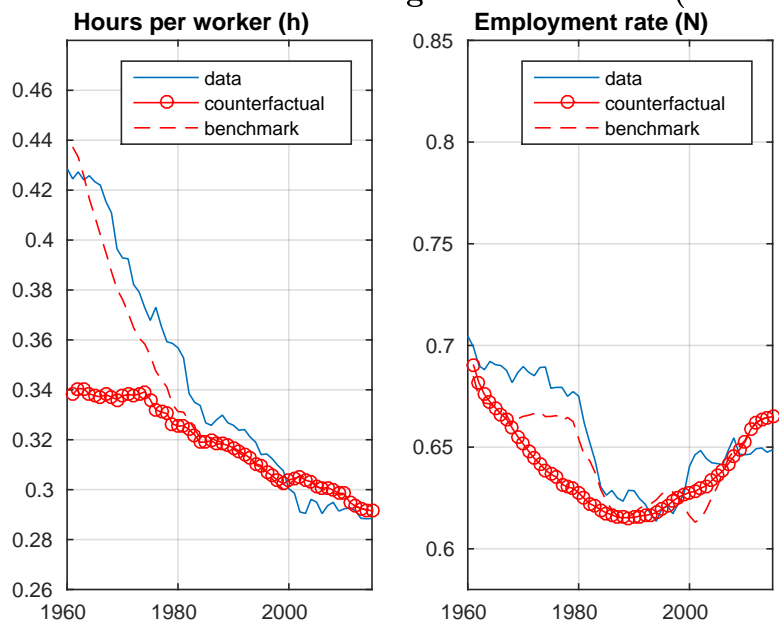
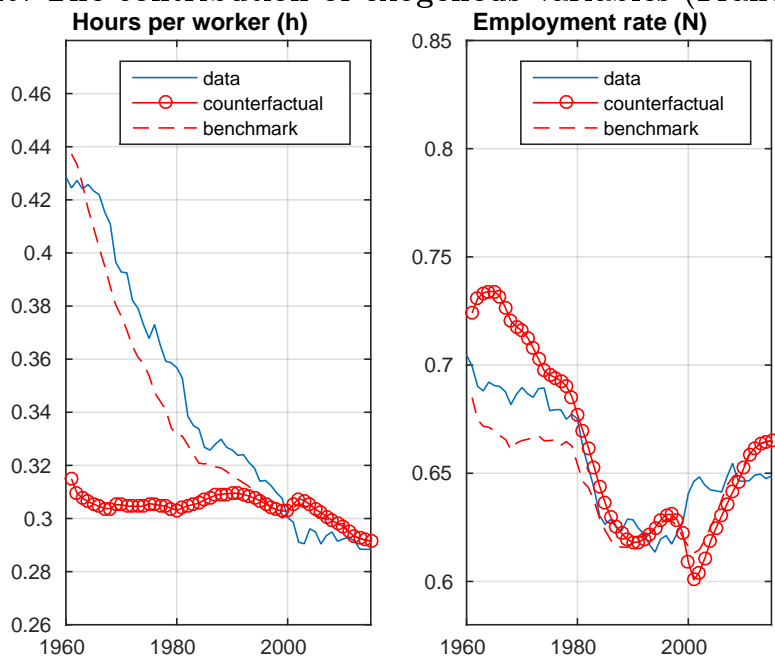


Figure 23: The contribution of exogenous variables (France): LMI



If we look at the evolution of hours for France in the top left panel of Figure 22, we see clearly the explicative power of the tax wedge: Hours remain flat until 1975 and then start to decrease, reflecting the evolution of the tax wedge that we 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 gained from the steady state analysis: 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 11).

## J.2 Additional model predictions

We report the complete set of information about the fit of the model: Figures 24-27 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.

Figure 24: The US economy

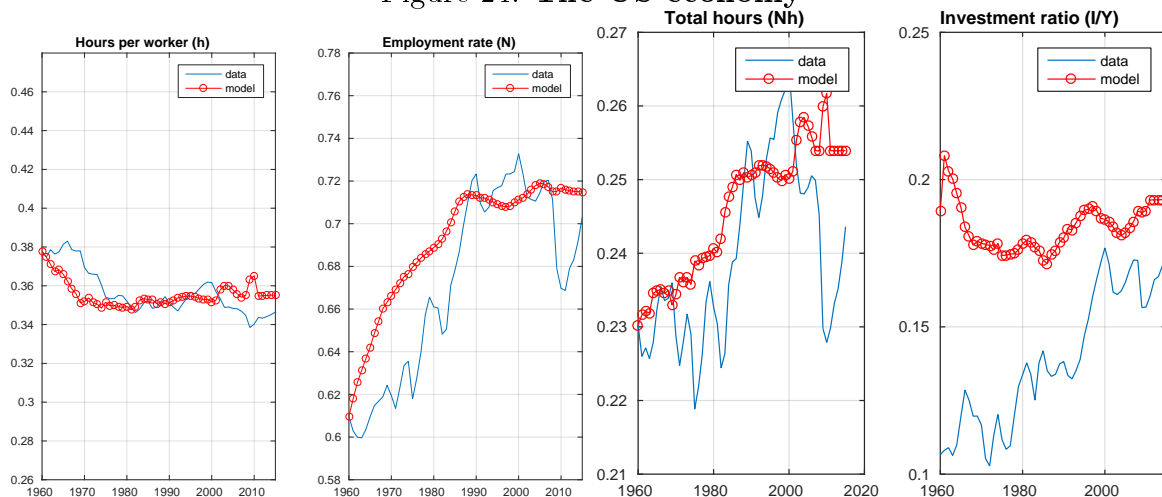


Figure 25: The French economy

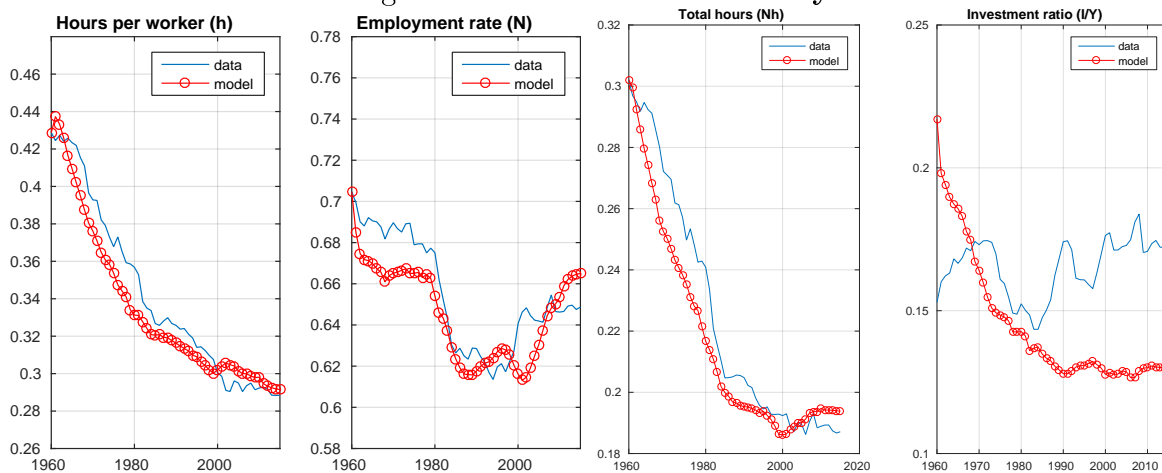


Figure 26: The UK economy

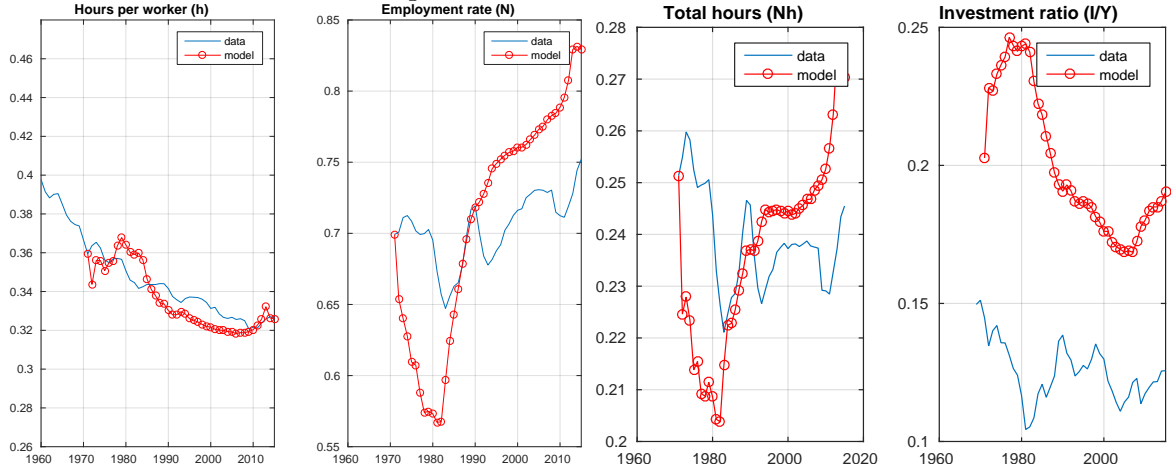
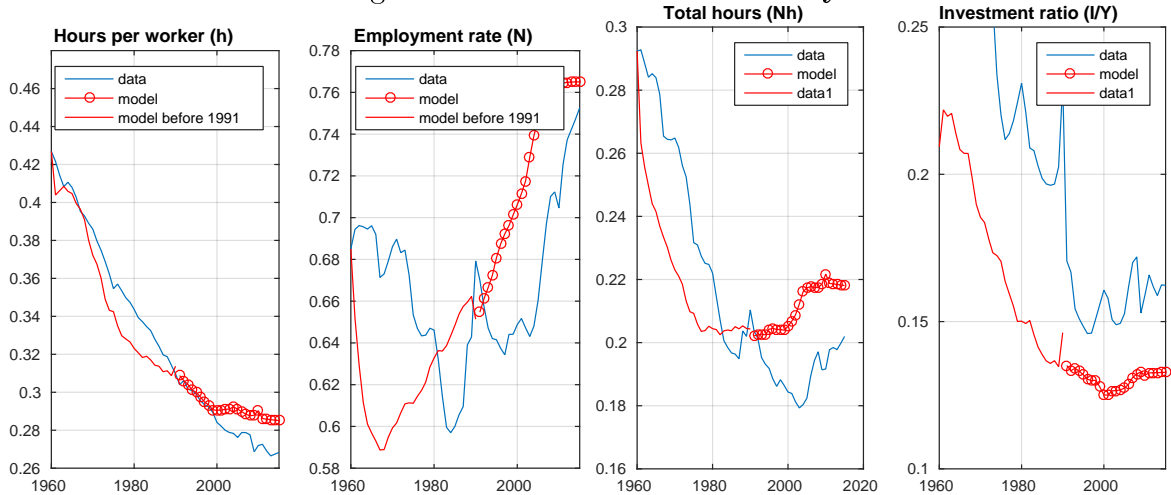


Figure 27: The German economy





## K Steady state analysis

We first report all the equations that compose the model:

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

We next 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 <sup>49</sup>:

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

By continuing with substitutions, we arrive at 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.

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

---

<sup>49</sup>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  $\bar{c} = 0$ .

## L Proofs of proposition

Equation (5) implicitly defines the consumption  $C(\theta, h)$  as a function of  $\theta$  and  $h$ , which can be integrated into the two other relationships.

$$Ch^{1+\eta} = \frac{\alpha(1-\tau_w)}{\sigma_l(1+\tau_c)} \left(\frac{r}{1-\alpha}\right)^{-\frac{(1-\alpha)}{\alpha}} Ah \quad (3)$$

$$\frac{\omega\theta^{1-\psi}}{\Upsilon} \left[\frac{1}{\beta} - (1-s)\right] + \left(\frac{1-\epsilon}{1-\rho\epsilon}\right)\omega\theta = \frac{\epsilon}{1-\rho\epsilon} \left[ \begin{array}{l} (1-\rho)\alpha Ah \left(\frac{r}{1-\alpha}\right)^{-\frac{(1-\alpha)}{\alpha}} \\ -C \left(\frac{1+\tau_c}{1-\tau_w}\right) \left(\Gamma^u + \sigma_l \frac{h^{1+\eta}}{1+\eta}\right) \end{array} \right] \quad (4)$$

$$C + \omega\theta \left(1 - \frac{1}{1 + \frac{n+s}{\Upsilon\theta^\psi}}\right) = Ah \left(\frac{r}{1-\alpha}\right)^{-\frac{(1-\alpha)}{\alpha}} \left(\frac{\left(\frac{r}{1-\alpha}\right) - (g + \delta)}{1 + \frac{n+s}{\Upsilon\theta^\psi}}\right) \quad (5)$$

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

### L.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 (5) with respect to  $h$ , we obtain  $dC = \frac{-A(\delta+g-\frac{r}{1-\alpha})}{\left(\frac{n+s}{\Upsilon\theta^\psi}+1\right)\left(\frac{r}{1-\alpha}\right)^{\frac{1}{\alpha}}} dh$ . Let us substitute the expression of the equilibrium real interest rate, which is given by  $r = \left(\frac{1+\tau_{inv}}{1-\tau_k}\right) \left(\frac{1+g}{\beta} - (1-\delta)\right)$ . We find 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.<sup>50</sup> If we now check the derivative with respect to tightness, we find the following expression:

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

The second term in square brackets is always positive, so that the overall sign depends on the conditions of the first term in square brackets; we find that if the first term in square brackets is positive too, there will be an overall positive sign in the numerator,

<sup>50</sup>This can be seen more easily if we re-arrange it as the following:

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

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 by an employment rate equal to at least  $1/3$ .

## L.2 Proof of proposition 2

Differentiating the equations (3) and (5) leads to  $(\eta + \epsilon_{C|h}) \frac{dh}{h} = -\epsilon_{C|\theta} \frac{d\theta}{\theta}$ , 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.

## L.3 Proof of proposition 3

Differentiating equation (4) leads to

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

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 if and only if

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

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 (3), 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  $n \rightarrow 0$  and  $\beta \rightarrow 1$ ,

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

given that

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

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

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

**18-11. Unemployment fluctuations over the life cycle**

Jean-Olivier Hairault, François Langot, Thepthida Sopraseuth

**18-10. Layoffs, Recalls and Experience Rating**

Julien Albertini, Xavier Fairise

**18-9. Environmental policy and health in the presence of labor market imperfections**

Xavier Pautrel

**18-8. Identity mistakes and the standard of proof**

Marie Obidzinski, Yves Oytana

**18-7. Presumption of innocence and deterrence**

Marie Obidzinski, Yves Oytana

**18-6. Ethnic Discrimination in Rental Housing Market: An Experiment in New Caledonia**

Mathieu Bunel, Samuel Gorohouna, Yannick L'Horty, Pascale Petit, Catherine Ris

**18-5. Evaluating the impact of firm tax credits. Results from the French natural experiment CICE**

Fabrice Gilles, Yannick L'Horty, Ferhat Mihoubi, Xi Yang

**18-4. Impact of type 2 diabetes on health expenditure: an estimation based on individual administrative data**

François-Olivier Baudot, Anne-Sophie Aguadé, Thomas Barnay, Christelle Gastaldi-Ménager, Anne Fargot-Campagna

**18-3. How does labour market history influence the access to hiring interviews?**

Emmanuel Duguet, Rémi Le Gall, Yannick L'Horty, Pascale Petit

**18-2. Occupational mobility and vocational training over the life cycle**

Anthony Terriau

**18-1. Retired, at last? The short-term impact of retirement on health status in France**

Thomas Barnay, Eric Defebvre

---

**17-11. Hiring discrimination against women: distinguishing taste based discrimination from statistical discrimination**

Emmanuel Duguet, Loïc du Parquet, Pascale Petit

**17-10. Pension reforms, older workers' employment and the role of job separation and finding rates in France**

Sarah Le Duigou, Pierre-Jean Messe

**17-9. Healthier when retiring earlier? Evidence from France**

Pierre-Jean Messe, François-Charles Wolff

**17-8. Revisiting Hopenhayn and Nicolini's optimal unemployment insurance with job search monitoring and sanctions**

Sebastien Menard, Solenne Tanguy

**17-7. Ethnic Gaps in Educational Attainment and Labor-Market Outcomes: Evidence from France**

Gabin Langevin, David Masclet, Fabien Moizeau, Emmanuel Peterle

**17-6. Identifying preference-based discrimination in rental market: a field experiment in Paris**

Mathieu Bunel, Yannick L'Horty, Loïc du Parquet, Pascale Petit

**17-5. Chosen or Imposed? The location strategies of households**

Emilie Arnoult, Florent Sari

**17-4. Optimal income taxation with composition effects**

Laurence Jacquet, Etienne Lehmann

**17-3. Labor Market Effects of Urban Riots: an experimental assessment**

Emmanuel Duguet, David Gray, Yannick L'Horty, Loic du Parquet, Pascale Petit

**17-2. Does practicing literacy skills improve academic performance in first-year university students? Results from a randomized experiment**

Estelle Bellity, Fabrices Gilles, Yannick L'Horty

**17-1. Raising the take-up of social assistance benefits through a simple mailing: evidence from a French field experiment**

Sylvain Chareyron, David Gray, Yannick L'Horty

---

**16-8. Endogenous wage rigidities, human capital accumulation and growth**

Ahmed Tritah

**16-7. Harder, better, faster...yet stronger? Working conditions and self-declaration of chronic diseases**

Eric Defebvre

**16-6. The influence of mental health on job retention**

Thomas Barnay, Eric Defebvre

**16-5. The effects of breast cancer on individual labour market outcomes: an evaluation from an administrative panel**

Thomas Barnay, Mohamed Ali Ben Halima, Emmanuel Duguet, Christine Le Clainche, Camille Regaert

**16-4. Expectations, Loss Aversion, and Retirement Decisions in the Context of the 2009 Crisis in Europe**

Nicolas Sirven, Thomas Barnay

**16-3. How do product and labor market regulations affect aggregate employment, inequalities and job polarization? A general equilibrium approach**

Julien Albertini, Jean-Olivier Hairault, François Langot, Thepthida Sopraseuth

**16-2. Acces to employment with age and gender: results of a controlled experiment**

Laetitia Challe, Florent Fremigacci, François Langot, Yannick L'Horty, Loïc Du Parquet, Pascale Petit

**16-1. An evaluation of the 1987 French Disabled Workers Act: Better paying than hiring**

Thomas Barnay, Emmanuel Duguet, Christine Le Clainche, Yann Videau

---



**15-10. Optimal Income Taxation with Unemployment and Wage Responses: A Sufficient Statistics Approach**

Kory Kroft, Kavan Kucko, Etienne Lehmann, Johannes Schmieder

**15-9. Search frictions and (in) efficient vocational training over the life-cycle**

Arnaud Chéron, Anthony Terriau

**15-8. Absenteeism and productivity: the experience rating applied to employer contributions to health insurance**

Sébastien Ménard, Coralia Quintero Rojas

**15-7. Take up of social assistance benefits: the case of homeless**

Sylvain Chareyron

**15-6. Spatial mismatch through local public employment agencies. Answers from a French quasi-experiment**

Mathieu Bunel, Elisabeth Tovar

**15-5. Transmission of vocational skills at the end of career: horizon effect and technological or organisational change**

Nathalie Greenan, Pierre-Jean Messe

**15-4. Protecting biodiversity by developing bio-jobs: A multi-branch analysis with an application on French data**

Jean De Beir, Céline Emond, Yannick L'Horty, Laetitia Tuffery

**15-3. Profit-Sharing and Wages: An Empirical Analysis Using French Data Between 2000 and 2007**

Noélie Delahaie, Richard Duhautois

**15\_2. A meta-regression analysis on intergenerational transmission of education: publication bias and genuine empirical effect**

Nicolas Fleury, Fabrice Gilles

**15\_1. Why are there so many long-term unemployed in Paris?**

Yannick L'Horty, Florent Sari

---

## **TEPP Working Papers 2014**

---

### **14-14. Hiring discrimination based on national origin and the competition between employed and unemployed job seekers**

Guillaume Pierné

### **14-13. Discrimination in Hiring: The curse of motorcycle women**

Loïc Du Parquet, Emmanuel Duguet, Yannick L'Horty, Pascale Petit

### **14-12. Residential discrimination and the ethnic origin: An experimental assessment in the Paris suburbs**

Emmanuel Duguet, Yannick L'Horty, Pascale Petit

### **14-11. Discrimination based on place of residence and access to employment**

Mathieu Bunel, Yannick L'Horty, Pascale Petit

### **14-10. Rural Electrification and Household Labor Supply: Evidence from Nigeria**

Claire Salmon, Jeremy Tanguy

### **14-9. Effects of immigration in frictional labor markets: theory and empirical evidence from EU countries**

Eva Moreno-Galbis, Ahmed Tritah

### **14-8. Health, Work and Working Conditions: A Review of the European Economic Literature**

Thomas Barnay

### **14-7. Labour mobility and the informal sector in Algeria: a cross-sectional comparison (2007-2012)**

Philippe Adair, Youghourta Bellache

### **14-6. Does care to dependent elderly people living at home increase their mental health?**

Thomas Barnay, Sandrine Juin

### **14\_5. The Effect of Non-Work Related Health Events on Career Outcomes: An Evaluation in the French Labor Market**

Emmanuel Duguet, Christine le Clainche

### **14\_4. Retirement intentions in the presence of technological change: Theory and evidence from France**

Pierre-Jean Messe, Eva Moreno – Galbis, Francois-Charles Wolff

### **14\_3. Why is Old Workers' Labor Market more Volatile? Unemployment Fluctuations over the Life-Cycle**

Jean-Olivier Hairault, François Langot, Thepthida Sopraseuth

### **14\_2. Participation, Recruitment Selection, and the Minimum Wage**

Frédéric Gavrel

### **14\_1. Disparities in taking sick leave between sectors of activity in France: a longitudinal analysis of administrative data**

Thomas Barnay, Sandrine Juin, Renaud Legal

---

**13\_9. An evaluation of the impact of industrial restructuring on individual human capital accumulation in France (1956-1993)**

Nicolas Fleury, Fabrice Gilles

**13\_8. On the value of partial commitment for cooperative investment in buyer-supplier relationship**

José de Sousa, Xavier Fairise

**13-7. Search frictions, real wage rigidities and the optimal design of unemployment insurance**

Julien Albertini, Xavier Fairise

**13-6. Tax me if you can! Optimal non linear income tax between competing governments**

Etienne Lehmann, Laurent Simula, Alain Trannoy

**13-5. Beyond the labour income tax wedge: The unemployment-reducing effect of tax progressivity**

Etienne Lehmann, Claudio Lucifora, Simone Moriconi, Bruno Van Der Linden

**13-4. Discrimination based on place of residence and access to employment**

Mathieu Bunel, Emilia Ene Jones, Yannick L'Horty, Pascale Petit

**12-3. The determinants of job access channels: evidence from the youth labor market in Franc**

Jihan Ghrairi

**13-2. Capital mobility, search unemployment and labor market policies: The case of minimum wages**

Frédéric Gavrel

**13-1. Effort and monetary incentives in Nonprofit et For-Profit Organizations**

Joseph Lanfranchi, Mathieu Narcy

---

## The TEPP Institute

---

The CNRS Institute for Labor Studies and Public Policies (the TEPP Institute, FR n°3435 CNRS) gathers together research centres specializing in economics and sociology:

- L'**Equipe de Recherche sur l'Utilisation des Données Individuelles en lien avec la Théorie Economique** (Research Team on Use of Individuals Data in connection with economic theory), **ERUDITE**, University of Paris-Est Créteil and University of Paris-Est Marne-la-Vallée
- Le **Centre d'Etudes des Politiques Economiques de l'université d'Evry** (Research Centre focused on the analysis of economic policy and its foundations and implications), **EPEE**, University of Evry Val d'Essonne
- Le **Centre Pierre Naville** (Research on Work and Urban Policies), **CPN**, University of Evry Val d'Essonne
- Le **Groupe d'Analyse des Itinéraires et des Niveaux Salariaux** (Group on Analysis of Wage Levels and Trajectories), **GAINS**, University of the Maine
- Le **Centre de Recherches en Economie et en Management**, (Research centre in Economics and Management), **CREM**, University of Rennes 1 et University of Caen Basse-Normandie
- Le **Groupe de Recherche ANgevin en Économie et Management** (Angevin Research Group in Economics and Management), **GRANEM**, University of Angers ;
- Le **Centre de Recherche en Economie et Droit** (Research centre in Economics and Law) **CRED**, University of Paris II Panthéon-Assas ;
- Le **Laboratoire d'Economie et de Management Nantes-Atlantique** (Laboratory of Economics and Management of Nantes-Atlantique) **LEMNA**, University of Nantes ;
- Le **Laboratoire interdisciplinaire d'étude du politique Hannah Arendt** – Paris Est, **LIPHA-PE**
- Le **Centre d'Economie et de Management de l'Océan Indien**, « **CEMOI** », équipe d'accueil n°EA13, rattachée à l'Université de la Réunion
- 

The TEPP Institute brings together 223 researchers and research professors and 100 PhD students who study changes in work and employment in relation to the choices made by firms and analyse public policies using new evaluation methods.