Labor market institutions and homeownership*

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Abstract

This paper studies to what extent *labor market institutions* can explain homeownership rate differences over time and across countries. Using panel data from 19 OECD countries over the period 1965-2014, I find empirical evidence that employment rigidities are positively correlated with homeownership, whereas real wage rigidities are negatively correlated with homeownership. The empirical findings are rationalized through a DSGE model with labor rigidities, and search and matching frictions, where heterogeneous households face a housing tenure decision. Labor market frictions affect housing tenure choice through their impact on employment and wage volatility. The housing market is directly linked to labor rigidities via an endogenous credit constraint. Performing counter-factual analyses, I find that labor market institutions account for a relevant share of the difference in homeownership between countries and over time. I also show that labor reforms which reduce unemployment benefits can dampen the effect of policies targeted to increase homeownership.

JEL Classification: J08; J30; J50; R20; R21.
Keywords: Housing markets; Labor market institutions; DSGE; Labor reforms.

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1 Introduction

In the last decades homeownership rate changed significantly in some OECD countries, while it remained almost the same in others.[1] Housing is one of the most important elements of households' wealth and its dynamics affect many aspects of the economy. The existing literature has shown that demographic change, macroeconomic conditions, innovations in the financial market, and specific housing policies, can explain part of homeownership evolution over time. Furthermore, the persistence of cross-country differences in the long-run is attributed mainly to country-based preferences and to different levels of mortgage market development.[2] Another relevant fact, which is worth consideration, is that during the last decades there have been also large changes in the legal framework of the labor market of many countries.

In this paper I investigate whether labor markets institutions (LMIs) play a role in explaining the heterogeneity we observe in homeownership rates across countries and over time. Labor market legislation affects several elements that influence the housing tenure decision. Specifically, LMIs have an impact on the income risk related to the volatility of employment and real wages, which previous studies have found to be important for the housing tenure choice.[3] The relevance of the legal framework of the labor market for homeownership has not been investigated by the existing literature, which has focused mainly on the effect of high levels of homeownership on labor outcomes, like unemployment spells and labor mobility.[4] This strand of the literature has found that a higher level of homeownership is associated with lower labor mobility and longer unemployment spells, but it also assumes that differences in homeownership are mainly due to country-specific preference for ownership. In this paper, I investigate the possibility that an external source, such as labor market institutions, can affect both the homeownership rate and labor outcomes. For my analysis, I can exploit both the cross-country and the over time variation of labor market legislation. Indeed, there have been significant changes in labor market institutions within countries, but also in the relative differences of labor rigidities between countries over time.

Previous studies have found that *employment rigidities* (ER) and *real wage rigidities* (RWR) have opposite effects on the volatility of employment and real wages.[5] ER tend to reduce the volatility of employment. RWR, on the one hand reduce the volatility of wages, but on the other

[1] In the Appendix I show the evolution of homeownership rate from 1965 to 2014 for 19 OECD countries.

[2] See Chiuri and Jappelli (2003), Chambers et al. (2009a), Andrews (2010), Andrews and Caldera-Sánchez (2011a), Andrews and Caldera-Sánchez (2011b), Andrews et al. (2011), Caldera-Sánchez and Johansson (2013). Some of these works investigate homeownership over time, while others make cross-country comparisons.

[3] The existing literature has analyzed whether labor income risk and volatility affect housing tenure decision. There is widespread consensus in assessing that labor income risk and volatility have a negative effect on homeownership. This fact has been analyzed both theoretically and empirically (see Haurin (1991), Robst et al. (1999), Ortalo-Magné and Rady (2002), Diaz-Serrano (2005b), Diaz-Serrano (2005a), Sinai and Souleles (2005), Davidoff (2006)). Gathergood (2011) finds that unemployment risk at the household level reduces the probability that a renter becomes home owner. Attanasio et al. (2012), using a life-cycle model, find that individuals delay the purchase of their first residence when incomes are low or uncertain. Furthermore, an increase in income variance leads to a reduction in residence ownership.

[4] See Oswald (1996), Henley (1998), Barcelo (2006), Battu et al. (2008), Rupert and Wasmer (2012), Bentolila et al. (2012), Bajari et al. (2013) and Sterk (2015).

[5] See in particular Abbritti and Weber (2010), Abbritti and Fahr (2013) and Gnocchi et al. (2015), which investigate the role of LMIs on the volatility of macroeconomic outcomes, such as inflation, output, unemployment and wages. I exploit the results of this literature to identify a channel that links labor market institutions with homeownership.

hand have been found to increase the volatility of employment. This is because when a firm is hit by a negative shock and cannot adjust wages, it may be forced to reduce employment. Given that ER and RWR affect differently the volatility of employment and income, it is important to distinguish between the different types of labor rigidities, to correctly evaluate the impact of labor market institutions on homeownership.

In the first part of the paper I provide empirical evidence on the relationship between LMIs and homeownership. I consider data from 19 OECD countries over the period 1965-2014 and compute principal components of a large set of labor market institutions, which represent both employment rigidities and real wage rigidities. The use of principal components allows me to consider the impact of interactions and combinations of institutions, having interpretable results. Using panel regression analysis, I find that an overall more rigid labor market is positively correlated with homeownership. This is the result of the opposing effects of employment and wage rigidities. Indeed, I show that ER, represented by employment protection, strong labor unions and generous unemployment benefits, are positively correlated with homeownership, whereas real wage rigidities, such as wage bargaining centralization, are negatively correlated with homeownership.

These results can be explained by the fact that employment rigidities tend to reduce the volatility of employment. Generous unemployment benefits instead, tend to smooth the negative impact of unemployment shocks. This reduces *de facto* real wage volatility, without increasing employment volatility. On the other hand, real wage rigidities reduce the volatility of real wages, but they also increase the volatility of employment. Since housing tenure decision is largely affected by the risk of becoming unemployed, higher employment volatility has a negative impact on homeownership. In my panel regression analysis, I control for the elements that the literature has found to influence the housing tenure choice, such as demographics, economic situation, taxes on property, successions and transactions, net migration flows, financial market innovations, rental costs and housing prices.

In order to get additional evidence of the effects of changes in labor market legislation on homeownership, I also examine the impact of specific reform episodes, using a difference in difference approach. In the spirit of Gnocchi et al. (2015), I consider four different groups of reforms which reduced labor rigidities. I analyze employment protection reductions, unemployment benefit cuts, losses of unions' power and decentralization of wage bargaining. I find that reductions in employment protection and less generous unemployment benefits are negatively correlated with homeownership, whereas reforms that reduce union power or that decentralize the wage bargaining are positively correlated with homeownership.[6] These findings confirm panel regression results and are in line with the literature which investigates the impact of LMIs on macroeconomic outcomes, such as GDP, inflation, unemployment and wages.

In the second part of the paper, in order to investigate the mechanism behind my empirical findings, I construct a DSGE model with search and matching frictions, and labor market rigidi-

[6]This finding is consistent with my previous results. Indeed, considering separately union coverage and extension of collective agreements in the panel regression analysis, I find that the former is negatively, whereas the latter is positively correlated with homeownership. The opposite effects for two similar institutions may suggest that the two indicators capture the dual role of labor unions, active both in wage bargaining and employment bargaining.

ties, both in terms of employment and wages, where heterogeneous households face a housing tenure decision. The model has enough details in the labor sector to disentangle the heterogeneous effects of different labor institutions. My model creates a bridge between the literature on housing demand, and the literature on labor institutions and macroeconomic outcomes. With respect to the former, I consider a more detailed labor sector, where it is possible to study the effects of specific labor legislation.[7] On the other hand, with respect to the latter, I incorporate the housing market, and study its dynamics.[8] In my model the housing market is directly linked to the labor market via an endogenous credit constraint which depends on the expected income and its volatility. Standard exogenous credit constraints in the literature, such as in Iacoviello (2005) and Andres et al. (2013), are not affected by income uncertainty. The version I propose in my model leads to more credit when household's income is higher and less volatile, while it shrinks credit availability during times of low income or high uncertainty. The credit constraint in my model reflects the fact that financial institutions take into account the repayment ability of the borrower, moreover it allows me to disentangle the different effects of labor market institutions on the housing market.

The model is able to replicate second moments of wages and unemployment for USA, France, United Kingdom (UK) and Japan. Moreover it matches well the homeownership rates of these countries. I perform different types of counter-factual experiments to investigate how labor market institutions interact with the housing market. Firstly, for the USA, I consider the hypothetical case of the adoption of employment protection, benefit replacement rates and unions' strength as in France. Since the US has much more flexible labor institutions than France, this experiment is useful to study the impact of a hypothetical large increase in labor market rigidity. I find that this policy change would lead to an increase in US homeownership of 3.04%. This sizable effect on homeownership is driven, within the model, by the impact of different LMIs on the level and volatility of wages and employment.

As a second type of counter-factual experiment, I evaluate the impact of a series of labor market reforms that took place in the United Kingdom in the 1980s, which reduced the benefit replacement rate. I find that these reforms, if everything else was unchanged, would have leaded to a reduction of homeownership of 1.42%. This means that some labor reforms undertaken by the UK during the 1980s may have dampened the positive impact of other specific housing policies on homeownership.[9] Results from my counter-factual experiments suggest that LMIs play a not negligible role in driving homeownership dynamics. Therefore models that want to study the impact of labor reforms on the entire economy, should also take into account the direct effects of these reforms on the housing market.

The rest of the paper is organized as follows. Section 2 describes the data for homeownership, labor market institutions and the covariates. Moreover, it presents the principal component analysis. Section 3 shows the panel regression results under different specifications and it

[7] See Diaz-Serrano (2005a) andAttanasio et al. (2012).

[8] See Rumler and Scharler (2009), Abbritti and Weber (2010), Gnocchi et al. (2015). Andres et al. (2013) have a model with housing and labor market rigidities, but without housing tenure choice.

[9] I am working on studying the impact of a labor reform that reduced unions' strength in Japan in 1986. In the same year a law which increased tax deductibility of mortgages was approved. Its aim was to enhance homeownership, which instead remained stable. I want to evaluate, through counter-factual experiments, if the labor reform could have dampened the effect of the financial reform.

presents the robustness checks. Section 4 describes the data on labor market reform episodes. Section 5 presents the results from the difference in difference analysis. Section 6 describes the theoretical model and presents the solution method and calibration. Section 7 shows the match of the model to the data and it describes the results from the counter-factual experiments. Finally, Section 8 concludes the paper.

2 Data and principal component analysis

I collected annual data from 1965 to 2014 for 19 OECD countries using different sources. The time period considered is long enough to analyze long-run trend of homeownership and it includes also the most significant labor market reforms for many of the countries studied. Moreover I analyze a relatively large sample of countries in order to account for possible country-specific differences in the level of homeownership. The countries included are: *Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland United Kingdom and United States.*

2.1 Home ownership data

Homeownership rate is defined as the percentage of total population that owns the main residence (OECD definition). Complete data on homeownership are relatively rare, since statistical offices of different countries often use specific criteria to define homeownership.[10] Data on homeownership are obtained from the CEP-OECD Institutions Dataset constructed by Nickell (2006) from data by Andrew Oswald and the OECD Employment Outlook 2005[11] . I complete these data with information obtained directly from the statistical offices or central Banks of each country. Fig.1 shows the evolution over time of homeownership for each country. It is possible to see that some countries like Italy, Netherlands or Spain experienced a large increase in the rate of homeownership between 1965 and the 2014, whereas other countries like Denmark, Japan or US remained quite stable. Fig.2, where countries are ordered according to their mean value of homeownership, shows more clearly the differences over time *between* countries. The red diamonds represent the mean value of homeownership for the entire period considered, while the blue circles show the evolution over time of homeownership within each country. As we can see, some countries that started with a relatively low level of homeownership experienced a large increase, while others had a much smaller variation.

2.2 Labor market institutions

I combine data from a variety of datasets largely used by the literature on labor market institutions. In particular I use the CEP-OECD Institutions Dataset, constructed by Nickell (2006), the ITCWSS database from Visser (2011) and directly the OECD Employment Protection Legislation Indicators. I consider a large set of institutions because I want to represent different

[10] A typical example is represented by the Scandinavian countries, which have different forms of dwelling's ownership and social housing. In case of conflict or ambiguity among different definitions I used the one of OECD, in order to have data as homogeneous as possible.

[11] The original dataset of Nickell (2006) spans from 1960 to 2003 and it includes 20 countries, but I had to exclude Portugal due to lack of data on homeownership.

aspects of the labor market legislation. In particular, I disentangle between rigidities related to employment and real wages. This because they have been found to have opposite effects on the volatility of employment and wages.

I consider 14 labor market institutions, described in Table 6: (i) employment protection for permanent contracts; (ii) employment protection for temporary contracts; (iii) union density; (iv) union coverage; (v) benefit duration; (vi) benefit replacement rate; (vii) unemployment benefit; (viii) tax wedge; (ix) wage bargaining centralization; (x) union concentration; (xi) government intervention in wage bargaining; (xii) bargaining level; (xiii) extension of collective agreements and (xiv) minimum wage setting. I include a wider range of LMIs compared to the majority of the existing literature and for each of these variables, an higher value indicates a more rigid or centralized labor market. The descriptive statistics of each LMI are reported in Table 7 of the Appendix. The majority of labor market reforms took place between the 1980s and the 1990s, therefore these two decades drive the largest part of the over-time variation of my data.

The two indexes of employment protection (EPR and EPT) are proxies for the cost of firing a worker and they reflect the duality of treatment between permanent and temporary contracts, which is present in many countries. They represent a quite net measure of employment rigidity since they both reduces job flows. There is no clear evidence that higher EPL raises overall unemployment level, and the same time it has been shown that EPL tend to increase unemployment spells and long-term unemployment.[12]

Union density (UD) indicates the ratio of trade union members over total employees. Union coverage (UC) instead captures the proportion of workers covered by collective agreements signed by labor unions. Union concentration (CONC) represents the proportion of total union members in the largest 1-10 unions, providing a proxy for the power of strike actions. Finally extension of collective agreements (EXT), is a measure similar to UC, but not normalized to employment. These measures can be seen as proxies for the strength of labor unions and it is therefore important to consider all of them to understand the real impact of union power, which could be both over employment and over wages.

Rigidities representing wage bargaining are: (CENT) an index of the degree of centralization of wage bargaining, (LEVEL) the predominant level at which bargaining takes place, (GOVINT) an index of government intervention in collective agreements, (MWS) the presence and the level of minimum wage and (TW), a measure of tax wedge. TW represents the inefficiency of labor market, since a high tax wedge influences the reservation wage of workers. These institutions represent real wage rigidities, which are expected to reduce the volatility of wages, but at the same time increase the volatility of employment.

Finally, unemployment benefit institutions are represented by benefit duration (BD), benefit replacement rate (BRR) and an indicator of the combination of the two (UB). These are expected to increase the degree of real wage rigidity in the economy on one side, since they increase the reservation wage that workers are willing to accept, but on the other side they also reduce the negative impact of facing an unemployment shock. Depending on which of the two effects prevails the final impact of unemployment benefits could be in favor or detrimental for

[12] See Bentolila and Bertola (1990) and Nickell and Layard (1999).

homeownership.

2.3 Control variables

Among my covariates I include what the existing literature has identified as important drivers of homeownership. I use 15 control variables, taken from different sources described in the Appendix. The choice of these controls is motivated mainly by the literature on housing.[13]

The sample of my controls includes: (i) population between 15 and 64, as % of the total population, in order to capture the potential effect of the aging of a country; (ii) real house prices; (iii) price to income ratio, which is the ratio between housing prices and average income; (iv) price to rent ratio, in order to control for the convenience of the outside option with respect to buy an house; (v) real personal disposable income index, since it has been shown that wealthier households are more likely to be home owners; (vi) real interest rate of each country, to capture the changes in the possibility of accumulate down-payment and to control for the conditions of the mortgage market; (vii) net migration rate (per 1000 inhabitants), because migration flows may influence significantly the housing market and homeownership rate; (viii) the financial reform index by Abiad et al. (2008), which is a synthetic measure of 7 different indicators of financial markets efficiency; (ix) revenues from taxes on property, as % of GDP; (x) revenues from taxes on immovable property, as % of GDP; (xi) revenues from taxes on estate, inheritance and gifts, as % of GDP and finally (xii) revenues from taxes on financial and capital transactions; (xiii) GDP growth, to control for macroeconomic conditions; (xiv) unemployment rate; (xv) rent cost. In the Appendix I provide a more detailed description of each control and the relative descriptive statistics.

2.4 Principal component analysis

As it has been pointed out by Abbritti and Weber (2010), labor market institutions tend to influence each other. Therefore their interactions should be taken into consideration when it comes to evaluate the effects on the economy of a labor reform. With a large number of variables there would be too many pairwise combinations to consider and the meaning of these interaction is not always obvious. In order to capture the impact of different labor market institutions and their combinations, having interpretable results, I use *principal component analysis* (PCA).[14]

With respect to labor market institutions, following Gnocchi et al. (2015), I adopt two different specifications for the construction of the principal components.[15] As first specification, I divide the 14 labor market institutions into four groups, on the basis of economic meaning and their possible impact on the economy. This process leads me with one component for each group, which I call Economic Factors, and allows me to disentangle the different effects of employment rigidities and wage rigidities, on homeownership. In the second specification, I consider all LMIs equally and I construct a measure of *overall rigidity* of the labor market. This is is useful to understand the total effect of a more rigid labor market framework, since it

[13] See Andrews and Caldera-Sánchez (2011b) and Andrews and Caldera-Sánchez (2011a) for an extensive discussion on this topic.

[14] Also Gnocchi et al. (2015) adopted principal component analysis for studying the impact of a large set of labor market institutions on macroeconomic outcomes.

[15] The principal components are obtained using correlation specification, equivalent to using standardized data.

is often the case that countries with more rigidity on employment present also more rigidity in wage setting.

2.4.1 Economic factors

Under this first specification I divide labor market institutions into four groups according to their field and I call them *Economic Factors*, as done by Gnocchi et al. (2015). The five Economic Factors are: (i) *Employment Protection legislation* (EPL) constructed with employment protection for permanent contract and employment protection for temporary contracts; (ii) *Unions' Strength* (UnS) that includes union density, union concentration, union coverage and extension of collective agreements; (iii) *Wage Bargaining* (WB) with bargaining coordination, bargaining centralization, tax wedge, government intervention in wage bargaining, level of prevalent wage bargaining and minimum wage setting and (iv) *Unemployment Benefits* (UB), with benefit duration, benefit replacement rate and unemployment benefits. Table 9 shows the correlation between Economic Factors and original LMI. EPL explains 80.90% of total variability of permanent and temporary contracts protection. UnS corresponds to 40.89% of the variability of unions' strength related institutions, whereas WB refers to 49.41% of variability of wage bargaining related LMIs and UB to 67.41% of total variability of unemployment benefit variables.

2.4.2 Statistical factors

As second specification, considering all 14 labor institutions equally, I construct what I call *Statistical Factors*. This is the most general specification possible, since it does not assume any specific economic relation between the institutions. The analysis of the loadings suggests to keep 4 factors, namely SF1, SF2, SF3 and SF4. Where SF1 explains 35% of the total variability, SF2 14.66%, SF3 12.67% and SF4 10%. In total the four statistical factors explain 73.13% of the variability of all the labor market institutions considered. In order to give an interpretation to these four components I compute the correlation for each of them with the original labor market institutions. As it is possible to see from Table 10, SF1 is highly positively correlated with all the LMI, so I interpret the first component as a measure of *overall rigidity* in the labor market. SF1 is the only Statistical Factor that I will consider for my analyses.[16]

2.4.3 Principal controls

Following the same reasoning adopted for labor market institutions, I construct principal components also of the set of covariates, chosen to control for the factors that can affect homeownership. Applying PCA to the control variables I get 5 components that I call *Principal Controls*. These explain 75.41% of total variability of original controls. In particular the first component accounts for 30.21% of the variability, the second for 17.75%, the third for 12.96%, the fourth

[16] SF2 is highly positively correlated with the UB institutions and SF3 reflects mainly the movements of minimum wage setting, EPL and the extension of collective agreements. Finally SF4 is highly correlated with unemployment benefits, employment protection measures and with tax wedge.

for 7.96% and the fifth for 6.53%.[17] Table 11 presents the correlation between the components derived by the control variables and the original controls.

3 Empirical results

3.1 Panel regression analysis

In this section I document the correlation between labor market institutions and homeownership. In order to exploit both the cross-sectional and over time variation of the data, I adopt panel regression analysis including country fixed effects, year fixed effects and country-specific time trends. Country fixed effects account for the fact that there may exist country-specific preferences for homeownership. Year fixed effects account for time specific characteristics. Finally, the country-specific time trend allow for trends to vary across countries. My baseline regression reads:

$$ho_{i,t} = \alpha + \beta' \mathbf{LMI}_{i,t} + \gamma' \mathbf{X}_{i,t} + \mu_i + \nu_t + cstt_{i,t} + \varepsilon_{i,t}$$

where $ho_{i,t}$ is homeownership rate at time t in country i. α is a constant, $\mathbf{LMI}_{i,t}$ is the vector of principal components obtained from labor market institutions and it is different for each specification of PCA: Economic Factors and Statistical Factors. $\mathbf{X}_{i,t}$ represents the set of principal components derived from the original control variables. μ_i are country fixed effects, ν_t are time fixed effects and $cstt_i$ represents the country-specific time trends. Following Nickell et al. (2005), I estimate a generalized least squares model, always calculating robust standard errors allowing for heteroskedasticity with cross-sectional correlation and panel specific first order serial correlation.

3.1.1 Evidence from Economic Factors

Table 17 shows the panel regression estimates using the four economic factors. Column (1) represents my baseline model with all Economic Factors, principal controls, fixed effects and time trends. Column (2), (3), (4) instead consider EPL with each of the others Factors UnS, WB and UB, one per time. As it is possible to see, the employment protection factor results significantly and positively correlated with homeownership in all the specification. In particular, from column (1) it is possible to see that one standard deviation increase in EPL is associated with an increase on 0.315% in homeownership. Also unemployment benefit is positively correlated with homeownership. In this case the increase of one standard deviation in UB leads to an increase of homeownership of 0.259%.

A priori, the effect of unions' strength is less clear. Indeed it depends whether UnS acts more as employment rigidity or wage rigidity. [18] In all specifications UnS has positive and significant sign, and this suggests that actually labor unions represent more an employment

[17] As alternative specification for the construction of the principal controls, I divide the covariates into 3 groups, according to their economic meaning: (i) Housing control; (ii) Economy control and (iii) Tax control. This leads me with three principal controls. Results under this alternative specification are used as robustness check.

[18] Petrakis and Vlassis (2000) find that if unions' power is sufficiently high, they bargain solely over wages supporting the right-to-manage model hypothesis; otherwise they bargain over both wages and employment.

rigidity than a wage rigidity. The effect on homeownership is of 0.484%. Finally, the wage bargaining component is significant and negatively correlated with homeownership, in line with the expectation that a more centralized wage bargaining is associated with lower homeownership rates, due to its impact on volatility of wages and employment. One standard deviation increase in WB is associated with a reduction in homeownership equal to 0.287%.

[Table 17 here]

In order to better understand the results of EPL, in Table 18 I perform a panel regression using the two original measures of employment protection for permanent and temporary contracts, while I keep using the other Economic Factors. This exercise shows that actually all the positive correlation between employment protection and homeownership is driven by EPL on permanent contracts, whereas the coefficients for temporary contract are negative. In particular, one standard deviation increase of EPL for permanent contracts is associated with an increase in homeownership of 4.526%. On the other hand, one standard deviation increase in EPL of temporary contracts leads to a reduction in the share of homeowners equal to 0.409%. By comparing the first column with the others, I find that results are robust to considering one factor at the time. A similar result has been found also by Faccini and Bondibene (2012), who investigated the impact of LMIs on unemployment volatility.

One possible explanation for this finding could be the fact that temporary contracts are *per se* detrimental for homeownership. Indeed households with a temporary contract may have more difficulties in accumulating the down payment for buying an house, and banks may be less willing to accord a mortgage to a temporary worker. Under this assumption, more protection to temporary contracts could increase the set of workers willing to accept this type of contract, instead of waiting for another job offer, but at the same time it does not generate any positive effect on homeownership.

[Table 18 here]

3.1.2 Evidence from Statistical Factors

With respect to Statistical Factors, I am interested only in SF1, which can be interpreted as a measure of *overall rigidity* of labor market. Table 19 reports the panel regression estimates using the four Statistical Factors. Column (1) represents my baseline model. The other columns consider each factor taken separately. From the first column it is possible to see that the *overall rigidity* measure is positively and significantly correlated with homeownership rate. This suggests that a generally more protected labor market is associated with higher levels of homeownership. One standard deviation increase in the overall rigidity coefficient is associated with an increas in homeownership of 0.320%. This result can be reconciled with the idea that the positive impact of employment protection and high unemployment benefits prevails over the negative effect of a more centralized wage bargaining. In the second column instead, the coefficient of SF1 is negative and not significant, reflecting the fact that SF1 is the results of opposite forces. Also SF2 SF3 and SF4 present significant coefficients. In particular SF2 suggests a positive correlation between unemployment benefits measures and homeownership, whereas the interpretation of SF3 and SF4 is less clear.

[Table 19 here]

3.1.3 Evidence from original LMIs

I also look at the original LMIs. Panel regression results in Table 20 confirm the positive correlation between employment protection of permanent contracts and homeownership, and the negative correlation with respect to temporary contracts protection. The institutions that compose the UnS factor have negative sign when one look at union density and coverage, whereas union concentration and extension of collective agreement present positive and significant coefficients. This result may be due to the fact that unions bargain over wages, but also over employment and it seems that the degree of concentration of labor unions acts more as an employment rigidity.

With respect to the institutions that compose the wage bargaining factor, I also get mixed results. Wage bargaining centralization, level of wage bargaining, government intervention and tax wedge are negatively correlated with homeownership, as expected. Minimum wage has instead a positive coefficient. It is worth to say that minimum wage has two different effects on the volatility of real wage: on one hand it lower real wage volatility since it prevents wages to be set below a certain level. On the other hand, the fact that firms cannot set freely wages may lead to a relative higher unemployment during an economic crisis, because firms have to adjust employment instead of wages. These two effects act in opposite directions with respect to homeownership. The positive sign of the extension of collective agreements can be explained by the fact that these agreements can act also as employment protection.

Finally, it is worth to notice that analyzing each LMI individually could be misleading, since the interactions among institutions are important, as found by Gnocchi et al. (2015). At the same time it is not convenient to consider all the possible interactions between LMIs in one regression, first of all because they are many, and secondary because the interpretation of estimated coefficients could be not clear.

[Table 20 here]

3.1.4 Robustness checks

I perform a series of different robustness checks. As first, I want to asses whether the results depend on my use of specific principal controls. Hence I use panel regression analyses adopting an alternative specification for the principal controls. Under this choice, I divide the covariates into 3 groups according to their nature and I obtain three principal controls: (i) *Economy control*; (ii) *Housing control* and (iii) *Taxes control*. [19] Table 12 in the Appendix shows correlation between original controls and the 3 principal controls. Using these alternative components for the controls I get very similar results with respect to my baseline specification, as it is possible to see from Tables 21-23. As additional robustness check, I perform my panel regression analyses

[19] Economy control is composed by working population, real personal disposable income, financial reform index, net migration rate, long-term real interest rate, GDP growth and unemployment rate. It explains 40.99% of original variability. Housing control comprehends real housing prices, rental cost, price to income ratio and price to rent ratio. This explains 66.22% of original variability. Finally Taxes control includes property tax, succession tax and transaction tax. This component instead explains 53.84% of original variability.

using the original covariates. I get again similar results to those of my baseline specification.[20] These checks seem to suggest that my results are not driven by the choice of principal controls.

Another type check I do regards the timing of the effects. Changes in labor institutions may take time to be implemented and tend to be announced in advance. My baseline specification, in which I consider *homeownership* at time t, allows for anticipation effects. If institutions are announced in advance and if homeownership responds to such announcements, a contemporaneous regression should capture this, since *homeownership* at time t will be affected by announcement in $t-1$ of institutional change at time t. If instead I disregard announcement effects, I would expect institutions announced and implemented in time t to affect household housing tenure decision in time $t+1$. I consider both timing and results are consistent even when using lead homeownership rate (see Tables 24-28).

Finally, a possible concern with this type of estimations is reverse causality. Hence, following a procedure largely used in the literature on labor market institutions, I collapse my data into 5-years not overlapping periods.[21] Then for LMIs I consider data at the beginning of each 5-years period, while I use the average of homeownership and controls over the period.[22] On one hand this procedure has the advantage of excluding the possibility of reverse causality, since the average rate of homeownership after the beginning of each sub-period should not affect the value of LMIs at the beginning of the same sub-period. On the other hand, it has the disadvantage of reducing significantly the amount of data and information I can use for my estimates. Indeed I am left with only 10 time periods and 19 countries. This could be potentially a problem for panel regression analysis, since homeownership and LMIs have already relatively small variability and I am left with few observations. I still find significant results using the reduced dataset, in particular the estimates are very similar for EPL and UnS and UB also under this specification. WB instead presents a positive sign, although it is not significant in the main specification. Considering individual LMIs government intervention and level of wage bargaining have the expected negative sign. Also the statistical factor for overall rigidity has the expected sign. Results under the 5-year interval specification are shown in the Appendix. (See Tables 29-31) These results confirm my previous findings and exclude the possibility that in the main specification estimates are driven by reverse causality.

4 Labor market reforms and homeownership

Using panel regression analysis I have shown that it exists a statistically significant correlation between labor market institutions and homeownership. The results are qualitatively in line with the theoretical and empirical literature that investigated the impact of LMIs on the business-cycles and macroeconomic outcomes.

In this section I analyze specific labor reforms episodes, in order to asses whether changes in labor market legislation, which changed employment and real wage rigidity, had an impact on homeownership rates. My approach is similar to Gnocchi et al. (2015), who analyzed the

[20] This robustness check is not included in the paper to save space and is available upon request.

[21] See for instance Rumler and Scharler (2009), Faccini and Bondibene (2012) and Gnocchi et al. (2015).

[22] This means for instance that for lustrum 1965-1969, for my principal component analysis and regressions, I use the value of LMIs in 1965, while for homeownership and the controls I use the average between 1965 and 1969.

impact of labor market reforms on business-cycles. I consider a labor reform as a treatment that occurs in some countries, but not in others.

4.1 Labor market reforms data

I gather information on labor market reforms from different sources. In particular for European countries, following Boeri and Garibaldi (2009), I use data from the 'Social Policy Reform Inventory' from Fondazione Rodolfo De Benedetti (FRDB), which covers the period 1970-2009. Moreover I use information from the Database for Institutional Comparisons in Europe constructed by Cesifo-DICE. Finally, I use information from Gnocchi et al. (2015), who collected data regarding labor market reforms for Australia, Canada, Japan and USA.[23] I restrict my attention to *structural* and *complete* reforms that *reduced* the rigidity of the labor market.

According to the definition of the De Benedetti database, a structural reform is defined as one that changed *not marginally* the legislation on the topic that addresses. A complete reform is a change in the legislation that is target ideally to the *entire work force* and not only to a subgroup of it. This means that I will focus only on reform episodes that produced a non-marginal change in the labor regulation for the whole labor force. I look only at reforms that increased the flexibility of labor market, because in the period I consider there was a larger number of this type of reforms and I want to have homogeneity in the reform episodes I analyze. The data I use provide information on the date the bill was passed and they include detailed description of the reform, and its scope. Finally I restrict my attention to those reforms which were not undo by later reforms. In Table 1 I describe in detail the reforms I consider.

4.1.1 Employment protection reforms

The 'Social Reform Inventory' constructed by FRDB identifies three different categories of employment protection reforms: (i) reforms that shorten the notice period for firing an employee; (ii) reforms that reduced or removed the costs of dismissal; and (iii) reforms aimed at relaxing restrictions for fixed-term contracts. The reforms I consider took place in 1991 and reduce the notice period for dismissal in the case of Finland, while in the case of Italy I consider a reform that made less stringent the economic dismissal.[24]

4.1.2 Replacement rate and unemployment benefits reforms

This group of reforms refers to both changes in replacement rate and in unemployment benefit legislation. In particular, all the reforms I consider involve more stringent requirements to obtain unemployment benefits, or they lower the entity and shorten duration of the benefits. The wave of reforms analyzed took place in 2000. In particular Austria reduced replacement rates and made more stringent the eligibility criteria fro unemployment benefits. Spain enforced the duties to get unemployment benefit and made them stricter. Finally Sweden imposed the rule that after three rejections of job offers, a person is not entitled anymore for the benefit.

[23] I use Gnocchi et al. (2015) also to define reform episodes regarding wage bargaining structure, for which there no data availability in the other source I consider.

[24] Potentially, I can identify another wave of employment protection reforms that affected France and Japan in 1986. I excluded this wave of EPL reforms since the countries interested experienced also subsequent institutional reforms on the same topic.

4.1.3 Wage bargaining reforms

Since no formal data about wage bargaining reforms are available, I relay on the list of reforms identified by Gnocchi et al. (2015) using information contained in the labor market indexes. In particular they looked at the degree of coordination in the wage bargaining process, the government involvement in wage bargaining and the extent to which collective agreements are extended to non-unionized workers.

With respect to wage bargaining reforms I investigate the wave of reforms that took place at the end of the 1980s. The reforms I consider decentralized the level of wage bargaining to the firm level in Denmark in 1987 and liberalized fixed-term contract and reduced government intervention in Spain in 1986. [25]

4.1.4 Union power reductions

With respect to reforms that reduced the power, or at least the influence of labor unions, following Gnocchi et al. (2015) I consider the waive of Thatcher's labor market reforms that took place in 1980 in the United Kingdom. I need to take into account the fact that in 1980 UK approved also the *Housing Act*, which consisted in the sell of part of the state-owned houses which were rented at a subsidized rental. This reform had a very strong impact on the housing market, since it increased homeownership, generating potential confounding issues for my estimates. In my difference in difference estimates, I will take the impact of this housing reform into account with a specific dummy variable.

Table 1: Description of labor market reforms

EPL		
Finland	1991	The notice period was shortened from 2 months to $1-2$ weeks.
Italy	1991	The administrative authorization in case of individual dismissal for economic reasons is abolished.
UB & RR		
Austria	2000	Replacement rates are lowered and eligibility criteria are stricter.
Spain	2000	Duty to actively seek for a job is enforced. Unemployed rejecting three suitable job offers loose the benefit. An offer is suitable if job is identical to previous jobs. After 12 months, unemployed must accept any other job after retraining.
Sweden	2000	Duty to actively seek for a job is enforced. Unemployed rejecting three job offers loose the benefit.
WB		
Denmark	1987	Bargaining shifts down to the industry level or firm level.
Spain	1986	Liberalization of fixed-term contracts, reductions in government intervention.
UnS		
United Kingdom	1980	Thatcher's labor market reforms: Social Security Act (No.2) and Employment Act.

[25] Since the date of the reforms in the two countries is different, I consider 1987 as year of treatment, capturing a potential delay impact of the reform in Spain but excluding the possibility that the Danish reform had a significant anticipation effect.

5 Evidence using difference in difference approach

In order to investigate the effects of specific labor market reform episodes on homeownership I adopt a difference in difference approach (DD). I consider labor market reforms as a 'treatment' that is implemented in some countries, but not in others. For each type of reform considered, I divide the time period into pre-treatment and post-treatment and I group my sample of reform episodes into four different groups: (i) *employment protection reforms*; (ii) *replacement rate and unemployment benefits reforms*; (iii) *wage bargaining reforms*; (iv) *union power reductions*. The only countries in my sample that did not experience any structural and complete reforms in any of these groups for the period considered are Norway and USA. [26]

As alternative specification, I include in the control group of each reform type, all those countries that did not undertake important reforms in the sector considered. Under this second specification I also include dummy variables for other labor reforms that happened in these counties. Finally, I construct a version of the control groups comprehensive of all non-treated countries for each specific reform. Under this third specification, I take in account the fact that some of the countries in the control groups undertook reforms in different topic of the labor legislation. With respect to the treated groups instead, their composition changes on the basis of the type reform considered.

The main identifying assumption of my DD analysis is that the dependent variable of both treated and control groups presents a similar trend (parallel trend assumption) before the reform took place. In my case, homeownership trend in each of the countries considered is driven by a variety of difference sources. In particular, I expect some of the covariates considered in the panel regression to be responsible for a large part of the difference in homeownership trends observed across countries. Therefore, in order to test the parallel trend assumption in this framework, I perform a panel regression of homeownership over the set of covariates, including also time and country fixed effects.[27] Then I use the residuals of this regression for a visual inspection of parallel trends, for each of the reform I analyze. Figures 3-6 show that the parallel trend assumption, for a limited period before the reforms, is fulfilled for each group considered.

A critical assumption of my difference in difference analysis is that there is no unobserved variable correlated with homeownership, that co-moves systematically over time differently between treated and control groups. Since I consider all developed countries, this possible difference is less of a concern, but in order to verify this assumption, in Table 34 I show means and standard errors of the principal controls, used in the panel analysis, between treated and control countries. The hypothesis that treated and control group are equal cannot be rejected at 5% level of confidence only for some pair and characteristic examined, providing mixed results. Therefore, in order to account for potential omitted variable bias, I include in my DD regression the set of control variables used also in the panel regression analysis.

Another important assumption of this identification strategy is that labor market reforms

[26] Norway experienced a very large housing boom starting from the 1990s, for reasons not related to LMIs, and this may be a confounding factor for my estimates. I adopted alternative specifications for the control group, in order to check whether my results depend on the path of Norwegian housing market and qualitatively it does not seem to be the case.

[27] This is the model I estimate for obtaining the residual to test the parallel trend assumption:
$ho_{i,t} = \alpha + \gamma' \mathbf{X}_{i,t} + \mu_i + \nu_t + \hat{\varepsilon}_{i,t}$

are not triggered by some elements that have a causal effect also on homeownership. I argue that, even if homeownership tends to be lower during recessions and this are periods when institutional reforms are more common, there is not a specific type of labor reform that is more likely. In any case, I control for this possibility including in the regression what I call the *initial condition* of homeownership, which consist in the five-years lags of homeownership rate. The length of this lag has been chosen in order to take into account the fact that in general it takes some time for an household to accumulate the sufficient down-payment to buy an house. This element takes into account the possibility that countries with different pre-existing levels of homeownership may have different propensity of undertaking labor reforms.

The difference in difference model reads:

$$ho_{i,t} = \alpha + \delta_1(Reform_i \times Post_t) + \delta_2 Reform_i + \delta_3 Post_t + \theta ho_{it-5} + \beta' \mathbf{X}_{it} + \lambda_i + \gamma_t + cstt_{i,t} + \varepsilon_{it}$$

where $ho_{i,t}$ is homeownership rate at time t for country i, $Reform_i$ is a dummy that takes value 1 if the country undertook a labor market reform and 0 otherwise. $Post_t$ is a dummy that takes value 1 after the year of the reform and zero before. The interaction term $Reform_i \times Post_t$ capture the effect of interest. $\mathbf{X}_{it}$ is the vector of principal controls, λ_i and γ_t are country and year fixed effect respectively, moreover I include country-specific time trends $cstt_{i,t}$. Finally ho_{it-5} represents the five-years lag of homeownership. I adopt a generalized least square estimation, allowing for potential heteroskedasticity and panel-specific first order serial correlation.

It is relevant to notice that, since I consider reforms that reduce labor market rigidities, I expect to find opposite signs with respect to the panel regression analysis.

5.1 Results from difference in difference analysis

Table 32 reports results of the difference in difference estimates for the four groups of reforms. The first specification includes as control countries only Norway and USA, which are the only countries in my sample that did not undertake significant and complete reforms increasing labor market flexibility in the period considered. In the second specification instead, the control groups are composed by those countries that did not undertake the reform investigated. Since some of these countries have done reforms in other fields of labor market, I include dummy variables for each of these reforms, to control for their potential effect. [28] In the Appendix I present also an alternative specification, which adopts reform-specific control groups, but without the dummies for other type of reforms.

As it is possible to see the from Table 32, the two specification are qualitatively very similar, and differ only in terms of size-effect. It is worth to say that the second specification can relay on much more observations, and it is likely to be more accurate. Also my robustness specification presents similar results. This seems to suggest that the choice of the countries in the control group is not driving the results.

[Table 32 here]

[28] e.g. for the reform of EPL91, I include dummy variables for each of the other reforms: UB00, WB87 and UP80.

5.1.1 Employment protection reforms

Difference in difference estimates show how countries that passed reforms reducing employment protection at the beginning of 1990s had a statistically significant reduction in homeownership rate. Depending on the specification of control group considered, this reduction varies between -6.701% and -2.465%. This suggests that a lower degree of employment protection is detrimental for homeownership, as found in the panel regression analysis, both for the Economic Factors and the original LMIs. These results are in line with the findings of Faccini and Bondibene (2012) and with the difference in difference estimates of Gnocchi et al. (2015), who consider the impact of labor reforms on business-cycle volatility.

5.1.2 Replacement rate and unemployment benefits reforms

I consider the wave of reforms in 2000 and I find a significant decrease in homeownership rate due to the reduction in unemployment benefits or stricter duties to get the benefit. The reduction in homeownership varies between -3.116% and -1.328%, according to the different control group specifications. This confirms my findings from the panel regression analysis and it is also in line with the literature that found that a reduction of benefit replacement rate and unemployment benefits induce an increase in the volatility of unemployment (See Faccini and Bondibene (2012) and Gnocchi et al. (2015)).

5.1.3 Wage bargaining reforms

With respect to the reforms of wage bargaining that took place in 1987, I find that decentralizing the wage bargaining process increases homeownership. This is consistent with my findings from panel regression analysis, and it is in line with the results of Abbritti and Weber (2010), who found that larger real wage rigidity leads to more unemployment volatility. The increase in homeownership due to reforms that decentralized wage bargain is sizable between 1.803% and 1.705%, depending on the control group specification. It is worths to notice that coefficients' size appear to be quite stable across alternative specifications.

5.1.4 Union strength reforms

Finally, reforms that reduced union power in UK had a positive impact on homeownership rates.[29] This result is actually consistent with my findings from panel regression using original LMIs. Indeed, panel regression analysis has shown that union density is negatively correlated with homeownership, and the reform that took place in UK in 1980 leaded to a reduction of union density. The estimated coefficient varies between 10.75% from the specification with Norway and USA as controls and 6.02% for the second specification.[30] One possible explanation for this large effect could be that for this estimate I can rely only on 135 observation in the main specification. Alternatively, it is possible that the impact of the package of Thatcher reforms regarding unions was actually very large. The sign of this estimate is in line with the

[29] In all specifications I include a dummy variable for the Housing Act approved in UK in 1980.
[30] The result with the alternative specification used as robustness is 6.360%.

difference in difference estimates of Gnocchi et al. (2015), who found that those countries which implemented reforms reducing union power experienced an increase in unemployment volatility.

5.1.5 Robustness checks of difference in difference

As robustness check for my difference in difference analysis I computed my estimates under an alternative specification for the control groups. For each type of reforms I defined a control group composed by all those countries which did not undertook a reform of the type considered. This means that I have a different control group for each type of reform I analyze. Under this specification, I do not include the dummy variables for other types of reforms. Results are shown in Table 33 and are very similar to those of my two main specifications. As additional robustness check, I performed my main estimates with alternative lags of the initial conditions of homeownership, in order to asses the possible size of the bias. Also in this case the results are largely unchanged.[31]

6 The model

6.1 Environment

In order to study the interactions between labor market institutions the housing market, I build a DSGE model. The model is populated by heterogeneous households who face an housing tenure decision and it includes different labor market frictions, such as search and matching *à* la Mortensen-Pissarides, Nash bargaining over wages and hours. Moreover, there are time varying Rotemberg-type adjustment costs for wages and employment.[32] The richness of details in the labor sector allows me to disentangle the potentially opposite effects of employment rigidities and real wage rigidities on labor outcomes.

I link the housing market with the labor market via an endogenous credit constraint, which depends on aggregate expected income and its volatility. This means that credit available to credit constraint households is time varying and it depends on the economic situation, increasing during periods of stability and shrinking in period of high uncertainty. This feature generates a direct channel between housing market and labor market institutions, since labor rigidities have an impact of expected income and its volatilities.

The household sector is built mainly as an extension of Rubio (2014).[33] There are two types of households, savers and borrowers, who differ in terms of discount factor. Due to a tax advantage of being homeowner, the savers always choose to own their main residence. The borrowers are credit constraint in equilibrium and they cannot buy as much housing, as they would like. This feature of the model reflects the fact that in the real world, it is common that some households become homeowners through inheritance or gifts, whereas others have to save and take a mortgage to buy an house. I assume that borrowers can rent part of their housing from the savers, who own extra housing as investment. It is useful to have heterogeneous agents

[31] Results for these last robustness are available upon request.

[32] Adjustment costs over wages and employment have an asymmetric component that creates potentially downward rigidities.

[33] This model is based on Iacoviello (2005). An alternative way of including renters in the Iacoviello framework has been proposed by Alpanda and Zubairy (2016).

in this context because this allows me to have an endogenous rental market. I also assume that changing the stock of owned housing is costly, since the household face an adjustment cost. On the other hand, changing the amount of rented housing can be done without any fixed cost.

The firm and labor sectors of my model instead are based on Abbritti and Fahr (2013), who combine nominal rigidities with search and matching in the labor markets, allowing also for explicitly defined employment and wage rigidities. Finally, in the economy is present an authority who sets monetary policy.

6.2 Households

6.2.1 Savers

Households get utility from consumption and housing services, which can be obtained by owning or renting the main residence. Households earn labor income and if unemployed, they get an unemployment benefits b. Finally, they obtain returns from investing in a risk free bond a_t. They optimize over consumption, bond holdings and housing stock at each period in time. The utility function that savers maximize reads:

$$\max_{\{C^s,H^s,H_z,a^s\}} E_0 \sum_{t=0}^{\infty} \beta_t^s \left[\ln(C_t^s) + j_h \ln(H_t^s) - j_n \frac{(n_t)^{1+\gamma}}{1+\gamma} e_t^s \right]$$

where $\beta^s > 0$ is the discount factor of the patient households, C_t^s is consumption at time t, H_t^s represents the stock of housing owned. w_t is hourly wage, n_t are the hours worked and e_t^s is the employment status, which represents the share of employed among the household. Since households pool consumption, each member is fully insured against unemployment. $\gamma > 0$ is the inverse Frisch labor supply elasticity, $j_h > 0$ represents the relative weight of housing in the utility function, and j_n the weight of disutility from labor.

The maximization problem is subject to the following budget constraint:

$$\begin{aligned} C_t^s + \frac{a_t^s}{p_t r_t} + q_{h,t}[(1-\tau_h)(H_t^s - H_{t-1}^s) + (H_{z,t} - H_{z,t-1})] = \\ w_t n_t e_t^s + b(1-e_t^s) + \frac{a_{t-1}^s}{p_t} + q_{z,t} A_z H_{z,t} - AC_{h,t}^s + T_t \end{aligned} \tag{1}$$

$q_{h,t}$ is the real price of housing and $AC_{h,t}^i = \frac{\chi_h}{2} q_{h,t} H_{t-1}^i \left(\frac{H_t^i}{H_{t-1}^i} - 1 \right)^2$ is the quadratic adjustment cost which an household encounters to change the owned housing stock.[34] a_t^s represents the bond holding and its interest rate is given by r_t. p_t instead represents the price level for period t and b is the unemployment benefit, obtained by the share of the household which is unemployed.

τ_h represents the tax subsidy assigned to owned housing. [35] Savers choose to get housing services by owning their main residence, thanks to this favorable tax treatment and because they do not face any credit constraint. Moreover, savers can decide to own additional housing and rent it out to the borrowers, as investment. Following Rubio (2014), I assume that savers

[34] Alternatively, a linear adjustment cost has been proposed by Iacoviello and Pavan (2013).

[35] A more generous tax treatment for homeowners reflects the presence of policies that favor homeownership in many OECD countries.

transform extra-housing housing stock $H_{z,t}$ into rental services, using the following production function: $Z_t = A_z H_{z,t}$, where A_z represents the efficiency in the production of rental services and it could be interpreted as a proxy for the legal protection for homeowners. Extra-housing is rented at price $q_{z,t}$. Finally, T_t is the lump-sum transfer received from the government. I can rewrite the problem using a Lagrangian equation:

$$\mathcal{L} = \max_{\{C^s, H^s, H_z, a^s\}} E_0 \sum_{t=0}^{\infty} \beta_t^s \left\{ \ln(C_t^s) + j_h \ln(H_t^s) - j_n \frac{(n_t)^{1+\gamma}}{1+\gamma} e_t^s \right\} +$$

$$+\beta_t^s \left\{ \lambda_t^s \left[w_t n_t e_t^s + b(1-e_t^s)\theta + \frac{a_{t-1}^s}{p_t} + q_{z,t} A_z H_{z,t} - AC_{h,t}^s + T_t - C_t^s - \frac{a_t^s}{p_t r_t} \right.\right.$$

$$\left.\left. - q_{h,t}[(1-\tau_h)(H_t^s - H_{t-1}^s) - (H_{z,t} - H_{z,t-1})] \right] \right\}$$

The first order conditions for this optimization problem are:

$$\frac{1}{C_t^s} = \beta^s E_t \left(\frac{r_t}{C_{t+1}^s \pi_{t+1}} \right) \tag{2}$$

$$\frac{j}{H_t^s} = \frac{q_{h,t}}{C_t^s} \left[(1-\tau_h) + \chi_h \left(\frac{H_t^s}{H_{t-1}^s} - 1 \right) \right] - \beta^s E_t \frac{q_{h,t+1}}{C_{t+1}^s} \left[(1-\tau_h) + \frac{\chi_h}{2} \left(\frac{H_{t+1}^s}{H_t^s} \right) \left(\frac{H_{t+1}^s}{H_t^s} + 1 \right) \right] \tag{3}$$

$$\frac{q_{h,t}}{C_t^s} = A_z \frac{q_{z,t}}{C_t^s} + \beta^s E_t \frac{q_{h,t+1}}{C_{t+1}^s} \tag{4}$$

Equation (2) represents the intertemporal condition for consumption, the Euler equation. Equation (3) is the intertemporal condition for owned housing, where marginal benefit from consuming housing services equates marginal the cost in terms of consumption. Equation (4) is the FOC for housing which is bought to be rented out to borrowers.

or

6.2.2 Borrowers

The maximization problem of the borrowers is similar to the one of savers and it reads:

$$\max_{\{C^b, H^b, Z, a^b\}} E_0 \sum_{t=0}^{\infty} \beta_t^b \left[\ln(C_t^b) + j_h \ln(\tilde{H}_t^b) - j_n \frac{(n_t)^{1+\gamma}}{1+\gamma} e_t^b \right] \tag{5}$$

where $\beta^s > \beta^b > 0$ is the discount factor of the impatient households. The main difference is represented by $\tilde{H}_t^b$, a CES aggregator composed by owner-occupied housing, H_t^b and rented housing, Z_t. $\tilde{H}_t^b$ reads:

$$\tilde{H}_t^b = \left[\xi_h (H_t^b)^{\varepsilon_h} + (1-\xi_h) Z_t^{\varepsilon_h} \right]^{\frac{1}{\varepsilon_h}} \tag{6}$$

where ξ_t indicates the preference for owner-occupied housing and ε_h is the elasticity of substitution on preferences between owner-occupied housing and rental services. This can be interpreted as the fact that some of the borrowers live in owner-occupied houses and the others live in rented houses. Equation (5) therefore represents the aggregate preferences of all household members

with respect to each type of housing services.[36]

The maximization problem of borrowers is subject to a budget constraint similar to the one of the savers, plus a credit constraint, represented by equation 8:

$$C_t^b + \frac{a_{t-1}^b}{p_t} + q_{h,t}(1-\tau_h)(H_t^b - H_{t-1}^b) + q_{z,t}Z_t = \frac{a_t^b}{p_t r_t} + w_t n_t e_t^b + b(1-e_t^b)\theta - AC_{h,t}^b \quad (7)$$

and

$$a_t^b \leq \underbrace{[\Gamma_h + \Gamma_e(EI) - \Gamma_v vol(EI)]}_{\Gamma} E_t\left(\frac{\pi_{t+1}}{r_t} q_{h,t+1} H_t^b\right) \quad (8)$$

Here, a_t^b represents the outstanding debt of borrowers. $EI = w_t n_t e_t + b(1-e_t)$ is the expected income, which is composed by labor income if employed, $w_t n_t e_t$, and unemployment benefits if unemployed, $b(1-e_t)$. $vol(EI)$ is the standard deviation of expected income and is used as proxy for aggregate uncertainty.

Finally, $\Gamma = [\Gamma_h + \Gamma_e(EI) - \Gamma_v vol(EI)]$ represents the share of mortgaged housing, which can be seen as the inverse of the down-payment. It depends on three parameters: Γ_h, Γ_e and Γ_v. The credit constraint of my model is endogenous, and its novelty is the fact that it depends not only on legal requirements on mortgages, as standard in the literature.[37] In my model, the share of mortgaged housing is a function of the net present value of the housing stock owned through Γ_h, but it also depends positively on the level of the aggregate expected income through Γ_e, and negatively on its volatility thanks to Γ_v. In this way, the housing market is endogenously linked to the labor market and it has pro-cyclical properties, since the credit available for borrowers shrinks during period of low expected income or high volatility.

This composition of the LTV ratio is consistent with the fact that lending criteria for assigning a mortgage take into account minimum down-payment, as well as future income and its uncertainty. Labor institutions interact with the housing tenure decision through their impact on the expected value and volatility of aggregate income.

I build the Lagrangian function of the borrowers problem, with λ^* being Lagrangian multiplier for the collateral constraint:[38]

$$\mathcal{L} = \max_{\{C_t^b, H_t^b, Z_t, a_t^b\}} E_0 \sum_{t=0}^{\infty} \beta_t^b \Bigg\{ \ln(C_t^b) + j_h \ln(\tilde{H}_t^b) - j_n \frac{(n_t)^{1+\gamma}}{1+\gamma} e_t^b$$

$$+\lambda_t^b \left(\frac{a_t^b}{p_t r_t} + w_t^b n_t e_t^b + b(1-e_t^b)\theta - AC_{h,t}^b - C_t^b - \frac{a_{t-1}^b}{p_t} - q_{h,t}(1-\tau_h)(H_t^b - H_{t-1}^b) + -q_{z,t}Z_t \right)$$

$$+\lambda_t^* \left(\Gamma E_t \left(\frac{\pi_{t+1}}{r_t} q_{h,t+1} H_t^b \right) - a_t^b \right) \Bigg\}$$

[36] Alternatively the CES aggregator can be thought as a representation of the share of renters at the country level.

[37] The standard credit constraint, adopted by Iacoviello (2005) and Andres et al. (2013) reads: $a_t^b \leq \Gamma_h E_t\left(\frac{\pi_{t+1}}{r_t} q_{h,t+1} H_t^b\right)$ and depends only on the net present value of the housing stock. Exceptions are represented by Pataracchia et al. (2103), who model a LTV dependent on riskiness of loans and Falagiarda and Saia (2017), who use an endogenous credit constraint dependent also on systemic and idiosyncratic risk.

[38] The Lagrange multiplier of the collateral constraint, λ^* is positive in steady-state and therefore the collateral constraint is always binding and it holds with equality, as it has been shown by Rubio (2014).

The first order conditions are:

$$\frac{1}{C_{b,t}} = \beta^b E_t \left(\frac{r_t}{C^b_{t+1}\pi_{t+1}} \right) + \lambda^*_t \tag{9}$$

$$\frac{j_h}{(\tilde{H}^b_t)^{\varepsilon_h}} \xi_h (H^b_t)^{\varepsilon_h - 1} = \frac{q_{h,t}}{C^b_t} \left[(1-\tau_h) + \chi_h \left(\frac{H^b_t}{H^b_{t-1}} - 1 \right) \right]$$

$$- \beta^b E_t \frac{q_{h,t+1}}{C^b_{t+1}} \left[(1-\tau_h) + \frac{\chi_h}{2} \left(\frac{H^b_{t+1}}{H^b_t} \right) \left(\frac{H^b_{t+1}}{H^b_t} + 1 \right) \right] - \lambda^*_t \Gamma E_t \left(\frac{\pi_{t+1}}{r_t} q_{h,t+1} \right) \tag{10}$$

$$\frac{j_h}{\tilde{H}^{\varepsilon_h}_t} \frac{(1-\xi_h) Z^{\varepsilon_h}_t}{Z_t} = \frac{q_{z,t}}{C_{b,t}} \tag{11}$$

The FOCs for the borrower have similar interpretation, with respect to those of the savers with a relevant difference in the housing demand equation (10). In this case in fact, the demand equation relates the marginal utility of owner-occupied housing with the effective user cost of housing minus the marginal value of housing as collateral. This means that, ceteris paribus, an increase of the collateral's value has a positive impact on the owner-occupied demand for housing of borrowers. Finally equation (11) represents the FOC with respect to the rented housing.

6.3 Aggregation

Aggregate employment and consumption is a weighted average, based on the size of each of the household groups. The share of borrowers in the economy is represented by ν.[39] Following Andres et al. (2013), I assume that labor from savers and borrowers is pooled by a *labor union*, which weights the interest of the two groups according to their relative size. Even though savers and borrowers may have different reservation wages, they delegate the bargain process with firms to the labor union.

As a result of this assumption, all workers will receive the same wage and will work the same number of hours, having also the same rate of unemployment. This assumption is consistent with the fact that from the point of view of the firms, labor from savers and borrowers are perfect substitutes and there is no discrimination between groups. Another result of this feature of the model is the absence of wealth effect in the wage decision.

$$C_t = (1-\nu) C^s_t + \nu C^b_t \tag{12}$$

$$e_t = (1-\nu) e^s_t + \nu e^b_t \tag{13}$$

$$0 = (1-\nu) a^s_t + \nu a^b_t \tag{14}$$

C_t represents the aggregate consumption, e_t is aggregate employment and equation 14 states that bonds are in zero net supply.

[39] I assume that the proportion between savers and borrowers is constant over time.

6.4 Labor market

In the model search and matching frictions à la Mortensen and Pissarides (1994) generate involuntary unemployment. Employment is determined by the characteristics of the labor market and by demand and supply conditions.

Workers and firms need to match for becoming productive and the number of newly formed matches between workers and firms is given by m_t. Number of matches depends on vacancies posted v_t, and job seekers u_t, following a constant return to scale matching technology, which efficiency is represented by the parameter $\bar{m}$. I denote by q_t the probability for a firm to fill an open vacancy and by f_t the probability for a worker to find a job. An exogenous fraction s of jobs is destroyed each period and unemployment rate u_t, is the sum of the fraction of savers and borrowers not employed after that the matching process has taken place.

Matching function:

$$m_t = \overline{m}(u_t)^{\zeta}(v_t)^{1-\zeta}$$

Job-seekers:

$$u_t = 1 - (1-s)e_{t-1} \tag{15}$$

Job-filling:

$$q_t = \frac{m_t}{v_t} = \overline{m}\left(\frac{v_t}{u_t}\right)^{-\zeta} \tag{16}$$

Job-finding:

$$f_t = \frac{m_t}{u_t} = \overline{m}\left(\frac{v_t}{u_t}\right)^{1-\zeta} \tag{17}$$

Employment:

$$e_t = (1-s)e_{t-1} + m_t \tag{18}$$

Unemployment rate:

$$ur_t = 1 - e_t \tag{19}$$

The timing of the actions is the following in each period: (i) workers and firms search on the labor market and new matches are formed; (ii) shocks realize; (iii) production in the final good sector occurs; (iv) some matches exogenously end and the separated workers enter unemployment group.

6.5 Firms

In the economy there is only one firm sector: the wholesale sector, populated by competitive firms which produce a homogeneous consumption good. Firms are owned by the savers and use labor of both savers and borrowers, and capital k_t as inputs in a constant returns to scale production function. Firms choose the number of vacancies v_t, at cost κ, and investment i_t, to maximize the expected sum of discounted profits, given the production function, the evolution of capital, and the adjustment costs for wages and employment, $AC_{w,t}$ and $AC_{e,t}$ (described in Appendix B).

Time-varying adjustment costs, $AC_{w,t}$ and $AC_{e,t}$, are convex and may be asymmetric, allowing for downward nominal rigidities, whereby wages are more easily increased during booms than cut during recessions, and the same is true for employment.[40] Total labor supply is the weighted sum of savers and borrowers labor. The maximization problem of firms reads:

$$\max_{\{v_t,i_t\}} E_0 \sum_{t=0}^{\infty} \beta_t^s \left\{ \frac{\lambda_t^s}{\lambda_0^s} \left[Y_t - w_t h_t e_t (1 + AC_{w,t}) - AC_{e,t} - \frac{\kappa v_t}{\lambda_t^s} - i_t \right] \right\}$$

subject to

production function

$$Y_t = z_t k_t^{\alpha} (n_t e_t)^{1-\alpha} \tag{20}$$

evolution of capital

$$k_{t+1} = (1 - \delta)\, k_t + i_t$$

Technology follows an AR(1) stochastic process:

$$\ln z_t = \rho_z \ln z_{t-1} + \varepsilon_t^z \tag{21}$$

$$\varepsilon_t^z \sim N\left(0, \sigma_z^2\right)$$

The first order condition with respect to vacancies yields the *job creation condition* $\mathbf{J}_t$. Due to free entry the condition, $\mathbf{J}_t$ is equal to the expected cost of posting a vacancy, $\frac{\kappa}{\lambda_t^s q_t}$. By the definition of job creation condition, the expected cost of posting a vacancy equates the value of a filled vacancy, which is given by revenues from output net of wages and adjustment costs for wages and employment, plus the expected continuation value of the job next period:[41]

$$\mathbf{J}_t \equiv \frac{\kappa}{\lambda_t^s q_t} = \underbrace{\frac{(1-\alpha) Y_t}{e_t}}_{\frac{\partial Y_t}{\partial e_t}} - w_t n_t (1 + AC_{w,t}) - \frac{AC_{e,t}^{'}}{e_{t-1}} + \beta^s E_t \left\{ \frac{\lambda_{t+1}^s}{\lambda_t^s} \left[(1-s)\mathbf{J}_{t+1} + \frac{AC_{e,t+1}^{'} e_{t+1}}{e_t^2} \right] \right\} \tag{22}$$

Maximizing with respect to capital yields the standard Tobin's Q for investment decisions (the shadow price of capital), which equates the marginal cost of investment to its expected benefit (the marginal product of capital):

$$1 = \alpha \frac{Y_t}{k_t} + (1 - \delta) \beta^s \frac{\lambda_{t+1}^s}{\lambda_t^s} \tag{23}$$

[40] Abbritti and Fahr (2013) have shown that asymmetric adjustment costs are necessary to match the skewed distribution of growth rates of wages and unemployment, that we see in the data for US and other OECD countries.

[41] Derivations are shown in Appendix B.

6.6 Nash Bargaining over Wages and Hours

Savers and borrowers delegate the bargain process with firms to a labor union, which follows the interests of the households, only on the basis of the size of the two groups. The union maximizes the aggregate marginal value of employment for workers.[42]. As a result of this assumption, all workers receive the same wage, work the same number of hours and the have same rate of unemployment. Nominal wages and hours worked are bargained by maximizing the Nash product of workers and firm surpluses:

$$\max_{\{w_t,n_t\}} (\mathbf{N}_t - \mathbf{U}_t)^{\eta} (\mathbf{J}_t)^{1-\eta}$$

Where

$$\mathbf{N}_t = (1-\nu)\mathbf{N}_t^s + \nu \mathbf{N}_t^b \tag{24}$$

and

$$\mathbf{U}_t = (1-\nu)\mathbf{U}_t^s + \nu \mathbf{U}_t^b \tag{25}$$

Marginal value of employment for each type of household, with $i = \{s, b\}$:

$$\mathbf{N}_t^i = w_t n_t - \frac{(n_t)^{1+\gamma}}{\lambda^i(1+\gamma)} + \beta^i E_t \left\{ \frac{\lambda_{t+1}^i}{\lambda_t^i} \left([1-(1-f_{t+1})s]\mathbf{N}_{t+1}^i + s(1-f_{t+1})\mathbf{U}_{t+1}^i \right) \right\}$$

Marginal value of unemployment:

$$\mathbf{U}_t^i = b + \beta^i E_t \left\{ \frac{\lambda_{t+1}^i}{\lambda_t^i} \left(f_{t+1}\mathbf{N}_{t+1}^i + (1-f_{t+1})\mathbf{U}_{t+1}^i \right) \right\}$$

6.6.1 Wages

Bargaining over the nominal wage yields the optimal sharing rule, similar to the standard Nash bargaining solution:[43]

$$\omega_t \mathbf{J}_t = (1-\omega_t)(\mathbf{N}_t - \mathbf{U}_t)$$

with ω_t being the effective time-varying bargaining power of the worker:

$$\omega_t \equiv \frac{\eta}{\eta + (1-\eta)\tau_t} \tag{26}$$

and where τ_t reflects the evolution of current and expected wage adjustment costs. Its derivation is in Appendix B. In the absence of adjustment costs, τ_t is equal to 1, and I obtain the constant sharing rule, with $\omega_t = \eta$.

With adjustment costs the bargaining power becomes state-dependent. During periods of rising wages, $AC'_{w,t} > 0$, the effective bargaining power of workers decline whereas during periods of declining wages, the bargaining power of workers increase. The asymmetry in the

[42] This assumption has been adopted also by Andres et al. (2013)
[43] See derivations by Arseneau and Chugh (2008).

wage adjustment cost function magnifies this effect, i.e. bargaining power increases by more in recessions than it is reduced in expansions.

The bargained wage becomes:

$$\frac{\omega_t \kappa}{\lambda_t^s q_t} = (1-\omega_t)\left[w_t n_t - j_n \frac{(n_t)^{1+\gamma}}{1+\gamma}\left(\frac{\nu}{\lambda_t^b} + \frac{1-\nu}{\lambda_t^s}\right) - b + \beta(1-s)E_t\left(\frac{\omega_{t+1}}{1-\omega_{t+1}}\frac{\kappa}{\lambda_t^s q_{t+1}}(1-f_{t+1})\right)\right] \quad (27)$$

So the optimal real wage reads:

$$w_t = \frac{\omega_t}{(1-\omega_t)}\frac{\kappa}{\lambda_t^s q_t}\left[j_n \frac{(n_t)^{1+\gamma}}{1+\gamma}\left(\frac{\nu}{\lambda_t^b} + \frac{1-\nu}{\lambda_t^s}\right) + b - \beta(1-s)E_t\left(\frac{\omega_{t+1}}{1-\omega_{t+1}}\frac{\kappa}{\lambda_t^s q_{t+1}}(1-f_{t+1})\right)\right]\frac{1}{n_t}$$

6.6.2 Hours

The number of hours worked are also set to maximize the joint surplus. In the absence of wage adjustment costs, the marginal rate of substitution between consumption and hours worked equates the marginal product of labor of an hour of work for the firm ($mpl_t = \frac{\partial^2 Y_t}{\partial e_t n_t}$), adjusted for the relative price.

Wage adjustment costs reduce hours worked by reducing net productivity, introducing a wedge between the marginal rate of substitution and the marginal product of labor: the latter needs to be higher to compensate for the deadweight loss of the adjustment cost. A second effect leads to an intertemporal reallocation of hours worked, whereby hours increase when wages are larger than the marginal rate of substitution, and wages are growing. Equation for bargained hours reads:

$$\eta\left(\frac{1-\omega_t}{\omega_t}\right)\left[w_t - j_n (n_t)^{\gamma}\left(\frac{\nu}{\lambda_t^b} + \frac{(1-\nu)}{\lambda_t^s}\right)\right] = -(1-\eta)\left[\frac{(1-\alpha)^2 Y_t}{n_t e_t} - w_t(1 + AC_{w,t})\right] \quad (28)$$

6.7 Closure

The monetary authority adopts an augmented Taylor rule, with nominal interest rate smoothing according to parameter ρ_r and responds to deviations from target inflation and output growth. The term ε_t^r captures an i.i.d monetary policy shock.[44]

$$r_t = r_{t-1}^{\rho_r}\left[r\left(\frac{\pi_t}{\pi}\right)^{\omega_\pi}\left(\frac{Y_t}{Y_{t-1}}\right)^{\omega_y}\right]^{1-\rho_r}\varepsilon_t^r \quad (29)$$

$$\varepsilon_t^r \sim N\left(0, \sigma_r^2\right)$$

6.8 Market clearing

The resource constraint states that output may be used for consumption, investment or to cover costs of adjusting wages, employment and housing stock (dead-weight losses). The goods

[44] In the model prices are flexible, but since debt contracts are set in nominal terms, inflation affects the borrowers' debt burden and hence monetary policy is still relevant. Therefore, I include also a monetary policy shock to have a better match with data volatility.

market clearing condition reads:

$$C_t + i_t + T_t = Y_t - AC_{w,t} w_t n_t e_t - AC_{e,t} - \sum_{s,b} AC^i_{h,t} \tag{30}$$

I assume that housing supply is fixed and normalized to unity, hence:

$$H^s_t + H^b_t + H_{z,t} = 1 \tag{31}$$

Finally, the equilibrium government budget constraint is given by:

$$T_t = \tau_h q_{h,t}[(H^s_t - H^s_{t-1}) + (H^b_t - H^b_{t-1})] \tag{32}$$

6.9 Calibration

The calibration presented in this section refers to quarterly USA data. In order to calibrate the model, I choose parameters according to the consensus in the housing and the labor literature. For the household part I mainly relay on Rubio (2014), while for the production sector and the labor market I follow Abbritti and Fahr (2013) or I chose them according to model's steady-state relationships. Finally, parameters related to adjustment costs of wage and employment, and LTV ratio are chosen to target specific moments of the data.

With respect to the labor market parameters governing the search and matching process, the matching function elasticity parameter ζ is set to 0.5 as in Abbritti and Fahr (2013). The job-finding rate is set to 0.45, to get a separation rate of around 0.06 as Abbritti and Fahr (2013). Given the separation rate, and a job filling rate of 0.9, I obtain a matching efficiency parameter $\overline{m}$ of 0.561.

The parameters related to housing in the utility function are calibrated to match empirical moments, such as average homeownership rate. On the other hand, parameters in the utility function governing labor supply, are calibrated to match unemployment and hours worked. The weight of housing in the utility function, j_h is obtained to match homeownership rate from the data, and it corresponds to 0.9969. The share of total LTV ratio, which depend on the legal requirements, Γ_h is set to 0.8, corresponding to the average value for US in the last decades. Γ_e, the component of LVT that is related to expected income, is set to 0.7, as a proxy for the rule of thumb in the mortgage market, which suggests that the monthly mortgage payment should not exceed 30% of monthly income. Finally Γ_v, which is the weight of expected income volatility in the credit constraint, is chosen as residual to match homeownership rate.

Disutility of labor, j_n, is set at 1.5, corresponding to 7 daily working hours and an unemployment rate of 6%. The inverse Frisch elasticity of labor supply γ is set at 4.0 as in Trigari (2009) and Christoffel et al. (2009). Capital has a share α of 0.3 in the firm production function and depreciates at rate δ of 3%. Union' bargaining power is 0.45, since Rubio (2014) used for US 0.4 and Andres et al. (2013) used 0.5. Firm vacancy posting costs κ results 0.254, which correspond to total vacancy posting costs equal to 1.5% of GDP. With respect to wage and employment adjustment costs, I set χ_e at 40.8 and ψ_e at -1700, making it more costly to lay-off

workers than to fire them. Moreover χ_w is set at 40.5 and ψ_w at 24100, making wages downward rigid. Wages are not indexed against inflation such that ι is 0. These parameter values are based Abbritti and Fahr (2013) who calibrated their model to match the volatility and skewness of wage inflation and employment.

The Taylor rule places a weight ω_π of 1.5 on inflation and ω_y of 0 on output growth, with interest rate persistence ρ_r of 0.85. The monetary policy shock has 0 persistence and standard deviation σ_{mp} of 0.001. The technology shock has persistence ρ_z of 0.95 and standard deviation σ_z of 0.64 as in Abbritti and Fahr (2013).

I calibrate the model also for France, United Kingdom and Japan, to asses whether my model can replicate moments of economies with different levels of labor protection. The baseline calibration for these three countries differs from the one of USA, both with respect to the parameters regulating the housing sector and those regarding the labor market. Indeed, legal requirements on LTV ratio, mortgage interest rates deductibility and taxation on housing, differ across these countries. Housing related parameters are calibrated according to the data evidence, and to match homeownership rates of each country. Labor market parameters instead are calibrated to match second moments of wages and unemployment rate. In particular, France, UK and Japan have a less generous tax treatment for owned housing. France presents also much larger employment and wage rigidities. With respect to UK, in the baseline calibration want to match data over the period 1970-2011, whereas in the section where I evaluate the impact of labor reforms, I calibrate the model to match British data over the pre-reform period 1970-1980. Details on the model calibration for France and UK can be found in Appendix B.[45]

[45] My baseline calibration for USA, France and UK is based on data between 1970q1 and 2011q4, while for Japan I refer to the period 1971q1 and 2011q4.

Table 2: Parameter Values - USA

Param.	Value	Description	Source
Households			
β^s	0.99	Time discount factor - savers	Rubio (2014)
β^b	0.98	Time discount factor - borrowers	Rubio (2014)
j_h	0.9969	Utility weight on housing services	Corresponds to 70% of homeownership for borrowers
j_n	319.36	Disutility of labor	Corresponds to 7/24 time allocation to work in SS.
γ	4	Inverse Frisch elasticity of labor supply	Trigari (2009), Christoffel et al. (2009).
Housing market			
χ_h	0.1	Adjustment cost parameter for housing	Close to zero, following Iacoviello (2005)
τ_h	0.25	Tax subsidy on homeownership	Rubio (2014)
ξ_h	0.5	Preference for homeownership	Indifference between ownership and renting
ϵ_h	0.5	Elasticity between renting and owning	Rubio (2014)
A_z	1	Efficiency of rental market	Rubio (2014)
ν	0.36	Share of borrowers in the economy	Rubio (2014)
Γ_h	0.8	Legal component of LTV	Average rate in USA
Γ_e	0.7	Weight of expected income in LTV	Rule of thumb: mortgage payment max 1/3 of monthly income
Γ_v	0.377	Weight of *Vol(EI)* in LTV	To match homeownership rate from the data
Firm production			
α	0.3	Share of capital in production	Andres et al. (2013)
δ	0.03	Capital depreciation rate	12% annual rate
η	0.45	Union's exogenous bargaining power	0.5 in Rubio (2014), 0.4 in Andres et al. (2013)
κ	0.226	Cost of posting a vacancy	Result of $q_{SS} = 0.9$ and $f_{SS} = 0.45$ in SS (1.5% of GDP)
Labor Market			
ζ	0.5	Elasticity of matching function	Petrongolo and Pissarides (2001)
b	0.074	Unemployment benefit	Corresponds to 15.6% of replacement rate in SS.
s	0.0522	Separation rate	Result of $ur_{SS} = 6\%$ and $f_{SS} = 0.45$
$\overline{m}$	0.6364	CRS matching technology	Corresponds to $q_{SS} = 0.9$ from Ravenna and Walsh (2011)
Adjustment costs			
ι	0	Wage indexation to inflation	Abbritti and Fahr (2013)
χ_w	40.5	Adjustment cost parameter - wages	To match volatility of wage
ψ_w	24100	Asymmetry parameter - wages	Abbritti and Fahr (2013): match skewness of wage inflation
χ_e	40.8	Adjustment cost parameter - employment	To match volatility of employment
ψ_e	-1700	Asymmetry parameter - employment	Abbritti and Fahr (2013): match skewness of employment
Monetary policy			
ρ_r	0.85	Persistence of interest rate	Abbritti and Fahr (2013)
ω_π	1.5	Weight of inflation in Taylor rule	Abbritti and Fahr (2013)
ω_y	0	Weight of output growth in Taylor rule	Abbritti and Fahr (2013)
Exogenous shocks			
σ_z	0.64	Std. deviation of technology shocks	Abbritti and Fahr (2013)
σ_{mp}	0.001	Std. deviation of monetary policy shock	Christoffel et al. (2009)
ρ_z	0.95	Persistence of technology shock	Smets and Wouters (2003)

In order to solve the model, I use second-order perturbation method, applying also pruning for stability, as proposed by Kim et al. (2008), and done also by Abbritti and Fahr (2013).[46] This methodology is a local solution approach and it consists in approximating the model around its steady state using a second-order Taylor approximation. Since I do not need to linearize around the steady state, the model will be able to generate asymmetric responses to positive and negative shocks. Similarly to Abbritti and Fahr (2013), in order to get simulated first and second moments of the model, I simulate the model 1000 times for 166 periods. To have different starting points, I simulate additional 300 periods which I drop when it comes to the computation of simulated moments. Once I obtained the simulation of my model, I

[46]The model is solved using DYNARE version 4.4.

compare level of homeownership, and volatility of unemployment and wages, under different parametrization of labor market institutions.

7 Simulation results

The main novelty of my model is the fact that labor market institutions are directly linked to the housing market through an endogenous credit constraint. The constraint depends on the level and volatility of expected income, which in turn is a function of employment, wage and unemployment benefits. LMIs affect in a not trivial way the level and volatility of labor outcomes and the endogenous constraint I propose allows to study the impact of different labor legislations, on housing tenure decisions. This type of analysis could not have been possible adopting an exogenous credit constraint. Indeed, in a framework like the one of Iacoviello (2004), the labor market does not influence the credit available to borrowers, and consequently the share of homeowners in the economy.

The aim of the next section, is to evaluate how well my model can match with the data. Once I have established that the model can reproduce efficiently relevant moments of the data, then I can perform counter-factual experiments. In order to validate the results of my model, I present a comparison with data for USA, France and UK.

The choice of the countries has been done, in order to be able to perform different types of counter-factual experiments. US did not undertake any complete and structural labor reform in the last decades, and it has flexible institutions both in terms of employment and wage. Therefore US is particularly suitable to evaluate the impact of introducing more rigidity in the labor market. UK instead, has been chosen because in the 1980s it experienced a large drop in benefit replacement rates. In my analysis I use this fact to evaluate the effect of specific labor market reforms on the housing market.

7.1 Moments match

In order to validate my counter-factual experiments, I show that the model can match quite well the empirical data. I compare quarterly data for US, France, UK and Japan over the period 1970q1-2011q4, with simulations results from my model. I evaluate how well my model can replicate second moments of wages, unemployment and output. Moreover I check the fit for homeownership rate. Original data come from the OECD Economic Outlook and Main Economic Indicators, as for Abbritti and Fahr (2013). As it is possible to see from Table 3, the model fits well the volatility of wages, *Vol(w)* and of unemployment rate, *Vol(ur)*. Moreover it fits the homeownership rate, *ho%*, while it does a less good job in matching output volatility, *Vol(Y)*.[47] The volatility of expected income, *Vol(EI)* instead, is not compared with the original data since it is more difficult to compute a measure from the original data, which can map exactly into my model.

[47] With a different calibration of vacancy posting costs, I get a better match of output volatility. This comes at the cost of loosing precision in the match of unemployment volatility. Since the focus of my analyses is on unemployment and wage volatilities, I decided to keep my baseline calibration.

The moments derived from the model, which I compare with the data, are those relevant for the credit constraint and in turn, for the housing tenure decision. As it is possible to see from Table 3, USA presents a lager unemployment volatility with respect to the other countries. The volatility of wages in US instead is smaller, and Japan has the largest value. The second part of my analysis, reported in the next section, consists on evaluating what would be the impact of changes in labor market institutions for the volatility of wage and employment and for the rate of homeownership.

Table 3: Model match with the data

	United States		France		United Kingdom		Japan	
	Data	*Model*	*Data*	*Model*	*Data*	*Model*	*Data*	*Model*
Vol(Y)	1.59	1.27	1.10	1.97	1.53	1.03	1.74	1.09
Vol(w)	0.92	0.92	1.22	1.22	2.24	2.23	17.11	17.11
Vol(ur)	11.87	11.87	6.17	6.16	8.56	8.67	7.05	7.05
Vol(EI)	-	0.87	-	1.52	-	2.16	-	16.96
ho%	66.44%	66.44%	53.51%	53.51%	62.45%	62.44%	61.63%	61.63%

Note: This table reports average level of homeownership rate $ho\%$, derived from annual data from 1970 to 2011. It also presents second moments of HP(1600) detrended quarterly data for the period 1970q1-2011q4 (1971q1-2011q4 for Japan). Y is GDP per-capita, w is nominal wage and ur is unemployment rate. The first column for each country shows the original data, each second column reports the simulation results of the model.

7.2 Counter-factual experiments

In this section I conduct two different types of counter-factual experiments. In the first type of experiment I want to evaluate the impact on the housing market, of a hypothetic large change in labor market institutions. At first, I calibrate my model for the USA economy and I evaluate what would be the change in homeownership rate, if USA would adopt labor market institutions as in France. I chose to apply French LMIs to US because I want to evaluate a large change in labor legislation. At the same time, in this experiment I want to consider institutions which are actually adopted in some country, to compare two feasible labor regimes. Since France has a much stricter legislation both for employment and wage protection, it is a good case to have a counter-factual with USA.

In the second type of experiment instead, I look at real labor reforms that took place in UK in the 1980s, which reduced benefit replacement rates. I evaluate the impact on homeownership, everything else equal.[48] This second type of experiment allows me to make a comparison with my empirical findings from the difference in difference analysis. Moreover, evaluating a real reform is useful to understand if the impact of labor reforms on the housing market is actually of a relevant size.

Table 4 shows the results from a hypothetical change of USA LMIs toward French labor institutions. In order to perform this counter-factual experiment, I introduce in the US economy, higher employment protection, by reducing the separation rate, s. Moreover I increase unions'

[48] I am also working on the evaluation of a reform that took place Japan in 1986, which reduced benefit replacement rate and that happened at the same time of a tax reform in favor of homeownership.

strength, by augmenting the bargaining power of the labor union, η. Finally, I increment the benefit replacement rate, *brr*, to reach the French level. Column (3) presents the impact on homeownership, applying all French labor market institutions together in US. The result is an increase of 3.24% in homeownership rate. This result is driven by the fact that a more rigid labor market in this context, leads to a significant reduction in unemployment volatility and a smaller reduction in wage and expected income volatility. This translates to a less binding credit constraint and therefore to more homeownership. Indeed, even if larger frictions in the labor market increase unemployment level, more generous unemployment benefits and the reduction in employment uncertainty, overcome the potential negative effects.

From column (4) to (7) instead, I show what would happen if US would introduce one French institution by time. The overall effect seems to be driven mainly by the positive impact that high benefit replacement rates have on homeownership. This can be explained by the fact that the generosity of unemployment benefits impact directly the credit available to borrowers, whereas changes in employment protection and union's strength have an indirect effect, through the change in wages and unemployment.

In general we can see that the volatility of wages is the variable which is impacted the most, by an increase of labor rigidity. All the labor institution that I consider in this policy experiment were found to be positively correlated with homeownership, so the results are in line with my empirical findings. I do not present any policy experiment regarding the centralization of wage bargaining, since I do not have a clear mapping between this institution and a parameter of my model.

Table 4: USA policy experiment

		France *Labor Market Institutions applied* in USA			
	Baseline	All LMIs	Brr ↑	UnS↑	EPL↑
Vol(Y)	1.27	1.27	1.27	1.27	1.27
Vol(w)	0.92	0.88	0.89	0.92	0.89
Vol(ur)	11.87	2.69	5.19	7.10	3.44
Vol(EI)	0.87	0.81	0.83	0.87	0.84
EI (*level*)	0.45	0.45	0.46	0.45	0.45
$ho\%$	66.44%	68.46%	67.96%	66.50%	66.65%
$\Delta ho\%$	-	3.04%	2.29%	0.10%	0.31%

Note: EI is the expected income. Volatilities of output, Y, nominal wage, w, unemployment rate, ur, and expected income, EI, are represented by standard deviations. $ho\%$ is the rate of homeownership in percentage points. $\Delta ho\%$ indicates the percentage change of homeownership.

Table 5 presents the second type of counter-factual experiment I performed. For this analysis, I calibrate my model to match relevant moments of UK economy before the labor reforms undertaken 1980. How the model match original data can be seen comparing column(1) with column (3). In 1980 UK approved also the so called *Housing Act*, which consisted in a large sell of state-owned houses. This Act had the effect of increasing significantly homeownership

in UK. Therefore, the British context of the 1980s can be a good case to study the potentially dampening effect of labor reforms for other reforms. As second step, I change just the parameter related to benefit replacement rate of the model, in order to evaluate the effect of the original reform, as if everything else was unchanged. What I find is that the reforms that reduced benefit replacement rate in UK in 1980s reduced homeownership by 1.42%. Over the same period actual homeownership rate in UK increased by 29.76%. This result suggest that rate of homeowners would have increased even more without the effect of the reforms. The mechanism in place here is the same as in the previous experiments. In this case, less generous unemployment benefits increased the volatility of wages, unemployment and expected income, without affecting the levels. A higher level of uncertainty leads to a less credit available to borrowers, and consequently less homeownership.

Table 5: UK reforms evaluation

	Data		*Simulation: Benefit replacement rate* $\downarrow$	
	Pre-1980	Post-1980	Pre-1980	Post-1980
Vol(Y)	1.71	1.36	1.03	1.03
Vol(w)	3.76	1.37	3.74	3.88
Vol(ur)	9.28	7.76	9.38	14.69
Vol(EI)	-	-	3.66	3.79
$ho\%$	50.40%	65.40%	50.40%	49.69%
$\Delta ho\%$	29.76%		-1.42%	

Note: volatilities of output, Y, nominal wages, w, and unemployment rate, ur, are represented by standard deviations. $ho\%$ is the rate of homeownership in percentage points. $\Delta ho\%$ indicates the percentage change of homeownership.

7.3 Robustness

As first robustness check, I evaluate the impact of changes in labor market institutions, adopting the standard exogenous credit constraint for borrowers: $a_t^b \leq \Gamma E_t \left(\frac{\pi_{t+1}}{r_t} q_{h,t+1} H_t^b \right)$. This constraint is not affected by labor market condition, since Γ depends only on legal requirements on LTV ratio. As we can see from Table 35 in Appendix B, since changes in LMIs have no effect on the credit available to households, they also have no impact on the homeownership rate. This robustness check shows the importance of considering an endogenous credit constraint, as I do in my baseline model. Indeed, existing models with exogenous constraints are not suitable to investigate the interactions between labor market and housing market.

As second robustness check, I compute a version of the model without adjustment costs for employment and wages. As it is possible to see from Table 36 in Appendix B, the model under this specification can still replicate fairly well the average homeownership rate, but it does a much poorer job in matching second moments of the labor market. The volatility of wages and unemployment are crucial aspects for the dynamics of credit available to borrowers, in my model. Hence the adoption of adjustment costs improves significantly the ability of the model to replicate the interactions between labor institutions and the housing market.

8 Conclusions

In this paper I investigate the role of labor markets institutions in explaining the heterogeneity we observe in homeownership rates across countries and over time. The main novelty consists in the new perspective I take on the mechanisms that link the labor market with the housing market. Indeed, the relevance of labor legislation for housing tenure choice, has not been investigated by the existing literature, which focused on the effects of an high level of homeownership on labor outcomes.

In the first part of the paper, using panel data from 19 OECD countries over the period 1965-2014, I find that an overall more rigid labor market is positively correlated with homeownership. I also show that this is the result of opposite forces. In fact, employment protections, unemployment benefits and the strength of labor unions are positively correlated with homeownership, whereas a centralized wage bargaining is negatively correlated with the share of homeowners in the economy. The opposite effects on homeownership, of different labor market institutions can be explained by the fact that different LMIs affect differently many elements which are important for the housing tenure choice. This is true in particular for the impact of labor legislation on the volatility of employment and real wages. In order to have additional empirical evidence, I use a difference in difference approach to look at the effects of specific labor reforms episodes. I find that reforms which reduced employment protections or made less generous the unemployment benefits had a significant negative impact on homeownership. On the other hand I find that reforms which reduced union coverage or decentralized the wage bargaining had a positive impact on homeownership, in line with my panel regression analysis.

In the second part of the paper, I construct a DSGE model which includes housing tenure decision of households, search and matching frictions, and labor market rigidities, both in terms of employment and wages. The model has enough details in the labor sector to disentangle the heterogeneous effects of different labor institutions. The housing market and labor market are directly linked via an endogenous credit constraint, which depends on the expected income and its volatility. The model is able to replicate second moments of wages and unemployment, moreover it matches well with the homeownership rates for USA, France, United Kingdom and Japan. The key features of my model are suitable to evaluate in a net way how specific types of labor frictions can affect the housing tenure choice. Indeed I am able to map employment protection, union's strength and unemployment benefits from the data, to parameters of my model.

Using simulations and counter-factual analysis, I study the impact of hypothetical changes in labor market institutions and also the effect of real labor reforms. In the first experiment I perform for USA, I apply labor market institutions as in France, keeping everything else equal. I find that an over all more rigid labor market, would lead to an increase in US homeownership of 3.24%. The second experiment I perform is to evaluate the impact of the labor market reforms that took place in the United Kingdom in 1980s, which sharply reduced the benefit replacement rate. I find that these reforms, if nothing else would have changed, could have leaded to a reduction in homeownership of 1.42%.

In light of my empirical and theoretical results, it is possible to argue that the interactions between labor market legislation and the housing market are broader than those previously

highlighted by the literature. In this paper I show that labor market institutions affect the hosing tenure decision through their impact on employment and wage volatilities. Moreover, using counter-factual experiments, I show that changes in labor legislation have a non negligible impact on the housing market. The main implication of these results is that, when it comes the evaluation of a labor market regime or reform, one should also take into account their effect on the housing market.

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A Appendix

A.1 Data description

Figure 1: Home ownership rate

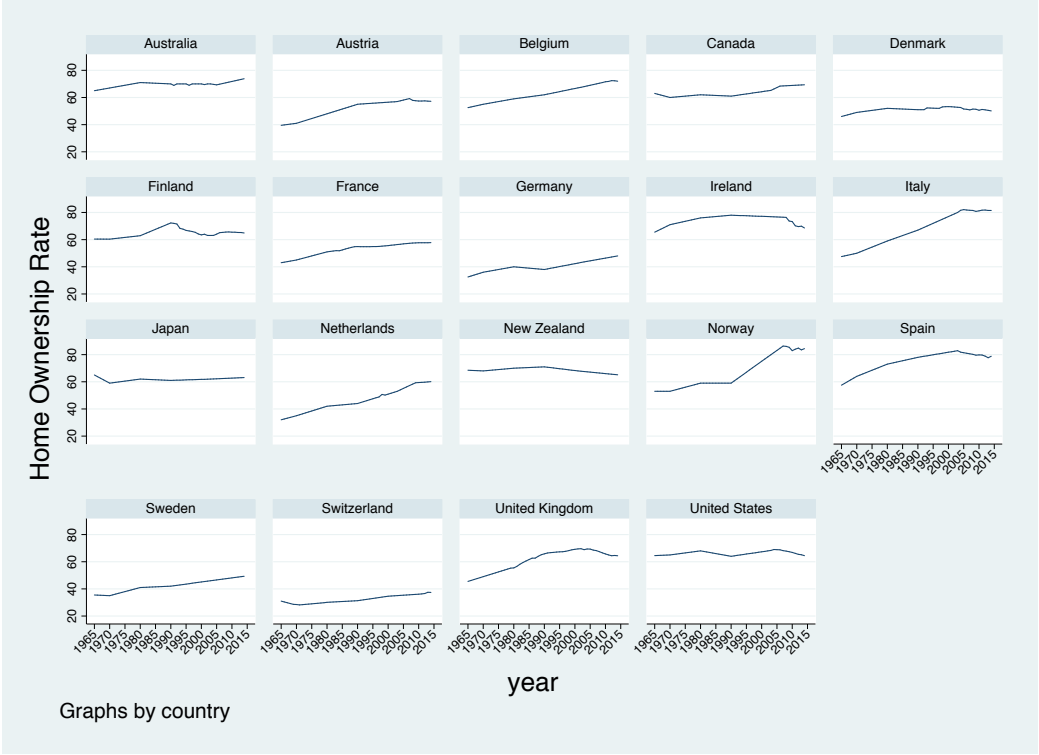
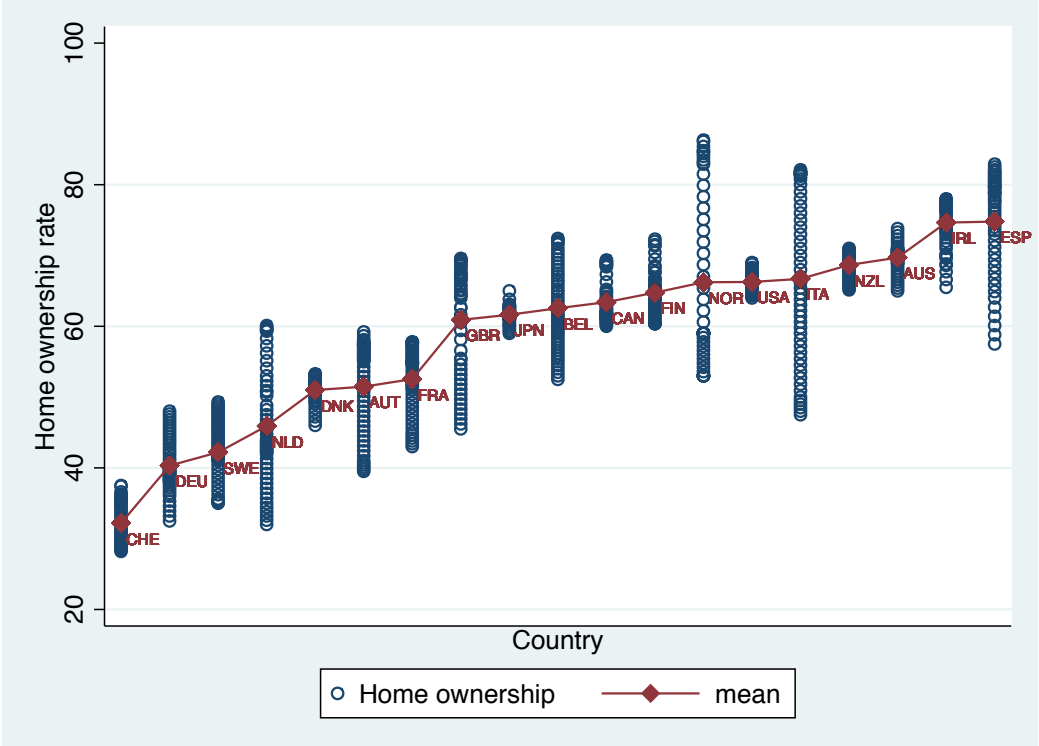


Figure 2: Home ownership rate, mean by country



A.1.1 Labor market institutions

Table 6: Description of Labor Market Institutions

LMI	Description	Source
Employment protection for permanent contracts (EPR)	EPR measures the strictness of regulation of individual dismissal of employees on regular/indefinite contracts. It is expressed in a 0-6 scale.	OECD
Employment protection for temporary contracts (EPT)	EPT measures the strictness of regulation on the use of fixed-term and temporary work agency contracts. It is expressed in a 0-6 scale.	OECD
Union density (UD)	Ratio of wage and salary earners that are trade union members, divided by the total number of wage and salary earners. Constructed using both survey and administrative data.	OECD
Union coverage (UC)	This indicator refers to the percentage of workers covered by collective agreements normalized on employment.	CEP-OECD
Union concentration (CONC)	Summary measure of concentration of unions at industry and sectoral level. CONC ranges between 0-1.	CEP-OECD
Extension of collective agreements (EXT)	Mandatory extension of collective agreements to non-organized employers. It has a 0-3 scale, where 3 indicates that the extension is virtually automatic and more or less general.	ITCWSS
Wage bargaining centralization (CENT)	Summary measure of centralization of wage bargaining, taking into account both union authority and concentration at multiple levels. Derived from Iversen's centralization index, it ranges between 0-1.	CEP-OECD
Government intervention in wage bargaining (GOVINT)	Index of government intervention in the wage bargaining process. It spans between 1 and 5, where 1 means no intervention.	ITCWSS
Bargaining level (LEVEL)	Index between 0 and 5, which indicates the predominant level where the wage bargaining takes place. e.g. firm level, industry, nation level.	ITCWSS
Tax wedge (TW)	Tax wedge is the sum of the employment tax rate, the direct tax rate and the indirect tax rate. It is a measure of market inefficiency.	CEP-OECD
Minimum wage setting (MWS)	Degree of government intervention and discretion in setting the minimum wage. It ranges between 0 and 8, where 0 indicates no minimum wage.	ITCWSS
Benefit duration (BD)	Benefit duration index. It captures the level of benefits available in the later years of a spell relative to those available in the first year.	CEP-OECD
Benefit replacement rate (BRR)	It indicates the average across the first five years of unemployment for three family situations and two money levels. The data are taken from OECD Indicators database.	CEP-OECD
Unemployment benefits (UB)	Indicator of unemployment benefits which combines the amount of the subsidy with their tax treatment, their duration and the conditions. By Allard(2005).	CEP-OECD

Table 7 provide the descriptive statistics of the labor market institutions I consider for my estimates.

Table 7: Descriptive statistics for Labor Market Institutions

Variable	Obs	Mean	Std. Dev.	Min	Max
Employment protection (temp.)	950	1.84	1.46	.25	5.25
Employment protection (perm.)	950	1.99	.79	.26	3.55
Union density	950	39.52	19.49	7.55	83.86
Union coverage	950	68.46	26	7	99
Union concentration	950	.32	.11	.14	.59
Wage bargaining centralization	950	.41	.19	.08	.98
Government Intervention	950	2.6	1.24	1	5
Level of wage bargaining	950	3.01	1.34	1	5
Ext. of collective Agreements	950	1.35	1.24	0	3
Minimum wage	950	-3.72	2.96	-8	0
Tax wedge	950	46.36	14.82	10.6	85.6
Benefit duration	950	.46	.36	0	1.16
Unemployment benefits	950	12.06	8.5	0	42.1
Benefit replacement rate	950	27.13	13.11	.35	65.21

A.1.2 Control variables

- Working age population as % of total population: Employment and Labor Market Statistics, OECD;
- Real interest rate: long term real interest rate, constructed using long term nominal interest rate and inflation from OECD Economic Outlook Database;
- Real house prices: seasonally adjusted, index based in 2010 from OECD Analytical House Price database;
- Rent cost from OECD.
- Price to income ratio: nominal house prices divided by nominal disposable income per head, index based in 2010 from OECD Analytical House Price database;
- Price to rent ratio: Nominal house prices to rent prices, index based in 2010 from OECD Analytical House Price database;
- Real Personal disposable income Index: quarterly data from FED, collected by Adrienne and Martínez-García (2011);
- Net Migration rate (per 1000 inhabitants): OECD Facts book 2010: Economic, Environmental and Social Statistics;
-Financial reform index (normalized): constructed by Abiad et al. (2008) it ranges over the period 1973-2005. It comprehends: *Credit controls and excessively high reserve requirements*, *Interest rate controls*, *Entry barriers*, *State ownership in the banking sector*, *Capital account restrictions*, *Prudential regulations and supervision of the banking sector* and *Securities market policy*;
-Revenues from taxes on property, as % of GDP from OECD Comparative Tables;
-Revenues from taxes on immovable property, as % of GDP from OECD Comparative Tables;
-Revenues from taxes on estate, inheritance and gifts, as % of GDP from OECD Comparative Tables;
-Revenues from taxes on financial and capital transactions from OECD Comparative Tables.
- GDP growth, World Bank.

Table 8 shows the descriptive statistics of the 15 controls.

Table 8: Descriptive statistics for control variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Pop. 15-64	950	65.58	2.38	58.01	69.92
Real house prices	950	71	30.23	22.8	169.24
Rent cost	950	55.89	33.34	2.8	146.3
Price to rent ratio	950	82.11	37.11	8.2	199.69
Price to income ratio	950	92.79	35.01	14.7	213.65
Personal disposable income	950	81.29	18.24	38.22	126.47
Financial Reform Index	950	.71	.28	.1	1
Net Migration rate	950	2.44	3.9	-13.2	22.2
Property tax	950	1.99	.96	.38	5
Tax on immovables	950	1.13	1.01	0	4.18
Tax on successions	950	.19	.15	0	.92
Tax on transactions	950	.46	.36	0	4.36
Real interest rate	950	7.35	3.59	.55	21.25
GDP growth	950	2.86	2.59	-8.27	12.88
Unemployment rate	950	6.05	4.08	0	26.1

Principal component analysis

Table 9: Correlation between Economic Factors and original LMIs

	(1) EPL	(2) UnS	(3) WB	(4) UB
Employment protection (temp.)	0.899***			
Employment protection (perm.)	0.899***			
Union density		0.626***		
Union coverage		0.915***		
Union concentration		0.321***		
Ext. of coll. Agreements		0.550***		
Gov. Intervention			0.644***	
Level of wage bargaining			0.862***	
Wage bargaining centralization			0.768***	
Minimum wage			0.551***	
Tax wedge			0.648***	
Unemployment benefits				0.843***
Benefit duration				0.715***
Benefit replacement rate				0.894***
Observations	950	950	950	950

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10: Correlation between Statistical Factors and original LMIs

	(1) SF1 (overall rigidity)	(2) SF2	(3) SF3	(4) SF4
Employment protection (temp.)	0.465***	-0.674***	-0.192***	0.00381
Employment protection (perm.)	0.698***	-0.453***	-0.0935**	0.0782*
Union density	0.574***	-0.0202	0.519***	-0.0753*
Union coverage	0.888***	-0.0351	-0.0421	0.0995**
Union concentration	0.188***	0.652***	0.470***	0.283***
Wage bargaining centralization	0.717***	0.204***	0.301***	0.274***
Gov. Intervention	0.633***	0.00759	-0.365***	0.236***
Level of wage bargaining	0.792***	-0.0741*	-0.0249	0.337***
Ext. of coll. Agreements	0.430***	0.207***	-0.632***	0.379***
Minimum wage	0.457***	-0.170***	0.697***	0.0275
Tax wedge	0.675***	-0.270***	0.111***	-0.440***
Benefits duration	0.364***	0.759***	-0.178***	0.00477
Unemployment benefit	0.483***	0.311***	-0.0935**	-0.677***
Benefit replacement rate	0.630***	0.320***	-0.271***	-0.507***
Observations	950	950	950	950

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11: Correlation between PC controls and original controls

	(1) PC1	(2) PC2	(3) PC3	(4) PC4	(5) PC5
Pop. 15-64	0.677***	-0.0774*	-0.238***	0.0769*	0.148***
Real house prices	0.826***	-0.362***	0.257***	-0.0761*	0.155***
Rent cost	0.885***	0.288***	-0.136***	-0.0442	0.0133
Price to rent ratio	0.616***	-0.508***	0.315***	-0.133***	0.222***
Price to income ratio	0.392***	-0.640***	0.376***	-0.0955**	0.191***
Personal disposable income	0.839***	0.166***	-0.0854**	0.0240	-0.128***
Financial Reform Index	0.739***	0.460***	-0.173***	-0.0613	0.0137
Net Migration rate	0.438***	0.0910**	-0.0199	0.318***	-0.663***
Property tax	0.0452	0.732***	0.560***	0.0750*	0.0753*
Tax on immovables	-0.0265	0.728***	0.536***	-0.269***	-0.0287
Tax on successions	-0.122***	0.330***	0.576***	0.355***	0.327***
Tax on transactions	0.123***	0.0194	-0.261***	0.841***	0.284***
Real interest rate	-0.680***	-0.0246	-0.315***	-0.160***	0.203***
GDP growth	-0.352***	-0.243***	0.352***	0.313***	-0.0863**
Unemployment rate	0.116***	0.542***	-0.549***	-0.117***	0.387***
Observations	950	950	950	950	950

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12: Correlation between groups of PC controls and original controls

	(1) PC housing	(2) PC taxes	(3) PC economy
Real house prices	0.967***		
Rent cost	0.557***		
Price to rent ratio	0.899***		
Price to income ratio	0.771***		
Property tax		0.949***	
Tax on immovables		0.930***	
Tax on successions		0.606***	
Tax on transactions		-0.142***	
Pop. 15-64			0.659***
Personal disposable income			0.850***
Financial Reform Index			0.854***
Net Migration rate			0.513***
Real interest rate			-0.637***
GDP growth			-0.463***
Unemployment rate			0.313***
Observations	950	950	950

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 13: Descriptive statistics for Statistical Factors

Variable	Obs	Mean	Std. Dev.	Min	Max
SF1 (overall rigidity)	950	0	2.24	-5.12	3.95
SF2	950	0	1.43	-3.71	2.97
SF3	950	0	1.33	-3.3	2.34
SF4	950	0	1.18	-4.03	2.95

Table 14: Descriptive statistics for Economic Factors

Variable	Obs	Mean	Std. Dev.	Min	Max
EPL	950	0	1.27	-2.31	2.33
UnS	950	0	1.28	-3.27	2.55
WB	950	0	1.57	-3.19	3.28
UB	950	0	1.42	-2.76	4.69

Table 15: Descriptive statistics for PC of control variables

Variable	Obs	Mean	Std. Dev.	Min	Max
PC1	950	0	2.13	-4.77	5.01
PC2	950	0	1.63	-3.69	4.31
PC3	950	0	1.39	-3.43	4.17
PC4	950	0	1.09	-2.61	9.7
PC5	950	0	.99	-3.81	3.17

Table 16: Descriptive statistics for alternative PC of control variables

Variable	Obs	Mean	Std. Dev.	Min	Max
PC housing	950	0	1.63	-3.33	5.19
PC taxes	950	0	1.47	-2	5.28
PC economy	950	0	1.69	-3.51	3.85

A.2 Panel regression results

Table 17: GLS regressions with Economic Factors

	(1)	(2)	(3)	(4)
VARIABLES	Homeownership	Homeownership	Homeownership	Homeownership
EPL	0.315***	0.281***	0.254***	0.292***
	(0.0506)	(0.0412)	(0.0430)	(0.0415)
UnS	0.484***	0.407***		
	(0.0407)	(0.0314)		
WB	-0.287***		-0.199***	
	(0.0243)		(0.0211)	
UB	0.259***			0.304***
	(0.0231)			(0.0190)
Constant	67.92***	67.81***	68.06***	68.57***
	(0.395)	(0.376)	(0.408)	(0.388)
Observations	950	950	950	950
Controls	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
CSTT	✓	✓	✓	✓

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 18: GLS regressions with Economic Factors and separate EPLs

	(1)	(2)	(3)	(4)
VARIABLES	Homeownership	Homeownership	Homeownership	Homeownership
EPL (perm. contracts)	4.526***	4.823***	4.525***	4.689***
	(0.130)	(0.118)	(0.122)	(0.114)
EPL (temp. contracts)	-0.409***	-0.415***	-0.427***	-0.399***
	(0.0291)	(0.0281)	(0.0261)	(0.0253)
UnS	0.684***	0.528***		
	(0.0481)	(0.0466)		
WB	-0.304***		-0.176***	
	(0.0245)		(0.0222)	
UB	0.266***			0.306***
	(0.0278)			(0.0227)
Constant	63.66***	63.39***	64.17***	64.30***
	(0.391)	(0.362)	(0.400)	(0.368)
Observations	950	950	950	950
Controls	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
CSTT	✓	✓	✓	✓

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 19: GLS regressions with Statistical Factors

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership
SF1 (Overall rigidity)	0.320***	-0.0218			
	(0.0307)	(0.0198)			
SF2	-0.112**		0.119***		
	(0.0453)		(0.0253)		
SF3	1.179***			1.048***	
	(0.0463)			(0.0335)	
SF4	-0.522***				-0.396***
	(0.0320)				(0.0225)
Constant	70.54***	67.81***	67.80***	68.94***	68.69***
	(0.455)	(0.389)	(0.386)	(0.427)	(0.409)
Observations	950	950	950	950	950
Controls	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
CSTT	✓	✓	✓	✓	✓

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 20: GLS regressions with individual LMIs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
VARIABLES	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership
EPL (temp. contracts)	-0.541***	-0.413***													
	(0.0362)	(0.0213)													
EPL (perm. contracts)	3.369***		4.779***												
	(0.174)		(0.115)												
Union density	-0.0146***			0.0255***											
	(0.00451)			(0.00205)											
Union coverage	-0.0673***				-0.0302***										
	(0.00279)				(0.00144)										
Union concentration	4.199***					0.618***									
	(0.434)					(0.205)									
Ext. of coll. Agreements	1.814***						1.104***								
	(0.0718)						(0.0410)								
Wage bargain centralization	-6.014***							-1.424***							
	(0.427)							(0.200)							
Gov. Intervention	-0.253***								-0.365***						
	(0.0184)								(0.0165)						
Level of wage bargaining	-0.0617**									-0.0987***					
	(0.0309)									(0.0169)					
Minimum wage	0.614***										0.684***				
	(0.0282)										(0.0207)				
Tax wedge	-0.0626***											-0.0818***			
	(0.00589)											(0.00292)			
Benefits duration	-2.037***												-1.111***		
	(0.168)												(0.0843)		
Unemployment benefit	0.113***													0.102***	
	(0.00550)													(0.00339)	
Benefit replacement rate	-0.0225***														-0.0115***
	(0.00324)														(0.00168)
Constant	77.51***	68.39***	63.41***	66.77***	70.58***	67.77***	64.53***	68.62***	68.56***	68.15***	73.36***	70.42***	68.81***	67.73***	68.01***
	(0.697)	(0.381)	(0.377)	(0.385)	(0.431)	(0.388)	(0.370)	(0.408)	(0.437)	(0.405)	(0.421)	(0.412)	(0.391)	(0.401)	(0.390)
Observations	950	950	950	950	950	950	950	950	950	950	950	950	950	950	950
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CSTT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

A.2.1 Robustness checks for panel regressions

GLS using alternative specification for principal controls:

Table 21: Panel GLS Statistical Factors using PC housing, taxes and economy

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership
SF1 (Overall rigidity)	0.461***	0.549***			
	(0.155)	(0.143)			
SF2	0.491***		0.871***		
	(0.178)		(0.144)		
SF3	0.904***			0.870***	
	(0.223)			(0.188)	
SF4	-0.280*				-0.383***
	(0.160)				(0.130)
PC housing	-0.0908	-0.169**	-0.171**	-0.193***	-0.158**
	(0.0795)	(0.0694)	(0.0680)	(0.0685)	(0.0730)
PC taxes	-0.0711	-0.209*	-0.127	-0.0617	-0.218*
	(0.124)	(0.122)	(0.117)	(0.121)	(0.120)
PC economy	0.409***	0.344***	0.313***	0.362***	0.305**
	(0.137)	(0.124)	(0.118)	(0.129)	(0.121)
Constant	69.24***	68.48***	66.80***	69.02***	69.28***
	(1.142)	(0.826)	(0.811)	(0.814)	(0.863)
Observations	850	850	850	850	850
Controls	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
CSTT	✓	✓	✓	✓	✓

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 22: Panel GLS Economic Factors using PC housing, taxes and economy

	(1)	(2)	(3)	(4)
VARIABLES	Homeownership	Homeownership	Homeownership	Homeownership
EPL	0.146***	0.0583**	0.00439	0.105***
	(0.0375)	(0.0282)	(0.0252)	(0.0298)
UnS	0.528***	0.470***		
	(0.0291)	(0.0210)		
WB	-0.222***		-0.144***	
	(0.0187)		(0.0135)	
UB	0.379***			0.422***
	(0.0187)			(0.0142)
PC housing	0.204***	0.0931***	0.134***	0.215***
	(0.0136)	(0.0105)	(0.0112)	(0.0119)
PC taxes	-1.064***	-0.995***	-1.019***	-1.088***
	(0.0277)	(0.0205)	(0.0186)	(0.0216)
PC economy	0.209***	0.260***	0.188***	0.182***
	(0.0173)	(0.0137)	(0.0143)	(0.0144)
Constant	68.97***	68.31***	68.77***	69.49***
	(0.348)	(0.327)	(0.359)	(0.351)
Observations	950	950	950	950
Controls	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
CSTT	✓	✓	✓	✓

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 23: Panel GLS separate EPLs, using PC housing, taxes and economy

	(1)	(2)	(3)	(4)
VARIABLES	Homeownership	Homeownership	Homeownership	Homeownership
EPL (perm. contracts)	4.655***	4.831***	4.525***	4.637***
	(0.122)	(0.113)	(0.108)	(0.103)
EPL (temp. contracts)	-0.488***	-0.536***	-0.541***	-0.501***
	(0.0324)	(0.0289)	(0.0266)	(0.0268)
UnS	0.769***	0.698***		
	(0.0447)	(0.0426)		
WB	-0.243***		-0.108***	
	(0.0238)		(0.0208)	
UB	0.378***			0.389***
	(0.0250)			(0.0193)
PC housing	0.168***	0.0400**	0.0826***	0.167***
	(0.0187)	(0.0175)	(0.0171)	(0.0174)
PC taxes	-1.197***	-1.135***	-1.107***	-1.188***
	(0.0313)	(0.0259)	(0.0251)	(0.0257)
PC economy	0.401***	0.473***	0.386***	0.377***
	(0.0241)	(0.0209)	(0.0204)	(0.0210)
Constant	64.45***	63.83***	64.91***	65.26***
	(0.345)	(0.321)	(0.358)	(0.336)
Observations	950	950	950	950
Controls	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
CSTT	✓	✓	✓	✓

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

GLS using homeownership at $t+1$:

Table 24: GLS Statistical Factors using homeownership at $t+1$

	(1)	(2)	(3)	(4)	(5)
VARIABLES	F.ho_comb	F.ho_comb	F.ho_comb	F.ho_comb	F.ho_comb
SF1 (Overall rigidity)	0.0700**	0.00813			
	(0.0292)	(0.0224)			
SF2	0.0720		0.0850*		
	(0.0446)		(0.0435)		
SF3	0.0365			0.0210	
	(0.0334)			(0.0275)	
SF4	-0.0918***				-0.0733***
	(0.0292)				(0.0249)
Constant	61.23***	63.84***	63.93***	60.62***	64.82***
	(2.834)	(1.646)	(1.588)	(3.058)	(1.363)
Observations	931	931	931	931	931
Controls	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
CSTT	✓	✓	✓	✓	✓

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 25: GLS Economic Factors using homeownership at $t+1$

	(1)	(2)	(3)	(4)
VARIABLES	F.ho_comb	F.ho_comb	F.ho_comb	F.ho_comb
EPL	0.118***	0.0907***	0.0593*	0.0828**
	(0.0405)	(0.0335)	(0.0320)	(0.0322)
UnS	0.507***	0.367***		
	(0.0378)	(0.0270)		
WB	-0.329***		-0.241***	
	(0.0228)		(0.0197)	
UB	0.258***			0.288***
	(0.0206)			(0.0170)
Constant	67.21***	67.28***	67.37***	68.00***
	(0.414)	(0.399)	(0.425)	(0.407)
Observations	931	931	931	931
Controls	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
CSTT	✓	✓	✓	✓

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 26: GLS separate EPLs, using homeownership at $t+1$

	(1)	(2)	(3)	(4)
VARIABLES	F.ho_comb	F.ho_comb	F.ho_comb	F.ho_comb
EPL (perm. contracts)	4.555***	4.713***	4.509***	4.573***
	(0.115)	(0.107)	(0.109)	(0.101)
EPL (temp. contracts)	-0.464***	-0.476***	-0.488***	-0.471***
	(0.0275)	(0.0284)	(0.0237)	(0.0253)
UnS	0.667***	0.547***		
	(0.0457)	(0.0403)		
WB	-0.346***		-0.228***	
	(0.0220)		(0.0192)	
UB	0.209***			0.256***
	(0.0249)			(0.0204)
Constant	63.18***	62.98***	63.68***	63.88***
	(0.407)	(0.384)	(0.419)	(0.390)
Observations	931	931	931	931
Controls	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
CSTT	✓	✓	✓	✓

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 27: Panel GLS with individual LMIs using PC housing, taxes and economy

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
VARIABLES	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership
EPL (temp. contracts)	-0.552***	-0.542***													
	(0.0361)	(0.0182)													
EPL (perm. contracts)	3.029***		4.615***												
	(0.172)		(0.101)												
Union density	-0.0187***			0.0335***											
	(0.00407)			(0.00174)											
Union coverage	-0.0733***				-0.0360***										
	(0.00282)				(0.000818)										
Union concentration	4.178***					0.951***									
	(0.395)					(0.154)									
Ext. of coll. Agreements	1.871***						1.312***								
	(0.0782)						(0.0395)								
Wage bargain centralization	-5.815***							-0.718***							
	(0.418)							(0.135)							
Gov. Intervention	-0.255***								-0.343***						
	(0.0179)								(0.0133)						
Level of wage bargaining	-0.0704**									-0.0709***					
	(0.0300)									(0.0111)					
Minimum wage	0.618***										0.674***				
	(0.0258)										(0.0193)				
Tax wedge	-0.0751***											-0.0817***			
	(0.00567)											(0.00214)			
Benefits duration	-2.049***												-0.907***		
	(0.163)												(0.0608)		
Unemployment benefit	0.112***													0.105***	
	(0.00502)													(0.00254)	
Benefit replacement rate	-0.0115***														0.00160
	(0.00288)														(0.00112)
PC housing	0.459***	0.144***	0.0296**	0.131***	0.184***	0.117***	0.145***	0.122***	0.122***	0.126***	0.155***	0.0701***	0.0886***	0.266***	0.119***
	(0.0232)	(0.0126)	(0.0126)	(0.0105)	(0.0103)	(0.0102)	(0.0113)	(0.0101)	(0.0133)	(0.0106)	(0.0136)	(0.0109)	(0.0100)	(0.0112)	(0.00999)
PC taxes	-0.153***	-0.984***	-1.130***	-0.995***	-0.981***	-1.016***	-1.000***	-1.013***	-0.996***	-1.025***	-0.559***	-0.796***	-0.915***	-0.948***	-1.020***
	(0.0349)	(0.0189)	(0.0236)	(0.0181)	(0.0171)	(0.0164)	(0.0250)	(0.0170)	(0.0266)	(0.0168)	(0.0222)	(0.0181)	(0.0186)	(0.0208)	(0.0171)
PC economy	0.395***	0.292***	0.338***	0.271***	0.199***	0.221***	0.282***	0.208***	0.166***	0.216***	0.453***	0.179***	0.227***	0.139***	0.214***
	(0.0322)	(0.0134)	(0.0182)	(0.0134)	(0.0137)	(0.0120)	(0.0167)	(0.0135)	(0.0183)	(0.0135)	(0.0178)	(0.0150)	(0.0126)	(0.0155)	(0.0124)
Constant	78.67***	69.41***	64.22***	67.28***	71.83***	68.51***	64.82***	69.12***	69.57***	69.10***	73.26***	71.05***	69.51***	68.92***	68.74***
	(0.649)	(0.338)	(0.350)	(0.336)	(0.371)	(0.344)	(0.335)	(0.355)	(0.387)	(0.354)	(0.387)	(0.388)	(0.346)	(0.360)	(0.344)
Observations	950	950	950	950	950	950	950	950	950	950	950	950	950	950	950
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CSTT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 28: GLS with individual LMIs using homeownership at $t+1$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
VARIABLES	F.ho_comb	F.ho_comb	F.ho_comb	F.ho_comb	F.ho_comb	F.ho_comb	F.ho_comb	F.ho_comb	F.ho_comb	F.ho_comb	F.ho_comb	F.ho_comb	F.ho_comb	F.ho_comb	F.ho_comb
EPL (temp. contracts)	-0.623***	-0.526***													
	(0.0366)	(0.0195)													
EPL (perm. contracts)	3.290***		4.627***												
	(0.170)		(0.110)												
Union density	-0.0125***			0.0250***											
	(0.00473)			(0.00160)											
Union coverage	-0.0670***				-0.0277***										
	(0.00300)				(0.00124)										
Union concentration	4.018***					0.0975									
	(0.409)					(0.206)									
Ext. of coll. Agreements	1.778***						1.099***								
	(0.0704)						(0.0369)								
Wage bargain centralization	-6.409***							-2.033***							
	(0.411)							(0.156)							
Gov. Intervention	-0.244***								-0.366***						
	(0.0171)								(0.0174)						
Level of wage bargaining	-0.0402									-0.106***					
	(0.0288)									(0.0153)					
Minimum wage	0.622***										0.682***				
	(0.0278)										(0.0198)				
Tax wedge	-0.0663***											-0.0925***			
	(0.00589)											(0.00260)			
Benefits duration	-1.965***												-1.049***		
	(0.153)												(0.0713)		
Unemployment benefit	0.113***													0.0979***	
	(0.00543)													(0.00311)	
Benefit replacement rate	-0.0251***														-0.0117***
	(0.00311)														(0.00174)
Constant	78.38***	68.28***	63.10***	66.49***	70.03***	67.57***	64.23***	68.58***	68.16***	67.88***	72.98***	70.37***	68.42***	67.44***	67.69***
	(0.722)	(0.395)	(0.404)	(0.402)	(0.433)	(0.407)	(0.391)	(0.418)	(0.464)	(0.421)	(0.440)	(0.425)	(0.411)	(0.422)	(0.413)
Observations	931	931	931	931	931	931	931	931	931	931	931	931	931	931	931
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CSTT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

GLS using 5-years intervals data:

Table 29: Panel GLS Economic Factors 5-years intervals

	(1)	(2)	(3)	(4)
VARIABLES	Homeownership	Homeownership	Homeownership	Homeownership
EPL (perm. contracts)	6.607***	6.901***	7.138***	7.023***
	(1.793)	(1.717)	(1.736)	(1.736)
EPL (temp. contracts)	-0.647**	-0.665**	-0.621**	-0.557*
	(0.313)	(0.294)	(0.284)	(0.290)
UnS	1.216**	1.345***		
	(0.515)	(0.475)		
WB	0.101		0.445*	
	(0.291)		(0.269)	
UB	0.172			0.205
	(0.311)			(0.296)
Constant	61.57***	61.27***	62.10***	62.66***
	(2.522)	(2.408)	(2.403)	(2.406)
Observations	190	190	190	190
Controls	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
CSTT	✓	✓	✓	✓

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 30: Panel GLS Statistical Factors 5-years intervals

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership
SF1 (Overall rigidity)	0.508*	0.481*			
	(0.306)	(0.285)			
SF2	0.372		0.676**		
	(0.393)		(0.342)		
SF3	0.302			0.531	
	(0.445)			(0.432)	
SF4	-0.153				0.0370
	(0.296)				(0.321)
Constant	66.57***	67.85***	67.71***	68.00***	67.92***
	(2.035)	(1.940)	(2.062)	(2.031)	(2.115)
Observations	190	190	190	190	190
Controls	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
CSTT	✓	✓	✓	✓	✓

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 31: Panel GLS with individual LMIs 5-years intervals

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
VARIABLES	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership	Homeownership
EPL (temp. contracts)	-0.746**	-0.840***													
	(0.317)	(0.242)													
EPL (perm. contracts)	2.688		6.365***												
	(1.866)		(1.733)												
Union density	-0.0853*			0.0275											
	(0.0497)			(0.0336)											
Union coverage	-0.00906				0.0461*										
	(0.0310)				(0.0240)										
Union concentration	-5.971					1.383									
	(5.794)					(4.061)									
Ext. of coll. Agreements	2.243***						1.003*								
	(0.733)						(0.538)								
Wage bargain centralization	1.392							1.804							
	(4.725)							(3.029)							
Gov. Intervention	-0.0705								-0.191						
	(0.273)								(0.179)						
Level of wage bargaining	-0.277									0.342					
	(0.308)									(0.211)					
Minimum wage	0.450**										0.688***				
	(0.219)										(0.225)				
Tax wedge	0.00621											-0.0230			
	(0.0573)											(0.0444)			
Benefit duration	-3.051*												0.577		
	(1.768)												(1.441)		
Unemployment benefits	0.198***													0.0830**	
	(0.0554)													(0.0391)	
Unemployment benefit	-0.0905*														-0.00171
	(0.0499)														(0.0307)
Constant	72.32***	68.83***	62.35***	66.70***	64.32***	67.92***	64.33***	66.73***	68.47***	66.24***	73.14***	68.78***	67.13***	67.71***	67.92***
	(5.318)	(1.817)	(2.146)	(2.571)	(2.746)	(2.398)	(2.499)	(2.783)	(2.079)	(2.218)	(2.563)	(2.538)	(2.310)	(2.108)	(2.069)
Observations	190	190	190	190	190	190	190	190	190	190	190	190	190	190	190
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CSTT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

A.3 Results from difference in difference

Table 32: DD estimates

Controls:	(1)	(2)	(3)	(4)
Norway and US	EPL 91	UB 00	WB 87	UnS 80
Reform × Post	-6.701***	-3.116***	1.803*	10.75***
	(1.059)	(0.843)	(0.931)	(1.179)
Initial conditions	0.470***	0.591***	0.776***	0.335***
	(0.0603)	(0.0684)	(0.0631)	(0.0955)
Observations	180	225	180	135
Controls	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
CSTT	✓	✓	✓	✓
Controls:	(1)	(2)	(3)	(4)
all non-treated	EPL 91	UB 00	WB 87	UnS 80
Reform × Post	-2.465***	-1.328***	1.705***	6.026***
	(0.833)	(0.303)	(0.401)	(0.563)
Initial conditions	0.752***	0.711***	0.728***	0.727***
	(0.0295)	(0.0299)	(0.0291)	(0.0278)
Reforms Dummies	✓	✓	✓	✓
Observations	765	765	765	765
Controls	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
CSTT	✓	✓	✓	✓

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

A.4 Robustness of difference in difference

As robustness check for the difference in difference analysis I construct a different control groups for each of the reforms considered. In my baseline DD regressions the control groups were composed only by those countries that did not undertake significant labor market reforms in the period considered. Now I construct the control groups including all countries that are not *treated* by the specific reform that I investigate. Table 33 presents the results for these DD regressions.

Table 33: DD estimates, with different controls for each reform

Controls: Selection of non-treated	(1) EPL 91	(2) UB 00	(3) WB 87	(4) UnS 80
Reform × Post	-5.380***	-2.367***	1.548***	6.360***
	(0.786)	(0.372)	(0.422)	(0.706)
Initial conditions	0.518***	0.741***	0.744***	0.678***
	(0.0513)	(0.0403)	(0.0381)	(0.0356)
Observations	315	360	450	495
Controls	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
CSTT	✓	✓	✓	✓

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results are similar with those of my baseline DD regression.

A.5 Check of identification assumptions of difference in difference

Table 34: Treated and control groups' mean characteristics

Controls	**PC 1**	**PC 2**	**PC 3**	**PC 4**	**PC 5**
Control group	-.306	.029	.662	-.839	-.573
	(.211)	(.112)	(.157)	(.051)	(.081)
EPL91	-.142	-.831	-1.091	.460	.490
	(.187)	(.113)	(.076)	(.076)	(.057)
UB00	.048	-.829	-.881	-.133	-.134
	(.159)	(.142)	(.098)	(.086)	(.078)
WB87	-.465	.303	-.953	.321	.425
	(.224)	(.113)	(.137)	(.106)	(.091)
UnS80	-.973	2.77	1.43	-.230	.271
	(.331)	(.090)	(.154)	(.104)	(.055)

Check of parallel trend assumption:

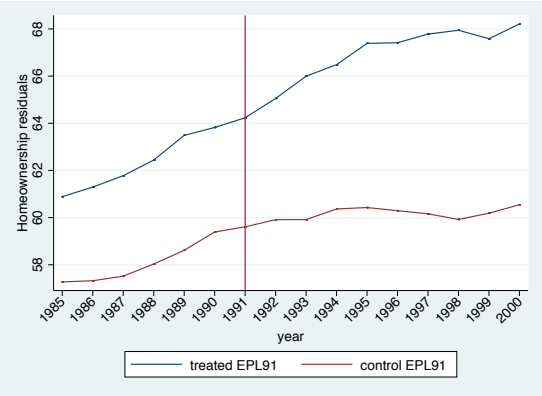


Figure 3: EPL reforms 1991

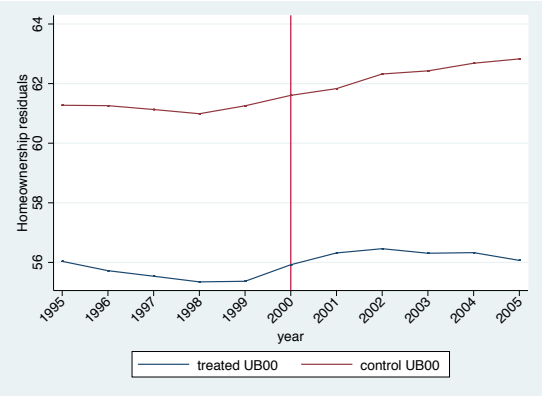


Figure 4: UB reforms 2000

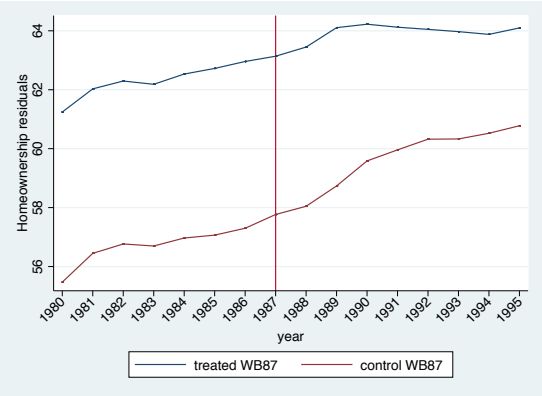


Figure 5: WB reforms 1987

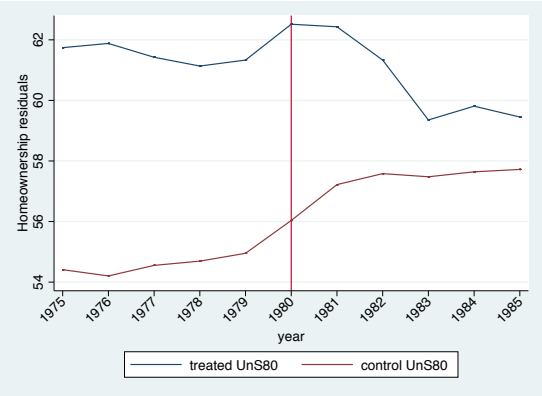


Figure 6: UnS 1980

B Model appendix

B.1 Firm sector

Here I present the equations describing the asymmetric adjustment costs of employment and wages, derived from Abbritti and Fahr (2013):

$$AC_{w,t} = \frac{\chi_w}{2}\left(\frac{\pi_t^w}{\pi_t^\iota} - 1\right)^2 + \frac{1}{\psi_w^2}\left(\exp\left\{-\psi_w\left(\frac{\pi_t^w}{\pi_t^\iota} - 1\right)\right\} + \psi_w\left(\frac{\pi_t^w}{\pi_t^\iota} - 1\right) - 1\right) \tag{33}$$

$$AC_{e,t} = \frac{\chi_e}{2}\left(\frac{e_t}{e_{t-1}} - 1\right)^2 + \frac{1}{\psi_e^2}\left(\exp\left\{-\psi_e\left(\frac{e_t}{e_{t-1}} - 1\right)\right\} + \psi_e\left(\frac{e_t}{e_{t-1}} - 1\right) - 1\right) \tag{34}$$

where:

$$\pi_t^w = \frac{w_t}{w_{t-1}}\pi_t \tag{35}$$

$$\pi_t = \frac{p_t}{p_{t-1}}$$

The derivatives with respect to employment read:

$$AC'_{e,t} = \frac{\partial AC_{e,t}}{\partial(e_t/e_{t-1})} = \chi_e \left(\frac{e_t}{e_{t-1}} - 1\right) + \frac{1}{\psi_e}\left[1 - \exp\left\{-\psi_e\left(\frac{e_t}{e_{t-1}} - 1\right)\right\}\right] \tag{36}$$

$$AC'_{e,t+1} = \frac{\partial AC_{e,t+1}}{\partial(e_{t+1}/e_t)} = \chi_e \left(\frac{e_{t+1}}{e_t} - 1\right) + \frac{1}{\psi_e}\left[1 - \exp\left\{-\psi_e\left(\frac{e_{t+1}}{e_t} - 1\right)\right\}\right]$$

B.2 Nash bargaining derivations

$$\begin{aligned}\tau_t &\equiv -\frac{\partial \mathbf{J}_t/\partial w_t}{\partial(\mathbf{N}_t - \mathbf{U}_t)/\partial w_t} \\ &= 1 + AC_{w,t} + AC'_{w,t}\frac{\pi^w_t}{\pi^\nu_t} - (1-s)\left[\frac{(1-\nu)\beta^s\lambda^s_{t+1}}{\lambda^s_t} + \frac{\nu\beta^b\lambda^b_{t+1}}{\lambda^b_t}\right] E_t\left[AC'_{w,t+1}\frac{n_{t+1}}{n_t}\frac{(\pi^w_{t+1})^2}{\pi^{1+\nu}_{t+1}}\right]\end{aligned} \tag{37}$$

$$AC'_{w,t} = \frac{\partial AC_{w,t}}{\partial(\pi^w_t/\pi^\nu_t)} = \chi_w \left(\frac{\pi^w_t}{\pi^\nu_t} - 1\right) + \frac{1}{\psi_w}\left[1 - \exp\left\{-\psi_w\left(\frac{\pi^w_t}{\pi^\nu_t} - 1\right)\right\}\right] \tag{38}$$

$$AC'_{w,t+1} = \frac{\partial AC_{w,t+1}}{\partial(\pi^w_{t+1}/\pi^\nu_{t+1})} = \chi_w \left(\frac{\pi^w_{t+1}}{\pi^\nu_{t+1}} - 1\right) + \frac{1}{\psi_w}\left[1 - \exp\left\{-\psi_w\left(\frac{\pi^w_{t+1}}{\pi^\nu_{t+1}} - 1\right)\right\}\right]$$

B.3 Model calibration for France, UK and Japan

In this section I describe the model calibration for France and UK.

France: the matching function elasticity parameter ζ is set to 0.5 as in the US case. Job-finding rate is set to 0.32. Separation rate is set to match unemployment rate of 8.4%. Given these values, I than obtain separation rate of 0.0432. Given the separation rate and a job filling rate of 0.9, I obtain the matching efficiency parameter $\overline{m}$ which yields 0.5367. Tax benefit for owned housing is set to 0.2, less generous with respect to USA. The weight of housing in the utility function, j_h is obtained from SS, to match homeownership rate and corresponds to 1.0634. The share of total LTV ratio, which depend on the legal requirements, Γ_h is set to 0.65, lower than US. Γ_e, the component of LTV that is related to expected income, is set to 0.73, which means that French mortgage sector is less developed than the US one. Finally Γ_v, which is the weight of expected income volatility in the credit constraint, is chosen as residual to match homeownership rate.

Disutility of labor, j_n, is set at 327.7, corresponding to 7 daily working hours and an unemployment rate of 8.4%. The inverse Frisch elasticity of labor supply γ is set at 4.0 as for USA. Capital has a share α of 0.3 in the firm production function and depreciates at rate δ of 3%. Union's bargaining power is 0.5. Firm vacancy posting costs help calibrate the job-finding and job-filling rates, suggesting κ at 0.334, implying total vacancy posting costs amount to 1.5% of GDP. With respect to wage and employment adjustment costs, I set χ_e at 1.4 and ψ_e at -24100 making it more costly to lay-off workers than to fire them. Moreover χ_w is set at 22 and ψ_w at 24100, making wages downward rigid. Wages are not indexed against inflation and the Taylor

rule parameter and the shocks are calibrated as for USA.

United Kingdom: the matching function elasticity parameter ζ is set to 0.5 as in the US case. Job-finding rate is set to 0.4. Separation rate is set to match unemployment rate of 7%. Given these values, I than obtain separation rate of 0.502. Given the separation rate and a job filling rate of 0.9, I obtain the matching efficiency parameter $\overline{m}$ which yields 0.6. Tax benefit for owned housing is set to 0.2, less generous with respect to USA. The weight of housing in the utility function, j_h is obtained from SS, to match homeownership rate and corresponds to 1.0634 The share of total LTV ratio, which depend on the legal requirements, Γ_h is set to 0.75, a bit less than US. Γ_e, the component of LTV that is related to expected income, is set to 0.7, as in US. Finally Γ_v, which is the weight of expected income volatility in the credit constraint, is chosen as residual to match homeownership rate.

Disutility of labor, j_n, is set at 322.79, corresponding to 7 daily working hours and an unemployment rate of 7% The inverse Frisch elasticity of labor supply γ is set at 4.0 as for USA. Capital has a share α of 0.3 in the firm production function and depreciates at rate δ of 3%. Union's bargaining power is 0.46, very close to France. Firm vacancy posting costs help calibrate the job-finding and job-filling rates, suggesting κ at 0.2872, implying total vacancy posting costs amount to 1.5% of GDP. With respect to wage and employment adjustment costs, I set χ_e at 30.5 and ψ_e at -3000 making it more costly to lay-off workers than to fire them. Moreover χ_w is set at 9.63 and ψ_w at 24100, making wages downward rigid. Wages are not indexed against inflation and the Taylor rule parameter and the shocks are calibrated as for USA.

Japan: the matching function elasticity parameter ζ is set to 0.5 as in the US case. Job-finding rate is set to 0.48, and unemployment rate in SS is 3%. Given these values, I than obtain separation rate of 0.0564. Given the separation rate and a job filling rate of 0.9, I obtain the matching efficiency parameter $\overline{m}$ which yields 0.520. Tax benefit for owned housing is set to 0.2, less generous with respect to USA as in France. The weight of housing in the utility function, j_h is obtained from SS, to match homeownership rate and corresponds to 1.0634 The share of total LTV ratio, which depend on the legal requirements, Γ_h is set to 0.8, a bit less than US. Γ_e, the component of LTV that is related to expected income, is set to 0.78. Finally Γ_v, which is the weight of expected income volatility in the credit constraint, is chosen as residual to match homeownership rate.

Disutility of labor, j_n, is set at 325.6, corresponding to 7 daily working hours and an unemployment rate of 3% The inverse Frisch elasticity of labor supply γ is set at 5, following Kuo and Miyamoto (2016). Capital has a share α of 0.3 in the firm production function and depreciates at rate δ of 3%. Union's bargaining power is 0.48, very close to USA. Firm vacancy posting costs help calibrate the job-finding and job-filling rates, suggesting κ at 0.2555, implying total vacancy posting costs amount to 2.8% of GDP. With respect to wage and employment adjustment costs, I set χ_e at 60.15 and ψ_e at -1700 making it more costly to lay-off workers than to fire them. Moreover χ_w is set at 0.0685 and ψ_w at 24100, making wages downward rigid. Wages are not indexed against inflation and the Taylor rule parameter and the shocks are calibrated as for USA.

B.4 Model robustness checks

Table 35: USA policy experiment, with *standard* credit constraint

		France *Labor Market Institutions applied* in USA			
	Standard constraint	All LMIs	Brr ↑	UnS↑	EPL↑
Vol(Y)	1.266	1.267	1.269	1.267	1.265
Vol(w)	0.935	0.916	0.913	0.935	0.917
Vol(ur)	11.761	3.971	5.928	7.791	4.710
Vol(EI)	0.886	0.864	0.854	0.885	0.868
Level (EI)	0.453	0.453	0.455	0.454	0.451
$ho\%$	66.44%	66.44%	66.44%	66.44%	66.44%
$\Delta ho\%$	-	0.00%	0.00%	0.00%	0.00%

Note: volatilities of output, Y, nominal wages, w, and unemployment rate, ur, are represented by standard deviations. $ho\%$ is the rate of homeownership in percentage points. $\Delta ho\%$ indicates the percentage change of homeownership.

Table 36: Match with the data, without AC_w and AC_e

	United States		France		United Kingdom		Japan	
	Data	*Model*	*Data*	*Model*	*Data*	*Model*	*Data*	*Model*
Vol(Y)	1.59	1.15	1.10	1.27	1.53	1.02	1.74	0.99
Vol(w)	0.92	0.83	1.22	0.77	2.24	0.87	17.11	0.80
Vol(ur)	11.87	6.83	6.17	1.16	8.56	3.10	7.05	0.66
Vol(EI)	-	1.02	-	1.07	-	0.89	-	0.81
ho%	66.44%	66.47%	53.51%	53.55%	62.45%	62.41%	61.63%	61.46%

Note: This table reports average level of homeownership rate $ho\%$, derived from annual data from 1970 to 2011. It also presents second moments of HP(1600) detrended quarterly data for the period 1970q1-2011q4 (1971q1-2011q4 for Japan). Y is GDP per-capita, w is nominal wage and ur is unemployment rate. The first column for each country shows the original data, each second column reports the simulation results of the model.