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Do Labor Market Institutions Matter for Fertility?*

Andrea Camilli† Andresa Lagerborg‡

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Abstract

Using annual data for 20 OECD countries over the period 1961-2014, we study whether *labor market institutions* (LMIs) not targeted to maternity impact the *total fertility rate* (TFR). We distinguish between *employment rigidities* (ER) and *real wage rigidities* (RWR), since the former reduces and the latter amplifies the response of the business cycle to shocks. Panel regressions and principal component analysis reveal that ER, such as employment protection and union strength, increase TFR. On the other hand, RWR, proxied by the centralization of wage bargaining and unemployment benefits, reduce TFR. We also find evidence that unemployment volatility reduces fertility whereas wage volatility raises fertility. Thus, to the extent that labor market institutions affect unemployment and wage volatility, they may also affect fertility. We complement our analysis with a DSGE model that incorporates households' fertility decision as well as unemployment and wage rigidities. We find that downward wage rigidities amplify real contractions in response to negative demand shocks and lead to large drops in employment and fertility.

JEL Classification: J01; J08; J13; J41; J51; D1
Keywords: fertility; labor market institutions; female labor force participation; income volatility; DSGE

1 Introduction

Starting in the 1960s, the majority of OECD countries experienced a significant reduction in fertility rates. During the same period, many countries adopted significant policies favoring fertility, making it important to understand which forces contributed to the evolution in fertility rates. In this paper we investigate whether *labor market institutions* (LMIs) that are not targeted to family-building, have an impact on fertility. Indeed a recent strand of the literature has shown that fertility became pro-cyclical in many countries starting in the mid-1990s, suggesting that there could have been changes in the economic framework that contributed to this fact.

Fertility decisions are affected by the possibility of large income shocks. Labor market institutions, to the extent that they affect volatility of unemployment and wages, may indirectly impact the level of fertility and its responsiveness to business cycles. Employment rigidities, restricting flows in and out of employment, reduce the volatility of unemployment. Real wage rigidities instead restrict wage movements and lead firms to adjust employment by more in response to shocks. In this way, real wage rigidities amplify the response of real business cycles to shocks, whereas employment rigidities act by dampening them. This channel, whereby LMIs affect fertility through the volatility of unemployment and real wages, has not been studied in

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the literature. This mechanism has relevant policy implications, whereby labor market reforms could indirectly affect household fertility decisions.

Using annual data for 20 OECD countries over the period 1961-2014, we study how the evolution of labor markets have impacted the *total fertility rate* (TFR). We control for the elements that can directly affect the fertility rate, such as maternity benefits, family allowances, female labor force participation, the gender wage gap, and economic conditions such as the unemployment rate and GDP growth. In our empirical analysis we compute the principal components of a large set of labor market institutions, which represent both *employment rigidities* (ER) and *real wage rigidities* (RWR). This approach allows us to reduce the number of regressors and consider the impact of interactions and combinations of institutions, having interpretable results.

Adopting panel regression analysis we find that the overall effect of labor market rigidities on fertility is the result of two opposing forces: wage and employment frictions. Considering specific groups of LMIs we find that *employment protection legislation* (EPL) and *union strength* (UnS) are positively correlated with fertility, whereas *wage bargaining centralization* (WB) and *unemployment benefits* (UB) are negatively correlated with fertility. These findings can be explained by the following facts: (i) EPL represents a clear employment rigidity that tends to reduce the volatility of employment; (ii) UnS can potentially adhere to bargaining over wages or employment (manning ratios)[1] and while we take an agnostic stance our empirical evidence suggests the latter effect; and (iii) WB and UB act as real wage rigidities, which have been found to increase the volatility of employment. Unemployment benefits may act as an imperfect substitute to maternity benefits but may also affect the reservation wage of workers, limiting de-facto real wage adjustments, and encouraging flows into and out of employment. Since fertility decisions are largely affected by the risk of becoming unemployed, we expect that unemployment volatility could have a negative impact on fertility.

Our paper contributes to the existing literature by taking a wider perspective on the analysis of fertility decision that examines the role of labor market institutions not targeted to fertility. For example, we do not consider unemployment benefits just as a possible substitute to maternity benefits and allowances, but we investigate its impact on labor income risk and volatility. Another contribution of this paper is the collection of data for 20 OECD countries for a time period of more than 50 years, which allows us to control for potential country or period-specific dynamics of fertility rates.

Finally, in order to better explain our empirical results and to be able to analyze policies we construct a theoretical model that incorporates household fertility decisions (in a similar fashion to Lagerborg (2016)) as well as detailed labor market frictions.[2] Children provide households with direct and durable utility, but also entail two types of costs: (i) a consumption cost that enters the household budget constraint, and (ii) a time cost for women in terms of time away from work and leisure. Finally, the decision to have children is irriversible, i.e. births are non-negative.[3] Our model also has search and matching frictions in the labor market and Nash bargaining over wages and hours. We include Rotemberg-type adjustment costs for wages and employment with an asymmetric component that creates downward rigidity. Downward wage rigidity amplifies the business cycle contraction in response to negative demand shocks, with sizeable effects on unemployment and fertility in the short run and a drop in long-run fertility rates.

The rest of the paper is organized as follows. Section 2 presents the literature related to this work. Section 3 describes the data for fertility, labor market institutions and the covariates used in our empirical analysis. Section 4 presents the empirical results from our regression analysis.

[1] Petrakis and Vlassisb (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.

[2] Model results are preliminary and may change in the next version of our working paper.

[3] This occasionally binding constraint is not currently implemented in our model. We expect to include this in the next version of our working paper.

Section 5 outlines our DSGE model with household fertility decisions and labor market frictions. Section 6 describes the model calibration and dynamics. Finally, Section 7 provides concluding remarks.

2 Related literature

The literature related to this paper can be divided broadly into three groups. The first strand, represented by Easterlin (1961), Erosa et al. (2002), Doepke et al. (2007), Orsal and Goldstein (2010) and Doepke and Kindermann (2014) among others, studies household fertility decisions and tries to explain the pattern of fertility rates post World War II. The second group is the one that analyzes the evolution and dynamics of female labor force participation and how this impacts fertility, in particular Ermisch (1988), Fernandez et al. (2004), Orazio Attanasio (2008), Jones et al. (2008), Fernandez and Fogli (2009), Fogli and Veldkamp (2011) and Olivetti (2013).

Finally, this paper is related to the literature that studies the impact of labor market frictions on the volatility of macroeconomic outcomes, such as Rumler and Scharler (2009), Abbritti and Weber (2010), Merkl and Schmitz (2011), Faccini and Bondibene (2012), Abbritti and Fahr (2013), and Gnocchi et al. (2015). This literature has found that employment rigidities tend to reduce the volatility of unemployment, without significantly affecting real wages, whereas real wage rigidities increase the volatility of unemployment. We exploit the results of this literature to identify a channel that links labor market institutions with fertility decisions. In particular, Abbritti and Weber (2010) investigated the importance of labor market institutions for inflation and unemployment dynamics. They divided LMIs between those responsible for *employment rigidities* (ER) and those that cause *real wage rigidities* (RWR), since these two types of institutions may have opposite dynamic effects on macroeconomics outcomes. If ER and RWR are complements their opposite effects tend to cancel each other out, since a high degree of ER is associated with lower unemployment volatility and high RWR are associated with high unemployment volatility. If instead they are substitutes, there could be an amplification effect. The authors found that a higher degree of employment rigidities reduces the volatility of unemployment and vacancies but increases the volatility of real wages. On the other hand, real wage rigidities increase the volatility of unemployment. Faccini and Bondibene (2012) instead investigated the impact of nine labor market institutions on unemployment volatility, finding that some LMIs matter for unemployment dynamics over the business cycle. Finally, Gnocchi et al. (2015) have found that more flexible labor institutions are associated with lower business cycles and lower unemployment volatility.

In this paper we want to take a broader point of view with respect to the existing literature on fertility, in order to consider an aspect that quite surprisingly has been largely ignored by the literature that investigates fertility dynamics: the legal framework of labor markets. Hence our work does not focus only on the main drivers of fertility that have been analyzed by the existing literature, but it considers additional elements that may impact the decision of having children, such as employment volatility and real wage volatility. The papers that are closest to our work are Adsera (2004) and Adsera (2011), which analyze the role of maternity benefits and allowances for fertility decisions, controlling for the impact of unemployment benefits, employment protection and share of public employment. In this paper we use a much wider set of labor market institutions and we also take into account their combinations and interactions.

3 The data

We collected annual data from 1961 to 2014 for 20 OECD countries using different sources.[4] The time period we consider is long enough to analyze both business cycle fluctuations and

[4] All variables are plotted in the Appendix.

the long-run trend in the total fertility rate. Moreover we analyze a relatively large sample of countries in order to account for possible country-specific differences in fertility. The countries included are: *Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland United Kingdom and United States.*

3.1 Total fertility rate

Our variable of interest is the *total fertility rate* (TFR), defined as the average number of children per woman. The measure of TFR that we use in our main analyses is from the OECD Health Database. Figure 7 shows the evolution of TFR from 1960 to 2014 for each of the countries considered. There has been a general downward trend in TFR between the 1960s and the 1970/80s, after which the total fertility rate stabilized. Figure 8 presents the average value of TFR in the period considered (red diamonds) as well as its dynamics over time (blue circles). This shows more clearly how some countries that started with a very high TFR, as Canada or Ireland, converged towards lower levels, while other countries that had already a low TFR, as Japan or Sweden, experienced a smaller evolution over the last 50 years.

For robustness, we also consider the birth rate measured as number of births per 1000 women aged between 15 and 49, obtained from the OECD.[5] Figure 7 shows that birth rates follow a very similar path to TFR. Birth rates have been steeply decreasing for age group 20-24 and increasing for age group 30-34, reflecting fertility postponement. Figure 9 shows birth rates for different age groups. Women in age groups 15-19 and over 40 have very low birth rates in all countries considered.

3.2 Labor market institutions

We gathered data describing labor market institutions from the OECD and Data Base on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts (ITCWSS). We have variables that represent both employment rigidities and real wage rigidities. In particular, we consider the set of LMI indicators described in Table 10. Table 11 provides descriptive statistics for each LMI. Figures 12-25 show the evolution of each LMI by country and over time. Employment protection institutions show very little variation, with few exceptions for countries such as Germany, Italy, Portugal, Spain, and Sweden, which experienced substancial reductions in protection. Union density, coverage, and concentration faced more heterogeneous changes in the last decades, with some countries increasing and others decreasing the strength of unions. Institutions that affect real wage rigidities include the centralization and level of wage bargaining, government intervention in the bargaining process, the extension of collective agreements, and the minimum wage. We see substantial variation in wage bargaining centralization and government intervention. We observe a general reduction in the minimum wage for countries such as Ireland, Japan, the Netherlands, Spain, and the UK. Unemployment benefits are defined as an average of benefit replacement rates and generally have displayed an increase in generosity since 1960.

3.3 Control variables

As control variables, we want to account for all other factors that can affect the fertility decision. First, we control for maternity benefits and family allowances that are related to maternity or paternity. This is necessary in order to be able to disentangle the effect between labor institutions targeted to fertility and those that do not specifically target fertility decisions. We

[5]The starting year for data on birth rates by age groups is later for some countries in our sample, namely: Norway in 1961, New Zealand in 1962, Sweden in 1968, US in 1970, Spain in 1971, UK in 1973, France in 1998, and Canada and Germany in 2000.

obtain this data from Gauthier (2011) for the period 1960-2010 and extend it until 2014 using the same data source, compiled from Social Security Programs Throughout the World and the Council of Europe. Second, we control for economic conditions such as GDP growth (obtained from the World Bank's World Development Indicators), unemployment rate (obtained from the IMF Economic Outlook and Gauthier (2011)), and the NAIRU (obtained from the OECD). These are important as many empirical papers have found that fertility relates to the business cycle. Finally, we also control for gender differentials such as female labor force participation and the gender wage gap, constructed using male and female wages obtained from the OECD. Table 12 provides descriptive statistics for our control variables.

3.4 Principal component analysis

In order to take into account the effects of combinations and interactions among labor market institutions, we adopt *principal component analysis*. This allows us to include a large number of LMIs in our estimates, reducing possible omitted variable bias, and at the same time allowing to save degrees of freedom and to have interpretable results from our empirical analysis. We divide LMIs on the basis of economic meaning, into four different groups of rigidities: (i) employment protection, (ii) union strength, (iii) wage bargaining, and (iv) unemployment benefits. For each group, we compute principal components that we call *LMI Factors*.

We also construct principal components of the control variables for the same reasoning. In particular we calculate one component for maternity benefits, one for economic conditions and one for the gender gap. In total we get three principal components that we call *Principal Controls*.

3.4.1 LMI Factors

We divide the LMI indicators into four groups, on the basis of economic reasoning: employment protection legislation (EPL), union strength (UnS), wage bargaining centralization (WB), and unemployment benefits (UB). EPL is the principal component combining employment protection legislation on permanent and temporary contracts. UnS summarizes union density, coverage, and concentration. We classify EPL and UnS as *employment rigidities* (ER).[6] WB comprises the centralization and level of wage bargaining, government intervention in the bargaining process, the extension of collective agreements, and the minimum wage. UB is defined as an average of benefit replacement rates and acts both as a substitute to maternity benefits but also increases the reservation wage, affecting employment inflows and outflows. In our framework both WB and UB are representative of *real wage rigidities*. Table 13 shows the correlation between the four LMI Factors and the original labor market institutions.

3.4.2 Principal Controls

We calculate three principal components that we use as control variables. One principal component combines maternity benefits and family allowances, which we label *PC maternity*. Another principal component combines GDP growth, the unemployment rate, and NAIRU, which we label *PC economy*. Finally, we create a principal component for the gender gap, combining female labor force participation and the wage gap, which we label *PC gender*. Table 14 shows the correlation between the three principal controls and the original covariates.

[6] Unions' strength factor could theoretically be included in either group, depending on the role of unions in increasing employment protection or limiting downward adjustment of wages. A priori we do not take a stance on this but our empirical evidence seems to suggest that unions act mainly as an employment rigidity.

4 Empirical Results

4.1 Panel regression analysis

In this section we document the correlation between LMIs and the total fertility rate. In order to exploit both the cross-sectional and over-time variation of the data, we use panel regression analysis with 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 fertility. Year fixed effects account for average fertility changes across years. For example, it takes into account the clear downward trend in fertility rates observed before the 1980s. Finally, the country-specific time trend allow for trends to vary across countries. Our baseline regression reads:

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

where $TFR_{i,t}$ is total fertility rate in year t in country i, α is a constant, μ_i are country fixed effects, ν_t are year fixed effects, and $cstt_i$ represent the country-specific time trends. $\mathbf{LMI}_{i,t}$ is the vector of labor market institutions or their principal components. $\mathbf{X}_{i,t}$ represents the set of principal components derived from the original control variables and is the same for all specifications.

4.1.1 Evidence from Principal Components

Table 1 shows the panel fixed effects regression estimates using the four LMI Factors. Column (1) represents our preferred model, while columns (2)-(5) present results including one LMI Factor at the time. From column (1), we can see that EPL and UnS, both employment rigidities, are positively correlated with fertility. The fact that EPL has a positive impact on fertility is not surprising since employment protection increases the perception of economic stability of households and reduces the volatility of employment. The positive sign for union strength can be explained by the fact that unions work for preventing large employment adjustments, acting then as an employment rigidity. WB and UB instead, are negatively correlated with fertility, and behave as real wage rigidities. WB tends to reduce the volatility of wages at the expense of increasing the volatility of employment, having a negative impact on fertility. The negative sign for UB suggests that its role is more similar to a real wage rigidity than to a substitute for maternity benefits. By comparing the first column with the others, we find that results are robust to considering one factor at a time.

By decomposing the effects of each LMI factor, we observe that wage bargaining rigidities drive most of the variation in TFR (see Figure 10).[7] Among the employment rigidities, union strength appears to be the most relevant. We can furthermore see the effects played by our control variables (see Figure 11). Economic conditions and maternity benefits seem to play a major role in impacting fertility. Gender inequality appears to be less important, but consistently slightly depresses fertility, consistent with diminishing gender gaps.

4.1.2 Evidence from Individual LMIs

Looking at individual LMIs, panel regression results confirm that rigidities related to employment have a positive effect on fertility, whereas rigidities related to wages affect fertility negatively (see Table 2). EPL for permanent contracts appear to favor fertility, whilst this rigidity

[7] We also compute the first principal component considering all labor market institutions together at once, representing a measure of overall rigidity of the labor market. We robustly find that more rigid labor markets are associated with lower total fertility rates. This finding is consistent with the notion that an overall more rigid labor market leads to higher volatility in unemployment and business cycles more generally (Gnocchi et al., 2015). Results are available from the authors upon request.

has no significant effect for temporary contracts (columns 1-2). Rigidities related to union strength are positively correlated with fertility with the exception of union coverage (columns 3-5). It is possible that union coverage does not translate to higher employment rigidity if collective agreements are wage-related.

Wage rigidities appear to depress fertility. More rigid wage bargaining—as measured by the degree of government intervention, the level at which bargaining takes place, the extension of collective agreements, centralization of wage bargaining, and the minimum wage—is negatively correlated with fertility (columns 6-11). As aforementioned, unemployment benefits may act as a substitute to maternity benefits but they can also increase the reservation wage of workers, acting as a downward wage rigidity, and this could explain the negative correlation found with fertility (column 12).

4.1.3 Robustness: Evidence from Birth Rates by Age

As a robustness check, we repeat the same analysis using birth rates (per 1,000 females) by age groups. Regression results using average birth rates are very similar to TFR (see Table 4). Signs and significance are robust for most age groups. Looking at LMI factors, results are in line with our main estimation (see Table 3). Employment rigidities carry a positive sign for all age groups except: EPL for age groups 30-34 and 45-49 (where the latter is insignificant) and UnS for age group 15-19.[8] Real wage rigidities are even more robust: all age groups have the correct sign. More rigid or centralized wage bargaining tends to reduce birth rates. Unemployment benefits also robustly reduce birth rates.

Considering individual LMIs, results for average births again remain robust. We obtain that EPL is significant for permanent contracts, confirming robustness of our results using TFR. Whereas EPL on permanent contracts shifts births from older to younger cohorts (under 30), EPL has the opposite effect on temporary contracts. LMIs governing the strength of unions have a positive effect on birth rates.[9] Wage bargaining rigidities and the unemployment benefit depress birth rates. We note that the youngest cohort, aged 15-19, seems to respond differently to several labor market institutions, with opposite signs to other age groups.

4.1.4 Robustness Checks: Alternative Specifications

We conduct several robustness checks with respect to alternative specifications (see Table 16). We consider a specification that omits the country-specific time trend (column 2). We also consider a generalized least squares specification that corrects for potential country-specific serial correlation in residuals (column 3). Finally, we implement Wild Cluster Bootstap that corrects standard errors for the small number of country clusters (column 4). Coefficient signs and significance remain mostly robust, although significance is largely reduced when implementing the Wild Cluster Bootstrap procedure.

As additional robustness check, we want to asses whether the results depend on our use of specific principal controls. Therefore as first alternative specification we performed our panel regressions with a principal component for maternity, which includes separately maternity benefits length and generosity, and that presents family allowances for different number of children separately. Finally, in order to exclude the possibility that the use per se of principal component analysis is driving our results we perform the same empirical analysis using directly the eight control variables which were used to compute the three principal controls. The results

[8] EPL appears to shift births towards younger age groups (higher coefficients for younger cohorts). On the other hand, union strength appears to reduce birth rates only for the youngest cohort (ages 15-19), who might not reap benefits from union negotiations over higher pay and number of employees.

[9] Union coverage, which had a negative sign for TFR, here is insignificant. However, we see that union coverage shifts births from younger to older cohorts.

under these two alternative specifications are very similar with respect to those of our baseline model.[10]

Another check we do is with respect to the timing of fertility and institutional change. Changes in institutions may take time to be implemented and tend to be announced in advance. Our baseline specification in which we consider TFR at time t considers announcement effects. If institutions are announced in advance and if fertility responds to such annoucements, a contemporaneous regression should capture this since TFR at time t will be affected by announcement in *t-1* of institutional change at time *t*. If we instead disregard announcement effects, we would expect institutions announced and implemented in time t to affect household fertility decisions taken contemporaneously, which would show up in data on fertility and birth rates in time *t+1*. We consider both timings and results are consistent even when using lead fertility (see Tables 15 and 17).[11]

Table 1: Panel Regressions with LMI Factors

	(1)	(2)	(3)	(4)	(5)
VARIABLES	TFR	TFR	TFR	TFR	TFR
EPL	0.0618**	0.0713***			
	(0.0260)	(0.0264)			
UnS	0.0895***		0.0522**		
	(0.0228)		(0.0214)		
WB	-0.0592***			-0.0462***	
	(0.0103)			(0.00981)	
UB	-0.00238**				-0.00321***
	(0.00103)				(0.00103)
PC maternity	0.0448***	0.0470***	0.0442***	0.0433***	0.0504***
	(0.00996)	(0.00999)	(0.0100)	(0.00992)	(0.0101)
PC economy	0.0365***	0.0278***	0.0339***	0.0379***	0.0293***
	(0.00993)	(0.00994)	(0.00984)	(0.00981)	(0.00984)
PC gender	0.0250	0.0346*	0.0320*	0.0289	0.0234
	(0.0191)	(0.0193)	(0.0192)	(0.0191)	(0.0194)
Constant	14.78***	15.27***	15.21***	15.96***	15.50***
	(0.833)	(0.828)	(0.837)	(0.811)	(0.816)
Observations	1,080	1,080	1,080	1,080	1,080
R-squared	0.898	0.893	0.893	0.895	0.894
Controls	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
CSTT	✓	✓	✓	✓	✓

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

[10]The tables with the results of these robustness checks are not included in the paper to save space, but are available upon request.

[11]One potential concern regards endogeneity. There could, for example, exist a political economy effect through which high fertility leads society to want more employment protection. For the next version of this working paper we hope to include evidence such as including more lags and leads of LMIs.

Table 2: Panel Regressions with Individual LMIs

VARIABLES	(1) TFR	(2) TFR	(3) TFR	(4) TFR	(5) TFR	(6) TFR	(7) TFR	(8) TFR	(9) TFR	(10) TFR	(11) TFR	(12) TFR
EPL (perm. contracts)	0.277***	0.185***										
	(0.0481)	(0.0472)										
EPL (temp. contracts)	0.00854		0.0179									
	(0.0136)		(0.0142)									
Union density	0.00985***			0.00384***								
	(0.00155)			(0.00139)								
Union coverage	-0.00233**				-0.00258**							
	(0.00108)				(0.00109)							
Union concentration	1.008***					0.725***						
	(0.197)					(0.158)						
WB centralization	-0.449***						-0.264**					
	(0.167)						(0.123)					
Gov. intervention in WB	-0.0298***							-0.0327***				
	(0.00820)							(0.00767)				
WB level	0.00114								-0.0206**			
	(0.00869)								(0.00826)			
Ext. of coll. agreements	-0.0877***									-0.0424**		
	(0.0204)									(0.0172)		
Minimum wage	-0.0272***										-0.0212***	
	(0.00561)										(0.00582)	
Unemployment benefit	-0.00246**											-0.00321***
	(0.00104)											(0.00103)
PC maternity	0.0462***	0.0507***	0.0457***	0.0433***	0.0476***	0.0482***	0.0440***	0.0479***	0.0441***	0.0441***	0.0413***	0.0504***
	(0.00976)	(0.0100)	(0.0100)	(0.0100)	(0.0100)	(0.00993)	(0.0100)	(0.00994)	(0.0100)	(0.0100)	(0.0100)	(0.0101)
PC economy	0.0314***	0.0287***	0.0304***	0.0364***	0.0300***	0.0266***	0.0353***	0.0319***	0.0362***	0.0343***	0.0299***	0.0293***
	(0.00981)	(0.00981)	(0.00993)	(0.00992)	(0.00986)	(0.00981)	(0.00992)	(0.00975)	(0.00994)	(0.00985)	(0.00979)	(0.00984)
PC gender	0.0502***	0.0311	0.0333*	0.0362*	0.0406**	0.0430**	0.0323*	0.0288	0.0312	0.0310	0.0261	0.0234
	(0.0192)	(0.0191)	(0.0193)	(0.0193)	(0.0196)	(0.0192)	(0.0192)	(0.0191)	(0.0192)	(0.0192)	(0.0192)	(0.0194)
Constant	12.26***	14.78***	15.50***	14.72***	15.87***	15.14***	15.64***	15.98***	15.86***	15.79***	16.16***	15.50***
	(0.916)	(0.842)	(0.828)	(0.884)	(0.820)	(0.817)	(0.816)	(0.814)	(0.819)	(0.817)	(0.823)	(0.816)
Observations	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080
R-squared	0.908	0.894	0.893	0.893	0.893	0.895	0.893	0.895	0.893	0.893	0.894	0.894
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CSTT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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

Table 3: Panel Regressions with LMI Factors and Birth Rate by Age Group

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Av. birth	Birth 15-19	Birth 20-24	Birth 25-29	Birth 30-34	Birth 35-39	Birth 40-44	Birth 45-49
EPL	1.315	0.969	9.581***	1.187	-3.192**	0.331	0.109	-0.0121
	(0.905)	(0.825)	(2.122)	(2.185)	(1.620)	(1.034)	(0.393)	(0.0397)
UnS	5.069***	-2.226***	1.599	11.28***	12.96***	8.217***	2.847***	0.212***
	(0.696)	(0.635)	(1.633)	(1.681)	(1.247)	(0.796)	(0.303)	(0.0306)
WB	-2.122***	-0.251	-2.793***	-3.273***	-3.606***	-3.345***	-1.216***	-0.110***
	(0.278)	(0.253)	(0.652)	(0.671)	(0.497)	(0.318)	(0.121)	(0.0122)
UB	-0.0926***	-0.233***	-0.336***	-0.0249	-0.0147	-0.0269	-0.0144	-0.00512***
	(0.0275)	(0.0250)	(0.0644)	(0.0663)	(0.0492)	(0.0314)	(0.0119)	(0.00121)
PC maternity	2.298***	-0.406	3.038***	4.657***	3.183***	3.857***	1.532***	0.144***
	(0.286)	(0.260)	(0.670)	(0.690)	(0.511)	(0.326)	(0.124)	(0.0125)
PC economy	0.993***	0.307	0.529	1.349**	2.993***	1.685***	0.203*	-0.0100
	(0.267)	(0.244)	(0.627)	(0.645)	(0.479)	(0.305)	(0.116)	(0.0117)
PC gender	1.199**	-0.435	-0.930	7.407***	2.526***	-0.544	0.259	0.0346
	(0.543)	(0.495)	(1.274)	(1.311)	(0.972)	(0.621)	(0.236)	(0.0238)
Constant	354.9***	199.7***	1,144***	854.0***	67.61	82.19***	122.1***	11.17***
	(25.16)	(22.95)	(59.03)	(60.78)	(45.07)	(28.77)	(10.94)	(1.103)
Observations	914	914	914	914	914	914	914	913
R-squared	0.908	0.874	0.943	0.904	0.882	0.917	0.927	0.908
Controls	✓	✓	✓	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
CSTT	✓	✓	✓	✓	✓	✓	✓	✓

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

Table 4: Panel Regressions with Individual LMIs and Birth Rate by Age Group

VARIABLES	(1) Av. birth	(2) Birth 15-19	(3) Birth 20-24	(4) Birth 25-29	(5) Birth 30-34	(6) Birth 35-39	(7) Birth 40-44	(8) Birth 45-49
EPL (perm. contracts)	2.774**	7.306***	20.84***	4.182	-7.815***	-3.972**	-1.552***	-0.133**
	(1.376)	(1.212)	(3.153)	(3.365)	(2.514)	(1.549)	(0.575)	(0.0588)
EPL (temp. contracts)	0.525	-1.096**	2.423**	0.358	0.292	0.948	0.479**	0.0417*
	(0.526)	(0.463)	(1.204)	(1.286)	(0.961)	(0.592)	(0.220)	(0.0225)
Union density	0.228***	-0.135***	0.366***	0.747***	0.374***	0.141***	0.0612***	0.00583***
	(0.0444)	(0.0392)	(0.102)	(0.109)	(0.0812)	(0.0500)	(0.0186)	(0.00190)
Union coverage	0.00535	-0.156***	-0.377***	-0.0357	0.299***	0.159***	0.100***	0.0104***
	(0.0434)	(0.0383)	(0.0995)	(0.106)	(0.0793)	(0.0489)	(0.0182)	(0.00186)
Union concentration	47.32***	25.43***	63.45***	66.24***	80.51***	68.29***	21.02***	1.387***
	(5.930)	(5.227)	(13.59)	(14.51)	(10.84)	(6.680)	(2.480)	(0.254)
WB centralization	-20.79***	-24.08***	-38.53***	-35.05***	-22.99***	-16.72***	-2.467	0.0268
	(4.641)	(4.090)	(10.64)	(11.35)	(8.482)	(5.227)	(1.940)	(0.199)
Gov. intervention in WB	-0.814***	-0.171	-1.373**	-1.487**	-1.652***	-0.679**	-0.125	-0.0116
	(0.244)	(0.215)	(0.558)	(0.596)	(0.445)	(0.274)	(0.102)	(0.0104)
WB level	-0.136	0.684***	0.777	0.291	-0.706*	-1.506***	-0.639***	-0.0608***
	(0.231)	(0.204)	(0.530)	(0.565)	(0.422)	(0.260)	(0.0966)	(0.00990)
Ext. of coll. agreements	-2.229***	0.677	-6.442***	-4.141***	-2.377**	-1.392**	-1.321***	-0.179***
	(0.548)	(0.483)	(1.255)	(1.340)	(1.001)	(0.617)	(0.229)	(0.0235)
Minimum wage	-0.315*	0.206	0.564	-1.114***	-0.330	-1.000***	-0.481***	-0.0297***
	(0.162)	(0.143)	(0.372)	(0.398)	(0.297)	(0.183)	(0.0679)	(0.00695)
Unemployment benefit	-0.0504*	-0.213***	-0.273***	0.00838	0.0598	0.0367	0.0135	-0.00246**
	(0.0286)	(0.0252)	(0.0655)	(0.0699)	(0.0523)	(0.0322)	(0.0120)	(0.00122)
PC maternity	2.181***	-0.166	2.916***	3.914***	3.234***	3.767***	1.413***	0.133***
	(0.288)	(0.254)	(0.659)	(0.704)	(0.526)	(0.324)	(0.120)	(0.0123)
PC economy	0.906***	0.0763	0.634	1.610**	2.686***	1.320***	0.120	-0.0120
	(0.269)	(0.237)	(0.617)	(0.659)	(0.492)	(0.303)	(0.113)	(0.0115)
PC gender	2.252***	0.473	1.550	8.741***	3.751***	0.619	0.487**	0.0449*
	(0.567)	(0.500)	(1.299)	(1.387)	(1.036)	(0.639)	(0.237)	(0.0242)
Constant	306.1***	165.9***	979.8***	746.6***	35.25	90.19***	124.9***	11.03***
	(27.79)	(24.50)	(63.70)	(67.99)	(50.80)	(31.31)	(11.62)	(1.188)
Observations	914	914	914	914	914	914	914	913
R-squared	0.915	0.891	0.949	0.908	0.886	0.926	0.938	0.919
Controls	✓	✓	✓	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
CSTT	✓	✓	✓	✓	✓	✓	✓	✓

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

4.2 Investigating the Mechanism

4.2.1 The roles of wage volatility, unemployment volatility, and the unemployment rate

Fertility decisions are affected by the possibility of large income shocks. As a result, movements in wages may affect household fertility decisions. Even larger income shocks are generated by unemployment. The unemployment rate, proxying for the probability of becoming unemployed, is expected to detriment fertility. Similarly, unemployment volatility generates fluctuations in this probability of unemployment, and hence potential fluctuations in income.

We use panel regressions with country and year fixed effects to explore the effect of unemployment and wage volatility on fertility outcomes. To obtain measures for volatility, we collapse the data into decadal frequency and measure the standard deviation of unemployment and wages over the decade.[12] This reduces our sample from approximately 1,000 observations to 120 observations (6 decades for 20 countries), making statistical significance more difficult to obtain.

Table 5 investigates the role played by volatility in unemployment, in real/nominal wages, and in expected wages, as well as the level of the unemployment rate, in affecting the total fertility rate.[13] We find that unemployment volatility negatively correlates with fertility (column 1) whereas real and nominal wage volatility (columns 2 and 3) positively correlate with fertility. The combined effect of wage and unemployment volatility can be analyzed by considering the volatility of expected real wages, defined as the product of real wages and the employment rate (one minus the unemployment rate). Volatility in expected real wages is detrimental to fertility (column 4).

We interpret this as suggestive evidence that income risks associated with unemployment outweigh those associated with wage fluctuations in shaping household fertility decisions. Higher unemployment volatility is detrimental to fertility. By contrast, higher wage volatility means firms can adjust wages rather than employment, thereby reducing the large income risks associated with unemployment. Thus, we expect that more flexibility in LMIs governing employment rigidities, allowing for higher unemployment volatility, reduces fertility. In contrast, more flexibility in LMIs governing wage rigidities, allowing for higher volatility of wages, should increase fertility.

To investigate this hypothesis we estimate the effect of labor market institutions on volatility of unemployment, wages, and expected wages (see Table 6). We find that ERs such as EPL on permanent contracts reduces volatility of employment and expected wages, while increasing volatility of real wages. By contrast, RWRs such as centralized wage bargaining and unemployment benefits reduce volatility of real wages, at the expense of higher volatility of employment and expected wages.

Another discussion worth having is on the role of unemployment volatility versus unemployment levels. A higher unemployment rate translates into a higher overall probability of being unemployed. Higher unemployment volatility, on the other hand, does not necessarily translate into a higher risk of unemployment. Instead it means higher uncertainty over the probability of unemployment. This leads us to question what matters for fertility: is it the unemployment rate in levels or its volatility? Both seem to matter as can be seen in Table 5. Higher volatility of unemployment and higher unemployment rates both reduce fertility (columns 1 and 5). This result is robust to including both variables together (column 6).

[12] In our main estimates we use average male wages to compute the volatility of nominal and real wages. Results are also robust to using female wages and the average of male and female wages.

[13] Results are robust to using birth rates and to including maternity, economy, and gender principal controls. We do not include the economy principal control from specifications that include the level of unemployment, namely columns 6-8. Results are available from the authors upon request.

Table 5: The Role of Unemployment vs. Wage Volatility for Fertility

VARIABLES	(1) TFR	(2) TFR	(3) TFR	(4) TFR	(5) TFR	(6) TFR
Vol(u)	-0.118***					-0.0973**
	(0.0402)					(0.0408)
Vol(w/p)		0.0747***				
		(0.0239)				
Vol(w)			0.0690**			
			(0.0293)			
Vol(EW)				-0.0994**		
				(0.0481)		
u					-0.0280***	-0.0217**
					(0.0105)	(0.0106)
Constant	2.827***	2.698***	2.758***	2.828***	2.833***	2.864***
	(0.0536)	(0.0563)	(0.0528)	(0.0598)	(0.0555)	(0.0557)
Observations	120	100	100	91	120	120
R-squared	0.807	0.826	0.817	0.823	0.804	0.815
Country FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓

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

Table 6: The Role of LMIs for Volatility of Employment and Wages

VARIABLES	(1) Vol(u)	(2) Vol(u)	(3) Vol(u)	(4) Vol(w/p)	(5) Vol(w/p)	(6) Vol(w/p)	(7) Vol(EW)	(8) Vol(EW)	(9) Vol(EW)
PC maternity	-0.000507	-0.000572	-0.000542	0.561***	0.525***	0.515***	0.0442***	0.0446***	0.0447***
	(0.000838)	(0.000834)	(0.000839)	(0.171)	(0.169)	(0.175)	(0.0147)	(0.0146)	(0.0146)
PC economy	-8.42e-05	-0.00116	-0.000888	-0.0994	0.0971	0.0185	-0.0243	-0.0235	-0.0235
	(0.00100)	(0.000846)	(0.000856)	(0.198)	(0.191)	(0.195)	(0.0173)	(0.0165)	(0.0164)
PC gender	-0.00158	-0.00156	-0.00172	0.320	0.318	0.209	0.0290	0.0275	0.0282
	(0.00153)	(0.00152)	(0.00154)	(0.319)	(0.317)	(0.325)	(0.0262)	(0.0263)	(0.0257)
EPL (perm.)	-0.00601*			1.742**			0.0155		
	(0.00327)			(0.824)			(0.0846)		
WB centralization		0.0220**			-4.695**			0.0159	
		(0.0102)			(2.028)			(0.176)	
UB			0.000133*			-0.00537			-0.000143
			(7.19e-05)			(0.0156)			(0.00122)
Constant	0.0193***	-0.00171	0.00507*	-2.682	2.825***	1.180*	0.119	0.148*	0.157***
	(0.00715)	(0.00483)	(0.00283)	(1.865)	(0.922)	(0.614)	(0.193)	(0.0778)	(0.0489)
Observations	120	120	120	100	100	100	95	95	95
R-squared	0.434	0.442	0.435	0.525	0.530	0.496	0.287	0.287	0.287
Country FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓

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

4.2.2 Two Stage Least Squares

One channel through which labor market institutions may affect fertility outcomes is through the volatility of unemployment, wages, and expected wages. In order to study this channel, we employ a *two stage least squares* (2SLS) estimation in which LMIs act as instruments for volatility. We expect employment rigidities, such as EPL and UnS, to reduce the volatility of unemployment (while allowing for higher volatility of wages) and thereby increase fertility. Real wage rigidities, such as WB and UB, are expected to reduce the volatility of wages at the expense of higher volatility of unemployment, thereby reducing fertility.

We remain cautious in interpreting results as evidence in favor of our hypothesized channel. To the extent that there may exist other channels through which labor market institutions affect fertility, which are correlated with our measures of volatility of unemployment and wages, our results may also be capturing these other channels. This could happen, for example, if LMIs affect the level of expected wages and unemployment, which in turn affect fertility. In other words, we cannot exclude the fact that there may be other channels acting that our simply correlated with ours. The evidence presented here should be thought of as *not excluding* the possibility of our channel, rather than *proving* our channel.

We find scattered evidence that these predicted results are consistent with the data. Table 7 presents results for our estimations using two stage least squares.[14] The first channel we consider is whether labor market rigidities affect fertility through the volatility of unemployment (columns 1-4). The LMI factors yield no significance with the exception of UB. This may be due to the small sample size making it difficult to obtain statistically significance. We thus turn to evidence from individual LMIs, three of which yield significant results.[15] EPL relating to permanent contracts[16] is found to reduce unemployment volatility and thereby increase fertility (column 1). Wage bargaining centralization and unemployment benefits, both considered real wage rigidities, on the other hand increase unemployment volatility thereby reducing fertility (columns 2-3). In the first stage of the regression, each of these LMIs when considered separately matters in explaining unemployment volatility, however when all three LMIs are included, we lose significance possibly because of the small sample size. In the second stage, we observe that the unemployment volatility induced by these LMIs is detrimental for fertility. This two-stage analysis thus shows us that to the extent that these labor market institutions affect the volatility of unemployment, they also affect fertility.

Second, we study the channel by which LMIs affect fertility through real wage volatility (columns 5-8). The effect of LMIs through the volatility of wages carries the opposite sign. To the extent that LMIs increase real wage volatility, this has a positive effect on fertility. Employment protection on permanent contracts increases the volatility of real wages whereas more centralized (rigid) wage bargaining reduces real wage volatility. Unemployment benefits, despite having the predicted (negative) sign, have no significant effect on real wages.

Finally, we study the combined effect of unemployment and wages by studying the channel whereby LMIs affect fertility through the volatility of expected wages (see Table 8). Estimates carry the same sign as in the unemployment volatility channel.

[14] All results are robust to using birth rates instead of TFR. Results are avialable from the authors upon request.

[15] No significance is obtained for LMIs relating to union strength.

[16] EPL relating to temporary contracts has no effect.

Table 7: 2SLS - Role of Unemployment and Wage Volatility

2nd Stage:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	IV: EPL	IV: WB	IV: UB	IV: All	IV: EPL	IV: WB	IV: UB	IV: All
VARIABLES	TFR	TFR	TFR	TFR	TFR	TFR	TFR	TFR
Vol(u)	-0.709*	-0.591**	-0.282	-0.521***				
	(0.394)	(0.292)	(0.229)	(0.199)				
PC maternity	0.0383	0.0435	0.0570	0.0466	-0.0689	-0.0460	-0.239	-0.0548
	(0.0631)	(0.0540)	(0.0369)	(0.0486)	(0.101)	(0.0857)	(0.931)	(0.0793)
PC economy	-0.0116	0.000974	0.0340	0.00851	0.0192	0.0203	0.0112	0.0199
	(0.0747)	(0.0617)	(0.0436)	(0.0530)	(0.0648)	(0.0584)	(0.130)	(0.0607)
PC gender	0.0460	0.0616	0.102	0.0709	0.0430	0.0519	-0.0235	0.0485
	(0.122)	(0.103)	(0.0714)	(0.0911)	(0.112)	(0.100)	(0.415)	(0.103)
Vol(w/p)					0.316*	0.271**	0.650	0.288**
					(0.162)	(0.134)	(1.819)	(0.114)
Constant	3.086***	3.002***	2.783***	2.952***	2.338***	2.387***	1.972	2.368***
	(0.338)	(0.264)	(0.197)	(0.206)	(0.256)	(0.222)	(2.016)	(0.213)
Observations	120	120	120	120	100	100	100	100
Country FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓

1st Stage:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Vol(u)	Vol(u)	Vol(u)	Vol(u)	Vol(w/p)	Vol(w/p)	Vol(w/p)	Vol(w/p)
PC maternity	-0.0507	-0.0572	-0.0542	-0.0663	0.561***	0.525***	0.515***	0.561***
	(0.0838)	(0.0834)	(0.0839)	(0.0827)	(0.171)	(0.169)	(0.175)	(0.170)
PC economy	-0.00842	-0.116	-0.0888	-0.0416	-0.0994	0.0971	0.0185	-0.0117
	(0.100)	(0.0846)	(0.0856)	(0.101)	(0.198)	(0.191)	(0.195)	(0.201)
PC gender	-0.158	-0.156	-0.172	-0.197	0.320	0.318	0.209	0.390
	(0.153)	(0.152)	(0.154)	(0.152)	(0.319)	(0.317)	(0.325)	(0.319)
EPL (perm.)	-0.601*			-0.359	1.742**			1.404
	(0.327)			(0.339)	(0.824)			(0.858)
WB centralization		2.196**		1.714		-4.695**		-3.908*
		(1.016)		(1.049)		(2.028)		(2.078)
UB			0.0133*	0.0103			-0.00537	0.00282
			(0.00719)	(0.00724)			(0.0156)	(0.0154)
Constant	1.934***	-0.171	0.507*	0.596	-2.682	2.825***	1.180*	-0.553
	(0.715)	(0.483)	(0.283)	(0.949)	(1.865)	(0.922)	(0.614)	(2.282)
Observations	120	120	120	120	100	100	100	100
R-squared	0.434	0.442	0.435	0.465	0.525	0.530	0.496	0.548
Country FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

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

Table 8: 2SLS - Role of Expected Wage Volatility

2nd Stage:

VARIABLES	(1) IV: EPL TFR	(2) IV: WB TFR	(3) IV: UB TFR	(4) IV: All TFR
Vol(EW)	-1.851	-0.674	-0.867	-0.755
	(3.131)	(0.507)	(1.634)	(0.533)
PC maternity	0.0382	0.0912	0.0825	0.0876
	(0.238)	(0.0773)	(0.118)	(0.0848)
PC economy	-0.269	-0.0843	-0.115	-0.0970
	(0.534)	(0.113)	(0.275)	(0.122)
PC gender	-0.346	-0.0803	-0.124	-0.0986
	(0.795)	(0.181)	(0.408)	(0.196)
Constant	4.500	3.386***	3.569**	3.463***
	(3.025)	(0.535)	(1.574)	(0.568)
Observations	91	91	91	91
Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓

1st Stage:

VARIABLES	(1) Vol(EW)	(2) Vol(EW)	(3) Vol(EW)	(4) Vol(EW)
PC maternity	-0.0534	-0.0433	-0.0517	-0.0507
	(0.107)	(0.105)	(0.107)	(0.108)
PC economy	-0.135	-0.195	-0.153	-0.183
	(0.122)	(0.118)	(0.117)	(0.129)
PC gender	-0.242	-0.298	-0.227	-0.301
	(0.205)	(0.207)	(0.203)	(0.211)
EPL (perm.)	-0.312			-0.104
	(0.541)			(0.566)
WB centralization		1.830		1.714
		(1.320)		(1.388)
UB			0.00514	0.00347
			(0.00973)	(0.00991)
Constant	1.636	0.300	0.853**	0.509
	(1.245)	(0.575)	(0.385)	(1.519)
Observations	91	91	91	91
R-squared	0.433	0.447	0.433	0.449
Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
F-stat				0.682
p-value				0.567

Standard errors in parentheses

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

5 DSGE Model

In order to study how labor market institutions can affect household fertility, we build a DSGE model with enough features to describe the household's fertility decision but also the heterogenous impact of different labor market institutions. In particular, in our model children are irriversible (i.e. births are non-negative) and provide households with direct and durable utility, but also entail two types of costs: (i) a consumption cost that enters the household budget constraint, and (ii) a time cost for women in terms of time away from work and leisure. We also include several labor market frictions: search and matching frictions in the labor market, Nash bargaining over wages and hours, firm vacancy posting costs, and Rotemberg-type adjustment costs for wages and employment with an asymmetric component that creates downward rigidity.

We highlight the terms that relate to the household fertility decision in red and parameters that relate to labor market frictions in blue. In particular we are interested in frictions that have an empirical counterpart: (i) the separation rate (related to EPL), (ii) the unemployment benefit, and (iii) parameters governing wage and employment adjustment costs, which can be compared to RWR and UR more generally.[17]

5.1 The Labor Market

Search and matching frictions generate unemployment in a labor market that is divided into two segments based on gender, in which females and males can be denoted respectively by $i = F, M$. Job seekers u_t^i and firm vacancies v_t^i need to match to become productive, following a constant returns to scale matching technology. We denote by q_t^i the probability for a firm to fill an open gender-specific vacancy and by f_t^i the probability for a female or male worker to find a job. An exogenous fraction s of jobs is destroyed each period and new gender-specific matches m_t^i become operative in the same period. The unemployment rate ur_t^i is the fraction of female and male workers without employment after the matching process has taken place.

Matching:

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

Job-seekers:

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

Job-filling:

$$q_t^i = \frac{m_t^i}{v_t^i} = \overline{m}\left(\frac{v_t^i}{u_t^i}\right)^{-\zeta} \tag{2}$$

Job-finding:

$$f_t^i = \frac{m_t^i}{u_t^i} = \overline{m}\left(\frac{v_t^i}{u_t^i}\right)^{1-\zeta} \tag{3}$$

Employment:

$$e_t^i = (1 - s)e_{t-1}^i + v_t^i q_t^i \tag{4}$$

Unemployment rate:

$$ur_t^i = 1 - e_t^i \tag{5}$$

[17] Other parameters that relate to labor market frictions include vacancy posting costs and matching function efficiency, both corresponding to employment rigidities. Employment rigidities correspond to parameters: χ_e, ψ_e, s, κ, and $\overline{m}$, whereas real wage rigidities correspond to parameters: χ_w, ψ_w, η_i, and b. Note that we do not yet have model counterparts for union strength nor the centralization of the wage bargaining process, and that worker bargaining power is not an adequate proxy. Nash bargaining, calibrated to standard parameters, induces too much volatility in wages (highly procyclical movements reflecting high worker bargaining power), which dampens the cyclical movement in firms' incentives to hire. Therefore, a high value for worker bargaining power η_i traslates into more flexible wages.

5.2 Household Optimization

The representative household, consisting of a female and male member[18], jointly maximizes lifetime expected utility subject to its budget constraint. Consumption is pooled inside the household to perfectly insure against employment fluctuations. Utility is derived from consumption c_t, leisure of the female l_t^F and male l_t^M, and children n_t. Households earn income from wage labor, unemployment benefits b and interest on bonds a_t. Females and males work h_t^i hours at wage w_t^i, where the employment rate is e_t^i. Households optimize consumption, bond holdings, and fertility at each period. The number of children in the household follows a decay of δ_n, which represents the proportion of children reaching adulthood in each period, akin to models of probabilistic ageing (Gertler, 1999). The number of new births is non-negative, such that having children is an irriversible decision and has long-lasting utility and costs. The household optimization problem can be expressed as:

$$\max_{c_t,a_t,n_t} E_0 \sum_{t=0}^{\infty} \beta^t u\left(c_t, l_t^F, l_t^M, n_t\right) = \max E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \ln\left(c_t\right) - \sum_i \sigma_l^i \frac{\left(h_t^i\right)^{1+\xi}}{1+\xi} e_t^i + \sigma_n \ln\left(n_t\right) \right\}$$

s.t. BC:

$$c_t + \phi_c n_t + \frac{a_t}{p_t r_t} = \sum_i w_t^i h_t^i e_t^i + \sum_i b\left(1 - e_t^i\right) + \frac{a_{t-1}}{p_t}$$

Leisure:

$$l_t^M = 1 - h_t^M \tag{6}$$

$$l_t^F = 1 - h_t^F - \phi_l \left(n_t\right)^{\psi_l} \tag{7}$$

Number of children:

$$n_t = \left(1 - \delta_n\right) n_{t-1} + births_t \tag{8}$$

$$births_t \geq 0$$

where $births_t$ is the birth rate at time t. This problem can be rewritten as:

$$\max_{c_t,a_t,n_t} E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \ln\left(c_t\right) - \sum_i \sigma_l^i \frac{\left(h_t^i\right)^{1+\xi}}{1+\xi} e_t^i + \sigma_n \ln\left(n_t\right) \right\}$$

$$+\beta^t \lambda_t \left(\sum_i w_t^i h_t^i e_t^i + \sum_i b\left(1 - e_t^i\right) + \frac{a_{t-1}}{p_t} - c_t - \phi_c n_t - \frac{a_t}{p_t r_t} \right)$$

The first order conditions with respect to consumption, bond holdings, and the number of children yields:

$$\lambda_t = \frac{1}{c_t} \tag{9}$$

$$\frac{\lambda_t}{p_t r_t} = \frac{\beta E_t \lambda_{t+1}}{E_t p_{t+1}} \tag{10}$$

$$\frac{\sigma_n}{n_t} + \sigma_l^F \left(h_t^F\right)^{\xi} e_t^F \psi_l \phi_l \left(n_t\right)^{\psi_l - 1} = \lambda_t \left(\phi_c + w_t^F e_t^F \psi_l \phi_l \left(n_t\right)^{\psi_l - 1} \right) \tag{11}$$

[18] Each household is thought of as a continuum of members along the unit interval.

5.3 Firms

Firms use labor (employment e_t^i and hours h_t^i) and capital k_t as inputs in a constant returns to scale production function. They choose vacancy posting v_t^i and investment i_t to maximize the expected sum of discounted profits given the production function, evolution of capital, and adjustment costs for wages and employment. Adjustment costs are convex and may be asymmetric, allowing for downward rigidities whereby wages and employment are more easily increased than cut. ν captures the degree of indexation of wages to the gross inflation rate π_t. Total labor supply is a constant elasticity of substitution (CES) aggregate of female and male workers, where ρ determines the substitution elasticity[19] and θ is the firms' relative preference for female workers[20].

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

s.t.

$$y_t = z_t k_t^{\alpha} \left[\theta \left(h_t^F e_t^F \right)^{\rho} + (1-\theta) \left(h_t^M e_t^M \right)^{\rho} \right]^{\frac{1-\alpha}{\rho}} \tag{12}$$

$$k_t = (1-\delta) k_{t-1} + i_t \tag{13}$$

$$\pi_t^{i,w} = \frac{w_t^i}{w_{t-1}^i} \pi_t \tag{14}$$

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

$$AC_{w,t}^i = \frac{\chi_w}{2} \left(\frac{\pi_t^{i,w}}{\pi_t^{\nu}} - 1 \right)^2 + \frac{1}{{\psi_w}^2} \left(\exp\left\{ -\psi_w \left(\frac{\pi_t^{i,w}}{\pi_t^{\nu}} - 1 \right) \right\} + \psi_w \left(\frac{\pi_t^{i,w}}{\pi_t^{\nu}} - 1 \right) - 1 \right) \tag{15}$$

$$AC_{e,t}^i = \frac{\chi_e}{2} \left(\frac{e_t^i}{e_{t-1}^i} - 1 \right)^2 + \frac{1}{{\psi_e}^2} \left(\exp\left\{ -\psi_e \left(\frac{e_t^i}{e_{t-1}^i} - 1 \right) \right\} + \psi_e \left(\frac{e_t^i}{e_{t-1}^i} - 1 \right) - 1 \right) \tag{16}$$

Technology follows an AR(1) stochastic process:

$$\ln z_t = \rho_z \ln z_{t-1} + \varepsilon_t^z \tag{17}$$

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

The first order condition with respect to vacancies yields a job creation condition. This equates expected vacancy posting costs to the value of a filled vacancy, 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.

$$\mathbf{J}_t^i \equiv \frac{\kappa}{\lambda_t q_t^i} = MP e_t^i - w_t^i h_t^i (1 + AC_{w,t}^i) - \frac{AC_{e,t}^{i'}}{e_{t-1}^i} + \beta E_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} \left[(1-s) \mathbf{J}_{t+1}^i + \frac{AC_{e,t+1}^{i'} e_{t+1}^i}{e_t^{i2}} \right] \right\} \tag{18}$$

[19] The elasticity of substitution between female and male labor in production is $1/(1-\rho)$. $\rho \to 0$ represents perfect substitution, $\rho \to -\infty$ represents a Leontief production function, and $\rho \to 1$ represents the Cobb Douglas case.

[20] This gender bias in employment will determine the extent of gender discrimination in employment. $\theta = 0.5$ implies no gender discrimination, whereas firms discriminate against females when $\theta < 0.5$.

where

$$AC^{i'}_{e,t} = \frac{\partial AC^{i}_{e,t}}{\partial(e^i_t/e^i_{t-1})} = \chi_e \left(\frac{e^i_t}{e^i_{t-1}} - 1\right) + \frac{1}{\psi_e}\left[1 - \exp\left\{-\psi_e\left(\frac{e^i_t}{e^i_{t-1}} - 1\right)\right\}\right] \tag{19}$$

$$MPe^F_t = \frac{\theta(1-\alpha)y_t(h^F_t e^F_t)^{(\rho-1)}h^F_t}{h_t} \tag{20}$$

$$MPe^M_t = \frac{(1-\theta)(1-\alpha)y_t(h^M_t e^M_t)^{(\rho-1)}h^M_t}{h_t} \tag{21}$$

$$h_t = \theta\left(h^F_t e^F_t\right)^{\rho} + (1-\theta)\left(h^M_t e^M_t\right)^{\rho} \tag{22}$$

Maximizing with respect to capital yields 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):

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

5.4 Nash Bargaining over Wages and Hours

Nominal wages and hours worked are bargained by maximizing the Nash product of worker and firm surpluses:

$$\max_{w^i_t, h^i_t}(\mathbf{N}^i_t - \mathbf{U}^i_t)^{\eta_i}(\mathbf{J}^i_t)^{1-\eta_i}$$

for $i = F, M$. The exogenous gender-specific bargaining power of workers is denoted by η_i and determines how the joint surplus is shared between the worker and firm. $\mathbf{N}^i_t$ denotes the marginal value of employment, which comprises wage income net of labor disutility, plus the continuation value of being employed. $\mathbf{U}^i_t$ denotes the marginal value of unemployment, which comprises unemployment benefits plus the continuation value of being unemployed.

$$\mathbf{N}^i_t = w^i_t h^i_t - \frac{\sigma^i_l}{\lambda_t}\frac{\left(h^i_t\right)^{1+\xi}}{1+\xi} + \beta E_t\left\{\frac{\lambda_{t+1}}{\lambda_t}\left([1-(1-f^i_{t+1})s]\mathbf{N}^i_{t+1} + s(1-f^i_{t+1})\mathbf{U}^i_{t+1}\right)\right\}$$

$$\mathbf{U}^i_t = b + \beta E_t\left\{\frac{\lambda_{t+1}}{\lambda_t}\left(f^i_{t+1}\mathbf{N}^i_{t+1} + (1-f^i_{t+1})\mathbf{U}^i_{t+1}\right)\right\}$$

5.4.1 Wages

Bargaining over the nominal wage yields an optimal sharing rule similar to the standard Nash bargaining solution:[21]

$$\omega^i_t \mathbf{J}^i_t = (1-\omega^i_t)(\mathbf{N}^i_t - \mathbf{U}^i_t)$$

with ω^i_t being the effective time-varying bargaining power of the worker:

$$\omega^i_t \equiv \frac{\eta_i}{\eta_i + (1-\eta_i)\tau^i_t} \tag{24}$$

and where τ^i_t reflects the evolution of current and expected wage adjustment costs:

$$\tau^i_t \equiv -\frac{\partial \mathbf{J}^i_t/\partial w^i_t}{\partial(\mathbf{N}^i_t - \mathbf{U}^i_t)/\partial w^i_t} = 1 + AC^i_{w,t} + AC^{i'}_{w,t}\frac{\pi^{i,w}_t}{\pi^{\nu}_t} - (1-s)\beta E_t\left\{\frac{\lambda_{t+1}}{\lambda_t}AC^{i'}_{w,t+1}\frac{h^i_{t+1}}{h^i_t}\frac{(\pi^{i,w}_{t+1})^2}{\pi^{1+\nu}_{t+1}}\right\} \tag{25}$$

[21] See derivations by Arseneau and Chugh (2007).

$$AC^{i'}_{w,t} = \frac{\partial AC^i_{w,t}}{\partial(\pi^{i,w}_t/\pi^{\nu}_t)} = \chi_w \left(\frac{\pi^{i,w}_t}{\pi^{\nu}_t} - 1\right) + \frac{1}{\psi_w}\left[1 - \exp\left\{-\psi_w\left(\frac{\pi^{i,w}_t}{\pi^{\nu}_t} - 1\right)\right\}\right] \tag{26}$$

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

In the absence of adjustment costs, τ^i_t is equal to 1, and we obtain the constant sharing rule with $\omega^i_t = \eta_i$. With adjustment costs the bargaining power becomes state-dependent. During periods of rising wages, $AC^{i'}_{w,t} > 0$, the effective bargaining power of workers decline whereas during periods of declining wages, the bargaining power of workers increase. The asymmetry in the 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:

$$\frac{\omega^i_t \kappa}{\lambda_t q^i_t} = (1 - \omega^i_t)\left[w^i_t h^i_t - \frac{\sigma^i_l}{\lambda_t}\frac{\left(h^i_t\right)^{1+\xi}}{1+\xi} - b + \beta(1-s)E_t\left(\frac{\omega^i_{t+1}}{1-\omega^i_{t+1}}\frac{\kappa}{\lambda_t q^i_{t+1}}(1 - f^i_{t+1})\right)\right] \tag{27}$$

We can define a wage gap as:

$$\Phi_t \equiv \frac{w^M_t}{w^F_t} \tag{28}$$

5.4.2 Hours

The number of hours worked also reflect bargaining between the worker and firm, optimized to maximize their joint surplus. In the absence of wage adjustment costs, the marginal rate of substitution between consumption and hours worked ($mrs^i_t = \frac{\sigma^i_l}{\lambda_t}\left(h^i_t\right)^{\xi}$) equates the marginal product of labor of an hour of work for the firm ($mpl^i_t = \frac{\partial^2 y_t}{\partial e^i_t h^i_t}$), 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. In these ways, the second term on the right captures the change in costs due to current and expected wage changes.

$$\eta_i\left(\frac{1-\omega^i_t}{\omega^i_t}\right)\left(w^i_t - \frac{\sigma^i_l}{\lambda_t}\left(h^i_t\right)^{\xi}\right) = -(1-\eta_i)\left[\frac{\partial MPe^i_t}{\partial h^i_t} - w^i_t(1 + AC^i_{w,t})\right] \tag{29}$$

where:

$$\frac{\partial MPe^F_t}{\partial h^F_t} = \theta(1-\alpha)y_t(e^F_t h^F_t)^{\rho-1}\left[\frac{\rho}{h^{\rho}_t} + \theta(1-\alpha-\rho)\frac{1}{h^{2\rho}_t}(e^F_t h^F_t)^{\rho}\right] \tag{30}$$

and

$$\frac{\partial MPe^M_t}{\partial h^M_t} = (1-\theta)(1-\alpha)y_t(e^M_t h^M_t)^{\rho-1}\left[\frac{\rho}{h^{\rho}_t} + (1-\theta)(1-\alpha-\rho)\frac{1}{h^{2\rho}_t}(e^M_t h^M_t)^{\rho}\right] \tag{31}$$

5.5 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.

$$r_t = r_{t-1}^{\rho_r} \left[r \left(\frac{\pi_t}{\pi} \right)^{\omega_\pi} \left(\frac{y_t}{y_{t-1}} \right)^{\omega_y} \right]^{1-\rho_r} \varepsilon_t^r \tag{32}$$

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

The resource constraint states that output may be used for consumption or investment or to cover for adjustment costs to wages and employment (deadweight losses):

$$c_t + i_t = y_t - \sum_i AC_{w,t}^i w_t^i h_t^i e_t^i - \sum_i AC_{e,t}^i \tag{33}$$

6 Model Dynamics

6.1 Calibration

We calibrate the model similar to Abbritti and Fahr (2011) and Doepke et al. (2007). The parameter values and description are summarized in Table 9. The quarterly discount factor β is 0.992, yielding an annual rate of 0.97.

The labor market parameters governing the search and matching process are calibrated to match steady state values. The matching function elasticity parameter ζ is set to 0.5 as in Abbritti and Fahr (2013). The separation rate is set to match a steady state job-finding rate of 0.35 and unemployment rate of 0.08 for males. Given these two values, we than obtain the separation rate of 0.041, which we assume is the same for both genders. Given the separation rate and job filling rate of 0.9, we can obtain the matching efficiency parameter $\overline{m}$ which yields 0.561.

The parameters relating to fertility are calibrated to match empirical facts such as average fertility rates, female time spent with kids, and costs of raising children. The rate at which children reach adulthood δ_n is 0.025, implying 10 years of child-related utility and costs. The function describing the time cost of children has level parameter ϕ_l of 0.088, corresponding to an average fertility rate of 2 kids per family, 3 daily hours allocated by females to care for their children[22], and a curvature parameter ψ_l of 0.5. The parameter describing expenditures per child ϕ_c at 0.075 corresponds to 15% of parental net income in steady state, in line with OECD countries such as Norway and Canada.[23] The parameter describing preference for children in the utility function σ_n is 0.398, consistent with an average fertility rate of 2 kids per household.

Parameters governing the supply of labor are calibrated to match gender-specific unemployment and hours worked. Male disutility of labor parameter σ_l^M is set at 102.4, corresponding to 8 daily working hours and an unemployment rate of 7%. Female disutility of labor parameter σ_l^F is set at 475.5, corresponding to 5.3 daily working hours and an unemployment rate of 8%. The Frisch elasticity of labor supply ξ is set at 4.0 as in Trigari (2009) and Christoffel et al. (2009).

[22] We assume female working hours to be 66% of their male counterparts. This is consistent with U.S. Time Use data for years 2005-2013, in which fathers in full-time employment work 6 daily hours compared to an average of 4 hours for mothers in either full or part-time employment. We implicitly assume that childcare is an imperfect substitute for females and that a trade-off exists between working and having children in women's time endowment.

[23] The average annual cost of raising children was estimated at 18% of household income for Norway in 2014 (source: SIFO) and for Canada in 2011 (source: Fraser Institute).

Capital has a share α of 0.3 in the firm production function and depreciates at rate δ of 3%. The elasticity of substitution parameter between females and males in production ρ is 0.65 as in Doepke et al. (2007). Firms have a relative preference for males over females given by θ at 0.44, which corresponds to a 12% gender wage gap (lower than the 16% average for OECD countries over 2000-13). Workers' bargaining power is higher for males η_M at 0.5 than for females η_F at 0.35. Firm vacancy posting costs help calibrate the job-finding and job-filling rates, suggesting κ at 0.566 implying total vacancy posting costs amount to 3.5% of GDP.

Wage and employment adjustment costs are 0 in the baseline. In the UR setup, we set χ_e at 1.25 and ψ_e at 1,700 making it more costly to lay-off workers than to fire them. In the RWR setup, we set χ_w at 36.6 and ψ_w at 24,100 making wages downward rigid. Wages are not indexed against inflation such that ν is 0. These parameter values are taken directly from Abbritti and Fahr (2013) in which they are calibrated 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_r of 0.001. The technology shock has persistence ρ_z of 0.95 and standard deviation σ_z of 0.0064. These values are the same as Abbritti and Fahr (2013).

Table 9: Parameter Values

Param.	Value	Description	Source
Households			
β	0.992	Time discount factor	0.97 annual rate
σ_l^M	102.4	Disutility of labor - males	8/24 time allocation by males to work in SS.
σ_l^F	475.5	Disutility of labor - females	5.3/24 time allocation by females to work in SS.
ξ	4.0	Frisch elasticity of labor supply	Trigari (2009), Christoffel et al. (2009).
σ_n	0.398	Utility weight on children	Corresponds to 2 children per household in SS.
δ_n	0.025	Children's depreciation (cost & utility)	10 years of childhood.
ψ_l	0.5	Time cost of children (curvature)	0.33 in Doepke et al. (2007)
ϕ_l	0.088	Time cost of children (level)	3/24 time allocation by females to children in SS.
ϕ_c	0.075	Consumption cost of children (level)	15% of parental net income in SS (OECD).
Firm production			
α	0.3	Share of capital in production	Standard
δ	0.03	Capital depreciation rate	12% annual rate
η^M	0.5	Male workers exog. bargaining power	Bla (2010)
η^F	0.35	Female workers exog. bargaining power	Corresponds to $ur_{SS}^F = 0.08$
θ	0.44	Firms' preference for female workers	Corresponds to 12% wage gap in SS (16% in OECD).
ρ	0.65	Elasticity of substitution males/females	Doepke et al. (2007)
κ	0.566	Cost of posting a vacancy	Corresponds to $q_{SS}^F = 0.95$ and f=0.35 in SS (6% of GDP).
Labor Market			
ζ	0.5	Elasticity of matching function	Petrongolo and Pissarides (2001)
b	0.079	Unemployment benefit	Corresponds to 66% replacement rate in SS.
s	0.041	Separation rate	Corresponds to $ur_{SS}^M = 0.07$ and $f_{SS}^M = 0.35$
$\overline{m}$	0.561	CRS matching technology	Corresponds to $q_{SS}^M = 0.9$ (Ravenna and Walsh (2011))
Adjustment costs (baseline all 0)			
ν	0	Wage indexation to inflation	Abbritti and Fahr (2013)
χ_w	36.6	Adjustment cost parameter - wages	Abbritti and Fahr (2013): match volatility of wage inflation
ψ_w	24100	Asymmetry parameter - wages	Abbritti and Fahr (2013): match skewness of wage inflation
χ_e	50	Adjustment cost parameter - employment	Abbritti and Fahr (2013): 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	0.0064	Std. deviation of technology shocks	Smets and Wouters (2003)
σ_{mp}	0.001	Std. deviation of monetary policy shock	Christoffel et al. (2009)
σ_{rp}	0.001	Std. deviation of risk premium shock	Christoffel et al. (2009)
ρ_z	0.95	Persistence of technology shock	Smets and Wouters (2003)
ρ_{rp}	0.8	Persistence of risk premium shock	Christoffel et al. (2009)

6.2 Impulse responses in Set-Up with Wage Adjustment Costs

Figure 1 and 2 display impulse responses to a one-standard deviation positive and negative monetary policy shock. In response to a contractionary monetary policy shock, firms would like to cut wages and employment. In a setting with downward wage rigidities (χ_w at 36.6 and ψ_w at 24,100), wages are cut less than the fall in prices, leading to an increase in real wages. This aggravates the contraction of the business cycle with a steep rise in unemployment rates and large fall in consumption and output. This amplification effect is mirrored in household fertility decisions. Downward wage rigidities lead to asymmetric responses of fertility, with moderate increases in booms and large drops in births during recessions.

Wage adjustment costs in steady state are zero by construction and are not affected by the wage rigidity parameters. By contrast, the stochastic steady state, which considers a large number of simulated shocks, leads to lower fertility compared to the deterministic steady state. In other words, wage rigidities in the presence of economic shocks, reduce average fertility rates, consistent with our empirical findings.

Figure 3 displays impulse responses to a positive and negative technology shock. Here, the presence of wage adjustment costs play less of a role as real wages are procyclical and result in lower real distortions. Also in this case fertility is procyclical and wage rigidities amplify real effects and fertility response, with the exception of real prices.

Figure 1: IRF to Monetary Policy Shock

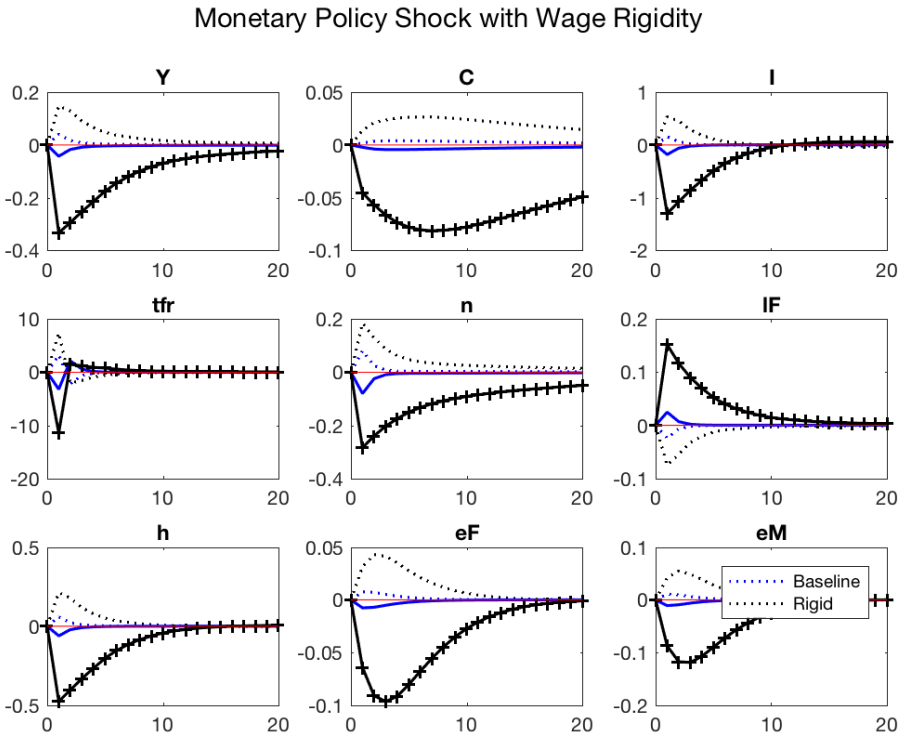
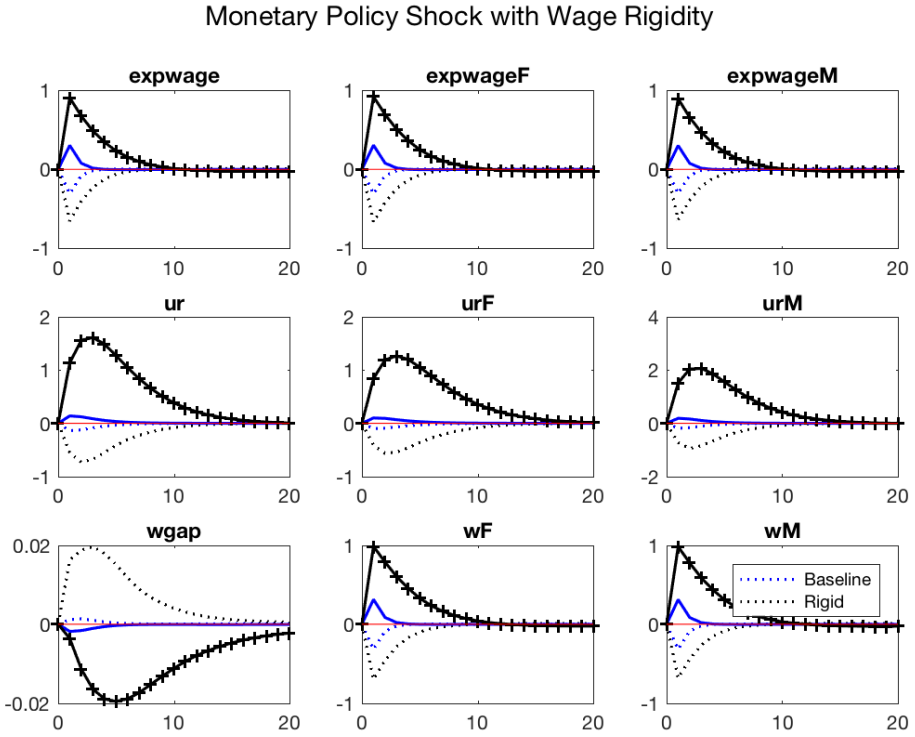


Figure 2: IRF to Monetary Policy Shock (cont.)



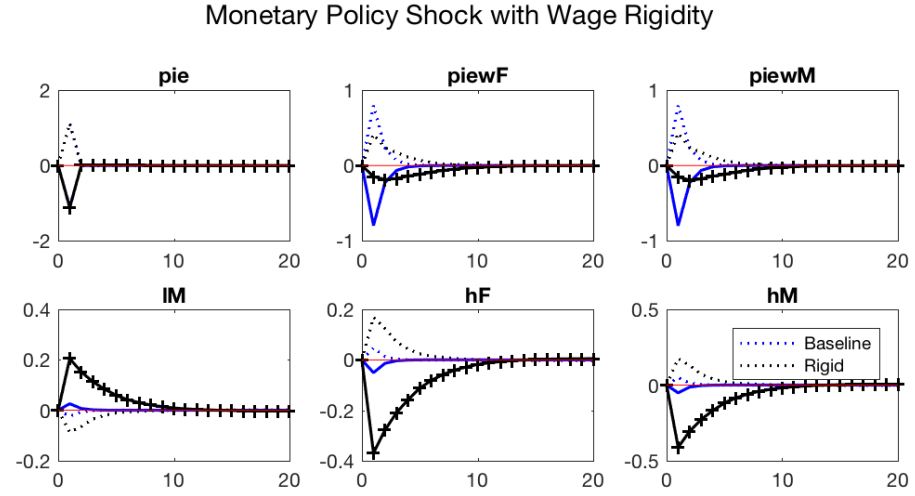
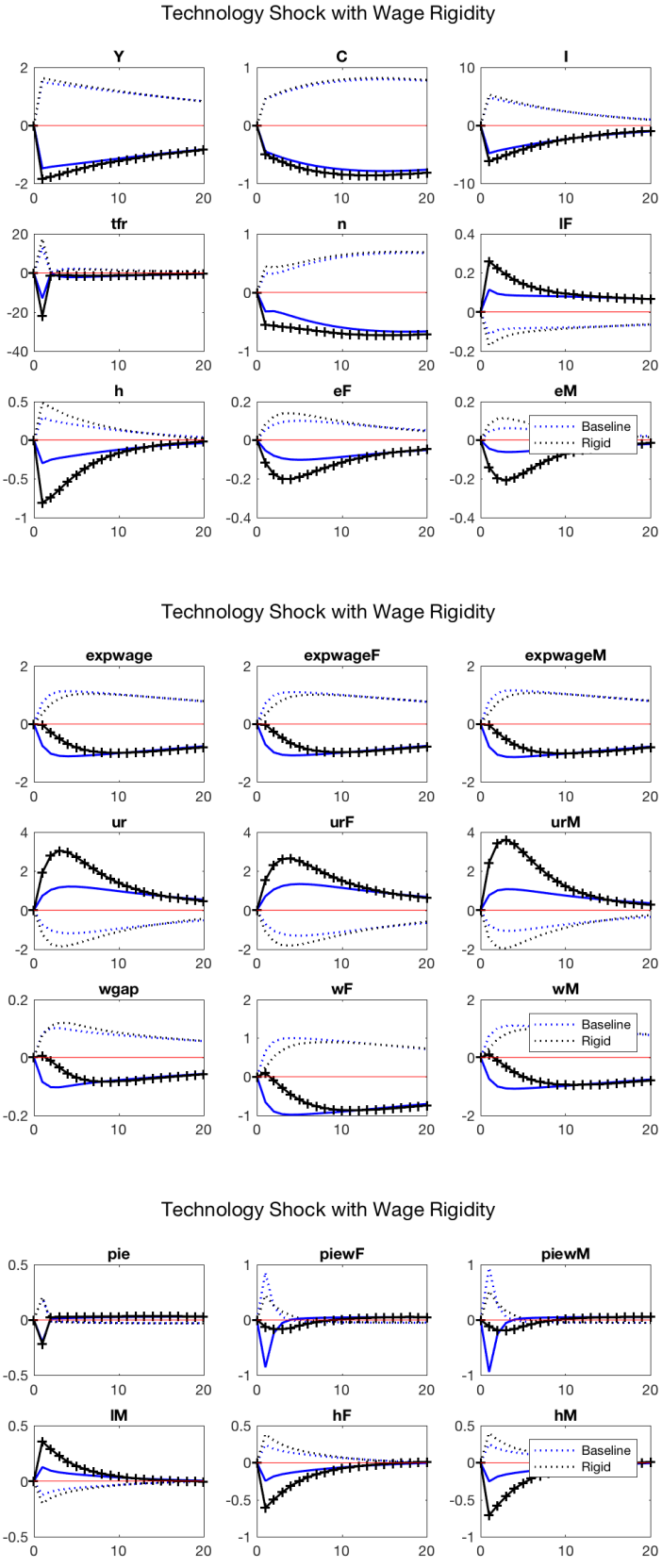


Figure 3: IRF to Technology Shock



6.3 Impulse responses in Set-Up with Employment Adjustment Costs

Figures 4 and 5 display impulse responses to a one-standard deviation positive and negative monetary policy shock. As the previous case, in response to a contractionary monetary policy shock, firms would like to cut wages and employment. In a setting with downward employment rigidities (χ_e at 50 and ψ_e at 1700), employment can be adjusted less and firms reduce nominal wages to compensate the fall in prices. The final effect is that nominal wages fall less than prices, so real wages rise. Therefore, employment rigidities dampen the real effects of business-cycles on output, consumption and employment but not on real wages. On the other hand, the effect of downward employment rigidities on fertility decisions seems negligible and the response is not significantly asymmetric. Under our preliminary calibration the effect of wage volatility prevails over employment volatility in driving expected wage volatility.

Figure 6 displays impulse responses to a positive and negative technology shock. Employment rigidities dampen unemployment but amplify the fertility response. On the other hand there is no effect on consumption, output and investment. In this case the response of volatility of expected wage is in line with our expectations and empirical findings.

Figure 4: IRF to Monetary Policy Shock

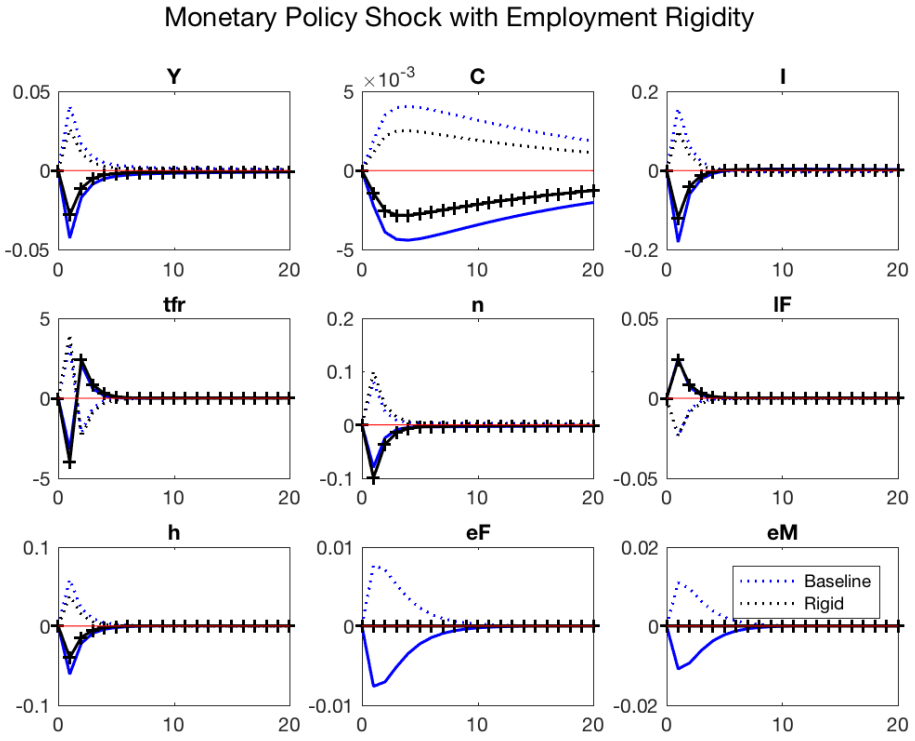
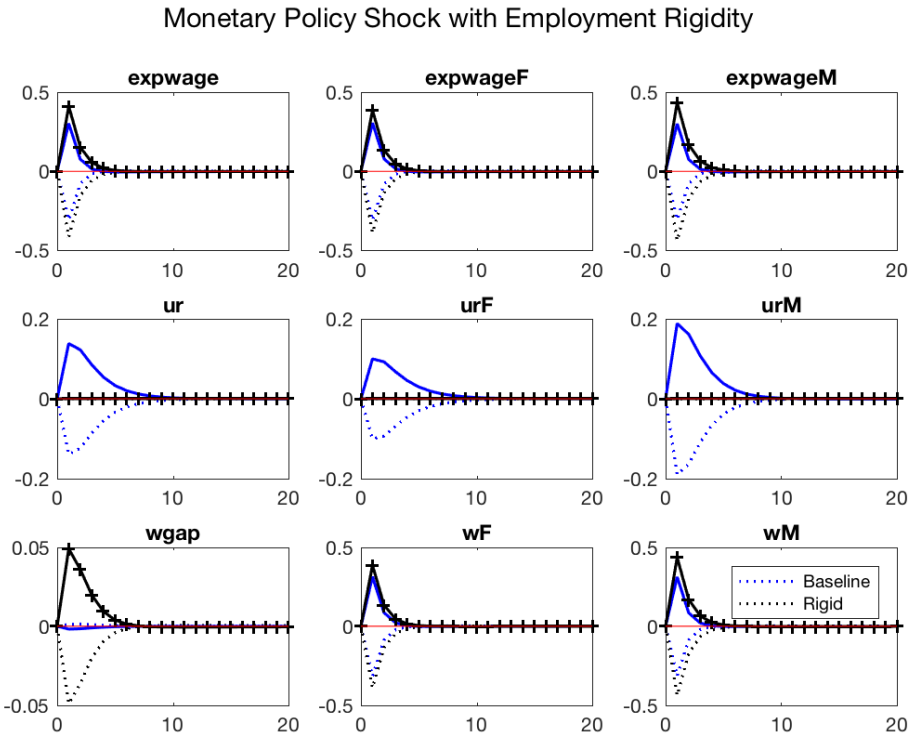


Figure 5: IRF to Monetary Policy Shock (cont.)



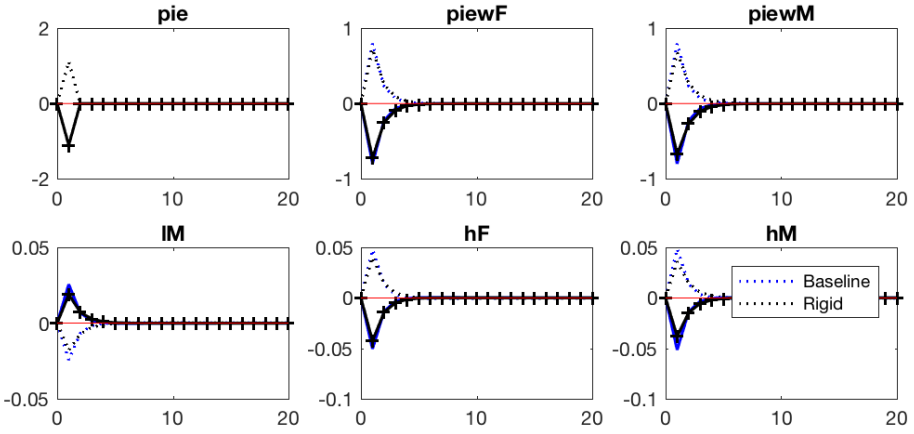
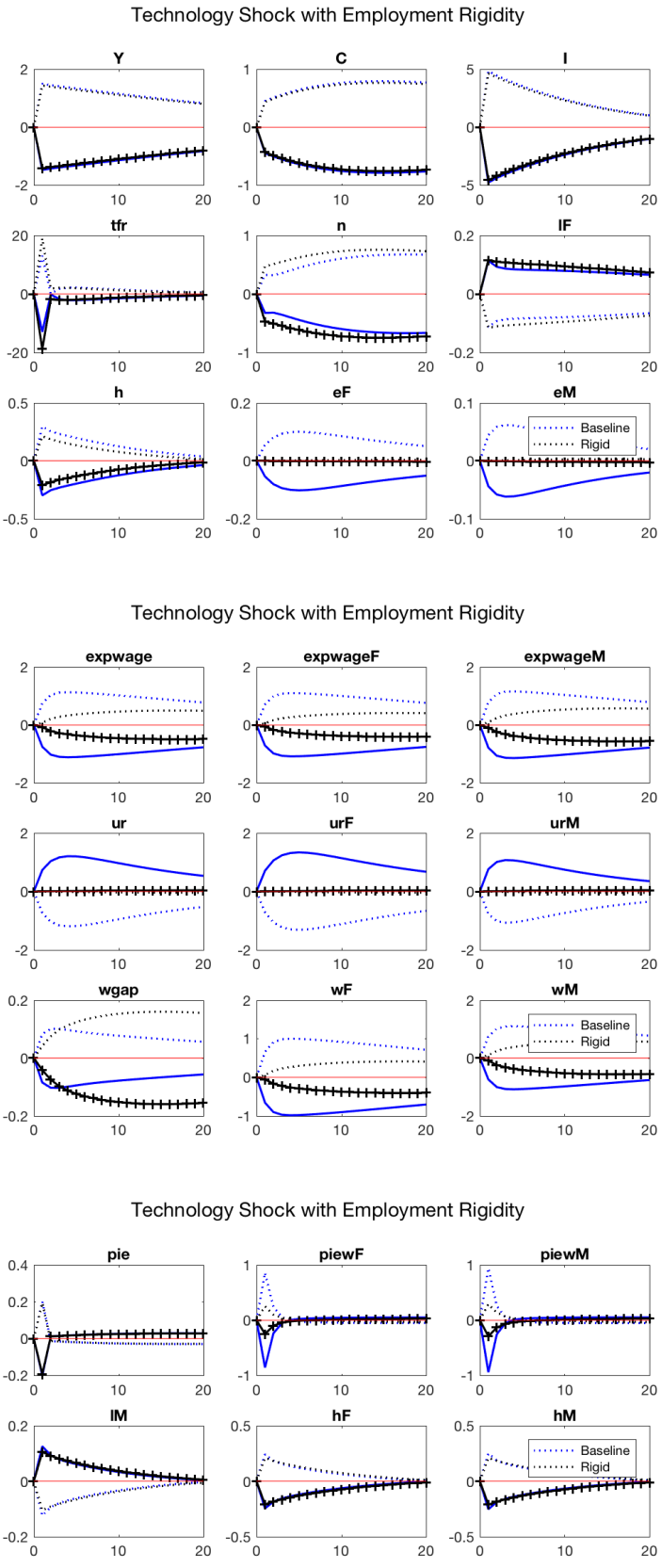


Figure 6: IRF to Technology Shock



7 Conclusion

This paper investigates the role of labor market institutions that do not explicitly target maternity, in explaining household fertility decisions. We use a panel dataset for 20 OECD countries spanning 1961-2014 including 11 different labor market institutions and estimate panel regressions for the effect of these institutions on total fertility rates. We analyze the different roles played by different categories of LMIs, dividing them into employment rigidities (ER) versus real wage rigidities (RWR). This differentiation is important since the former is expected to reduce the volatility of unemployment, whereas the latter reduces the volatility of wages but increases the volatility of unemployment. Since fertility decisions are affected by the possibility of large income shocks, the volatility of unemployment and wages can play a crucial part.

We estimate panel regressions controlling for country and time fixed effects and features such as maternity benefits, economic conditions, and gender inequality. We find that employment rigidities such as employment protection legislation and union strength[24] tend to increase fertility. On the other hand, real wage rigidities such as wage bargaining centralization and unemployment benefits tend to decrease fertility.

We study a mechanism that links LMIs and fertility through volatility of unemployment and expected wages. We find that unemployment and expected wage volatility is associated with lower fertility. We also find that employment rigidities such as EPL, reduce the volatility of employment and expected wages, whereas wage rigidities such as centralized wage bargaining centralization and unemployment benefits, increase these volatilities. Results using two stage least squares regressions show that instrumenting the volatility of expected wages and unemployment by these LMIs, we find a negative correlation with fertility, confirming our previous results. We remain cautious in interpreting this as proving the role of unemployment volatility but rather simply *not excluding* this channel.

We then build a DSGE model in which we incorporate household fertility decisions and a large set of labor market frictions. We examine the role of Rotemberg-type wage and employment adjustment costs with an asymmetric component that generates downward wage and employment rigidities. Downward wage rigidities amplify real contractions in response to negative demand shocks and lead to large drops in employment and fertility. As a result of this amplification effect in the presence of demand shocks, downward wage rigidities also reduce the stochastic steady state for fertility. Downward employment rigidities instead, in response to negative demand shocks, tend to dampen the real effects of business-cycles, with the exception of real wages. Indeed nominal wages fall less than prices, so real wages rise. On the other hand, the effect on fertility decision seems to be negligible. For further research we could explore the role of price adjustment costs and occasionally binding constraints in increasing the responsiveness of expected wages to unemployment. The former can give us better dynamics for real wages and the latter could capture the irreversibly nature of fertility decision.

This link we identify between labor market rigidities and fertility has relevant policy implications. For instance decentralization of wage bargaining could be an alternative to family-targeted policies. Lowering employment protection could dampen the effects of policies that favor fertility. To the extent that labor market reforms affect business cycle volatility, and especially the volatility of unemployment, this may also play a role in household fertility decisions.

[24] Whereas a priori we remain agnostic about the predominance of union bargaining over wages versus manning ratios, our empirical findings suggest the latter dominates in our data.

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Appendix

Figure 7: TFR vs. Average Birth Rate

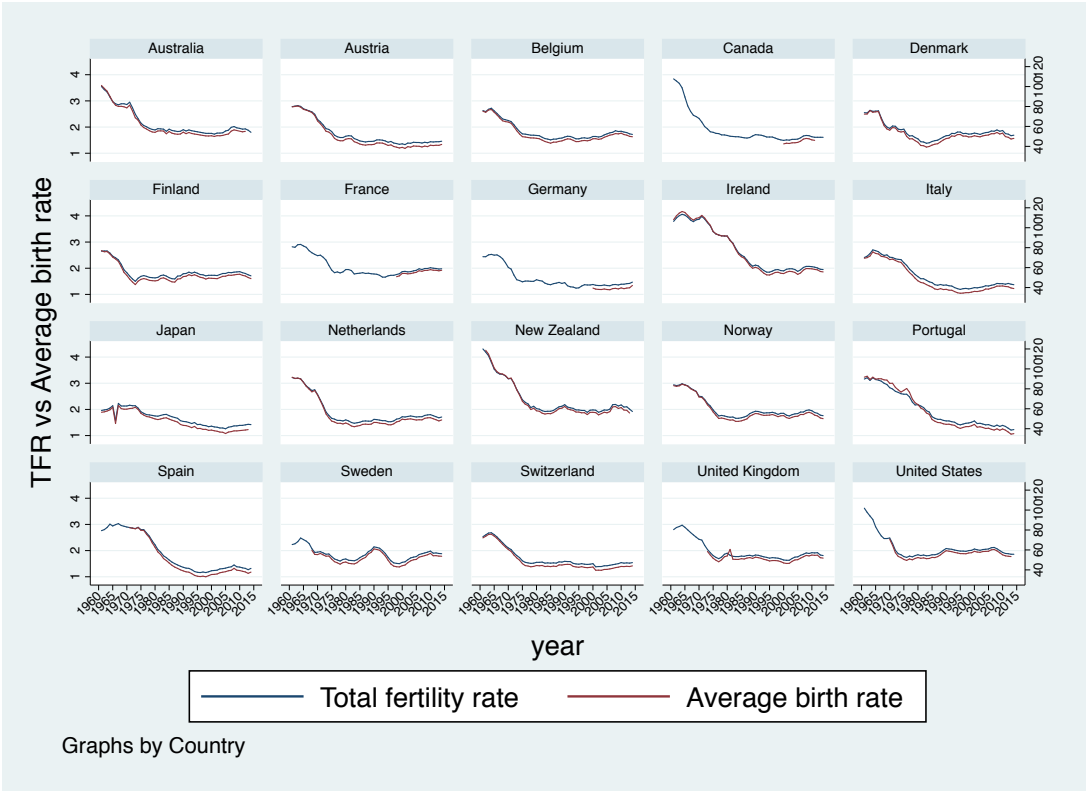

Figure 8: Heterogeneity in Total Fertility Rates

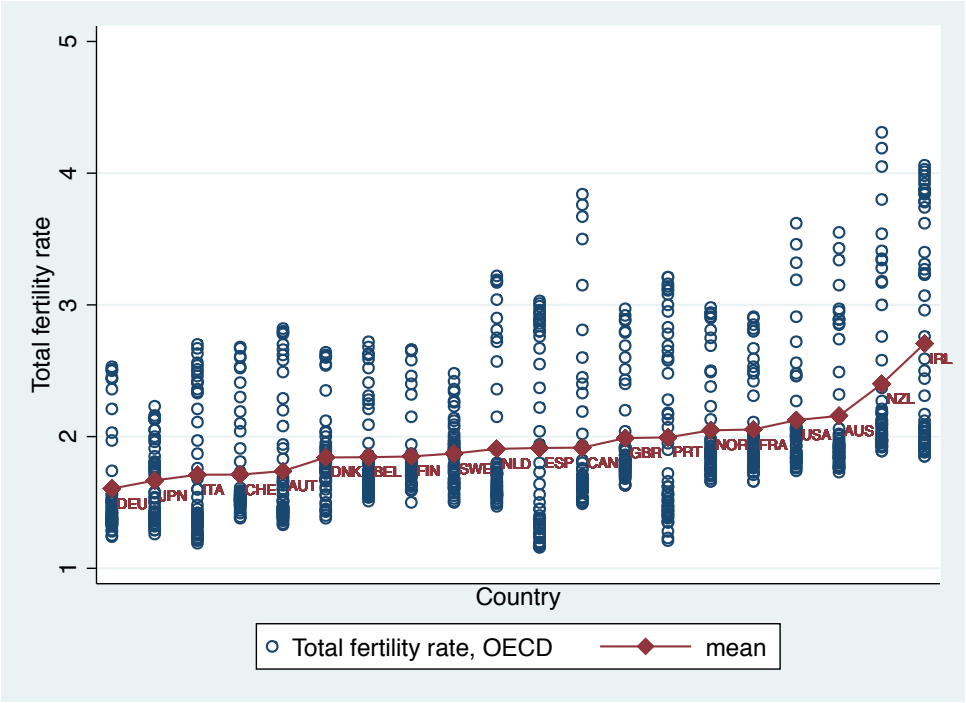

Figure 9: Birth Rate, by Age Group

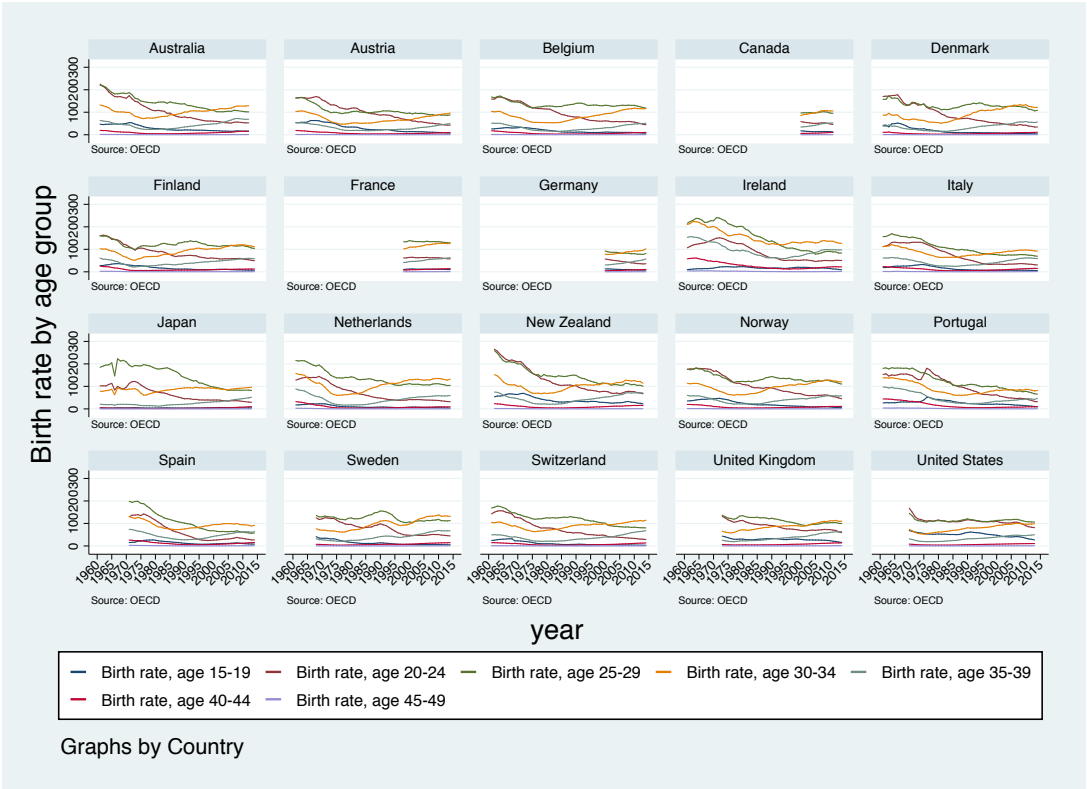

Table 10: Description of Labor Market Institutions

LMI	Description	Source
Employment protection for temporary contracts	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
Employment protection for permanent contracts	Measures the strictness of regulation of individual dismissal of employees on regular/indefinite contracts. It is expressed in a 0-6 scale.	OECD
Union density	It represents the ratio of wage and salary earners that are trade union members, divided by the total number of wage and salary earners. It is constructed using both survey and administrative data.	OECD
Union coverage	This indicator refers to the percentage of workers covered by collective agreements normalized on employment.	CEP-OECD
Union concentration	Summary measure of concentration of unions at industry and sectoral level. It ranges between 0-1.	ITCWSS
Wage bargaining centralization	Summary measure of centralization of wage bargaining, taking into account both union authority and concentration at multiple levels. Derived from Iversens centralization index, it ranges between 0-1.	ITCWSS
Government intervention in wage bargaining	Index of government intervention in the wage bargaining process. It spans between 1 and 5, where 1 means no intervention.	ITCWSS
Wage bargaining 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
Extension of collective agreements	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
Minimum wage	Degree of government intervention and discretion in setting the minimum wage. It ranges between 0 and 8, where 0 indicates no minimum wage.	ITCWSS
Unemployment benefit	Benefit replacement rates, which indicates the average across the first five years of unemployment for three family situations and two money levels.	OECD

Table 11: Descriptive Statistics for Labor Market Institutions

Variable	Obs	Mean	Std. Dev.	Min	Max
Employment protection (temp.)	1080	1.91	1.46	.25	5.25
Employment protection (perm.)	1080	2.13	.98	.26	5
Union density	1080	39.73	19.24	7.55	83.86
Union coverage	1080	68.9	25.22	7	99
Wage bargaining centralization	1080	.4	.18	.08	.98
Union concentration	1080	.32	.11	.14	.59
Gov. Intervention	1080	2.65	1.26	1	5
Level of wage bargaining	1080	3.04	1.32	1	5
Ext. of coll. Agreements	1080	1.43	1.26	0	3
Minimum wage	1080	-3.87	3.05	-8	0
Unemployment benefit	1080	26.13	13.56	0	65.21

Table 12: Descriptive Statistics for Control Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Family allowance, av. per child (USD)	1080	105	76	0	433
Maternity benefits	1080	2165	2549	0	13363
Female labor force participation	1080	47.3	11.7	17.8	71.2
Gender wage gap	1080	38	22	-11	119
GDP growth	1080	3.0	2.6	-8.3	12.9
Unemployment rate	1080	5.8	4.1	0	26.1
NAIRU	1080	6.0	3.5	0.2	20.3

Table 13: Correlation with Principal Components: LMIs

	(1) EPL	(2) UnS	(3) WB	(4) UB
Employment protection (temp.)	0.893***			
Employment protection (perm.)	0.893***			
Union density		0.805***		
Union coverage		0.798***		
Union concentration		0.467***		
Wage bargaining centralization			0.567***	
Government intervention			0.769***	
Level of wage bargaining			0.665***	
Extension of collective agreements			0.738***	
Minimum wage			0.0397	
Unemployment benefit				1
Observations	1080	1080	1080	1080

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

Table 14: Correlation with Principal Components: Controls

	(1) PC maternity	(2) PC gender	(3) PC economy
Family allowance	0.810***		
Maternity benefits	0.812***		
Female labor force participation		-0.818***	
Gender wage gap		0.819***	
GDP growth			0.390***
Unemployment rate			-0.947***
NAIRU			-0.918***
Observations	1080	1080	1080

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

Figure 10: Δ TFR: Decomposition by LMI Factors

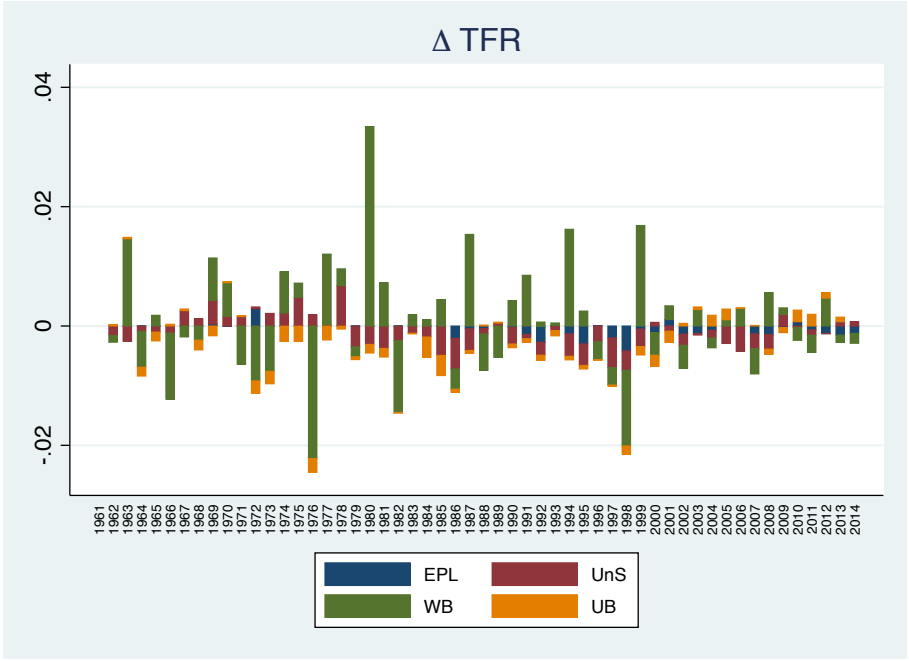

Figure 11: Δ TFR: Decomposition by LMI Factors and Controls

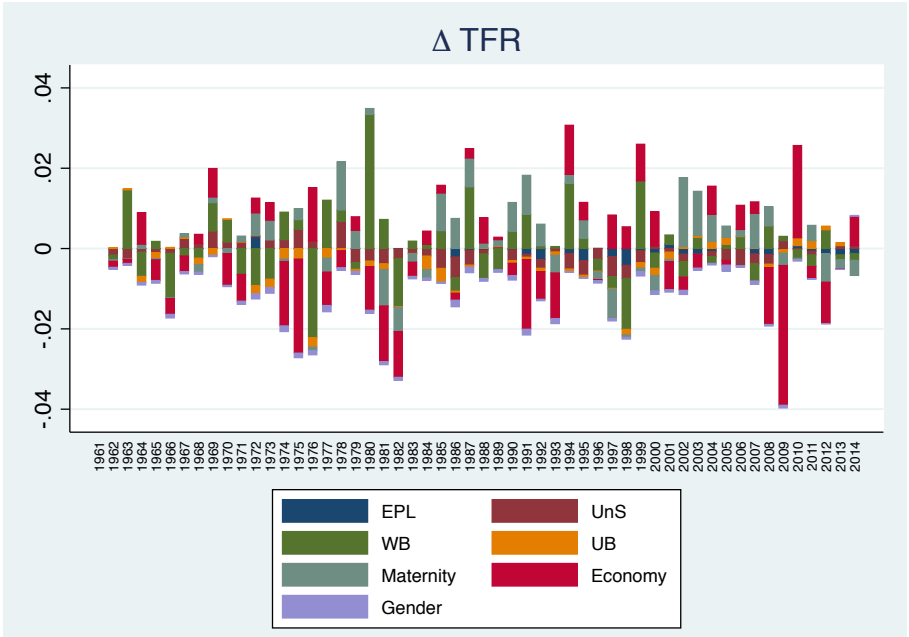

Table 15: Robustness: LMI Factors using Fertility at t+1

VARIABLES	(1) F.TFR	(2) F.TFR	(3) F.TFR	(4) F.TFR	(5) F.TFR
EPL	0.0410*	0.0491*			
	(0.0249)	(0.0253)			
UnS	0.102***		0.0599***		
	(0.0217)		(0.0203)		
WB	-0.0615***			-0.0458***	
	(0.00984)			(0.00933)	
UB	-0.00159				-0.00252**
	(0.000992)				(0.000990)
PC maternity	0.0474***	0.0511***	0.0491***	0.0477***	0.0543***
	(0.00948)	(0.00953)	(0.00952)	(0.00945)	(0.00963)
PC economy	0.0509***	0.0421***	0.0463***	0.0504***	0.0423***
	(0.00936)	(0.00942)	(0.00930)	(0.00928)	(0.00935)
PC gender	0.00824	0.0147	0.0135	0.00973	0.00640
	(0.0181)	(0.0183)	(0.0183)	(0.0181)	(0.0184)
Constant	14.33***	14.86***	14.61***	15.37***	14.99***
	(0.747)	(0.745)	(0.752)	(0.728)	(0.734)
Observations	1,060	1,060	1,060	1,060	1,060
R-squared	0.904	0.898	0.899	0.900	0.899
Controls	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
CSTT	✓	✓	✓	✓	✓

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

Table 16: Robustness: Alternative Specifications

VARIABLES	(1) Baseline TFR	(2) No CSTT TFR	(3) GLS TFR	(4) Wild TFR
EPL (perm. contracts)	0.277***	0.231***	0.308***	0.285***
	(0.0481)	(0.0418)	(0.0493)	(0.0600)
EPL (temp. contracts)	0.00854	-0.0135	0.00630	0.0200
	(0.0136)	(0.0121)	(0.0135)	(0.0334)
Union density	0.00985***	0.0105***	0.0108***	0.00731*
	(0.00155)	(0.00106)	(0.00157)	(0.00404)
Union coverage	-0.00233**	-0.00101	-0.00178*	-0.00184
	(0.00108)	(0.000722)	(0.00106)	(0.00349)
Union concentration	1.008***	0.669***	1.068***	0.987
	(0.197)	(0.190)	(0.200)	(0.662)
WB centralization	-0.449***	-1.082***	-0.446**	-0.581
	(0.167)	(0.148)	(0.177)	(0.516)
Gov. intervention in WB	-0.0298***	-0.0424***	-0.0379***	-0.0255
	(0.00820)	(0.00905)	(0.00911)	(0.0241)
WB level	0.00114	-0.000729	-0.00108	0.00572
	(0.00869)	(0.00977)	(0.00960)	(0.00977)
Ext. of coll. agreements	-0.0877***	0.0507***	-0.0984***	-0.0736*
	(0.0204)	(0.0184)	(0.0212)	(0.0411)
Minimum wage	-0.0272***	-0.0105*	-0.0282***	-0.0296*
	(0.00561)	(0.00551)	(0.00572)	(0.0167)
Unemployment benefit	-0.00246**	-0.00121	-0.00224**	-0.00245
	(0.00104)	(0.000936)	(0.00104)	(0.00310)
PC maternity	0.0462***	0.0381***	0.0473***	0.0332*
	(0.00976)	(0.00979)	(0.00969)	(0.0190)
PC economy	0.0314***	0.0169	0.0385***	0.0410*
	(0.00981)	(0.0105)	(0.00978)	(0.0213)
PC gender	0.0502***	0.127***	0.0485**	-0.0257
	(0.0192)	(0.0172)	(0.0192)	(0.0628)
Constant	11.45***	2.166***	2.711***	2.839***
	(0.855)	(0.152)	(0.183)	(0.321)
Observations	1,080	1,080	1,080	1,080
R-squared	0.908	0.847		0.930
Controls	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
CSTT	✓	No	✓	✓

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

Table 17: Robustness: Individual LMIs using Fertility at t+1

VARIABLES	(1) F.TFR	(2) F.TFR	(3) F.TFR	(4) F.TFR	(5) F.TFR	(6) F.TFR	(7) F.TFR	(8) F.TFR	(9) F.TFR	(10) F.TFR	(11) F.TFR	(12) F.TFR
EPL (perm. contracts)	0.205***	0.138***										
	(0.0482)	(0.0479)										
EPL (temp. contracts)	0.00528		0.0124									
	(0.0128)		(0.0134)									
Union density	0.00839***			0.00375***								
	(0.00148)			(0.00132)								
Union coverage	-0.00166				-0.00188*							
	(0.00104)				(0.00105)							
Union concentration	1.067***					0.744***						
	(0.188)					(0.150)						
WB centralization	-0.471***						-0.225*					
	(0.158)						(0.116)					
Gov. intervention in WB	-0.0341***							-0.0366***				
	(0.00775)							(0.00723)				
WB level	0.000768								-0.0189**			
	(0.00826)								(0.00787)			
Ext. of coll. agreements	-0.0619***									-0.0248		
	(0.0194)									(0.0163)		
Minimum wage	-0.0294***										-0.0236***	
	(0.00534)										(0.00550)	
Unemployment benefit	-0.00164											-0.00252**
	(0.00100)											(0.000990)
PC maternity	0.0485***	0.0534***	0.0504***	0.0485***	0.0518***	0.0534***	0.0489***	0.0526***	0.0488***	0.0494***	0.0458***	0.0543***
	(0.00931)	(0.00956)	(0.00954)	(0.00953)	(0.00956)	(0.00945)	(0.00956)	(0.00943)	(0.00954)	(0.00956)	(0.00952)	(0.00963)
PC economy	0.0436***	0.0432***	0.0436***	0.0486***	0.0435***	0.0389***	0.0475***	0.0447***	0.0484***	0.0459***	0.0421***	0.0423***
	(0.00928)	(0.00930)	(0.00942)	(0.00938)	(0.00934)	(0.00929)	(0.00941)	(0.00921)	(0.00942)	(0.00934)	(0.00926)	(0.00935)
PC gender	0.0289	0.0118	0.0138	0.0172	0.0186	0.0243	0.0130	0.00906	0.0122	0.0121	0.00605	0.00640
	(0.0182)	(0.0183)	(0.0184)	(0.0183)	(0.0186)	(0.0183)	(0.0183)	(0.0181)	(0.0183)	(0.0183)	(0.0182)	(0.0184)
Constant	12.61***	14.50***	14.99***	14.21***	15.25***	14.59***	15.09***	15.45***	15.26***	15.19***	15.63***	14.99***
	(0.826)	(0.762)	(0.745)	(0.797)	(0.739)	(0.734)	(0.734)	(0.729)	(0.736)	(0.736)	(0.738)	(0.734)
Observations	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060
R-squared	0.912	0.899	0.898	0.899	0.898	0.901	0.898	0.901	0.899	0.898	0.900	0.899
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CSTT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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

Table 18: 2SLS - Impact of LMIs through Unemployment Volatility

2nd Stage:

	(1)	(2)	(3)	(4)
	IV: EPL	IV: WB	IV: UB	IV: All
VARIABLES	Av. birth	Av. birth	Av. birth	Av. birth
Vol(u)	-23.87*	-17.80**	-9.669	-16.16***
	(13.95)	(8.854)	(7.285)	(6.114)
PC maternity	1.234	1.485	1.821	1.553
	(2.159)	(1.680)	(1.221)	(1.553)
PC economy	1.550	1.634	1.745	1.656
	(2.213)	(1.742)	(1.258)	(1.626)
PC gender	-0.280	0.853	2.368	1.158
	(4.966)	(3.722)	(2.763)	(3.318)
Constant	88.28***	84.16***	78.65***	83.05***
	(11.60)	(8.012)	(6.248)	(6.463)
Observations	109	109	109	109
Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓

1st Stage:

	(1)	(2)	(3)	(4)
VARIABLES	Vol(u)	Vol(u)	Vol(u)	Vol(u)
PC maternity	-0.0539	-0.0484	-0.0566	-0.0671
	(0.0871)	(0.0860)	(0.0869)	(0.0855)
PC economy	0.0759	-0.0281	0.00481	0.0421
	(0.106)	(0.0913)	(0.0922)	(0.106)
PC gender	-0.230	-0.203	-0.238	-0.269
	(0.178)	(0.175)	(0.178)	(0.176)
EPL (perm.)	-0.565*			-0.327
	(0.329)			(0.338)
WB centralization		2.264**		1.827*
		(1.050)		(1.083)
UB			0.0144*	0.0121
			(0.00766)	(0.00761)
Constant	1.863**	-0.239	0.510*	0.482
	(0.745)	(0.508)	(0.294)	(0.981)
Observations	109	109	109	109
R-squared	0.429	0.441	0.433	0.468
Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓

Standard errors in parentheses

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

Table 19: 2SLS - Impact of LMIs through Real Wage Volatility

2nd Stage:

	(1)	(2)	(3)	(4)
	IV: EPL	IV: WB	IV: UB	IV: All
VARIABLES	Av. birth	Av. birth	Av. birth	Av. birth
Vol(w/p)	9.744*	7.975*	13.93	8.861**
	(5.651)	(4.418)	(24.03)	(3.897)
PC maternity	-3.185	-2.106	-5.737	-2.646
	(4.040)	(3.258)	(14.93)	(3.085)
PC economy	0.472	0.488	0.433	0.480
	(2.468)	(2.145)	(3.329)	(2.303)
PC gender	-1.895	-0.996	-4.022	-1.446
	(5.343)	(4.514)	(13.64)	(4.647)
Constant	65.46***	67.23***	61.29**	66.34***
	(9.024)	(7.546)	(25.77)	(7.639)
Observations	89	89	89	89
Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓

1st Stage:

	(1)	(2)	(3)	(4)
VARIABLES	Vol(w/p)	Vol(w/p)	Vol(w/p)	Vol(w/p)
PC maternity	0.687***	0.620***	0.626***	0.684***
	(0.202)	(0.197)	(0.205)	(0.202)
PC economy	-0.0932	0.107	-0.00580	0.00638
	(0.238)	(0.235)	(0.240)	(0.245)
PC gender	0.698	0.632	0.531	0.766*
	(0.436)	(0.425)	(0.437)	(0.434)
EPL (perm.)	1.818*			1.370
	(0.966)			(1.000)
WB centralization		-5.045**		-4.200*
		(2.396)		(2.465)
UB			-0.0111	-0.00540
			(0.0191)	(0.0187)
Constant	-3.053	2.876**	1.151	-0.416
	(2.253)	(1.109)	(0.730)	(2.731)
Observations	89	89	89	89
R-squared	0.508	0.514	0.482	0.531
Country FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓

Standard errors in parentheses

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

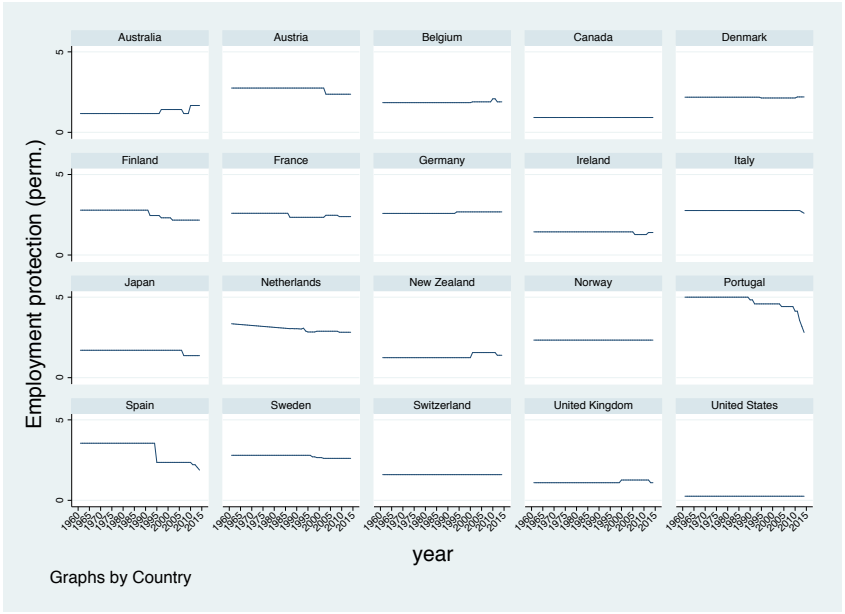

Figure 12: Employment protection, permanent contracts

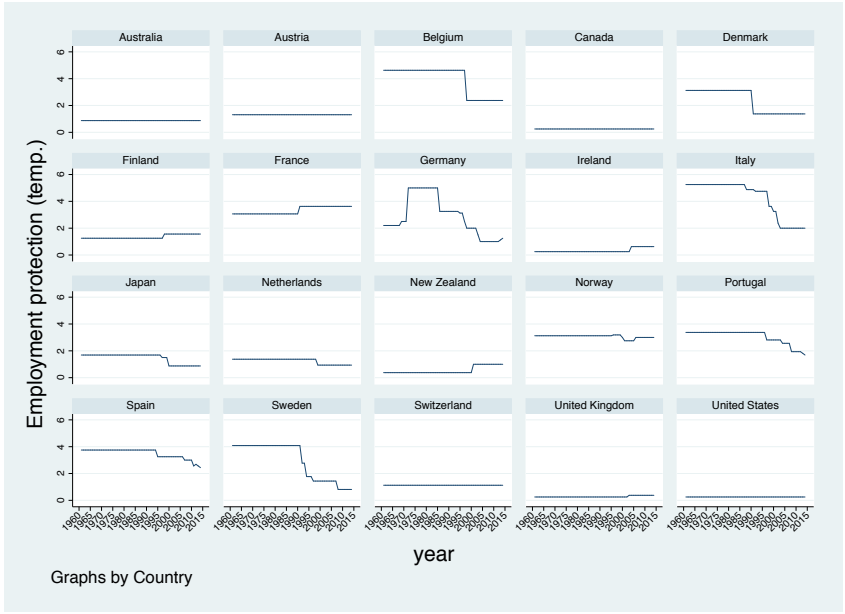

Figure 13: Employment protection, temporary contracts

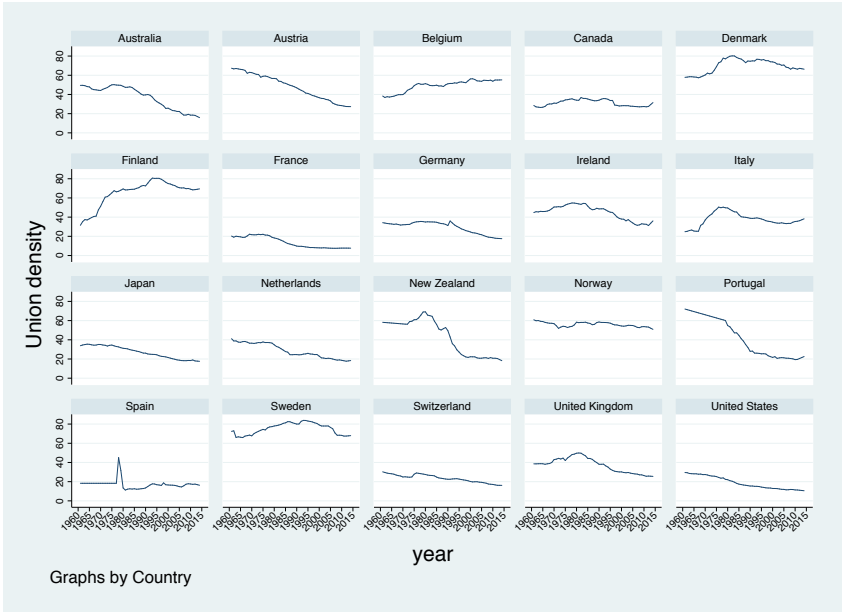

Figure 14: Union density

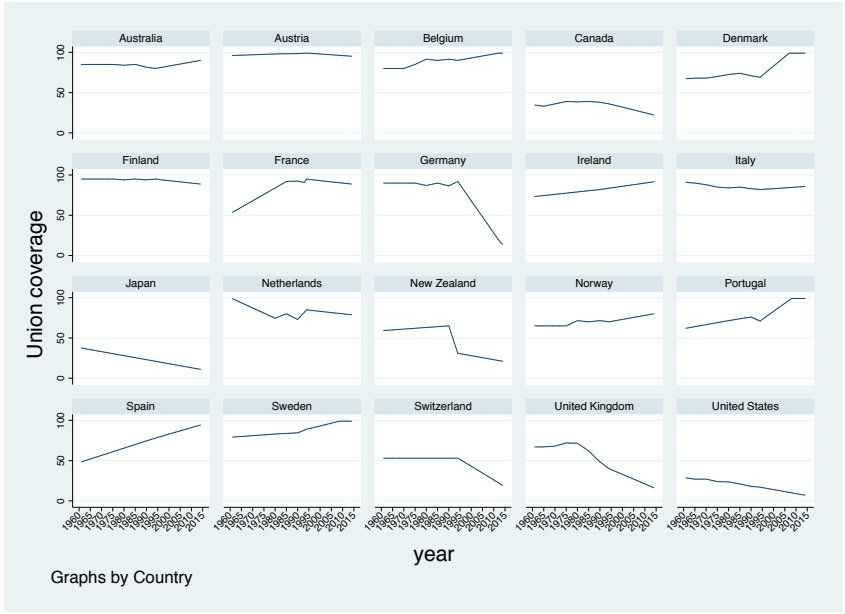

Figure 15: Union coverage

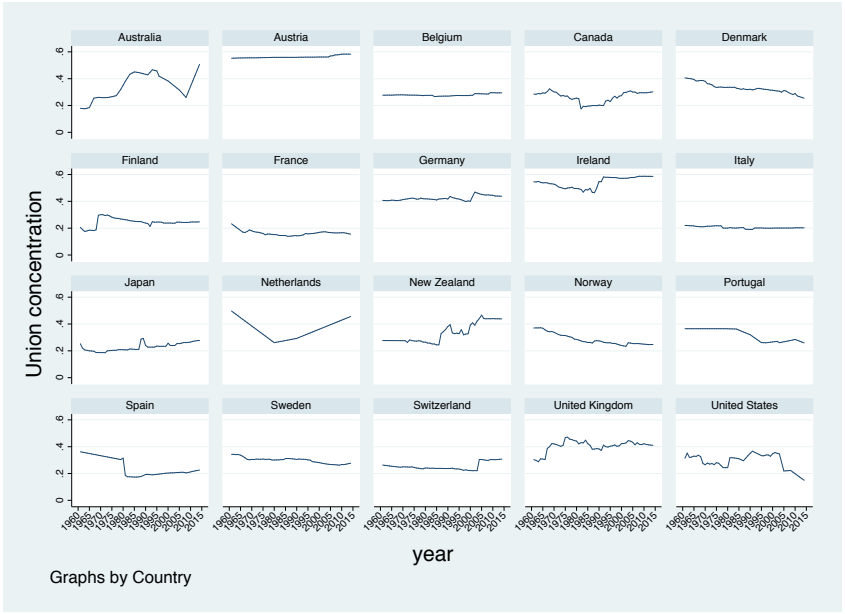

Figure 16: Union concentration

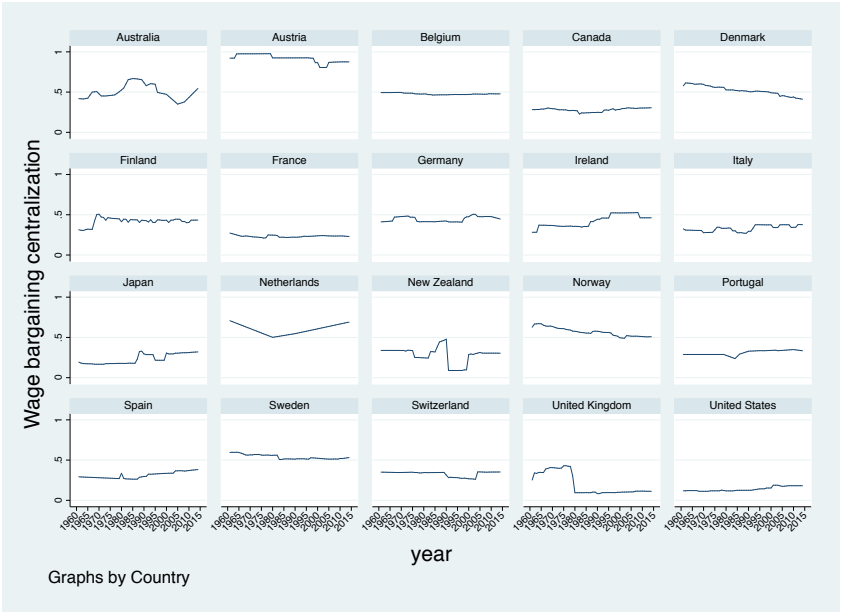

Figure 17: Wage bargaining centralization

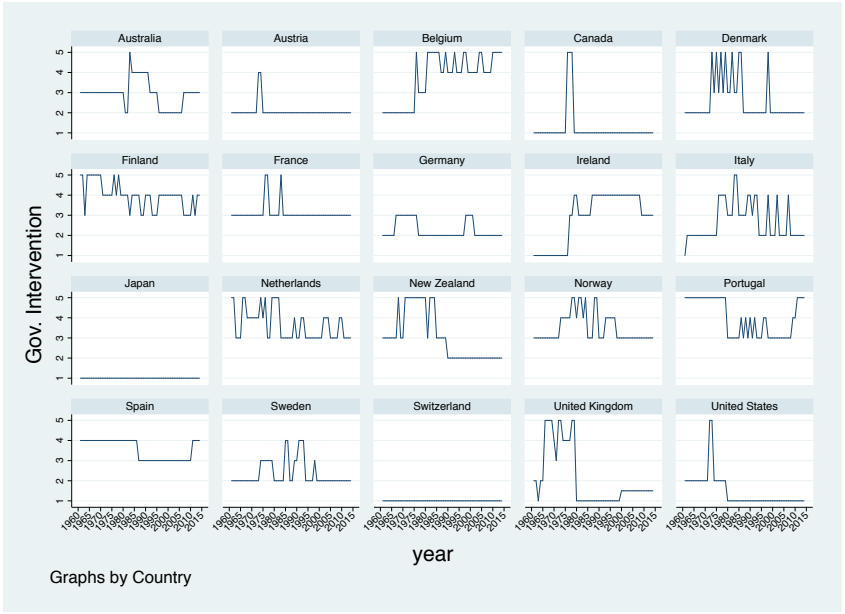

Figure 18: Government intervention

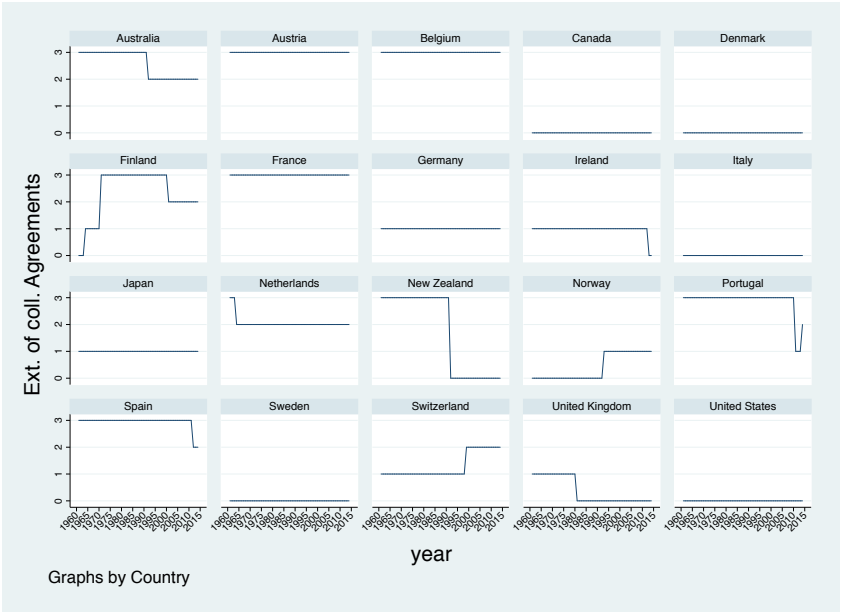

Figure 19: Ext. of collective agreements

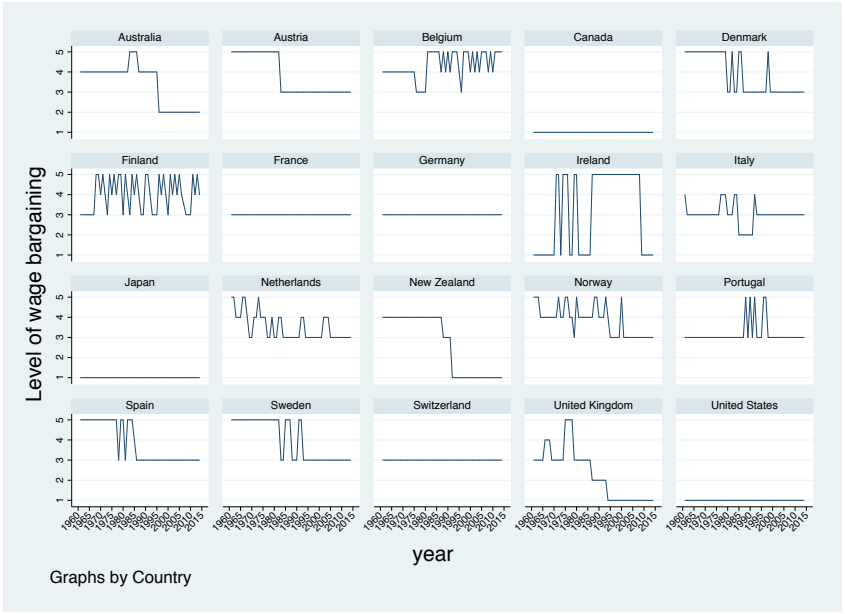

Figure 20: Level of wage bargaining

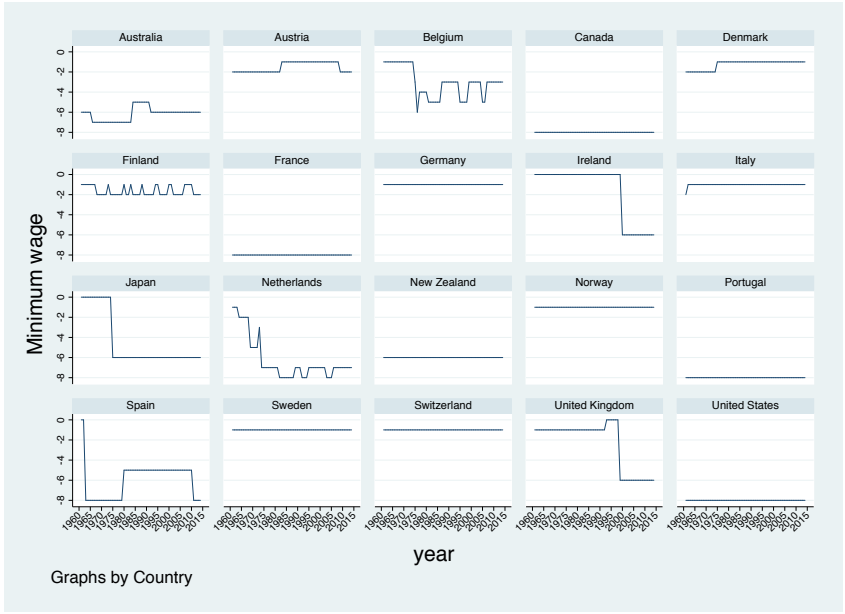

Figure 21: Minimum wage

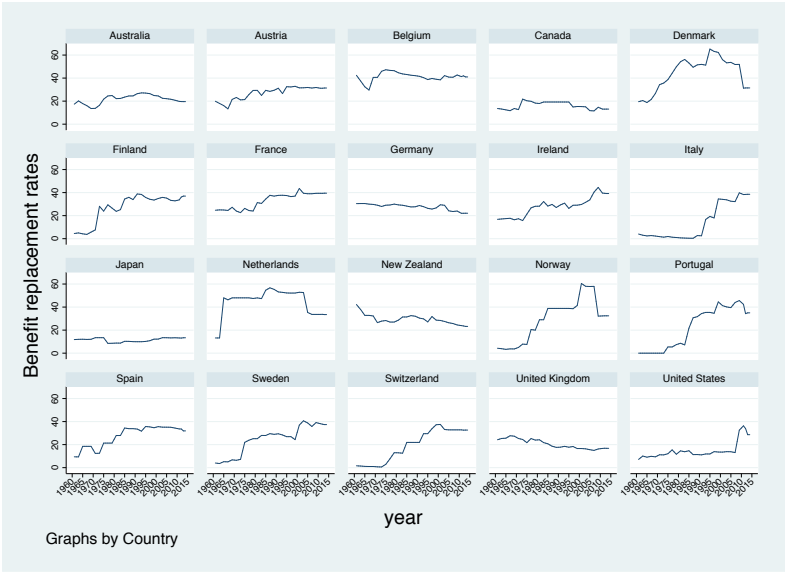

Figure 22: Unemployment benefit

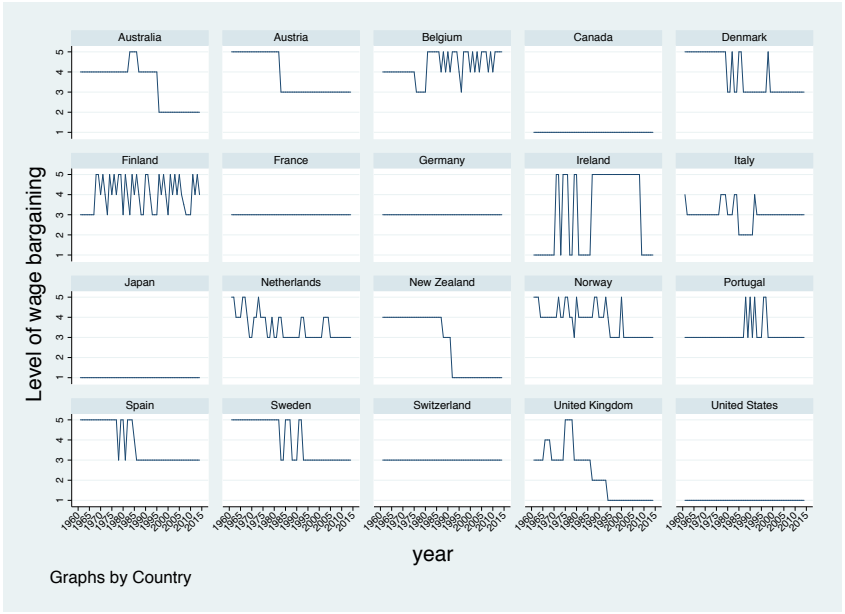

Figure 23: Level of wage bargaining

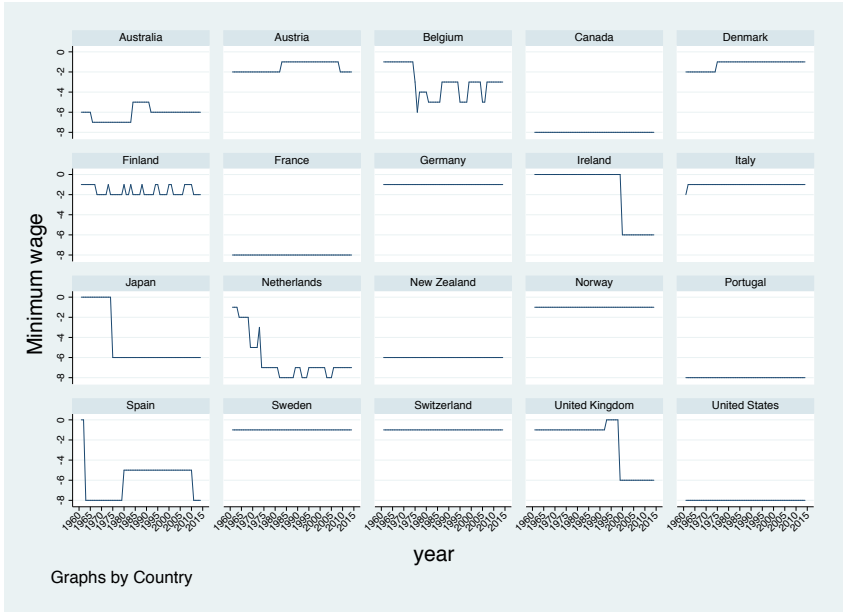

Figure 24: Minimum wage

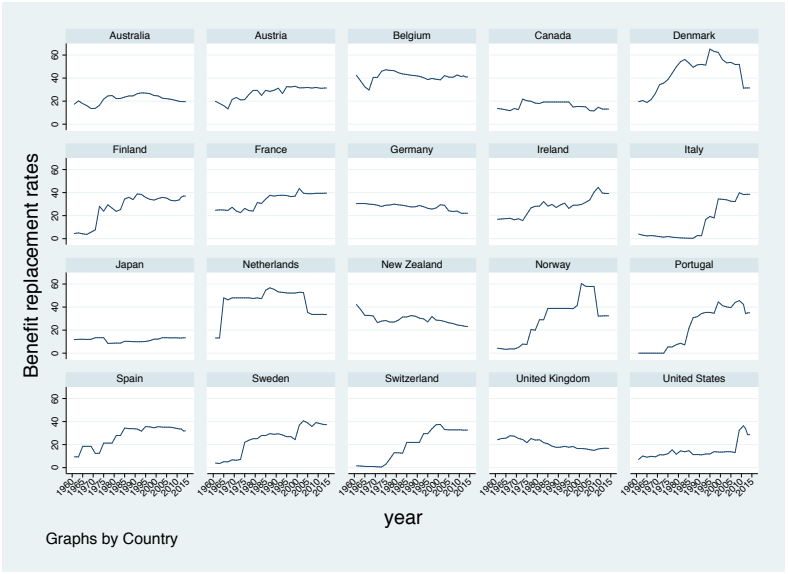

Figure 25: Unemployment benefit

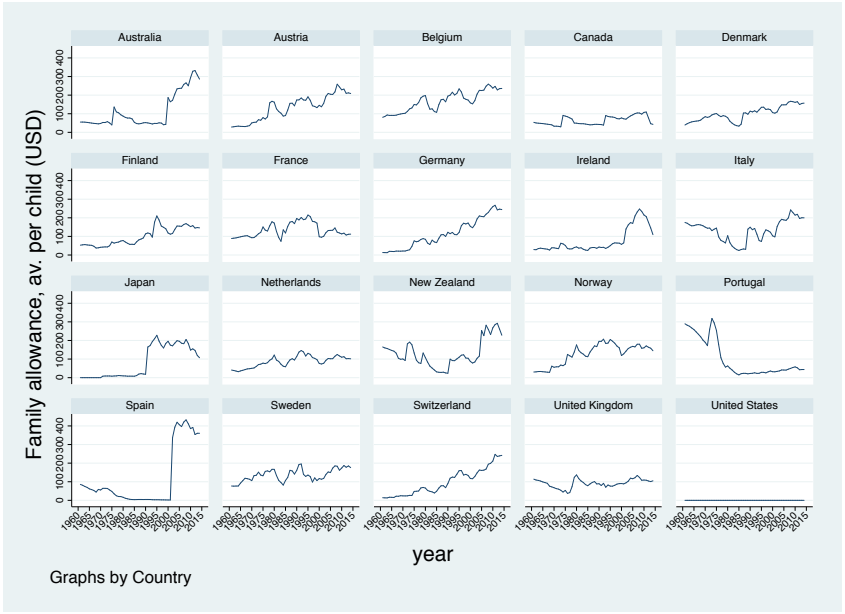

Figure 26: Family allowance, av. per child (USD)

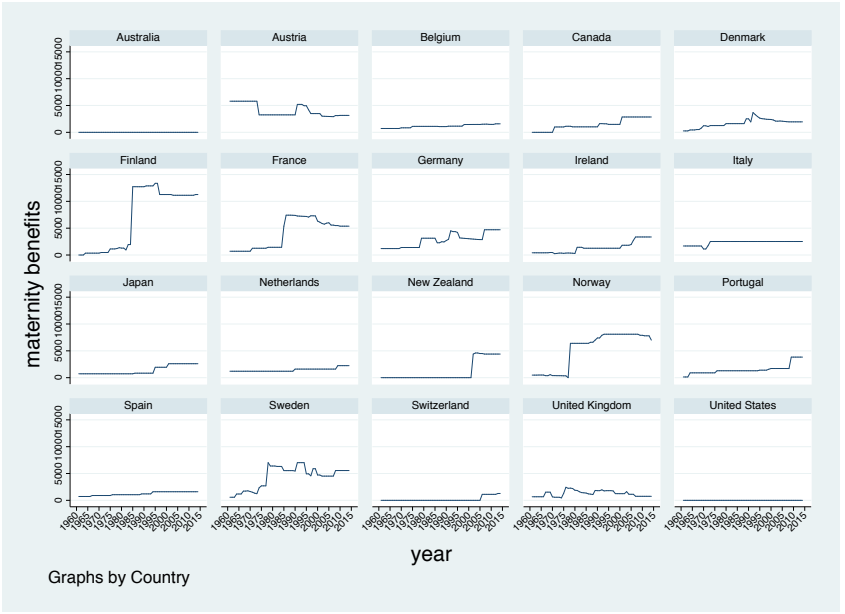

Figure 27: maternity benefits

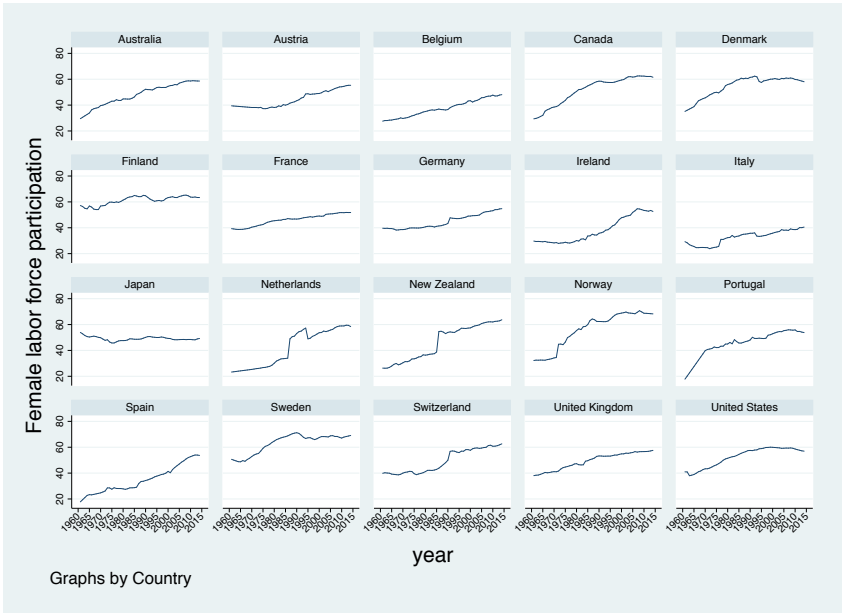

Figure 28: Female labor force participation

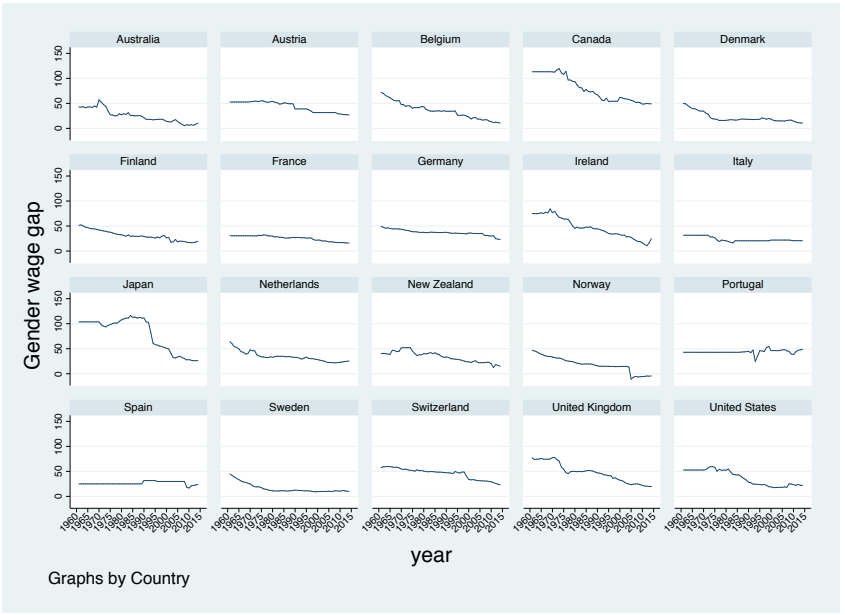

Figure 29: Gender wage gap

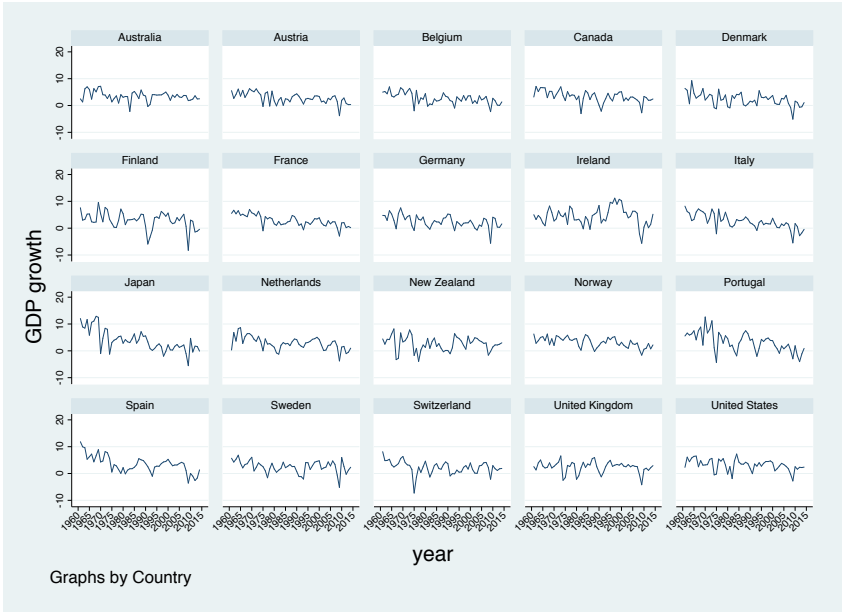

Figure 30: GDP growth

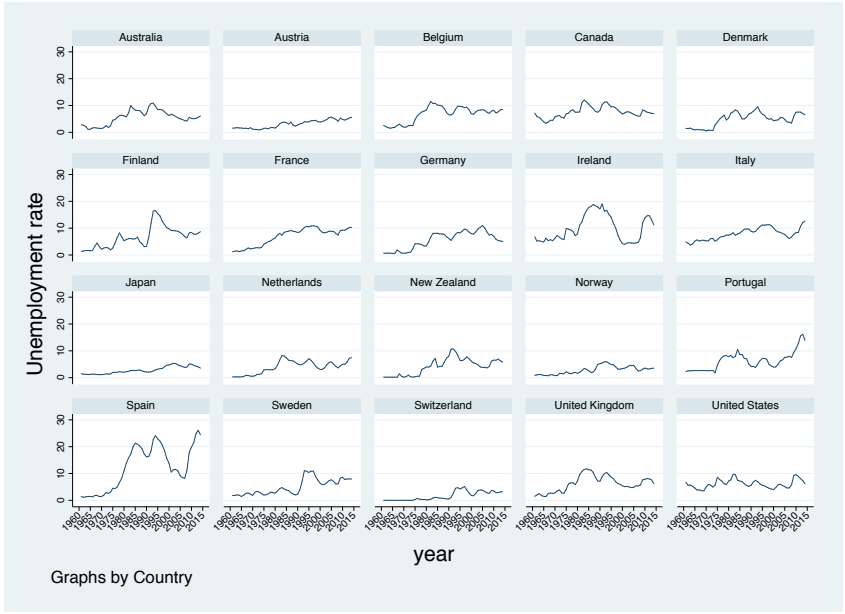

Figure 31: Unemployment rate

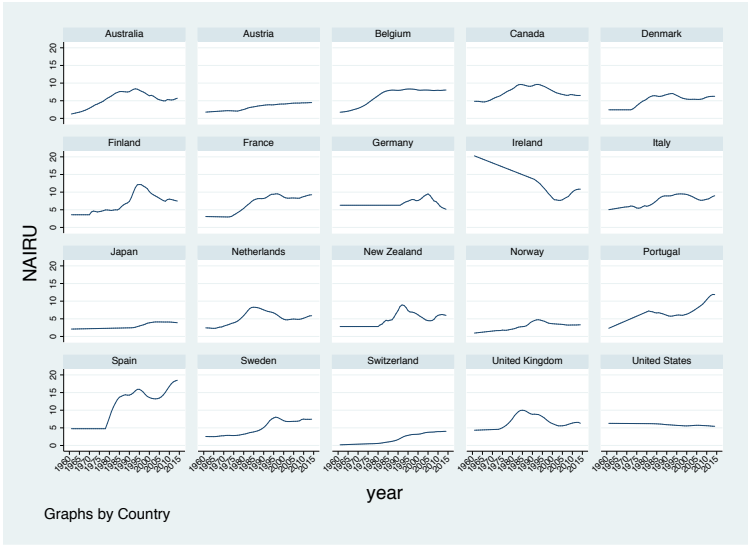

Figure 32: NAIRU