Labour Force Participation and Job Polarization: Evidence from Europe during the Great Recession[1]

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Abstract

Job polarization accelerated during the Great recession in Europe. Because of higher levels of occupational segregation by gender in Europe, and larger shocks to middling occupations that employ mostly male workers, it generated labour demand shocks much more asymmetric between men and women than in the US. We find that the labour force participation and employment rates of women increased considerably in response to the large decline in employment opportunities of men in regions most affected by the destruction of middle-skill jobs, particularly so for married women with less than high-school education. For male, the decline in demand in middling occupation explains some of the recent decline in their participation. Both for men and women, the Great recession mostly accelerated pre-existing trends. This suggests that a large share of the recent increases in women's participation in Europe is a response to job polarization.

JEL codes: J22, J24

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I. Introduction

Has the Great recession permanently affected the labour market of developed countries? More than seven years after the beginning of the Crisis, labour markets are far from being back to normal. While the unemployment rate returned to its pre-recession level in the US, the labour force participation rate of the population declined dramatically at the start of the Great recession and has not yet recovered. In Europe, participation also declined for men while it increased for women but the unemployment rate remains high.

What explains these differences in both sides of the Atlantic? Understanding this issue is crucial to assess the current health of the labour market. If many workers have left the labour force in response to the Great recession, the official unemployment rate may greatly understate the problems of the labour markets. Labour force participation is also socially desirable because individuals gain on the job a set of skills and ability that are lost when inactive. A decrease in participation diminishes the accumulation of human capital and the potential labour force, thus limiting future economic growth.

This paper studies the evolution of labour force participation during the Great recession across twelve European countries using individual level data from Labour Force Surveys (LFS) and the European Panel Data on Income and Living Conditions (SILC). While our main focus is on Europe, we draw several comparisons with the US to understand what factors are at play. In both Europe and the US, employment dramatically suffered during the Great recession, and over the longer run, the labour markets have been reshaped by the forces of mechanization and globalization. However, as we detail below, labour force participation responded quite differently across countries to these changes.

To explain these differences, we first highlight the impact of recent demographic changes. The larger baby boom cohorts started to reach the retirement age at the

beginning of the crisis. The ageing of baby boomers increased the share of the older population that participate less to the labour force and thus explains some of the recent decline in participation. As the share of retired baby-boomer increased more rapidly in the US, it triggered a larger decline of participation rates there than in Europe. We estimate that these demographic factors can explain up to a third of the differences in the behaviour of labour force participation between the US and European countries.

In the recent decade, Europe has also been characterized by twice as large increases in graduations rates from university and college than in the US, notably in South-Europe, and particularly so for women. Women with a higher level of education are more likely to join the labour force and the expansion of higher education contributed dramatically to the rise in participation in Europe. We estimate that it accounts for about a third of the increase in participation during the Great recession with respect to the US.

However, these compositional changes cannot explain everything. We observe large differences by gender and across education groups in the recent evolution of the participation rates. In particular, in the population with education below high-school level, the participation rates of men declined in all countries while, in contrast, the participation rates of low-educated women increased rapidly in the countries most affected by unemployment. In Spain, Greece and Italy respectively, the participation of women with education below high school increased by 12 p.p., 5.5 p.p and 2 p.p. from 2007-13, while these economies were in the midst of a severe recession.

To explain these facts, we investigate the role of changes in the patterns of labour demand during the last decades and in particular during the Great recession. We show that, as in the US (Jaimovich and Siu, 2012; Foote and Ryan, 2015), job polarization, that denotes the reallocation of employment toward lowest- and highest-

paying occupations, accelerated during the Great recession. However, as a consequence of larger job destructions in middling occupations, the recent polarization has been more intense in Europe. Another important difference with respect to the US is that segregation by gender across occupations is more pronounced in Europe and these differences have remained stable or been slightly increasing in recent years. The disappearing middle-skill routine jobs are much more likely to employ male workers in Europe, while expanding low skill occupations employ disproportionately female workers. As a result, job polarization and the destruction of middle skill jobs produced a dramatic decline in male labour market opportunities with respect to female to a much larger extent in Europe than in the US.

We investigate if such asymmetric shock provided women with incentives to participate in the labour market. A simple economic model of labour force participation predicts that, all else equal, job polarization should mostly affect men and women on the margin of participation and thus have little effect on highly-paid workers that have strong attachments to the labour force. An important insight of this framework is that, unlike men, the decision to participate for women is influenced both by women's opportunities but also by the decline in men's employments opportunities. We can also expect single women to be affected in case the decline in labour market opportunities of male workers affects the probability of marriage (Bertrand et al., 2015) and thus increases the incentives to accumulate experience in the labour market.

To test these hypotheses, we use a local labour market strategy that exploits variations across regions in the intensity of the labour demand shock by gender provoked by job polarization. To isolate demand from supply shocks, we construct a Bartik or "shift-share" instrumental variable based on the initial distribution of employment across occupations by gender in 1995. The logic of this widely used

instrument is that job polarization affected differently European regions in the last decades because they differ in their initial composition of employment. These differences made some regions more vulnerable than others to job polarization and job destructions. To construct the instrument, we combine the initial distribution of employment by gender across occupations in 1995 with the employment growth of the same occupations in the US during the 2000s. We use the employment growth from the US instead of following the more standard approach of using the growth at the national level for each country. Doing so mitigates the risk that the aggregate changes in employment across occupations and industries that are used to construct the instrument are driven by national changes in labour supply. Finally, to capture gender differences in labour demand, we decompose the Bartik instruments into separate demand shocks for male and female and test for a differential response by gender to these shocks.

We present results based on different complementary data sources and estimation methods. First, using data from the Labour Force Surveys, we relate the 2000-2013 changes in participation across regions to gender specific changes in labour demand. Across various alternative specifications, our regressions confirm that the participation and employment rates for women *increased* in response to the decline in male labour demand, in particular for low-skilled married women. While the effects are twice as large on married women, we also find substantial responses of single women to male labour demand shocks. We also find that women were also much more likely to join the labour force in regions that experienced larger increases in female labour demand.

For men, our estimates indicate a small procyclical response to labour demand shock that is driven by the contraction of middle-skill occupations. Once the effect of middle-skill occupation is accounted for in the model, we find no impact of changes in

labour demand in other occupations or sectors such as the construction sector. These results are robust to the inclusion of country by year fixed effects in the model and region specific time trends.

One concern with the previous results is that they might reflect changes in the composition of workers across regions due to migration in response to local shocks. Another concern, in particular for women, is that the results may reflect cohort effects unrelated with changes in labour demand. This might be the case for example if younger cohorts of women have different cultural values and attitudes with respect to the costs and benefits of participation (Fernandez, 2013). We assess the importance of these issues by exploiting data from the European panel on Income and Living Condition where we can track how the participation of the same individual changed in response to gender specific labour demand shocks in her region from 2003 to 2013. Using specifications with individual fixed effects, the results largely confirm our previous findings. Unsurprisingly, having a husband that becomes unemployed influences strongly the probability of the spouse to join the labour force. The effects of local male labour demand shock on women are lower by a third when we control directly for changes in the employment status of the husband.

In the last section of the paper, we investigate how much the previous model can account for differences in the evolution of the participation rates across countries in our sample. For women, the fit of the model is remarkably good for most countries with the exception of Ireland. Our estimates suggest that most of the increase in the participation of women (net of the effect of education and ageing) can be attributed to differences in gender specific demand shocks. For men, the model explains very little of the aggregate cross-country differences observed over either during the Great recession and the previous period.

An important question for policy makers is whether these changes reflect structural or cyclical forces. While our sample has a relatively limited longitudinal dimension to answer these questions, the evidence suggests that, to a large extent, the Great recession accelerated pre-existing trends. Nevertheless, cyclical factors might play a larger role for groups that are at the margins of participation such as low-skilled married women. As the unemployment rate remain high, and the patterns of labour demand seem to favour women's skills instead of men's, married women with less than high-school education still have strong incentives to join and remain in the labour force. It is therefore too early to tell whether some of the recent increase in the participation of women is here to stay.

This paper extends at least three distinct literatures. First, various authors have shown that the labour market outcomes of women is affected by the structure of available occupations in the economy.[4] Our results extend this work by pointing out how the acceleration of job polarization in Europe during the last recession disproportionately favoured women relative to men because of higher levels of occupational segregation. A second literature our work extends is the literature that tries to account for the decline in participation over the last two decades in the US. Our results are to some extent consistent with the earlier literature such as Juhn (1992) that identified the role of diminishing opportunities of male in the labour market to explain the decrease in their participation rates. Ours is the first paper to show that the recent evolution of the participation rates in Europe is also related with a decline in labour

[4] See Olivetti and Petrongolo (2014) that documented that gender biases in labour demand across European countries are related with differences in sectoral composition of the economy. Goldin (2006) shows that the expansion of the services sector has made available jobs that were physically less demanding and more respectable for women joining the labour force than typical jobs in factories.

demand in middle-skill occupations.[5] The third body of work our paper contributes to is on whether structural or cyclical factors are driving recent labour market changes. Our paper is the first to examine these questions across different European countries which helps to identify the causal mechanisms and allows us to pinpoint why the consequences of the Great recession were so much asymmetric between men and women in Europe.[6]

The remainder of the paper proceeds as follows. In section II, we present the data we use in the paper. Section III describes changes in participation across the 12 European countries in our sample and assesses the respective role of the ageing of the population and changes in the education level in explaining differences in participation across countries during the Great recession. Section IV investigates how job polarization influenced the labour force participation of men and women. Section V assesses the robustness of the previous results using panel data. In Section VI, we use our local labour markets estimates to account for some of the national trends since 2000. The last section concludes.

II. The Data

Our analysis is based on two complementary sources of harmonized European microdata. First, we exploit the European Union Labour Force Survey (LFS) over the period 1995-2013.[7] The data contains harmonized information on labour force status, occupation, industry affiliation and household composition across European Union countries. Data are available on an annual basis until 2002 and at a quarterly frequency

[5] Aaronson et al. (2014, p. 214) and Foote and Ryan (2014) found a strong negative relationship between the decline in participation and the destruction of employment in middle-skill jobs across regions in the US.

[6] The empirical literature reports much stronger evidence for discouraged worker effects than for added worker effects (Benati, 2001). However, recent work based on more recent data over a longer period found substantial evidence of added worker effects in the US (Mankart and Oikonomou, 2015).

[7] The restricted time span for the analysis is dictated by the availability of data on occupations in the LFS. While harmonized microdata is available for some countries since 1983, information on occupation are missing before 1995 for many countries.

thereafter.[8] A major strength of this dataset is that it is available for many countries over a relatively long period of time and that it has a relatively large sample size, with about 200,000 annual observations per countries per year. A limitation is that neither workers nor households can be tracked over time.[9]

To study transitions in the labor market, we exploit the European Union Statistics on Income and Living Conditions (SILC) longitudinal panel data collected from 2004 to 2014.[10] The SILC is a rotating panel where an individual is surveyed annually over four years.[11] This panel contains a rich set of information on household composition, employment and also retrospective information for each month indicating whether an individual was in the labour force or not, employed or unemployed, working in full or part time.[12] The panel contains inidividual transitions across employment, unemployment and non-participation for each member of the household which allows relating them to the economic status of the spouse. A year contains on average from 10,000 to 50,000 observations per country.

We consider 11 core Eurozone countries plus the UK.[13] Thus, our sample includes large countries such as Germany, France, Spain and Italy and also smaller countries such as Ireland, Greece and Portugal that suffered particularly during the crisis. Also included in the sample are Austria, Belgium, Finland, and the Netherlands.

[8] There are some exceptions for a small number of countries. See the data Appendix for details.

[9] While most countries adopted a rotating panel sampling scheme to collect the data as in the CPS for the US, it is not possible to follow individuals over time in the harmonized sample because of confidentiality issues.

[10] The data in SILC are periodically revised and various errors are corrected in each release. To allow for replication of the results in this paper, the appendix indicates the version of the data that we used. See Verdugo (2016) and the references therein for a discussion of the strength and limitation of the SILC dataset.

[11] An exception is France, where an individual can be interrogated up to nine times.

[12] The SILC panel is not based on a harmonised questionnaire but is constructed using a set of 'target variables' specified by EU regulations. Countries can choose relatively independently how to collect each variable. This implies that the SILC is potentially less homogenous than other surveys. On the other hand, this decentralised approach allows the data to be collected and released more rapidly.

[13] We do not include Eastern-European and Baltic countries that have recently joined the Euro. These countries are at a different stage of economic development and tend to have very different labour market institutions.

Unfortunately, in the SILC panel, data is missing for Germany and Greece after 2008.[14] Finally, to compare labour markets in Europe with the US, we exploit public use data from the US Current Population Survey (Flood et al., 2015).[15]

III. The Facts: Past and Present Trends in Participation

A. The Great convergence

We start by describing the trends in labour force participation in Europe and the US over the last two decades, with a particular attention on what happened during the Great recession. Figure 1 shows how the participation rates for the population aged 15 and above evolved from 1995 to 2013.[16] The first 18 years of this period are characterized by a remarkable convergence in participation rates: in all European countries, the participation rates increased and it increased much more rapidly where it was lower. That convergence came to a halt with the Great recession as participation rates remained flat from 2007 to 2013. Remarkably, the participation rates were stable in Spain or Italy that have been hit quite hard by the crisis and also in France where the unemployment rate increased substantially. Two exceptions are Ireland and Portugal where participation rates declined by about 3 points after the Great recession.

The picture is quite different in the US. While the US participation rate was relatively high in 1995, the gap with Europe narrowed considerably through the combination of faster growth in Europe and decreases in the US. The level of participation in the US also began to decline much earlier than the Great recession.

[14] The data appendix contains additional details on the construction of the sample.
[15] We use the Annual Social and Economic Supplement of the Current Population Survey.
[16] The official BLS figures for the US report participation rates for the population aged 16 and while Eurostat provides the participation rates for the population aged 15 and above. To provide a comparable picture, we tabulated with the individual level CPS data the rates for the population aged 15 and above.

The participation rates of the population mask contrasted evolutions by age groups and gender.[17] Figure 2 and 3 show separately the participation rates of men and women of prime age (aged 25-54) individuals. Differences by gender are particularly dramatic in Europe. For women, participation rates increased spectacularly until 2007, at a particularly rapid pace in countries with an initially lower participation rate. This is quite different from the US where the participation of women reached a plateau in the late 1990s (Krueger, 2016) and declined by 2 p.p. thereafter.

Also in contrast with the US, Figure 2 show that the participation of prime age men was stable from 1995 to 2007 in Europe and started to decline only after the Great recession. Another notable fact is that, when restricted to the prime age population, the participation rates in the US have become quite low relative to other countries in our sample for either men or women. Figure 3 shows that, in 2013, only Ireland and Italy had a participation rate of prime age women inferior to the US.

B. When the baby boomers retire

A first issue for the interpretation of the previous figures is that changes in the unadjusted participation rates reflect not only changes in participation but also changes in the age of the population. The large cohorts of the baby boom that were born around the 1950s started to reach the retirement age at the beginning of the 2010s. These large cohorts increased the age of the population and, as a result, the share of the population with lower participation rates. Aaronson et al. (2014) showed how these demographic changes explain a large share of the decrease in participation in the US in the last decade.

[17] See Périvier (2016) for a detailed discussion of recent trends by gender in Europe.

Table 1 indicates how the share of prime age workers has varied in recent years on our panel of countries. While a baby boom also occurred almost everywhere, some countries experienced a milder or late baby boom and differences in the share of baby boomers across countries are large.[18] In particular, since 2007, the share of prime age population declined more rapidly in the US.

How much do these demographic factors explain differences across countries during the Great recession? Note that the participation rates in year t and country c can be written as $l_t^c = \sum_i l_{it}^c s_{it}^c$ where s_{it}^c is the population share of demographic group i and l_{it}^C measure its participation rate. [19] Based on this decomposition, we construct two counterfactual changes. First, to account for demographic changes within countries, we estimate $l_{13}^C(s_{07}) = \sum_i l_{i,13}^C s_{i,07}^C$ that is the counterfactual participation rate that would have been observed in 2013 had the age distribution across 14 age groups in the population remained fixed at the 2007 level. Second, to assess the role of demographic differences with the US, we estimate for each country $l_t^c(US) = \sum_i l_{it}^c s_{it}^{US}$ that captures the counterfactual participation rates that would have been observed had the age distribution been the same than in the US in those years. Then, we estimate $l_{13}^c(US) - l_{07}^c(US)$ that is the counterfactual change in participation over 2007-13 that would have been observed had the demographic composition of these countries been similar to the one of the US in these two years.[20]

[18] See e.g. Avdeev et al. (2011). Obviously, these demographic differences are also exacerbated by the lower, often considerably lower, fertility rates in Europe.

[19] For confidentiality reasons, age is reported in 5 years brackets in the European LFS. We use the 14 available age groups that are available: 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, more than 80 years of age.

[20] Obviously, such decomposition abstract from general equilibrium effects that arise if there are interactions in participation decisions between groups, which is likely in practice.

The last two columns of Table 2 show the results of these decompositions. Demographic factors appear to have a non-negligible effect. According to the second to last column of the Table, had the demographic distribution remained constant at the 2007 level, the participation rates would have been much higher in 2013. Similarly, with a similar demographic composition than in the US, most European countries would have had higher participation rates both in 2007 and 2013. However, except in Belgium and Germany, where the effects are quite large, the decline in the counterfactual participation rate is inferior to 1 p.p. which is quite small in comparison to the 2.8 p.p decline in the US. Overall, demographic differences are far from fully accounting for the gap with the US and explain on average only a third of these differences.

C. The European education expansion

To understand the evolutions of participation for prime age adults, it is also important to take into account for the rapid growth in educational attainment in the period in Europe. Table 3 shows that education levels in the last decades have increased much more rapidly in Europe than the US.[21] The increase in tertiary education has been much larger for women than for men, and differences are particularly large in some countries.

To investigate the consequences of the increase in education on the participation rates, column 1 of Table 4 shows the results of regressions of the labour force participation rate of prime age workers in 2007 and 2013 on a constant and a dummy variable for 2013. By definition, the dummy captures how the participation rates changed in 2013 with respect to 2007. We add three education dummies to the model in column (2). To estimate how changes in educational attainment in the population affects this evolution. This implies that changes captured by the 2013 dummy in this

[21] See for example Carrasco, Jimeno and Ortega (2015) and Verdugo (2014) for studies emphasizing the consequences of this education expansion on the wage structure of Spain and France, respectively.

specification are now net of the effect of education.[22] Column (3) indicates how the growth in education contributed to the increase in participation in 2013 by reporting the differences between the two parameters.

The results show that controlling for education does not affect much the change in participation rates in the US for men and women and that it had relatively small effects on the participation of male in most countries. In contrast, the increase in education explains up to 2 p.p. of the increase in participation of female during the Great recession in Belgium, Ireland, France, Italy, Portugal and the UK. On the other hand, in Spain, Greece and also to a lower extent Austria, the growth in participation of women net of the effect of education remains substantial.[23]

Finally, it is also important to notice that there were also important changes in participation *within* groups of education over the period. Table 5 shows that there were much larger increases in participation among women with less than high-school education and for high-school graduates. Finally, the last two columns of Table 5 document changes in participation by marital status. We find substantial increase in the participation rates of married women. In most countries, the participation of married women increased substantially relative to the participation of single women. In the rest of the paper, we investigate the explanations for these patterns.

IV. Did Job Polarization Affect Participation?

[22] Results were virtually identical when age dummies were included in the regression, or if the interaction between 3 education and 4 age group dummies were used. These results are available upon request.

[23] Of course, interpreting the increase in the level of education during the Great recession as reflecting purely composition effects is probably erroneous. It is likely that both the boom that preceded the Great recession in some countries and the Great recession itself modified the incentives to attend higher education. See Charles, Hurst and Notowidigdo (2015) for causal evidence of a link between the construction booms and the decline in college attendance in the US during the 2000s.

A. How participation respond to the business cycle

To guide the empirical analysis below, we discuss theoretically how a shock such as the Great recession might have affected labour force participation. Following Becker (1965), the labour supply of an individual is based on a comparison between the marginal benefits and costs of taking a job. In a standard static model, labour force participation increases when wages are high, the probability to find a job is high, and the disutility cost of labour low. As during recessions, wages tend to decrease and finding a job becomes harder, marginal workers could be discouraged and drop out of the labour force or refrain from entering. The "*discouraged worker effect*", as it is known in the literature, would predict a decline in the participation of workers that have been more affected by the Great recession.

The labour supply decision is more complicated in households where the decision of each spouse affects the other. In traditional gender role, women are the secondary earner and, unlike married men, they make an arbitrage between market work and home production, not only leisure and thus have a higher opportunity cost of work (Mincer, 1962). Households also offer the possibility of insurance within the family.[24] The theory of the "*added worker effect*" posits that, if one spouse experiences a decline in income or face higher unemployment risks, the other spouse will raise temporarily her labour supply (Lundberg, 1985; Juhn and Potter, 2007).

Empirically, the literature report much stronger evidence for discouraged worker effects (Benati, 2001) than for added worker effects (Lundberg, 1985).[25] Two major explanations have been advanced. First, in a dynamic setting, individuals smooth their

[24] The theories underlying the notion of spousal labour supply as insurance to unemployment has been originally developed in Ashenfelter (1980), Heckman and MaCurdy (1980) and Lundberg (1985).

[25] However, using longer and more recent data, Mankart and Oikonomou (2015) found stronger evidence of added worker effects in the US.

labour supply over the life cycle. Heckman and MaCurdy (1980) highlight that, when capital markets are perfect, the added worker effect should be small if income losses are small with respect to lifetime earnings. Another issue is that the job prospects of husbands and wife might be correlated. During downturns, labour market opportunities might decline for both spouses thus diminishing the incentives to participate for the added worker.

The decline in the labour market opportunities of men could also influence the marriage market and thus indirectly the participation of single women. Bertrand et al. (2015) show that the probability of getting married for women decline when male labour market opportunities decline. As the pool of employed men shrank dramatically with the Great recession, labour force participation and the associated accumulation of human capital might have become more attractive for single women.

The Great recession in Europe offers an interesting setting to test these theories. First, the shock has been exceptionally large. Second, as we document below, and unlike previous recessions of the past, the shock has been disproportionately concentrated on male in Europe which makes it more likely to trigger a response from women.

B. Men and women during the Great Recession: why so different?

The division of labour by gender is based on the idea that men and women have on average different endowment of factors such as 'brain' and 'brawn' which explains why labour supply and demand vary by gender in many occupations.[26] As noted by Shin (2000), as a consequence of the current division of labour by gender, men and women are employed in occupations with different levels of volatility. As a result, the

[26] See e.g. Cortes et al. (2016) for recent evidence comparative advantages of women in high-wage occupations.

cyclicality of aggregate employment differs by gender. This has been clearly the case during the Great recession in Europe. Table 6 shows that net employment losses were much larger for men than women in countries that experienced the deepest recession such as Spain, Ireland, Portugal or Italy. For example, in Spain, total employment plummeted by 23% for men but by 'only' 8% for women.

These gender differences reflect to a large part the decline in middle-skill jobs and the associated polarization of employment. Recent work has emphasized that job polarization accelerated during the recent recessions in the US (Jaimovich and Siu, 2012; Foote and Ryan, 2015; Hershbein and Kahn, 2016).[27] For that country, Jaimovich and Siu (2015) estimate that 88% of job losses in routine occupation since the mid-1980s have occurred during a recession. We also find similar patterns in Europe during the Great recession. Table 7 documents job polarization in Europe following the broad categorization of Goos, Manning and Salomons (2014) into three groups: low paying, middling occupations and high paying occupations.[28] In most countries, employment in middling occupations fell rapidly, by 20 to 30% in Ireland, Greece, Italy and Spain in particular. In contrast, in high and low paying occupations, the number of employees declined much less or in some cases increased. As the share of total employment in middling occupations remains quite large, about 40% on average in our sample, most of the net job losses during the Great recession were concentrated on occupations in the middle of the distribution.

The recent polarization had more adverse consequence on men than women because of higher levels of occupational segregation by gender in Europe. Table 7

[27] While the secular trends of job polarization have now been well documented in Europe (Goos, Manning and Salomons, 2014), it has only been recently emphasized.

[28] To form these three groups, Goos, Manning and Salomons (2014) rank occupations by ISCO codes at the two digit level by their average wage measured in the 1990s. See the appendix of their paper for details.

shows that in Europe, in 2007, about 70% of employees in middling occupations are male. Women, in contrast, account for more than 60% of employees in the rapidly expanding low paying occupations and 40% in high paying occupations against 50% in both cases in the US.

These higher levels of occupational segregation in Europe have not diminished in the last decades. To assess segregation levels by occupation and their evolution systematically, we follow Dolado et al. (2001, 2003) and estimate the dissimilarity indexes across 20 occupation groups and 16 industries and their interactions.[29] Table 8 shows that the indexes of dissimilarity are systematically much higher in Europe across occupations consistent with the earlier evidence of Dolado et al. (2001, 2003), but not industries. Importantly, and in spite of the convergence in the participation rates of men and women documented before, gender segregation has not declined in the last decades.

To understand which occupations drive the previous differences between US and Europe, Appendix Table A3 compares the distribution of men and women across 20 occupation groups in the US and Europe (excluding the UK) in 2007. In Europe, a much higher proportion of women are in low skill service occupations with respect to the US: European female employees are much more likely than men to be "models, salesperson and demonstrators" and to be in "sales and elementary service occupations". In the high-paying group, they are more likely to be "associate professional". When these three occupation groups are excluded from the sample, the gap in dissimilarity levels between Europe and the US is diminished by half.

A final issue to interpret gender differences in labour demand shocks during the Great recession is how much the polarization of employment reflected between or

[29] One standard interpretation of the dissimilarity index is that it captures the share of women who would have to change occupation for the occupational distribution of men and women to become similar.

within industry variations. As documented by Goos, Manning and Salomons (2014) and Harrigan et al. (2016), the polarization of employment has both a within and between industry component. Clearly, employment losses were concentrated in particular industries during the Great recession: Table 7 shows that in most countries, employment in the manufacturing sector in Europe declined to a much greater extent than in the US. Also, in the construction sector, more than half of the jobs were destroyed in Spain, Greece, Ireland and Portugal. Unsurprisingly, the most intense job polarizations are also observed in these countries. Using simple (unreported) decomposition exercises, we find that the recomposition of employment across industries explain about half of the polarization of employment across occupations during the Great recession.

C. Empirical approach

We study in this section how labour demand shocks that were the consequences of job polarization and the Great recession affected the participation decision of men and women. We use variations across European regions over the period 2000-2013[30] obtained from the LFS. Thus we include years before and during the Great recession in order to assess how much the response of participation to these shocks differed during the crisis. We describe below the instrumental variable strategy that we adopt to isolate labour demand from supply shocks.

One challenge is how to empirically capture changes in local labour demand. While using potential wages would be consistent with a standard labour supply model, we prefer here to use instead changes in employment across particular groups of workers or occupations to approximate specific labour demand shocks. We do so for

[30] Many recent papers studying the impact of trade or technology during the last decade followed a labor market approach. See in particular Charles, Hurst and Notowidigdo (2016) or Chodorow-Reich and Wieland (2016) for recent work on the Great recession.

three main reasons. First, wages are quite hard to measure over the cycle because of composition biases (Solon, Bils and Parker, 1994) and this has been particularly the case during the Great recession in Europe (Verdugo, 2016). Using wages would also be problematic if they have been rigid in Europe during the Great recession as argued by Schmitt-Grohé and Uribe (2013) as their rigidity would mask large underlying demand shocks. Second, potential wages are also complicated to estimate for non-participants that might have been out of the labour force for a while. Third, and maybe more important, finding exogenous changes in wages to estimate labour supply responses is notoriously hard.[31]

We start with a simple model that relates the regional participation rates to labour demand shocks captured by variations in total employment:

$$LFPR_{rt} = \gamma emp_{rt} + \phi_r time + \alpha_r + \alpha_{ct} + u_{it} \quad (1)$$

where $LFPR_{rt}$ is the adjusted labour force participation rate in region r (in percentage points) for prime age workers, net of the effect of education and age, emp_{rt} is the log of total employment in the region, α_r are a region fixed effects, and u_{it} is an error term. The model includes region specific time trends ϕ_r that absorb the effects of deterministic trends in participation in the region. The model also includes a set of time by country fixed effects α_{ct} that accounts nonparametrically for any common variations in the participation rates in the country over time. We therefore fully absorb any national shocks on the participation rates and identify the model using variations within country over time. We estimate separately this model by gender and also across various demographic groups.

[31] See Devereux (2004).

A potential problem with the previous model is that it does not distinguish changes in labour demand specific to each gender. Women should respond differently to each in the presence of added worker effects and if labour markets are segmented such that changes in male and female labour demand are not perfectly correlated. To test this hypothesis, we estimate:

$$LFPR_{rt} = \gamma_1 emp_{rt}^{Male} + \gamma_2 emp_{rt}^{Female} + \phi_r time + \alpha_r + \alpha_{ct} + u_{it} \quad (2)$$

where the variables emp_{rt}^{Male} and emp_{rt}^{Female} captures changes in log employment of men and women, respectively.

Another issue is that the marginal worker might be more likely to respond to shocks in demand for specific skills. For example, the decline in demand for routine jobs in the manufacturing sector might not be compensated by the growth of employment in the service sector if mobility across occupations is low. To test this hypothesis, we estimate:

$$LFPR_{rt} = \pi_1 emp_{rt} + \pi_2 midd_{rt} + \pi_3 low_{rt} + \phi_r time + \alpha_r + \alpha_{ct} + u_{it} \quad (3)$$

where $midd_{rt}$ and low_{rt} test for a specific effect of changes in total employment in middling and low-paying occupations, respectively, while emp_{rt} controls for changes in overall employment.

The previous models are estimated using an instrumental variable approach to isolate variations in labour demand. Our identification strategy exploits the fact that the Great recession and job polarization reflect, to a large extent, the consequences of *global* labour demand shocks that reflect the effects of technology and the international trade. To create this instrument, we construct a variant of the well-known shift-share or

"Bartik" instrument following Bartik (1991) and Blanchard and Katz (1992).[32] The instrument exploits differences in initial specialization across local labour markets that make regions more or less vulnerable to globalization or technological change. While the composition of industries in some local labour markets exposed them to import competition, other labour markets specialized in routine task activities were exposed to technological change that polarizes employment.[33] As these shocks affected labour demand globally, an instrument using these sources of variation should be orthogonal with the unobserved local factors that influence the participation across regions and that are correlated with employment changes.

To construct the instrument, we use the more distant possible year available in the data to minimize correlations between the initial composition and unobserved trends in participation.[34] The reference year is 1995 thus chosen 12 years before the start of the Great recession, and also before major shocks such as the access of China to the WTO and the housing booms of the 2000s that followed the implementation of the Euro.

The instrument is as follows. In region r, in 1995, total employment can be defined as the sum of employment across occupations $k: Emp_{r,95} = \sum_{k} Empl_{kr,95}$. To predict employment growth based on these differences, the common Bartik approach would be to use variations in the growth of these occupations at the national level within each country over time. Such approach might be problematic in our case if changes in participation, in particular of women, drive differences in employment growth across occupations at the national level. To deal with this concern, we use instead employment

[32] This approach has been followed recently in many influential papers such as Autor, Dorn, and Hanson (2013) and Charles, Hurst and Notowidigdo (2016). See also Autor and Duggan (2003), Luttmer (2005) for other examples of work using variants of this "Bartik" measure.

[33] Autor, Dorn and Hanson (2015) demonstrated that the initial specialization of a region determined how it responded to technology and globalization during the last decade.

[34] Because regions were not coded consistently in some countries such as Finland or Ireland, we have been obliged to choose a more recent year sometimes. See the appendix for details.

changes across these occupations from the US to construct our instrument. As discussed previously, the participation rate of women in the US reached a plateau in the late 1990s and declined thereafter (Krueger, 2016). These developments suggest that it is quite unlikely that the structure of employment across occupations was substantially influenced by changes in the participation rate of women that are common across developed countries.[35] For each year, we estimate using CPS data $\Delta S_{kt}^{US} = \left(\frac{Emp_{kt}^{US} - Emp_{k,95}^{US}}{Emp_{k,95}^{US}} \right)$ where Emp_{kt}^{US} denote the number of employees in occupations k in period t in the US. Then, by combining the two previous elements, we obtain a counterfactual employment level in period t for region r: $Emp_{rt} = \sum_k \Delta S_{kt}^{US} Emp_{rk,95}$. Our final instrument for overall employment change emp_{rt} is obtained by using the log of the previous expression.

To create two separate instruments for the employment growth of men and women, we proceed in the same manner but use instead the initial distribution of men and women across occupations in 1995 to calculate $Emp_{rt}^{S} = \sum_k \Delta S_{kt}^{US} Emp_{rk,95}^{S}$ where S denotes the sex. Our instruments will thus predict counterfactual differences in employment growth by gender based on the initial distribution of employed men and women across occupations in 1995.

We create a set of instruments for changes in employment in middling and low-paying occupations for the model of Eq. (3) following a similar approach. In that case, differences employment changes in middling occupations across regions predicted by

[35] The approach of using foreing shocks instead of national level shocks to construct a shift-share instrument has been recently used by Autor, Dorn, and Hanson (2013).

the instrument reflect differences in the composition of middling occupations across regions.

To implement the instrument, we define occupations by using the interactions between 20 occupations and 16 industries that can be reasonably tracked over time in both the LFS and the CPS data. By using the interactions between these two dimensions, we exploit both the between and within industry components of job polarization in our identification.[36]

Our IV strategy will isolate labour demand shocks under two conditions: first, the initial specialization of the region across occupation by gender should not be correlated with unobserved factors influencing participation and correlated with changes in employment during the Great recession. To mitigate this concern, the model includes a determinist regional trend and our estimation sample starts in 2000, 5 years after the reference year used by our Bartik instrument. Second, the shocks to employment across occupations in the US should be unrelated with unobserved factors driving labour supply in Europe. An important threat to our empirical strategy is that common supply shocks drive both participation and job polarization across developed countries, because, for example, of the increase in women's participation in the labour force. The evidence presented earlier suggests this is quite unlikely as the participation of women followed very different patterns in the US and Europe before and during the Great recession. In addition, our estimates are conservative as they include time by country fixed effects in the model flexibly controls for changes in participation at the country level. This implies we identify the key coefficients from differences in economic

[36] The definitions of these occupations and industries are reported in supplementary Appendix.

specialization across regions within countries rather than relying in the national shocks themselves.

V. Results

Estimation results for the period 2000-2013 are presented in Table 9. In all specifications, the dependent variable is the participation rate of prime age workers that has been adjusted to accounts for the effect of changes in the distribution of education and experience in the population.[37] The regressions are also weighted by the initial population of the region in 1995 to ensure representativeness.[38] Reported standard errors are two-way clustered by year and region to address possible serial correlation within a region (Cameron and Miller, 2015).

The tables report the Kleibergen-Paap Wald F statistics that indicates whether our instruments are a strong predictor of observed changes in employment. The F-stats confirm the highly predictive power of our instruments. While the instruments are clearly stronger for total employment in isolation, the F-Stat remains above 10 when the regression includes separately male and female employment as in columns (4) or when the model is estimated in long differences as in Column (5).

Results in Column (1) and (2) indicate that the participation of male and female responds procyclically to overall labour demand shocks. While the coefficients are positive and statistically significant, they indicate very small effects. The coefficient from 2SLS estimates indicate that an increase by 10 log point of employment (reflecting a change in labour demand) increases the participation rates by 0.12 p.p. for men and 0.19 p.p. for women.

[37] The adjusted participate rates were obtained by using the residuals from a regression of the probability to participate to the labour force on 3 education dummies and 6 age dummies performed separately for each country over the entire period 2003-13.

[38] The weights applied to each year are fixed and thus do not varies with future changes in population. Unweighted results are very similar and are available upon request.

In columns (3) and (4), we distinguish between the consequences of changes in female and male labour demand. For men, both coefficients are small and statistically insignificant. On the other hand, we find that the participation of women *increases* in response to negative shocks to male labour demand. The 2SLS estimates in column (4) suggests that a decline by 10 log points of male employment increases the participation of women by 4.4 p.p. while an increase by 10 log points in female employment increases their participation by 4.4 p.p. This magnitude is non-trivial: over the 2007-13 period, total male employment declined by 4 log points while female employment increased by 2 log points on average across regions. Thus, the model predicts an increase by 2.7 p.p. in the adjusted participation rate of women over 2003-13 in the average region in our sample in response, with two third of this increase triggered by negative shocks to male labour demand.[39]

In column (5), we check the robustness of our results to alternative estimation methods by using long differences, from 2000-13, instead of the within estimator. This specification provides very similar results, albeit slightly lower coefficients. In Column (6), we use as a dependent variable the employment rate of women instead of the participation rate. The coefficients indicate that the employment rate of women also increased in response to the decrease in employment opportunities of men.

In Figure 4, we illustrate graphically the variations underlying the long differences model using the residuals of the previous 2SLS model. The figures make clear that no outlier or specific country or group of country are driving the results. More systematically, in supplementary Appendix Table A1, we explore whether our results

[39] As we make predictions based on results from 2SLS regressions, it is necessary to use the prediction from the first-stage regression as a covariate to get a consistent predictor (Skeels and Taylor, 2014). However, we use averages from the sample in our illustration and the average observed change in employment is equal to the average predicted change from the first stage regressions. This is because the average of the residuals is zero in the sample in first-stage OLS regression.

are driven by outlier countries by excluding each country one by one from the sample. We also assess in Table A2 whether the results vary between countries from the North and the South of Europe where the crisis had a different intensity. We find the results to be very robust and similar across these two groups of countries.[40]

A. Have some occupations more influence than others?

As discussed before, an issue with the previous model is that the marginal male worker may be more influenced by changes in demand in manufacturing or in construction than in total employment. To test this hypothesis, Table 10 explores various specifications that tests how participation responds to shocks in specific industries or occupations.

We start by including controls for manufacturing and construction in column (1) and (2). We find a small response of both men and women for changes in manufacturing employment. For men, column (2) shows that changes in employment in the construction sector have no influence on participation.[41]

Column (3) and (4) include controls for employment in middling and low skill occupations instead of by industries. For both genders, we find a substantial response of participation to employment in middling occupations but not to changes in the lowest-paying occupations. In Column (5), the model includes both manufacturing and middling occupations. Conditional on including middling occupations in the model, employment in manufacturing has no effect on men. Overall, while disentangling empirically the importance of each factor is delicate, these results suggest the participation of men responds more to employment in middling occupations than in

[40] We include Ireland in the group from South-Europe as this country also suffered a very deep recession. This choice has no influence the results.

[41] Clearly, our Bartik instrument that relies on US polarization is not appropriate to capture changes in demand in the construction sector in Europe. Recent construction booms and busts did not follow the same cycle across developed countries. We have constructed alternative Bartik instruments for changes in employment in the construction constructed using national level variations in total employment in the industry instead. While the instrument was clearly stronger, the results were qualitatively similar.

other occupations or industries. However, these findings must be interpreted with caution. First, the coefficients are small and, while being statistically significant, the predicted economic effects are not large. Second, in these specifications, we have to deal with at most 4 different endogenous variables. Because of the high level of correlation among these variables, our Bartik instruments are weaker and the point estimates of some coefficients imprecise.

To avoid weak instrument concerns, we keep the specifications of the models relatively parsimonious in the rest of the paper. For men, we include demand shocks in overall employment and in middling occupations. For women, we consider a simple model that controls separately for male and female employment.

B. How much do the results vary across individuals?

Table 11 investigates how the response varied across groups of men and women. In panel A, for men, we show how much the response differed across age groups and education levels. We find that the participation of men between 40 and 55 years of age tend to react much more than for younger men. Surprisingly, we find no response of worker with less than high-school education.

In panel B, we investigate the differences between married and single women. While both single and married women respond to changes in male employment opportunities, the response of married women is much larger. The estimated coefficients are twice as large for married women than for single women. This last result is consistent with the idea that our estimates reflect to a large extent the consequences of an added worker effect for married women. Across education groups, the coefficients are also larger for women with less than high-school education for whom labour supply might be the more elastic. On the other hand, we find a low response of university graduates that have the stronger attachment to the labour market.

C. How different was the Great recession?

An important issue to interpret our results and what happened in recent year is whether these reactions were driven by the Great recession or whether the Great recession only accelerated the existing pre-existing trends. To answer this question, we extend our estimation period to 1996-2013 and estimate separate models for the 1996-2007 and 2007-2013. These results are reported in Table 12. For both men and women, the results are qualitatively very similar in both periods. If anything, the coefficients are 20% lower when they are estimated before the Great recession suggesting that the relationship has been reinforced during the Great recession. Overall, it is clear that the results do not capture a phenomenon that is specific to the Great recession.

D. Robustness to alternative Bartik instruments

Finally, we check whether how much our results are affected by the particular construction of the Bartik instrument that we adopted. While using a Bartik approach to disentangle demand from supply shocks is now standard, it is less usual to use another country to construct the instrument.[42] In Table 13, we compare the results of our model that are reproduced in column 1 with those obtained from a traditional Bartik in Column (2). This last instrument predicts employment changes using the growth each occupations at the national level, instead of using the growth of these occupations from the US. While unsurprisingly the first-stage F-stat tends to be stronger in these specifications, we find very little differences in the estimated coefficients. In column 3, we experiment with a Bartik constructed using employment growth across occupations in Europe instead of the US (each time excluding the reference country). The results are

[42] Recent important exceptions include Autor et al. (2013, 2015).

also very similar. Overall, we conclude that our results are robust to alternative construction of the Bartik instrument.

VI. Evidence from panel data, 2003-2013

A concern with the previous results is that they are based on repeated cross-section data. Over a decade, the changes in the participation rates of prime age workers used to estimate the previous models do not completely correspond to changes in participation of the same individuals for two reasons. First, if many workers respond to local labour demand shocks by moving to other regions, some of the changes in regional participation rates will reflect changes in the composition of the population across regions. This will be the case, in particular, if those who move are selected and more or less likely to be in the labour force.

Second, the previous estimates were based on the population of prime age workers to avoid complications related with retirement and education decisions. Obviously, the composition of our sample changes over time. Older cohorts exit the sample when they attain 55 years of age and new cohorts enter when they attain 25 years of age. As a result, changes in participation of prime age workers in the last decades also reflect cohort effects. An important issue for women is that recent cohorts might have a more open attitude with respect to participation in the labour market. Social norms might have changed towards more egalitarian gender roles as cultural values and attitudes with respect to the costs and benefits of participation evolved (Fernandez, 2013 ; Petrongolo and Olivetti, Forthcoming). While the inclusion of time by year fixed effects at the country level should absorb some of these cohort effects, there is also strong evidence that attitudes vary within countries (see e.g. Duranton et al., 2009).

Another issue with the LFS results is that we cannot distinguish between the direct and indirect consequences of changes in male labour demand. The previous results can reflect both the response to direct income shocks such as the unemployment of the spouse, or indirect ones, such as lower expected incomes in the future. With panel data, we can control for the two channels simultaneously as we observe both variations in the economic status of the spouse over time and changes in economic opportunities for male in the local labour market.

To deal with these issues, we exploit data from the SILC European panel data set from 2004-2013. This panel follows individuals over a period of four year and thus allows us to estimate worker fixed-effects models that identify the response of participation from individual trajectories and not from cross-cohort variations. Comparisons between estimates from the LFS and SILC samples are nevertheless complicated by the fact that Germany does not participate to the SILC panel, and that data for Greece is missing after 2008. Another difference is that the sample size is much smaller: fewer years are available in the sample, and the definitions of regions in the panel are more aggregated in most countries to preserve confidentiality.[43]

The panel provides richer information on labour force participation than the LFS since it contains a retrospective calendar indicating for each month whether the individual was employed, in the labour force or out of the labour force. We use this information to estimate variants of the following model:

$$SHPR_{irt} = \alpha_i + \gamma_1 empl_{rt}^{Male} + \gamma_2 empl_{rt}^{Female} + \eta_1 SPUnemp_{it} + \eta_2 SPUnemp_{it-1} + \alpha_{ct} + u_{it}$$

where $SHPR_{it}$ is the share of the year where the individual declared she was in the labour force and $SPUnemp_{it}$ is a dummy variable equals to one when the spouse is

[43] Among the 10 countries in the SILC sample, we have 100 regions in the LFS but only 69 regions in the SILC.

unemployed and zero otherwise. We introduce both the contemporary and lagged employment status to allow for a delay in the response of the spouse. The model controls for an individual fixed effect α_i and is thus identified using within-individual variations over time, using at most four yearly individual observations that are available in the sample.[44] We restrict our sample to individuals remaining in the same region during the years they are observed in the sample.

Results are reported in Table 14. For men, we are not able to reproduce our previous finding in a model with individual fixed effects. We obtain much larger coefficients for total employment and employment in middling occupations with opposite coefficients. The point estimates tend to be imprecise and the signs of the coefficients shift depending on whether they are estimated on the group of 25-40 or on the group of 41-55 years old workers. One important issue is that the instruments are weaker in this specification than in the previous one.

For women, on the other hand, the coefficients are very close to those estimated previously with the LFS data. In Column (2) and (3) we find, consistent with the previous results, that labour demand shocks have twice as large effects on married women than on single women. In column (4), we add controls for the contemporary and lagged unemployment of the spouse. While, for men, we find little effect of the labour force status of the spouse, we find for women that having her husband unemployed during the last two years increase participation to the labour force by 4.4 p.p.

Unsurprisingly, a comparison between Column (3) and (4) indicates that controlling for the employment status of the spouse decreases the coefficient of regional male labour demand by a third. This suggests that about a third of the effect of men

[44] Region specific time trend are not included in this model. The results tend to get noisier when both individual fixed effects and regional trend are included in such limited period of time.

labour demand on participation estimated in Column (3) captures direct unemployment shocks at the household level. Finally, other variables that capture changes in the opportunity cost of employment for women have a large effect on the participation of women, as expected. We estimate that having a child of less than 3 years of age decreases participation by 2.5 p.p. while getting married decreases participation by 5.6 p.p.

Overall, the evidence in this section indicates that the previous results for women were not driven by migration or changes in the composition of cohorts as we have identified the key coefficients here using individual variations, not cross-cohort changes.

VII. How much did job polarization matters?

In this section, we use the effects previously estimated to assess how much changes in participation rates were influenced by gender specific labour demand shocks. To assess more credibly how much the previous model is able to explain cross-country differences during the Great recession, we perform an out of sample prediction by combining estimates from the period 1995-2007 from columns (1) and (4) in Table 12 in to predict aggregate changes in participation rates from 2007 to 2013 for men and women.

Our approach is the following. Denote $LFPR_{rt}(Emp_{rt}^{Male}, Emp_{rt}^{Female})$ the predicted labour force participation rate in region r and period t. We consider $\Delta LFPR_{r07-13}(Emp_{rt}^{Male}, Emp_{rt}^{Female})$ the predicted change in participation between 2013 and 2007 and $\Delta LFPR_{r07-13}(Emp_{r07}^{Male}, Emp_{r07}^{Female})$ the predicted change when Emp_{r07}^{Male} and Emp_{r07}^{Female} are fixed at their 2007 level. It is straightforward to derive that the difference between the two is given by:

$$\Delta LFPR_{r07-13}(Emp_{rt}^{Male}, Emp_{rt}^{Female}) - \Delta LFPR_{r07-13}(Emp_{r07}^{Male}, Emp_{r07}^{Female}) = \gamma_1 \Delta Emp_{rt}^{Male} + \gamma_2 \Delta Emp_{rt}^{Female}$$

The contribution of labour demand shocks is estimated using the difference between the out of sample predictions of the model with the predictions when there are no labour demand shocks. To get predictions at the country level, we use the weighted average of the regional predictions.

Figure 5 compares for each country at the national level the predicted and the actual change in participation rate. For men, the fit of the model is very poor both before and after the Great recession. Unsurprisingly, the model predicts the largest decrease in participation in Greece, Ireland and Spain where job destruction were the most important. Doing so, the model misses the large decline in participation of men in Italy, Belgium and Portugal. Similarly, it predicts no change in participation in Germany when a decline by one point is observed. We conclude that, for men, little cross-country differences in the evolution of the participation rate can be explained by labour demand shocks. Of course, this does not mean that labour demand shocks have no influence as the previous regressions have indicated that labour demand shocks indeed influence the participation rate across regions within countries. However, that indicates that most of the aggregate decline in male labour force participation is explained by other factors.

The picture is very different for women for which the fit of the model during the Great recession is surprisingly good. For most countries, the fit is remarkably good and they are quite close from the 45° line. This is in particular the case of Greece, Spain or Germany. There are nevertheless some important exceptions. First, the model is off the mark in Ireland as it predicts an increase in 4 p.p. in participation while a decline by 2 p.p. occurred. Second, the model also predicts an increase in participation in Italy and Portugal that did not happen. Nevertheless, while far from perfect, these predictions suggest a substantial role for differential labour demand shocks in explaining recent aggregate changes in labour force participation.

There are various concern associated with applying local estimates to a national context. A first issue is that the previous models included country by time fixed effects that might absorb the consequences of the same shocks at the national level. The fact that our estimates are conservative suggests they represent probably lower bounds of the actual effects. To check how much this is an issue, we have estimated the model without these fixed effects. In practice, we find qualitatively very similar coefficients.

A second concern is migration. Migration in response to local shocks might spread the effects to other local labour markets. To check whether this is an issue, we used data from the SILC panel to assess the intensity of the response to migration to employment shocks. [45] We found little evidence of systematic migration in response these labour demand shocks during the Great recession. This is not really surprising given of sample focus on prime age population and that migration rates are notoriously low after 30 years old.

VIII. Concluding Remarks

This paper has investigated the determinants of labour force participation in Europe in the last two decades, devoting a particular attention to what happened during the Great recession. We have shown that participation rates are influenced by changes in the composition of the populations and that these changes differed across countries, and in particular between Europe and the US. We find that some of the recent decrease in participation rates reflects the ageing of the large baby boom cohorts. For women, the rapid increase in their education level in Europe also explains a large share of the

[45] As migration can only be imperfectly observed in panel data because of attrition, we adopt two alternative definitions. In the first definition, we use information on actual internal migration. However, this approach might be a bit restrictive in that actual migrants might have been lost by attrition in the panel if an individual migrate to another country as only internal migration can be tracked in the SILC panel. A second definition is when we define migration by either by being located in another place or being missing in the sample.

increase their participation in the last decade and, in particular during the Great recession.

Focusing on prime age workers and adjusting the participation rates for changes in demographic and educational composition, we find that changes in labour demand that were more favourable for women than men explain a large share of the increase in their participation to the labour market. These differences in labour demand by gender in Europe reflect the consequence of job polarization where middling occupations that employ mostly men are declining while other occupations more likely to employ women are expanding. Job polarization was more intense in Europe during the Great recession than in the US because of higher level of gender segregation across occupation.

We also find that the participation of single women increased in response to male negative labour demand shocks but to a much lower extent than for married women. Overall, a model estimated using the 1996-2007 period predicts rather well aggregate cross-country differences in the changes in participation of women during the Great recession from 2007-2013, with the important exception of Ireland.

One limitation of our analysis is that we treat the increase in the education level of women as a composition effect. Of course, the large increase in graduation rates of women observed during the period might be driven to a large extent by the expansion of their opportunities in the labour market. Therefore, we are missing an important channel through which labour demand shocks are influencing participation.

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X. Appendix

LFS: We use annual files from the European LFS from the Dec 17th 2015 release from Eurostat. The labour force status is obtained with the variable ILOSTAT that refers to the International Labour Organization definition of the labour force status. Accordingly, labour force participation is defined as being employed during the reference week or seeking employment and being available for work.

Industry definition: Throughout the paper, we use Nace Rev. 2 from 2008 at the 1 digit level that has 21 industries. For years before 2008, the industry information is coded in Nace Rev. 1.. We convert this classification to Nace Rev. 2 using a cross-walk table that we manually created. To preserve consistency over time, we aggregated D (*Electricity*) with E (*Water supply*), H (*Transportation*) with J (*Information*) and L (*Real Estate*), M (*Professional activities*) with N (*Administrative and support service activities*) and we exclude agriculture from the sample. This leaves us with a total of 16 industries.

Aggregate industry definitions: "Manufacturing" is defined as aggregating B, C, D and E in Nave Rev. 2. "Construction" includes industry F. "Services" include all others sectors except agriculture (A).

Occupations: Following Goos et al. (2014), we use ISCO88 at the two digit level. After 2011, we convert data from ISCO08 into ISCO88 using a cross-walk table that we constructed. As in Goos et al. (2014, Table 1, p. 2512), low-paid occupations aggregate occupations 93, 51, 52 and 91. Middling occupations includes 81, 72, 83, 73, 71, 42, 82, 74. High-paying occupations include 12, 21, 22, 24, 13, 31, 34 and 32. See Appendix Table A3.

CPS: Industries: To match CPS industries codes with the codes in the LFS, we created a correspondence table between the variable IND1990 into Nace Rev. 2 from CPS at the

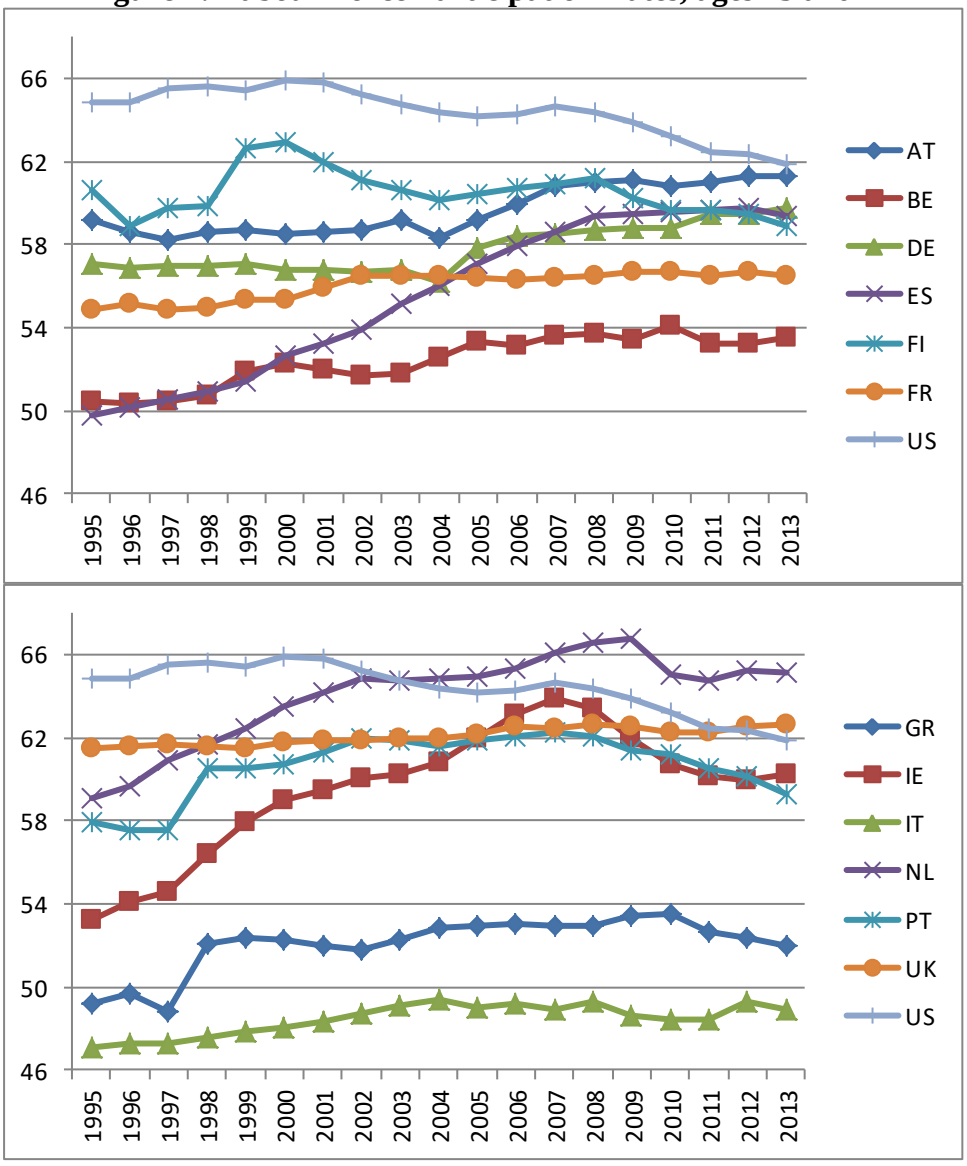
1 digit level. For occupations, we combine the variable occ2000 with codes ISCO88 using the cross-walk table established by the Center for Longitudinal Studies from UCL and available online at
http://www.cls.ioe.ac.uk/page.aspx?&sitesectionid=351&sitesectiontitle=Occupational+segregation (accessed January 26th, 2017).

Dissimilarity Indexes: The formula of the dissimilarity index is given by $D_t = \frac{1}{2}\sum_k |m_{kt} - f_{kt}|$ where m_{kt} and f_{kt} are respectively the share of men and women employed in occupation k in year t.

SILC Data: We use longitudinal SILC database from the July 28th 2016 release. We estimate the number of months in the labour force using the variables 211A-211L and 210A-210L. Individuals are classified as being in the labour force if the respondent declares that he is unemployed, employed or self-employed either full or part-time. We correct for panel errors by checking that there are no changes in sex or age of the respondent over time. In the regressions, we eliminate from the sample those that move to another region during the four years period in the sample.

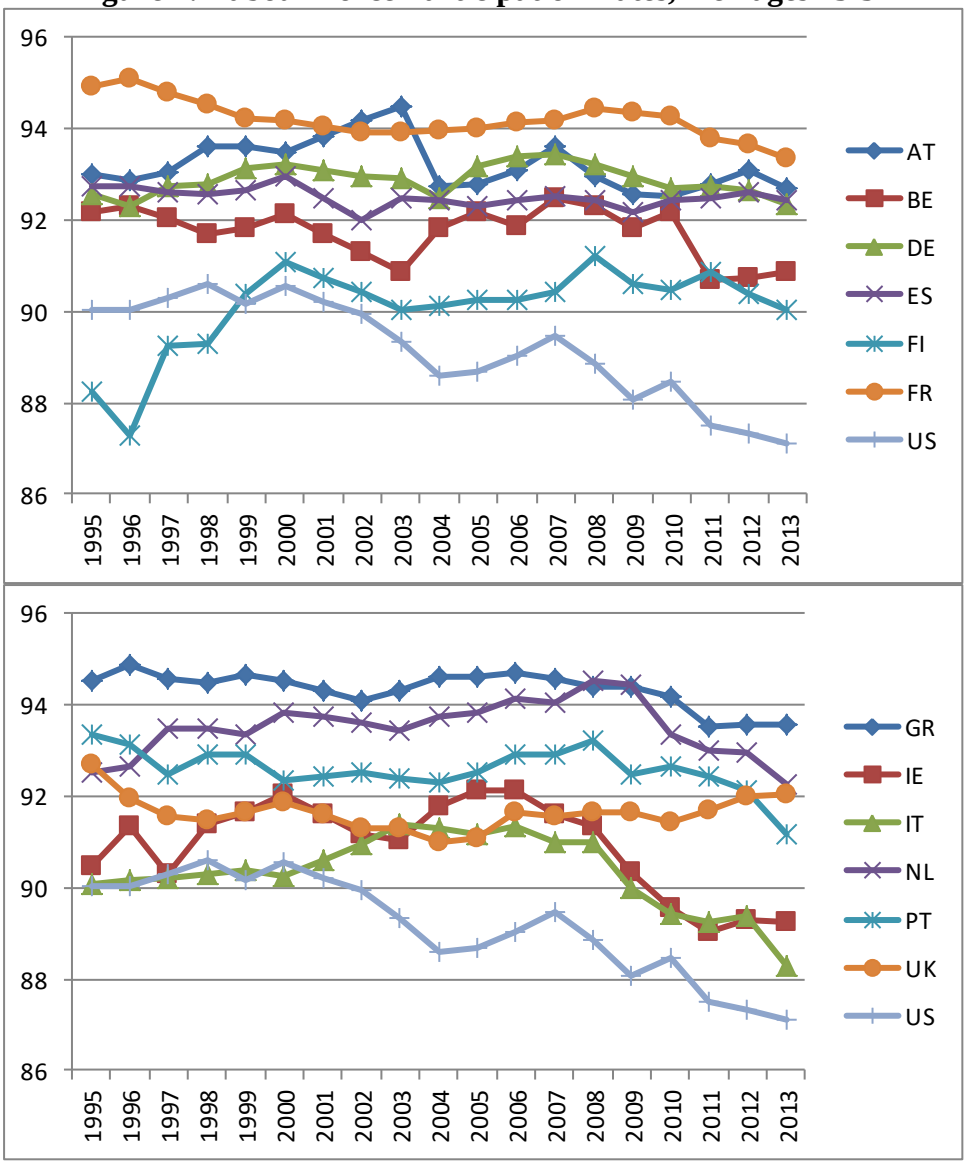
XI. Figures

Figure 1: Labour Force Participation Rates, ages 15 and +



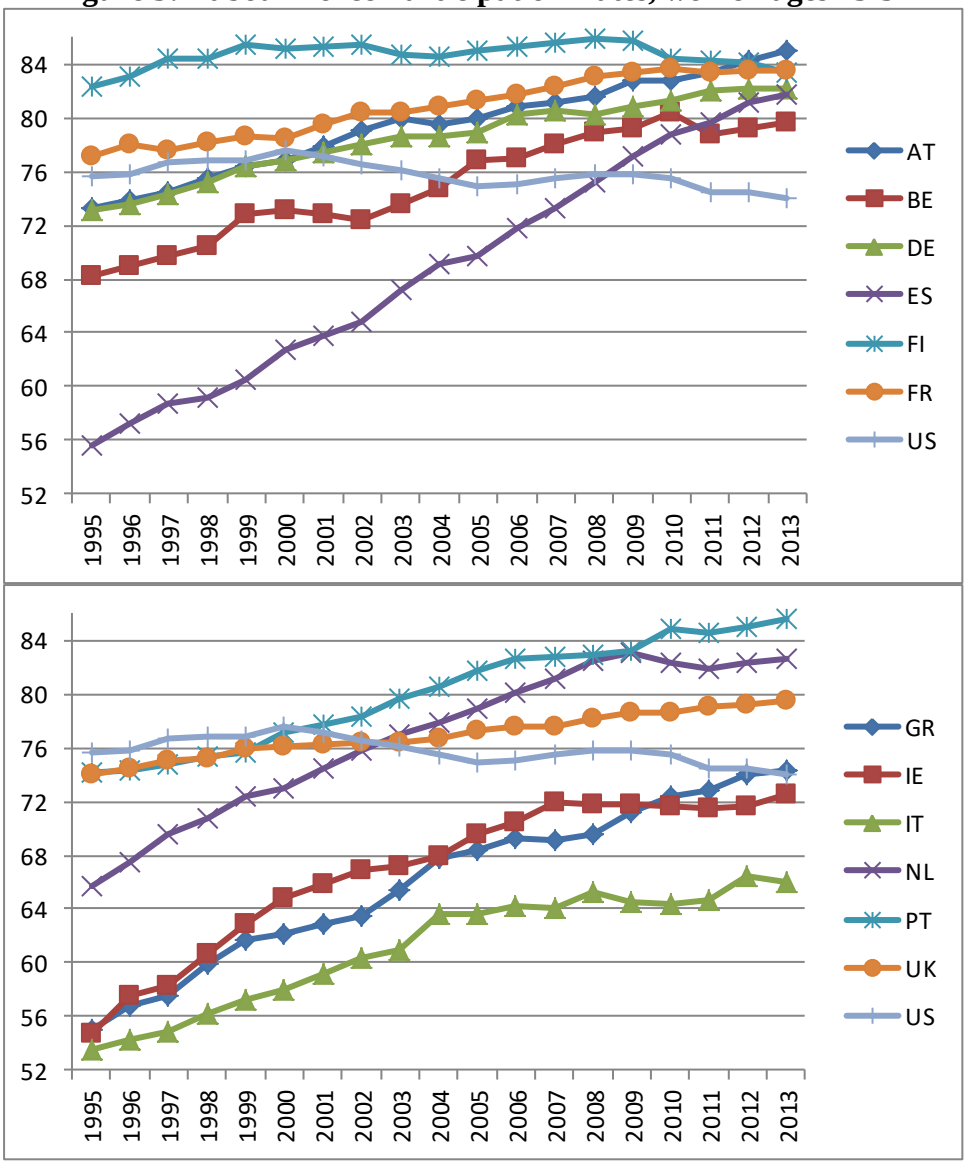
Sources: EU-LFS and CPS ASEC for the US. Tabulations by the authors.

Figure 2: Labour Force Participation Rates, men ages 25-54



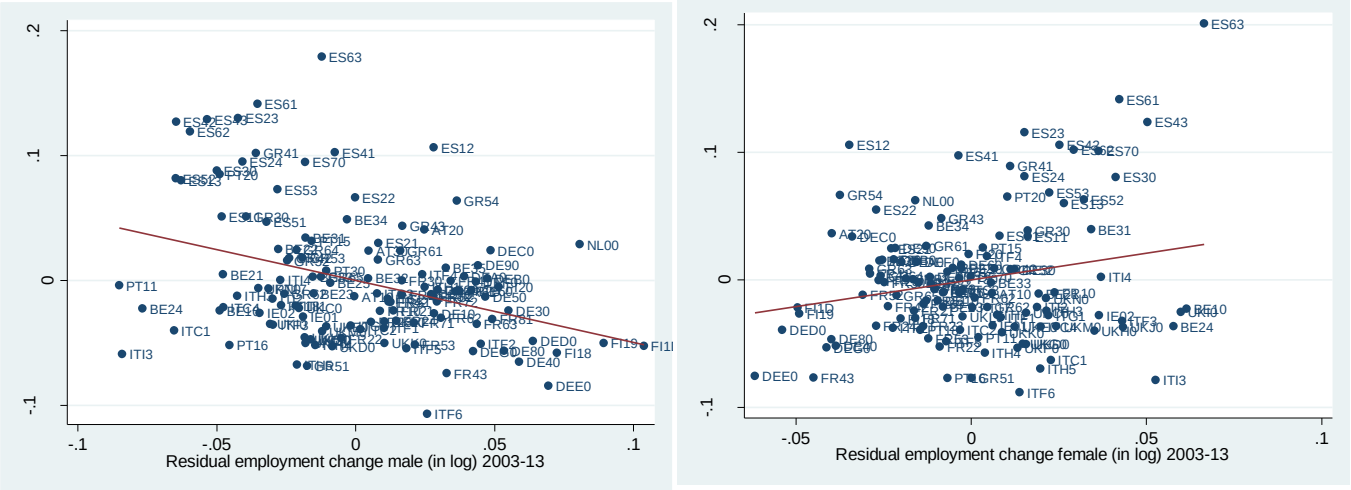
Sources: EU-LFS and CPS ASEC for the US. Tabulations by the authors.

Figure 3: Labour Force Participation Rates, women ages 25-54



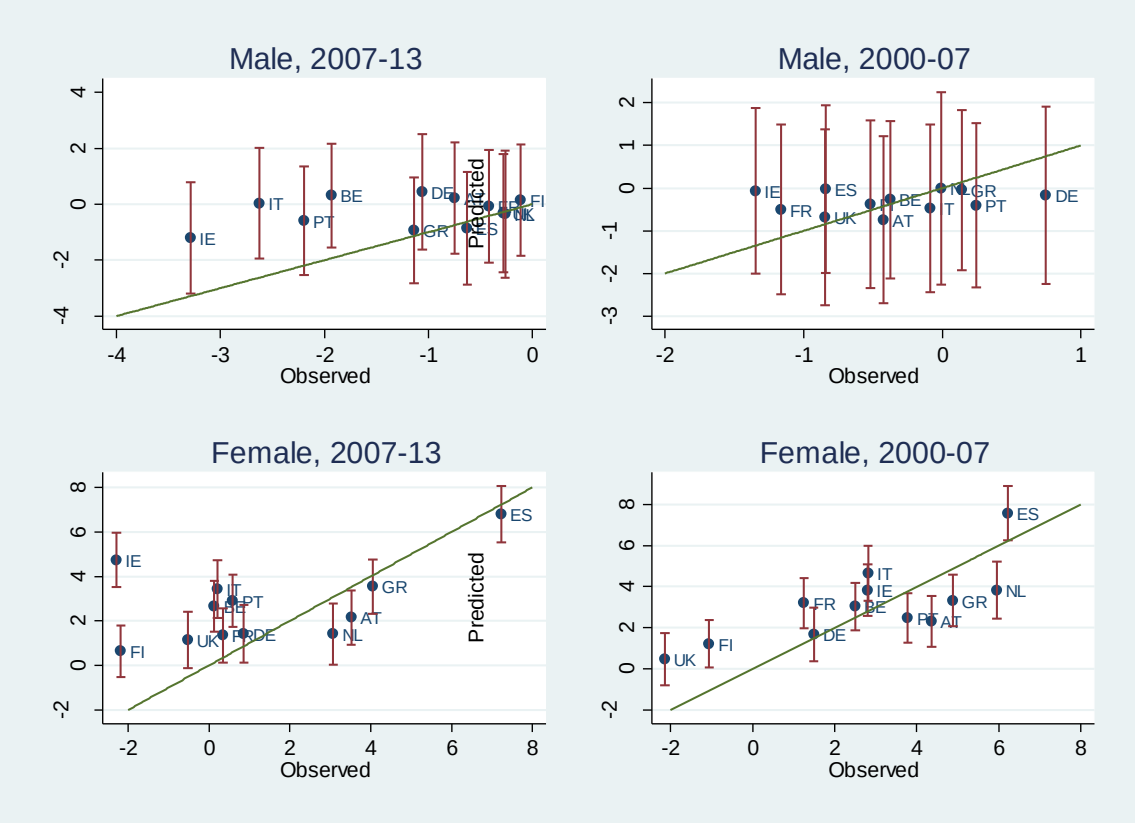
Sources: EU-LFS and CPS ASEC for the US. Tabulations by the authors.

Figure 4: Residuals changes in participation and Employment 2003-13



Notes: The figures show the residuals of the first difference regression reported in column 5 to Table 9.

Figure 5: How well does the model fit cross-country differences in participation before and during the Great recession?



Notes: The figure compares the predicted and actual changes in adjusted participation rates for men and women from 2007-13 and from 2000-07. The predictions are based on the model estimated over the 1990-2007 period. The models are reported in column (1) (3) for men and women respectively in Table 12. The figures report 95% confidence interval of the prediction. To facilitate comparisons, a 45 degree line is draw on each graph.

XII. Tables

Table 1: Share Prime Age Population, 25-54

	2007			2013			Change in share prime age 2007-13
	Share 15-24	Share 25-54	Share 55+	Share 15-24	Share 25-54	Share 55+	
US	17	53.3	29.7	16.3	50.2	33.5	-3.1
Austria	14.6	52.5	32.9	14.1	51.2	34.7	-1.3
Belgium	14.5	50.7	34.8	14.3	49.2	36.4	-1.4
Germany	13.8	49.3	36.9	12.6	47.9	39.5	-1.4
Spain	13.4	55.2	31.4	11.6	54.2	34.2	-1.0
Finland	15	48.3	36.7	14.5	46.0	39.6	-2.4
France	15.3	50.3	34.4	14.5	48.5	37	-1.8
Greece	13.6	51.2	35.2	11.9	50.0	38	-1.1
Ireland	18.3	56.0	25.7	14.9	56.0	29.1	0.0
Italy	12.0	51.1	37.0	11.5	49.8	38.6	-1.2
Netherlands	14.9	52.8	32.4	14.8	49.6	35.6	-3.2
Portugal	13.8	51.5	34.7	12.5	49.5	38	-2
UK	16.2	50.4	33.4	15.4	50.1	34.5	-0.3

Sources: EU-LFS and CPS ASEC for the US. Tabulations from the authors.

Table 2: Observed and Counterfactual Participation Rates

	Labor force participation rate in				Percentage point change 2007-13		
	2007		2013				
Country	Observed	Counterfactual using US demographics in 2007	Observed	Counterfactual using US demographics in 2013	Observed	Counterfactual change using 2007 demographics	Counterfactual change using US demographics
US	64.7	64.7	61.9	61.9	-2.8	-1.6	-2.8
Austria	60.8	63.2	61.3	62.5	0.5	1.6	-0.8
Belgium	53.6	56.8	53.6	55.2	0.0	0.8	-1.6
Germany	58.6	63.6	59.7	63.6	1.2	2.0	0.0
Spain	58.6	59.0	59.4	58.6	0.8	1.9	-0.4
Finland	61.0	64.8	58.9	62.9	-2.1	0.3	-1.9
France	56.4	59.6	56.5	59.0	0.1	1.8	-0.6
Greece	52.9	55.7	52.0	54.1	-0.9	0.4	-1.6
Ireland	63.9	61.7	60.2	57.9	-3.7	-2.6	-3.8
Italy	48.9	51.9	49.0	50.8	0.0	1.0	-1.1
Netherlands	66.1	67.8	65.2	67.0	-0.9	1.5	-0.8
Portugal	62.2	64.0	59.3	61.1	-2.9	-1.3	-3.0
UK	62.4	65.2	62.6	64.3	0.2	0.9	-0.9

Sources: EU-LFS and CPS ASEC for the US. Notes: The table compares observed and counterfactual participation rates in 2007 and 2013. The counterfactual participation rates were obtained by reweighting the sample to match the demographic composition of the US in either 2007 or 2013 (columns 3 and 5) and the demographic composition of the country in 2007 (column 7) using 14 age groups. See text for details.

Table 3: The Growth in Tertiary Education, ages 25-54

Share of the population with a tertiary education level								
	Men				Women			
	1995	2007	2013	Percentage point change 2007-13	1995	2007	2013	Percentage point change 2007-13
US	54.1	54.5	58.2	3.7	53.9	61.2	65.2	4.0
Austria	9.8	20.6	23.2	2.5	7.9	16.4	20.6	4.2
Belgium	26.4	32.0	34.4	2.4	28.2	37.7	42.5	4.8
Germany	28.8	27.2	30.2	3.0	18.6	22.2	28.0	5.8
Spain	20.0	30.5	34.2	3.7	18.2	34.3	40.1	5.8
Finland	na	32.2	35.9	3.7	na	46.3	51.9	5.5
France	19.9	27.4	33.1	5.7	21.1	31.7	38.6	6.9
Greece	18.7	24.4	27.9	3.5	15.1	24.4	30.6	6.2
Ireland	22.4	30.7	39.5	8.8	21.3	37.8	48.1	10.3
Italy	8.7	13.0	15.0	2.0	8.0	16.5	20.1	3.6
Netherlands	na	32.7	34.8	2.1	na	31.1	35.6	4.5
Portugal	10.9	11.8	16.7	5.0	14.6	18.6	26.3	7.6
UK	25.0	32.9	39.4	6.5	21.8	33.8	43.0	9.3

Sources: EU-LFS and CPS ASEC for the US. Notes: The table reports the share of the prime age population 25-54 with a tertiary education. The group of tertiary education includes short-term tertiary, Bachelor, Master and Doctoral or equivalent level.

Table 4: The Effect of Education on Participation in 2013-07, ages 25-54

Changes in participation rates (in percentage points)						
	Male			Female		
	2007-13 change	2013-07 change adjusted for education	Effect of education	2013-07 change	2013-07 change adjusted for education	Effect of education
	(1)	(2)	(1)-(2)	(4)	(5)	(4)-(5)
US	-2.6	-2.9	0.3	-1.4	-2	0.6
Austria	-0.9	-1.1	0.2	3.9	2.9	1.0
Belgium	-1.6	-2.1	0.5	1.7	-0.1	1.8
Germany	-1.1	-1.2	0.1	1.6	0.9	0.7
Spain	-0.1	-0.2	0.1	8.5	7.2	1.3
Finland	-0.4	-1	0.6	-2.3	-3.2	0.9
France	-0.8	-1.3	0.5	1.2	-0.3	1.5
Greece	-1	-1.1	0.1	5.1	3.1	2.0
Ireland	-2.4	-3.3	0.9	0.6	-2.5	3.1
Italy	-2.7	-2.9	0.2	1.9	0.3	1.6
Netherlands	-1.8	-1.8	0.0	1.4	0.5	0.9
Portugal	-1.7	-2.1	0.4	2.8	0.5	2.3
UK	0.5	0.0	0.5	2.0	-0.3	2.3
Education dummies	No	Yes		No	Yes	

Sources: EU-LFS and CPS ASEC for the US. Notes: Column 1 and 4 show the unadjusted change in participation rates of respectively male and female prime age individuals during 2007-13. Column 2 and 5

show the change in participation rate adjusted for changes in the level of education using a regression controlling for 3 education dummies.

Table 5: Change in Participation Rates by Education and Marital Status, 2007-13

Changes in participation rates, 2007-13								
	Men, 25-54			Women, 25-54				
	Below High-School	High-School Graduates	College Graduates	Below High-School	High-School Graduates	College Graduates	Married	Unmarried
US	-3.7	-3.4	-2.4	-2.1	-4.3	-1.0	-1.8	-1.5
Austria	-3.8	-0.6	-1.0	0.1	3.9	2.4	4.5	-1.1
Belgium	-4.2	-1.4	-1.2	-2.4	1.2	0.1	2.0	-1.0
Germany	-5.2	-0.6	-0.7	-3.3	2.2	0.5	2.0	-1.4
Spain	-0.6	0.3	-0.1	12.1	6.1	2.7	8.7	1.8
Finland	-1.8	-0.9	-0.7	-12.4	-2.5	-2.0	-2.1	-2.3
France	-3.1	-1.3	0.1	-4.4	0.0	2.1	1.4	-1.0
Greece	-1.5	-1.1	-0.7	5.5	3.4	0.1	5.2	0.1
Ireland	-4.5	-4.2	-1.4	-4.6	-2.2	-1.9	0.6	-1.4
Italy	-4.0	-2.1	-1.8	2.4	-1.4	0.1	1.5	0.6
Netherlands	-3.7	-1.6	-0.9	1.2	-0.5	1.5	2.2	-2.9
Portugal	-3.3	2.1	-2.0	-0.6	3.8	0.6	2.7	1.8
UK	-0.1	0.2	-0.3	-2.2	0.9	-0.4	2.2	-0.4

Sources: EU-LFS and CPS ASEC for the US. Notes: The table shows changes in participation rates in percentage points from 2007-13 for the indicated groups.

Table 6: Employment Change by Gender during the Great recession

Change in total number of employees, 2007-2013			
country	Women	Men	Percentage point difference Women-Men
US	0.1	-2.1	2.0
Austria	7.3	0.7	6.6
Belgium	7.4	0.3	7.1
Germany	8.2	4.6	3.6
Spain	-8.1	-22.8	14.7
Finland	-0.6	-2.2	1.6
France	2.5	-0.7	3.2
Greece	-19	-25.6	6.7
Ireland	-4.8	-15.9	11.1
Italy	1.8	-6.9	8.7
Netherlands	1.2	-3.2	4.4
Portugal	-9.6	-16	6.5
UK	3.6	1.2	2.4

Sources: EU-LFS and CPS ASEC for the US. Notes: The table shows the growth rate of the number of total employees from 2007-13 separately for men and women.

Table 7: Occupations and Industries during the Great recession

	Employment change 2007-13						Share women in 2007		
	Occupations			Industries					
Country	Lowest paying occupations	Middling occupations	Highest paying occupations	Manufacturing	Construction	Services	Lowest paying occupations	Middling occupations	Highest Paying occupations
US	2.1	-10.7	1.9	-13.4	-20.0	4.0	50.4	38.1	50.8
Austria	2.7	9.0	6.0	-7.9	13.3	7.3	64.5	32.4	40.1
Belgium	-0.9	11.1	13.2	-14.9	9.1	8	59.9	35.0	40.5
Germany	1.7	17.9	15.0	-4.4	9.2	10.8	66.3	31.4	45.5
Spain	-19.6	-30.1	-5.3	-28.3	-61.9	-4.7	60.7	24.0	42.0
Finland	-3.1	4.0	3.1	-17.7	1.1	3.0	72.6	28.9	46.8
France	6.0	-1.8	15.0	-12.4	1.2	3.4	69.5	36.6	43.3
Greece	-24	-35.8	-2.7	-38.7	-59.2	-17.8	55.6	26.1	37.9
Ireland	-8.6	-32.9	-6.5	-18.6	-63.8	1.1	56.8	31.8	40.2
Italy	-19.3	-2.1	29.7	-10.5	-18.6	1.3	53.4	28.9	38.7
Netherlands	-7.8	-9.6	19.2	-20.8	-17.2	-1.3	61.3	35.3	43.1
Portugal	12.5	-23.3	-12.4	-22.7	-48.1	-0.8	67.5	30.9	40.9
UK	15.9	-5.7	0.1	-15.3	-9.9	6.5	59.1	39.4	40.2

Sources: EU-LFS and CPS ASEC for the US.

Table 8: Dissimilarity Indexes of Segregation by Gender across Occupations

	ISCO 2 digit: 20 occupations			Nace 1 digit : 16 industries			Nace x ISCO: 20 occupations x 16 industries		
	1996	2007	2013	1996	2007	2013	1996	2007	2013
Austria	46.6	47.9	47.8	34.0	31.0	32.6	52.2	50.6	50.5
Belgium	43.1	41.7	46.4	31.8	31.2	33.5	50.4	48.1	49.3
Germany	49.0	47.9	45.9	31.6	31.9	31.8	52.1	50.8	49.9
Spain	39.8	46.7	42.8	33.5	37.1	31.7	48.0	52.8	48.2
Finland	50.0	53.5	51.0	38.1	38.6	40.7	56.7	56.7	54.8
France	49.9	48.9	45.8	28.3	30.7	31.3	51.4	50.1	50.1
Greece	36.4	40.2	31.7	22.3	26.6	21.8	40.2	43.6	36.4
Ireland	44.1	46.7	45.6	33.9	41.4	34.6	50.2	55.2	52.1
Italy	35.2	39.3	41.0	22.8	29.4	32.3	40.9	44.5	47.2
Netherlands	45.6	42.9	43.4	32.7	32.7	33.7	51.5	48.8	48.6
Portugal	38.0	42.1	42.3	25.2	30.0	32.7	44.0	48.2	49.0
UK	43.1	46.6	42.7	32.7	32.8	32.0	52.3	50.4	48.1
EU 11	43.0	45.2	44.0	28.5	31.0	30.9	45.5	47.8	47.6
US	37.4	36.5	34.5	29.6	30.4	30.2	45.8	43.7	42.0
Difference EU 11-US	*5.64*	*8.76*	*9.5*	*-1.1*	*0.62*	*0.75*	*-0.28*	*4.11*	*5.59*

Sources: EU-LFS and CPS ASEC for the US. Notes: The table shows the dissimilarity index of the distribution of men and women across the indicated definition of occupations and industries. The group of EU11 countries includes all European countries in our sample with the exception of the UK.

Table 9: Did Gender Specific Labour Demand Shock Influence Participation Rates?

Dependent variable						
Adjusted labour force participation rate of the region, 2000-13						Adjusted Employment rate
A. Male, 25-54						
	(1)	(2)	(3)	(4)	(5)	(6)
Log employment	0.012***	0.010***				
	(0.004)	(0.004)				
Log employment			0.015	-0.045	-0.027	-0.154
male			(0.025)	(0.040)	(0.085)	(0.118)
Log employment			-0.003	0.054	0.022	0.169
female			(0.022)	(0.037)	(0.079)	(0.110)
B. Female, 25-54						
Log employment	0.013**	0.013**				
	(0.006)	(0.006)				
Log employment			-0.311***	-0.444***	-0.335***	-0.587***
male			(0.023)	(0.041)	(0.111)	(0.087)
Log employment			0.317***	0.445***	0.322***	0.593***
female			(0.021)	(0.039)	(0.099)	(0.080)
N	1760	1760	1760	1760	128	1760
Kleibergen-Paap rk Wald F statistic		5089		11.4	10.7	11.4
Estimation method	OLS	2SLS	OLS	2SLS	2SLS, Long Differences 00-13	2SLS

Sources: EU-LFS. Notes: In column 1-5, the table shows regression results of the adjusted labor force participation rates of a region on the indicated variables. In column 6, the dependent variable is instead an adjusted employment rate. The dependent variables are adjusted for the effect of changes in age and education over time. The models are estimated with 2SLS using the Bartik instruments detailed in the text. Reported standard errors are two-way clustered by year and region. The regressions are weighted by the initial population of the region in 1995.

Table 10: The Consequences of Job Polarization and Manufacturing Decline

Dependent Variable: Adjusted labour force participation rate of the region, 2000-13					
	A. Male, 25-54				
	(1)	(2)	(3)	(4)	(5)
Log employment	-0.011	-0.011	-0.066***	-0.047	-0.040
	(0.009)	(0.016)	(0.024)	(0.038)	(0.040)
Log employment	0.014**	0.014**			-0.023
manufacturing sector	(0.007)	(0.007)			(0.018)
Log employment		0.000			
contruction sector		(0.015)			
Log employment			0.069***	0.063***	0.117**
middling occupations			(0.020)	(0.020)	(0.046)
Log employment				-0.013	-0.050
lowest-paying occupations				(0.024)	(0.042)
N	1760	1760	1760	1760	1760
Kleibergen-Paap rk Wald F statistic	207.1	22.8	20.6	10.4	3.9
Estimation method	2SLS	2SLS	2SLS	2SLS	2SLS
	B. Female, 25-54				
Log employment male	-0.469***	-0.502***	-0.496***	-0.508***	-0.488***
	(0.052)	(0.053)	(0.064)	(0.073)	(0.085)
Log employment female	0.455***	0.420***	0.383***	0.325***	0.334***
	(0.046)	(0.049)	(0.045)	(0.049)	(0.060)
Log employment	0.011	0.012*			-0.069**
manufacturing sector	(0.008)	(0.007)			(0.031)
Log employment		0.065***			
contruction sector		(0.015)			
Log employment			0.107***	0.130**	0.288***
middling occupations			(0.036)	(0.051)	(0.074)
Log employment				0.047	-0.067
lowest-paying occupations				(0.041)	(0.080)
N	1760	1760	1760	1760	1760
Kleibergen-Paap rk Wald F statistic	11.4	24.3	8.7	6.8	4.0
Estimation method	2SLS	2SLS	2SLS	2SLS	2SLS

Sources: EU-LFS. Notes: The table shows regression results of the adjusted labor force participation rates of a region on the indicated variables. The participation rates are adjusted for the effect of changes in age and education over time. The models are estimated with 2SLS using the Bartik instruments detailed in the text. Reported standard errors are two-way clustered by year and region. The regressions are weighted by the initial population of the region in 1995.

Table 11: What Group Responded the Most to the Demand Shocks?

Dependent variable: Adjusted labour force participation rate of the region, 2000-13					
	(1)	(2)	(3)	(4)	(5)
	A. Male, 25-54				
	Age 25-40	Age 40-55	Less than high-school education	High-school graduates	University graduates
Log employment	-0.002	0.102***	0.008	0.001	-0.027
	(0.026)	(0.038)	(0.042)	(0.029)	(0.021)
Log employment	0.064***	0.039***	0.028	0.058***	0.048***
middling occupations	(0.008)	(0.011)	(0.022)	(0.009)	(0.008)
Kleibergen-Paap rk Wald F statistic	75.2	75.2	75.2	75.2	75.2
	B. Female, 25-54				
	Married	Single	Less than high-school education	High-school graduates	University graduates
Log employment male	-0.626***	-0.272***	-0.566***	-0.457***	-0.081*
	(0.062)	(0.071)	(0.084)	(0.055)	(0.044)
Log employment female	0.629***	0.286***	0.572***	0.457***	0.079*
	(0.060)	(0.070)	(0.083)	(0.054)	(0.044)
Kleibergen-Paap rk Wald F statistic	11.3	11.3	11.3	11.3	11.3
Estimation method	2SLS	2SLS	2SLS	2SLS	2SLS
N	1760	1760	1760	1760	1760

Sources: EU-LFS. Notes: The table shows regression results of the labor force participation rates of the region on the indicated variables. For men in Panel A, columns 1 and 2 use the participation rates of those at age 25-40 and age 40-55, respectively. For women in panel B, columns 1 and 2 use the participation rates of married and single individuals, respectively. In columns 3, 4, 5, the participation rates are distinguished by education, with those having less-than high-school education, high-school graduates, and university graduates. The models are estimated with 2SLS using the Bartik instruments detailed in the text. Reported standard errors are two-way clustered by year and region. The regressions are weighted by the initial population of the region in 1995.

Table 12: Did the Response to Labour Demand Shocks Change during the Crisis?

Dependent Variable: Adjusted labour force participation rate of the region				
	Male, 25-54		Female, 25-54	
	(1)	(2)	(3)	(4)
Estimation period	1996-2007	2007-13	1996-2007	2007-13
Log employment	0.014	0.045		
	(0.020)	(0.029)		
Log employment middling occupations	0.045***	0.048***		
	(0.012)	(0.006)		
Log employment male			-0.390***	-0.481***
			(0.031)	(0.062)
Log employment female			0.389***	0.482***
			(0.030)	(0.061)
N	1296	896	1296	896
Kleibergen-Paap rk Wald F statistic	12	9.4	14.1	16.2
Estimation method	2SLS	2SLS	2SLS	2SLS

Sources: EU-LFS. Notes: The table shows regression results of the adjusted labor force participation rates of a region on the indicated variables. The participation rates are adjusted for the effect of changes in age and education over time. The models are estimated with 2SLS using the Bartik instruments detailed in the text. Reported standard errors are two-way clustered by year and region. The regressions are also weighted by the initial population of the region in 1995.

Table 13: Do the results change with alternative Bartik instruments?

Dependent Variable: Adjusted labour force participation rate of the region			
Construction of the instrument	US growth (occupations x Industries)	National growth of (occupations x Industries)	European growth (occupations x Industries)
	A. Male, 25-54		
Log employment	0.034	0.027	0.028
	(0.024)	(0.023)	(0.022)
Log employment middling occupations	0.050***	0.044***	0.047***
	(0.006)	(0.006)	(0.007)
Kleibergen-Paap rk Wald F statistic	6.1	20.1	13.2
	B. Female, 25-54		
Log employment	-0.444***	-0.377***	-0.412***
male	(0.041)	(0.043)	(0.048)
Log employment	0.445***	0.380***	0.414***
female	(0.039)	(0.039)	(0.045)
Kleibergen-Paap rk Wald F statistic	11.4	11.6	12
N	1760	1760	1760

Sources: EU-LFS. Notes: The table shows regression results of the adjusted labor force participation rates of a region on the indicated variables. The participation rates are adjusted for the effect of changes in age and education over time. The models are estimated with 2SLS using the Bartik instruments detailed in the text. Column 1, 2 and 3 uses Bartik instruments constructed respectively with US, national level, and European growth across occupations. Reported standard errors are two-way clustered by year and region. The regressions are also weighted by the initial population of the region in 1995.

Table 14: Panel data Evidence on the Response of Participation to Demand Shocks

Dependent variable: Share of the year in the labour force, 2003-2013					
A. Male, 25-54 of age					
	(1)	(2)	(3)	(4)	(5)
	All	Age 25-40	Age 41-55	Married	All
log employment	-0.330	0.318	-0.826**	-0.506*	-0.355
	(0.217)	(0.288)	(0.364)	(0.273)	(0.235)
log middling occupations	0.222	-0.413**	0.697**	0.380*	0.242
	(0.148)	(0.207)	(0.302)	(0.203)	(0.165)
Spouse unemployed				0.002	0.004*
				(0.002)	(0.002)
Spouse unemployed				-0.001	-0.001
last year				(0.002)	(0.002)
Child				0.000	0.002
				(0.002)	(0.001)
Married					0.009***
					(0.003)
Child less than 3 years					-0.002
of age					(0.001)
Kleibergen-Paap rk Wald F statistic	5.1	4.9	4.3	4.4	4.7
N	382 514	139 581	172 109	251 508	382 514
B. Female, 25-54 of age					
Sample composition	All	Singles	Married	Married	All
log employment male	-0.527***	-0.386*	-0.560***	-0.370**	-0.321**
	(0.165)	(0.210)	(0.161)	(0.159)	(0.159)
log employment female	0.560***	0.290*	0.634***	0.492***	0.366***
	(0.132)	(0.170)	(0.135)	(0.130)	(0.121)
Spouse unemployed				0.021***	0.021***
				(0.005)	(0.004)
Spouse unemployed				0.023***	0.021***
last year				(0.005)	(0.005)
Child				-0.018***	-0.010***
				(0.002)	(0.002)
Child less than 3 years					-0.015***
of age					(0.004)
Married					-0.056***
					(0.012)
Kleibergen-Paap rk Wald F statistic	18.8	21.5	17.1	15.8	17.5
N	413 669	124 613	282 419	282 419	413 669
Individual fixed effects	Yes	Yes	Yes	Yes	Yes
Method	2SLS	2SLS	2SLS	2SLS	2SLS

Sources: EU-SILC Panel. Notes: The table shows regression results where the dependent variable is the share of the year in the labor force for an individual in the panel. That variable is normalized to 1 when the entire year was reported in the labor force. The models are estimated with 2SLS using the Bartik instruments detailed in the text. Reported standard errors are clustered by region. All regressions include individual fixed effects.

XIII. Appendix not for publication

Table A1: Are the results in Table 9 robust to the exclusion of a country from the sample?

	Dependent variables : adjusted labour force participation rates											
	A. Men											
Country Excluded	AT	BE	DE	ES	FI	FR	GR	IE	IT	NL	PT	UK
log employment	0.009**	0.008*	0.007	0.018***	0.011***	0.014***	0.012***	0.010***	0.011***	0.010***	0.012***	0.010***
	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
N	1718	1606	1568	1508	1704	1466	1578	1732	1480	1746	1662	1592
Kleibergen-Paap rk Wald F statistic	5323.2	3245.3	4277.8	5844.9	5094.4	2052.6	2240.6	5102.4	5068.5	5103.9	5261.3	4960.4
	B. Women											
Country Excluded	AT	BE	DE	ES	FI	FR	GR	IE	IT	NL	PT	UK
log employment male	-0.449***	-0.475***	-0.410***	-0.401***	-0.443***	-0.402***	-0.448***	-0.444***	-0.442***	-0.444***	-0.445***	-0.432***
	(0.041)	(0.042)	(0.039)	(0.080)	(0.041)	(0.063)	(0.044)	(0.041)	(0.040)	(0.041)	(0.042)	(0.040)
log employment female	0.448***	0.471***	0.411***	0.411***	0.445***	0.408***	0.451***	0.445***	0.443***	0.445***	0.449***	0.434***
	(0.039)	(0.040)	(0.036)	(0.076)	(0.039)	(0.060)	(0.042)	(0.039)	(0.038)	(0.039)	(0.040)	(0.038)
N	1718	1606	1568	1508	1704	1466	1578	1732	1480	1746	1662	1592
Kleibergen-Paap rk Wald F statistic	11	11.4	14.2	4	11.4	21	10.4	11.4	11.3	11.4	11.5	11.1

Note: The table shows regression results of the adjusted labor force participation rates of a region on the indicated variables. In each column, the indicated country has been excluded from the sample. The dependent variables are adjusted for the effect of changes in age and education over time. The models are estimated with 2SLS using the Bartik instruments detailed in the text. Reported standard errors are two-way clustered by year and region. The regressions are weighted by the initial population of the region in 1995.

Table A2. Are the Results Similar in Countries from the South and the North of Europe?

	Men		Women	
	North	South	South	North
Log employment	0.007**	0.029***		
	(0.003)	(0.006)		
Log employment male			-0.450***	-0.490***
			(0.038)	(0.099)
Log employment female			0.452***	0.513***
			(0.039)	(0.105)
N	1134	626	1134	626
Kleibergen-Paap rk Wald F statistic	605.2	691.9	18.1	7.4

Note: Ireland is included in the South. Countries in the group of the North are Austria, Belgium, Germany, Finland, the Netherlands, and the United Kingdom. Countries in the South are Spain, Greece, France, Italy, Portugal, and Ireland.

Table A3 Distribution across occupations of men and women in 2007

		US			EU11 (excl UK)		
	ISCO Codes	Male	Female	Diff M-F	Male	Female	Diff M-F
High-Paying Occupations							
Corporate Managers & Managers Small Enterprises	10,11,12,13	15.5	12.1	3.4	9.5	5.7	3.8
Professionals	20,21,22	7.2	5.8	1.4	6.8	3.7	3.1
Teaching professionals	23	2.7	7.4	-4.6	2.5	5.7	-3.2
Other professionals	24	4.8	7.4	-2.6	4.2	4.7	-0.5
Physical, mathematical, and engineering associate professionals	30,31	3.2	1.6	1.6	6.2	1.7	4.5
Other associate professionals	33,34	8.0	10.2	-2.2	8.0	14.7	-6.7
Life science and health associate professionals	32	1.2	5.1	-3.9	1.1	5.1	-4.0
Middling occupations							
Stationary plan and related operators	80,81,82	2.6	2.0	0.6	5.6	2.6	2.9
Metal, machinery and related trade work	72	10.2	1.6	8.7	8.7	0.4	8.3
Drivers and mobile plan operators	83	6.5	0.9	5.6	6.8	0.4	6.5
Office clerks	41	4.2	13.9	-9.8	5.9	14.2	-8.2
Precision, handicraft, craft printing and related trade workers	73	0.7	0.2	0.5	0.9	0.4	0.4
Extraction and building trades workers	70,71	8.5	0.2	8.2	11.3	0.8	10.5
Customer service clerks	42	1.7	6.9	-5.2	0.9	3.6	-2.7
Other craft and related trade workers	74	0.7	0.5	0.2	2.4	1.5	0.9
Low-Paying Occupations							
Laborers in mining, construction, manufacturing, and transport	92,93	5.2	1.2	4.0	4.7	2.2	2.5
Personal and protective service workers	50,51	7.6	14.8	-7.2	5.1	13.1	-8.0
Models, salespersons, and demonstrators	52	2.9	3.2	-0.3	2.2	7.3	-5.1
Sales and elementary service occupations	90,91	3.9	4.5	-0.7	3.4	9.9	-6.5
Skill agricultural worker	61	2.8	0.5	2.3	3.9	2.3	1.6
	Total	100.0	100.0		100.0	100.0	