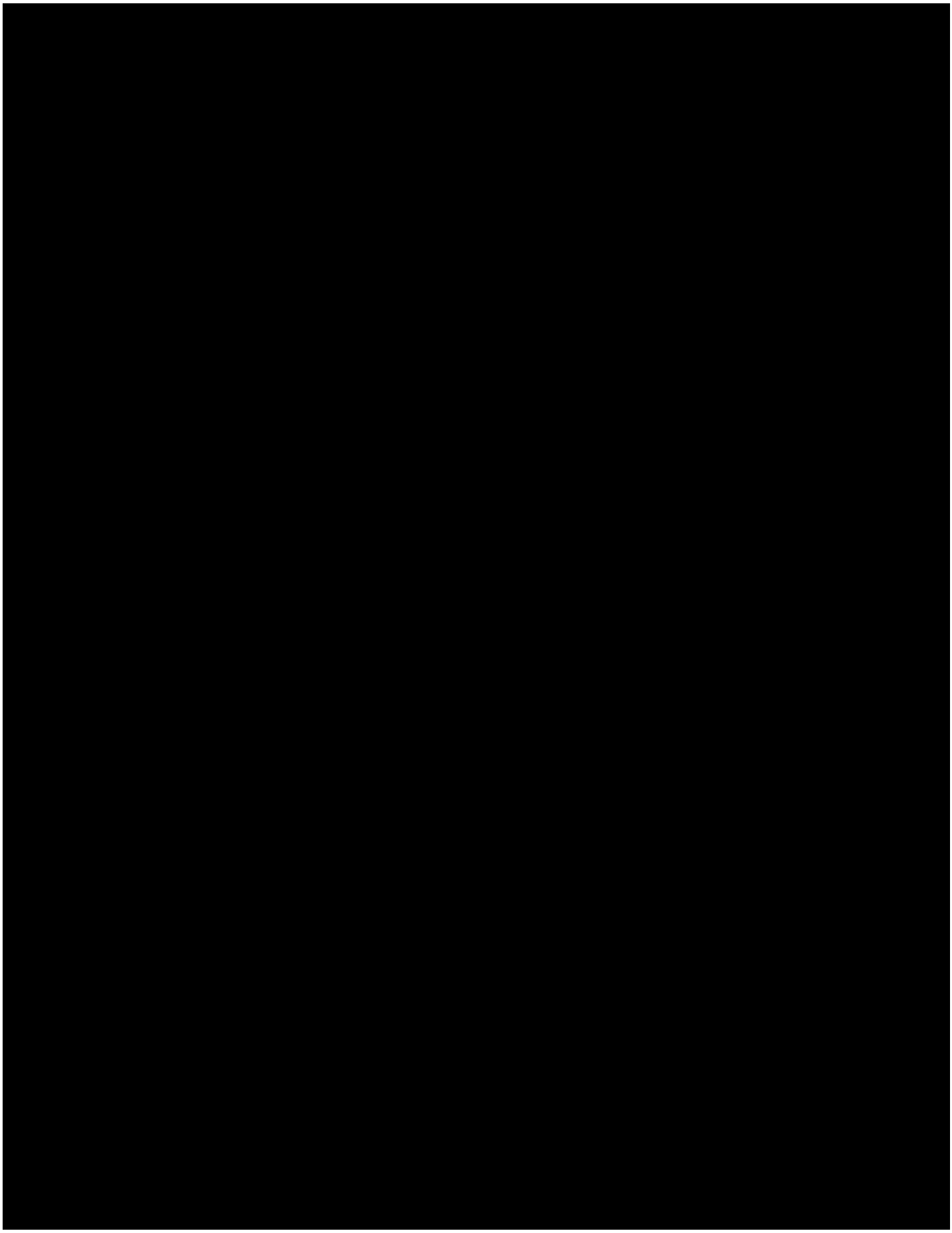

 WP/18/165

IMF Working Paper

Research Department

Still Attached? Are Social Safety Nets Working? Labor Force Participation in European Regions

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Authorized for distribution by Oya Celasun

July 2018

Abstract

The paper examines the evolution and drivers of labor force participation in European regions, focusing on the effects of trade and technology. As in the United States, rural regions within European countries saw more pronounced declines (or smaller increases) in participation than urban regions. Unlike in the United States, however, trade and technology, captured here using novel measures of initial exposures to routinization and offshoring, did not result in detachment from the workforce in European regions. Instead, regions with high initial exposures to routinization and offshoring experienced so-far larger increases in participation, likely driven by an added second worker effect.

JEL Classification Numbers: F16, F66, J21, J23, R12

Keywords: Labor force participation, exposure to routinization, exposure to offshoring, technology, automation

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[1] The authors would like to thank Oya Celasun, Jiri Podpiera, Alasdair Scott and Petia Topalova for very helpful comments on earlier drafts of the paper.

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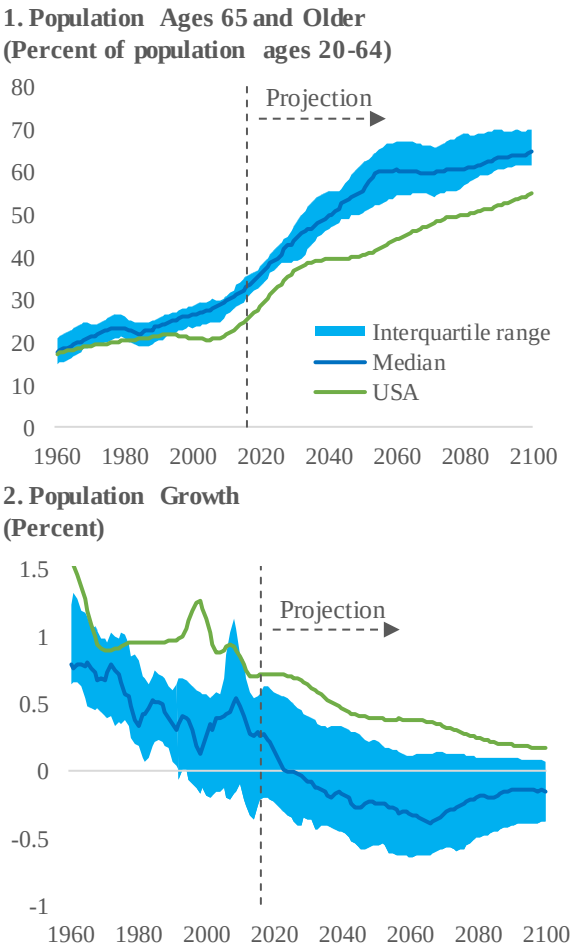
I. INTRODUCTION

In most European economies, dependency rates have increased considerably since the 1960s, driven by a combination of slow population growth and increasing life expectancy. As these trends gather pace, dependency ratios are projected to reach a striking 50 percent in more than three-quarters of countries by 2050 (Figures 1 and 2). These demographic trends weigh on labor force participation rates, and challenge the sustainability of social insurance schemes going forward.[2]

So far, however, participation rates have increased in the majority of European countries, and exhibited convergence, especially from the bottom (Figure 3).[3] This rise in participation rates stands in contrast with the stark decline in participation observed in the United States (see Chapter 2 of the April 2018 *World Economic Outlook*), despite milder demographic pressures (Figure 2). The large literature on the declining labor force participation rates in the United States highlighted the forces of trade and technology, suggesting that the disappearance of jobs due to automation and globalization may have led to the permanent detachment of some of the affected workers from the workforce (see Acemoglu and

Figure 1. Demographic Transition in European Economies, 1960-2100



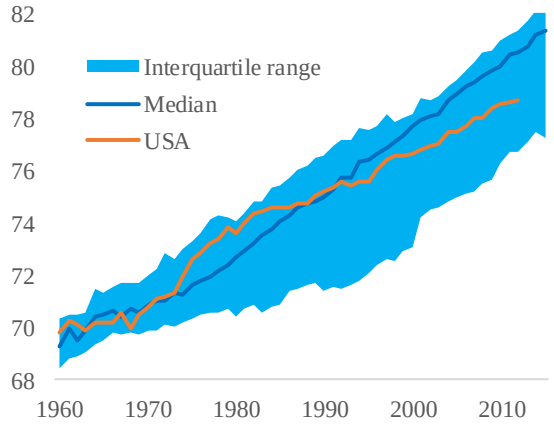
Sources: United Nations; and authors' calculations.
Note: Countries included in summary statistics are AUT, BEL, BGR, CHE, CYP, CZE, DEU, DNK, ESP, EST, FIN, FRA, GBR, GRC, HRV, HUN, IRL, ISL, ITA, LTU, LUX, LVA, MLT, NLD, NOR, POL, PRT, ROU, SVK, SVN, and SWE.

[2] The median European economy's population grew at only one fourth of a percent in 2016 and more then half of countries will see negative growth rates by 2025 (Figure 1, panel 2). The median country's life expectancy increased by more than 12 years over the course of the past five and a half decades (Figure 2, panel 1). Healthy life expectancy also increased: by 3.6 years for men and by 2.8 years for women in the median European country between 1990 and 2015 (Figure 2, panel 2).

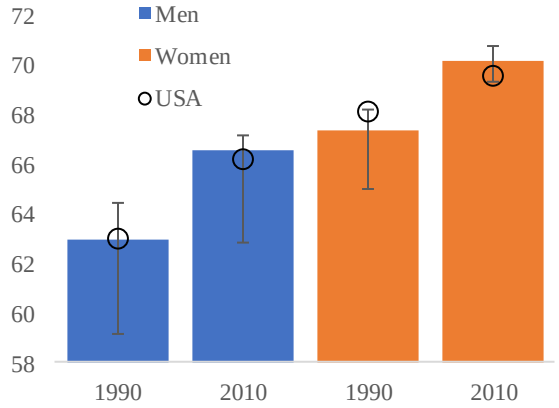
[3] Numbers are based on a balanced panel of 237 non-overlapping NUTS regions from 28 European advanced as well as emerging market and developing economies. Data is available for regions from the following countries: AUT, BEL, BGD, CYP, CZE, DEU, ESP, EST, FIN, FRA, GBR, GRC, HUN, IRL, ISL, ITA, LTU, LUX, LVA, MLT, NLD, NOR, POL, PRT, ROU, SVK, SVN, and SWE.

Figure 2. Changes in Life Expectancy in Advanced Economies

1. Life Expectancy at Birth, 1960-2015



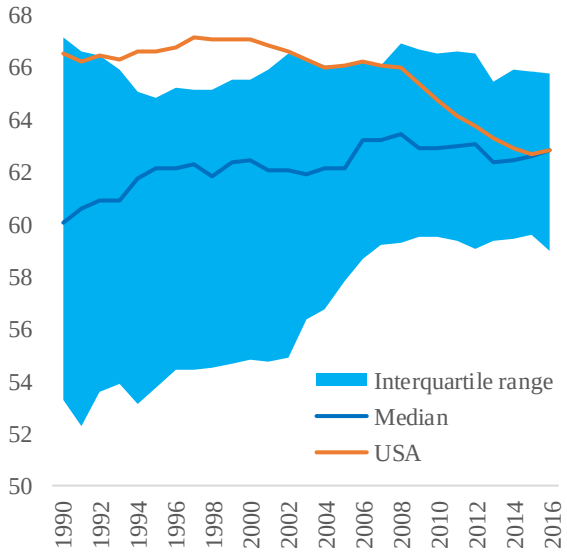
2. Healthy Life Expectancy by Sex, 1990 and 2010



Sources: United Nations; and authors' calculations.
Note: Countries included in summary statistics are AUT, BEL, BGR, CHE, CYP, CZE, DEU, DNK, ESP, EST, FIN, FRA, GBR, GRC, HRV, HUN, IRL, ISL, ITA, LTU, LUX, LVA, MLT, NLD, NOR, POL, PRT, ROU, SVK, SVN, and SWE.

Figure 3. Evolution of Labor Force Participation Rates, 1990-2016

(Percent)



Sources: Organisation for Economic Co-operation and Development; and authors' calculations.
Note: European countries included are AUT, BEL, CHE, CZE, DEU, DNK, ESP, EST, FIN, FRA, GBR, GRC, IRL, ISL, ITA, LUX, NLD, NOR, PRT, SVK, and SWE. Abbreviations in the footnote use International Organization for Standardization (ISO) country codes. Summary statistics are based on balanced panel starting in 1995.

Restrepo 2017, Autor, Dorn and Hanson 2016, Council of Economic Advisers 2016, Krause and Sawhille 2017). Recent work also emphasized widening geographic disparities in such trends, and their political economy implications (see Austin, Glaeser and Summers 2018, Brooks and others 2017a, b, c). In contrast, most of the literature on labor force participation in Europe focused on the role of policies and age and cohort effects, especially on the participation of women and older workers, with until recently little emphasis on the potential role of trade and automation in shaping participation trends over the past cople of decades. Notable recent exceptions include Gregory, Salomons and Zierahn (2016) and Graetz and Michaels (2015), who have noted that the impact of technology may be different in Europe.

This paper aims to contribute to this literature by examining the evolution and drivers of labor force participation rates in Europe, looking at heterogeneity across European

regions, and zooming in on the effects of automation and offshoring. In particular, the paper first examines to what extent the increase in participation rates observed in most European countries was uniform within each country, or whether there is evidence of significant regional effects. Second, using variation across Europe's subnational regions in demographic shifts, cyclical conditions, and education, it teases out the role of aging, educational gains, and economic growth. Finally, the paper builds novel measures of regional exposure to routinization and offshoring based on the occupational structure of the labor force to study the influence of the global forces of trade and technology. It is a companion paper to Hilgenstock and Koczan (2018), which applies a similar empirical strategy to examine participation rates in states and metropolitan areas in the United States. This paper aims to follow the methodology used there as closely as possible in order to allow for comparability of results, and focus attention on differences in findings rather than approaches. In particular, the novel local exposures to routinization and offshoring are constructed following a similar methdology.

The paper documents considerable heterogeneity across European regions in terms of changes in labor force participation rates. Similar to the United States, rural regions appear to confront more pronounced declines (or smaller increases) in participation compared to more urban regions.

The empirical results suggest that, while aging and cyclical conditions weighed on participation rates, these drags were more than offset by a striking rise in educational attainment. Strikingly, unlike in the United States, the forces of trade and technology did not result in detachment from the workforce in European regions on average, once labor markets had time to adjust. Instead, regions with high initial exposures to routinization and offshoring experienced so-far larger increases in participation. These include economically diverse urban regions (such as London, Paris, Madrid, Catalonia), some 'old industrial regions' (for instance in Northern Italy, Sweden and Switzerland, where automation may not have progressed as fast as in the US yet, or displaced workers found alternative employment instead of becoming detached from the workforce), as well as regions in Emerging Europe (parts of the Czech Republic and Hungary), which benefited from offshoring on the receiving end and saw gains in employment and participation as a result of increased integration in regional supply chains. This could be driven by an added second worker effect: higher initial exposures to routinization and offshoring are associated with larger subsequent increases in women's participation.

Routinization and offshoring may, however, weigh on participation rates and challenge the sustainability of social insurance systems in the future as the forces of automation become stronger, especially in advanced Europe, and labor costs rise in emerging Europe, making these regions less attractive as destinations for offshoring.

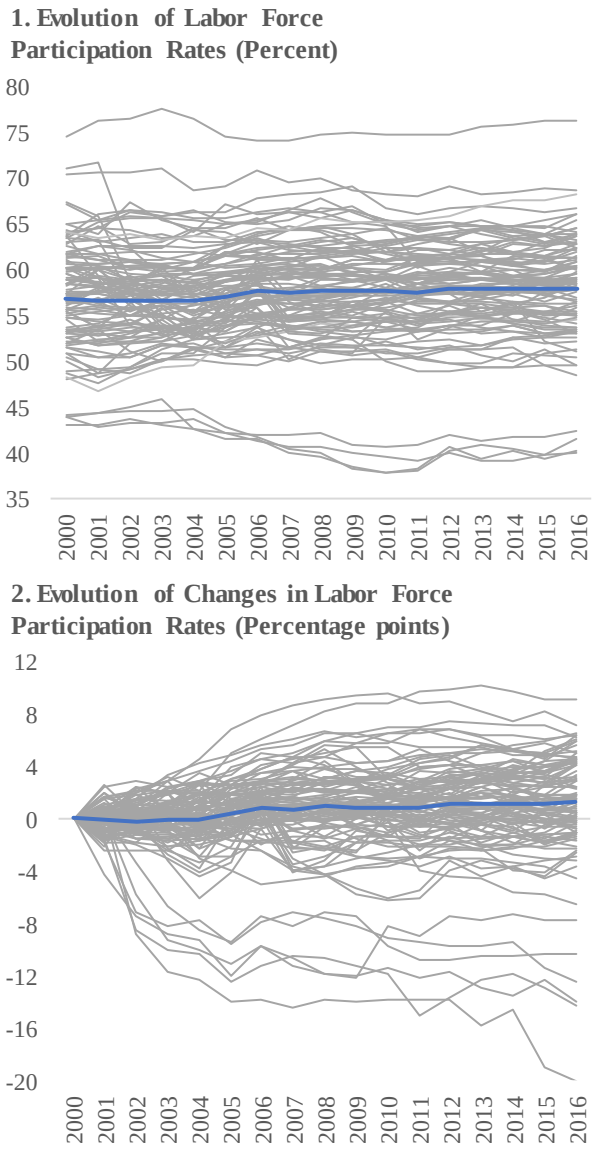
The rest of the paper is structured as follows. Section II provides a brief review of the literature on participation in the European countries, Section III introduces the data used, and

Section IV presents stylized facts. Section V outlines the empirical strategy, presents regression results and illustrates the relative contributions of different factors at the regional level. Section VI concludes.

II. LITERATURE

There is a large literature on the drivers of, especially women's, participation in Europe, and its link to policies. Genre and others (2010) point to the effects of institutions and policies, such as part-time incentives and maternity leave, on women's participation in Europe. Thévenon (2013) emphasizes the effects of the provision of childcare services (alongside the positive effects of education, the expansion of the service sector, and increase in part-time employment opportunities), and finds these to be stronger in the presence of other measures supporting working mothers (such as paid parental leave). Cipollone and others (2013) rely on individual-level data and find that labor market reforms can account for almost 25 percent of the actual increase in the participation of young women over the preceding two decades, more than 30 percent of that of highly educated women, though with relatively small effects on the participation of low skilled women. The role of labor market policies and institutions is confirmed in Christiansen and others (2016) who document that even controlling for women's expressed attitudes towards working, policies are a key driver of female employment in Europe using individual level data. Miani and Hoorens (2014) also highlight the role of family-friendly policies.

Figure 4. Heterogeneity of Developments in Labor Force Participation

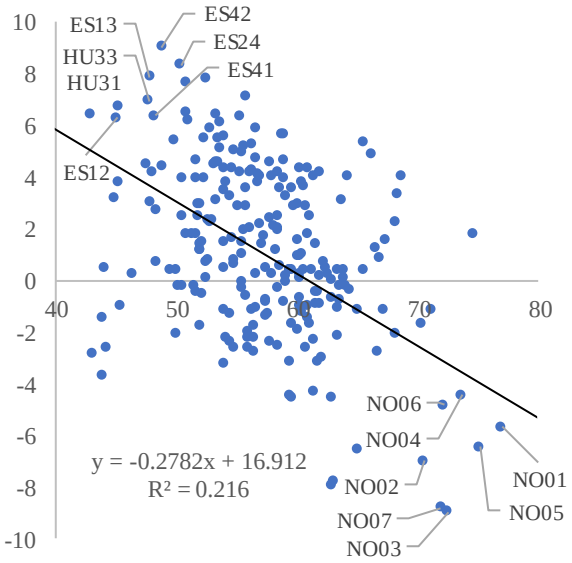


Sources: Eurostat; and authors' calculations.
Note: The 100 largest NUTS regions by 2016 total population are shown.

A separate literature has examined age and cohort effects in labor force participation (how participation varies over the life cycle and across different birth cohorts, respectively), typically for single countries (see for instance Euwals and others 2007 for the Netherlands). Balleer and others (2014) explore a cohort-model for six European economies, and find that cohort effects can account for a substantial part of the recent increase in women's

participation in Spain, the Netherlands and Germany, and has a smaller though still positive contribution in the UK, Italy and France.

Figure 5. Convergence of Labor Force Participation Rates



Sources: Eurostat; and authors' calculations.

Recent papers focusing on the impact of technology include Gregory, Salomons, and Zierahn (2016) and Graetz and Michaels (2015). Using a cross-industry, cross-country panel, Gregory, Salomons, and Zierahn (2016) estimate that in European regions the direct employment-reducing effects of automation ('routine-replacing technical change') on middle-skill employment have been offset by compensatory effects operating through product demand and local demand spillovers. Focusing directly on robotics, Graetz and Michaels (2015) conclude that in EU countries industry-level adoption of industrial robots raised labor productivity, increased value-added, augmented worker wages, had no measurable effect on overall labor hours, and modestly shifted employment in favor of high-skilled workers.

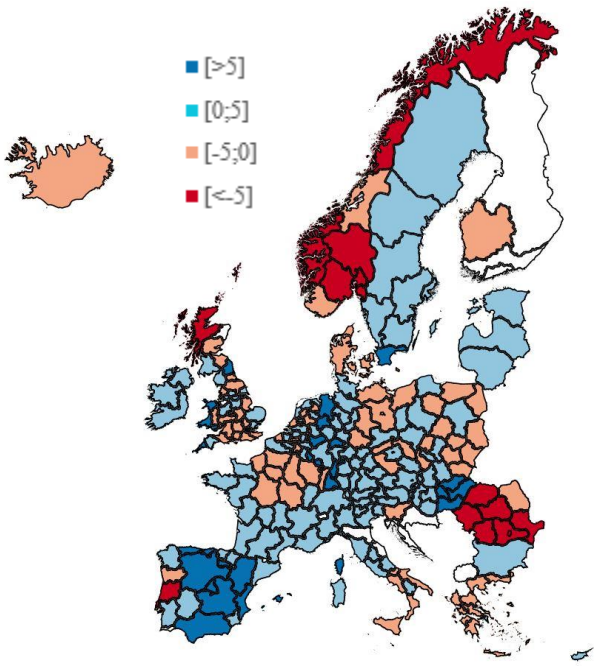
This paper aims to contribute to this literature by (1) zooming in further on the roles of trade and technology, relying on novel measures of initial local exposures to examine how these effects differ across regions and relative to the United States, and (2) allowing for within-country differences, analyzing the evolution and drivers of participation at the level of European regions. The use of subnational data allows for a more granular assessment of drivers of participation trends since the early 2000s. The analysis uses the heterogeneity across roughly 250 regions, exploiting variation which is partially lost when aggregated to the level of the 28 countries in Europe. To the best of our knowledge this is the first paper to examine these forces at this level of disaggregation in European countries.

III. DATA

The paper relies on data on labor force participation rates and populations from Eurostat for Nomenclature of Territorial Units for Statistics (NUTS) regions. The paper relies on NUTS-2 regions whenever possible. In case of missing data, the paper uses NUTS-1 regions. Country-level data are used for countries for which a regional breakdown does not exist (Iceland, Latvia, Lithuania and Luxembourg). This approach generates a sample of roughly 250 regions (for a full list of regions, see Appendix Table 1). Labor market indicators are available from 2000.

Regressions examine the effects of aging, cyclical conditions, trade and technology on participation at the regional level – these are proxied using old-age dependency ratios (defined as the population age 65 and older as a percentage of the population age 15 to 64), real GDP growth rates (both from Eurostat), and measures of initial exposures to routinization and offshoring. These novel measures (from Das and Hilgenstock 2018, see also Chapter 3 of the April 2017 *World Economic Outlook*) act as proxies for the initial share of jobs that are at risk of being automated or offshored within a geographical unit and thus allow for a more granular analysis of local exposures to the global forces of technology and trade. The two measures are constructed as employment-weighted averages of occupational scores for routinizability and offshorability. The routinizability scores are based on scores from Autor and Dorn (2013) which measure the "routine task intensity", or how intensive an occupation is in routine tasks, for 330 occupations based on the US Department of Labor's Dictionary of Occupational Titles. The offshorability scores rely on data by Goos, Manning, and Salomons (2014) who convert the professional coders' assessment-based measure in Blinder and Krueger (2014) into ISCO occupational categories. The employment-by-education data used in the construction of the two measures stems from the European Union Labour Force Survey (EULFS). Regressions also control for education, proxied using the share of the population within a region enrolled in tertiary education from Eurostat.

Figure 6. Changes in Labor Force Participation Rates, 2000-2016
(Percentage points)



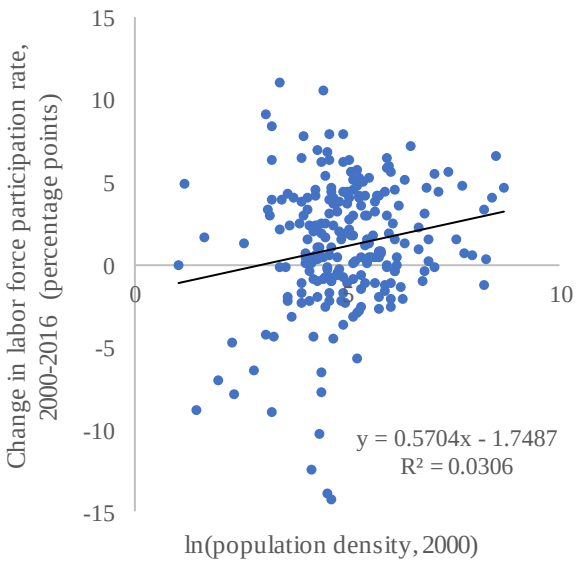
Sources: Eurostat; and authors' calculations.
Note: Regions in white denote regions for which data was not available.

IV. Stylized Facts

European regions exhibit considerable heterogeneity in levels as well as changes in participation rates.[4] Figure 4 plots the 100 most populous regions and illustrates that participation rates range from the high 30s (in regions in Southern Italy and Romania) to the high 60s and above (in regions in Germany, the Netherlands, Sweden, and the United

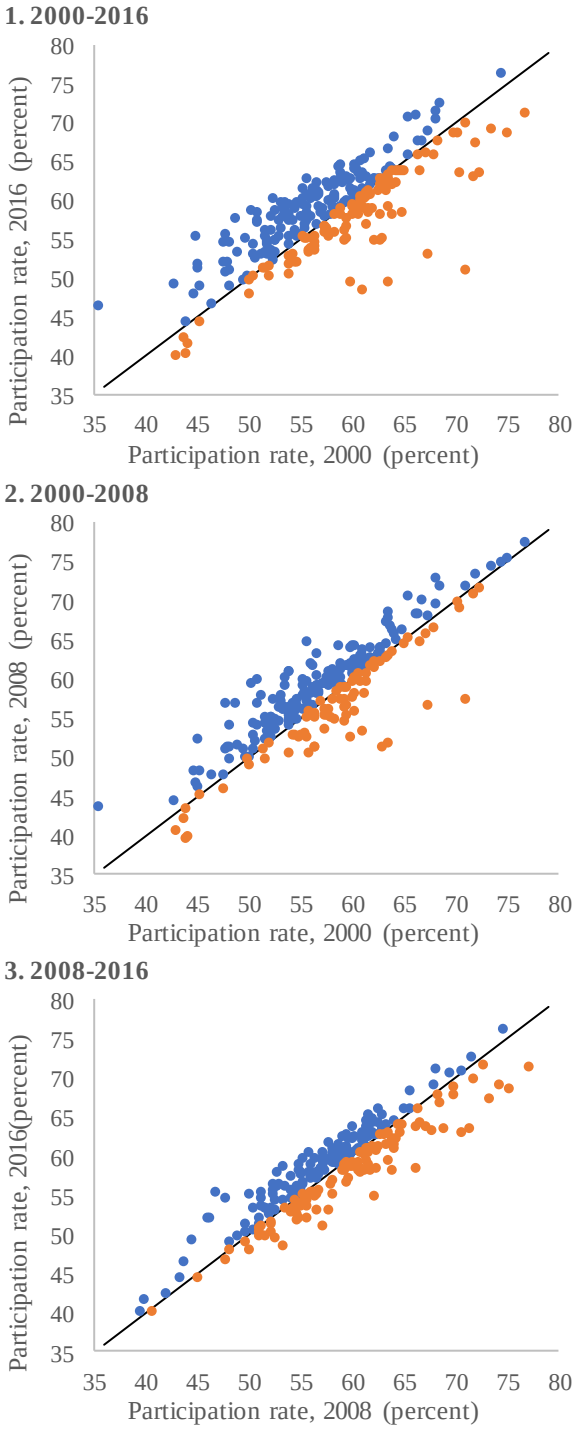
[4] The labor force participation rate is the fraction of the adult population (ages 15 and over) either working or looking for work.

Figure 7. Population Density and Changes in Labor Force Participation Rates



Sources: Eurostat; and authors' calculations.

Figure 8. Changes in Labor Force Participation Rates



Sources: Eurostat; and authors' calculations.

Kingdom), with changes ranging from 6–9 percentage point increases (in parts of Spain and Germany) to 15–20 percentage point drops (in parts of Romania).

Labor force participation rates have, however, converged over time (Figure 5). Regions with relatively higher participation rates in 2000 experienced larger declines (or smaller increases) over the following period (for instance some regions in Norway), while regions with relatively lower participation rates in 2000 experienced larger increases or smaller decreases (for instance in Hungary and Spain).[5]

While some countries show similar patterns across regions (increases in all regions in Hungary, Spain and Sweden, drops in all regions in Greece, Norway and Romania), most larger European

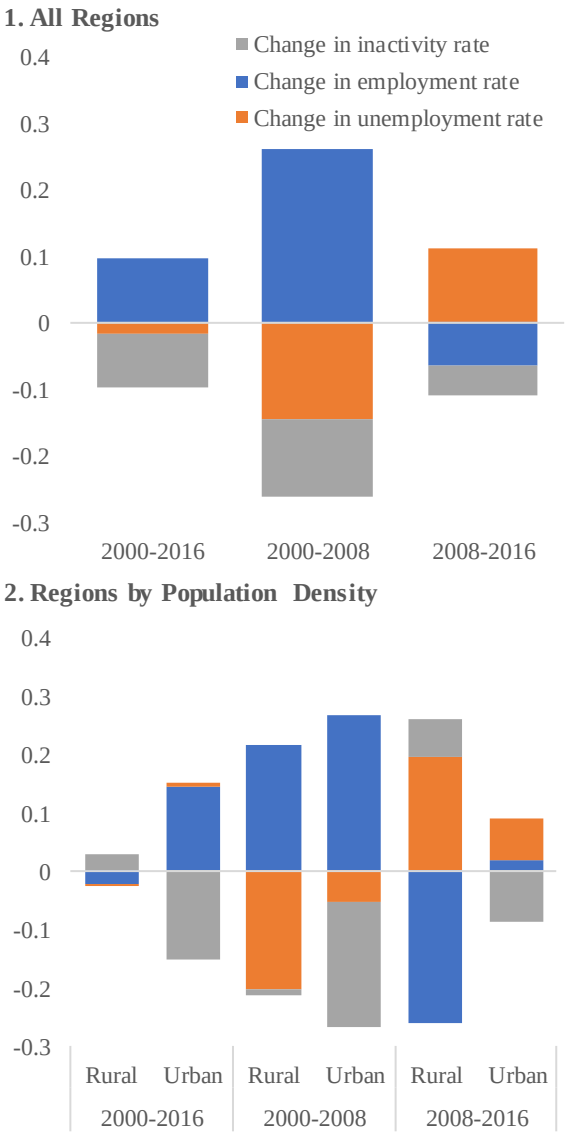
[5] In addition to this convergence across countries, there appears to be also convergence within country as indicated by decreasing standard deviations of regions within a country over time.

economies—among them Germany, France, Italy, Poland, and the United Kingdom—experienced significant within-country heterogeneity, with pronounced declines in some regions, and marked increases in others (Figure 6).

Initial population density appears to be positively correlated with changes in labor force participation (Figure 7). Participation rates increased more (or declined less) in urban regions, while they declined more (or increased less) in rural regions—a pattern similar to that observed in the United States (see Hilgenstock and Koczan 2018), though correlations are fairly low.[6]

Labor force participation rates increased in a majority (65 percent) of European regions over the period 2000–2016, with a median increase of 3 percentage points; the remaining 35 percent of regions exhibited a median decline of 1.7 percentage points (Figure 8, panel 1). While on average increases appear to be somewhat smaller, and declines more widespread after the Global Financial Crisis and during the European sovereign debt crisis (2008–2016) than in the pre-crisis period (2000–2008), this hides considerable heterogeneity in regions' experiences (Figure 8, panels 2 and 3). About a third of regions experienced a post-crisis decrease following a pre-crisis increase; 21 percent saw an increase in the post-crisis period after a decline in the pre-crisis period; 35 percent of regions saw increases in both periods and 11 percent saw decreases in both.

Figure 9. Changes in Labor Market Dynamics
(Percentage points)



Sources: Eurostat; and authors' calculations.
Note: Employment rate, unemployment rate, and inactivity rate area defined as total employment, total unemployment, and total inactive population as a percentage of total population, respectively. Rural regions are those below the 25th percentile of the population density distributionl; urban regions are those above the 75th percentile of the distribution.

[6] Participation is generally higher in urban areas as well.

While on average there is no clear break in participation after the Global Financial Crisis, margins of labor market adjustment changed considerably (Figure 9). Over the full 2000–2016 period rising employment was matched almost one-for-one by rising participation, with very little change in unemployment. The pre-crisis period was characterized by flows from unemployment and inactivity into employment. Post-crisis, employment started to decline, matched almost fully by a rise in unemployment, with still small increases in participation.

These averages again hide interesting urban-rural differences (Figure 9, panel 2). Unemployment appears to exhibit much larger swings in rural than in urban areas: while rural regions saw a larger decline in unemployment in the pre-crisis period compared to urban regions, they also saw a much larger increase in unemployment in the post-crisis period. Correspondingly, pre-crisis flows consisted mostly of movements from unemployment to employment in rural areas, and from inactivity to employment in urban areas. Employment dropped much more sharply post-crisis in rural areas, translating into large increases in unemployment and some increases in inactivity. Urban areas saw some rise in unemployment as well, though in the context of (small) increases in employment and activity.[7] Over the whole analysis period (2000–2016), urban regions still saw large increases in employment and activity, while rural areas saw small employment declines matched by moderate drops in activity.

V. Empirical Strategy and Results

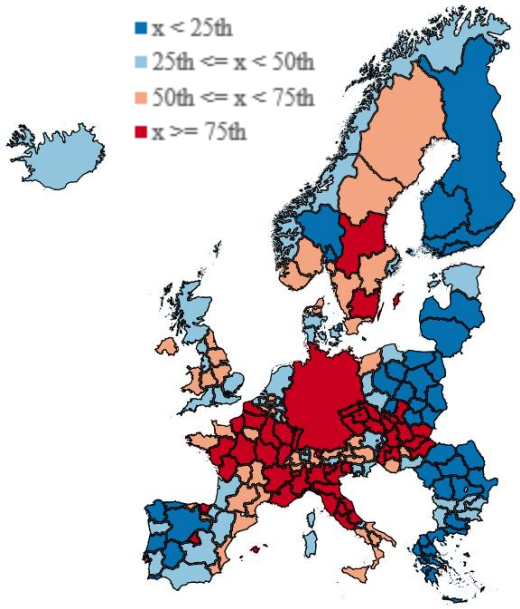
This section examines the drivers of changes in participation rates at the regional level, looking at the effects of aging, cyclical factors, education, trade and technology. Furthermore, this section tests the effects of the two novel measures of local exposures to routinization and to offshoring described in Section III.[8] The two measures are highly correlated, and most regions are relatively highly exposed to automation as well as offshoring (among them regions in Eastern France, Northern Italy, the Czech Republic, the Slovak Republic and Hungary – areas of 'old industry' as well as those integrated in the Central European supply chain), or neither highly exposed to automation nor to offshoring (more agricultural regions in Northern and Western Spain, Portugal, Poland, Romania, the Baltics, Greece and Finland). Some regions are, however, highly exposed to offshoring but not to automation (such as large parts of the United Kingdom, Southern France and Southern

[7] Pre-crisis increases and post-crisis declines in employment also characterized the most populous regions, though while unemployment increased in more than half post-crisis, participation only fell in the 10 regions (most of them in the South) with the most pronounced drops in employment (Annex Figure 1).

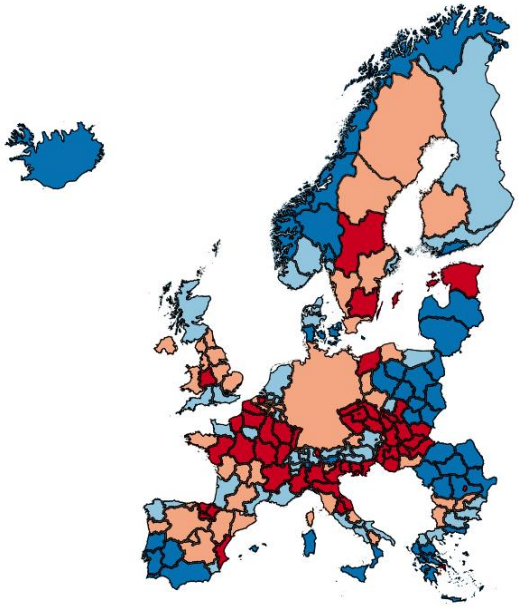
[8] Regional exposures cannot be constructed for Germany and the Netherlands due to data limitations, therefore, initial values in both cases are shown at the country level and regions from the two countries are excluded from the regression analysis.

Figure 10. Exposures to Routinization and Offshoring, 2000

1. Exposure to Routinization (index)



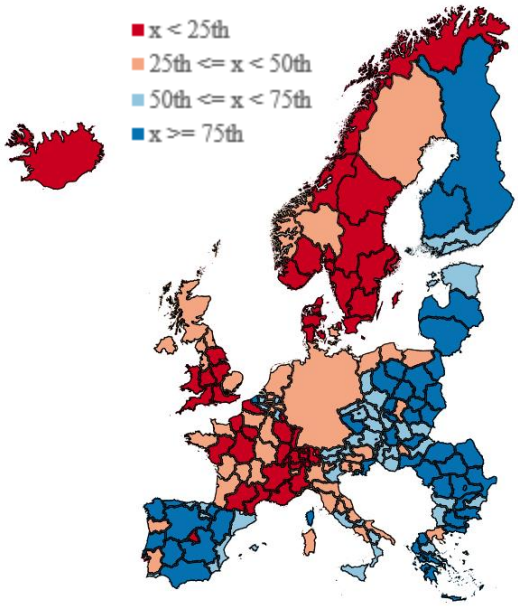
2. Exposure to Offshoring (index)



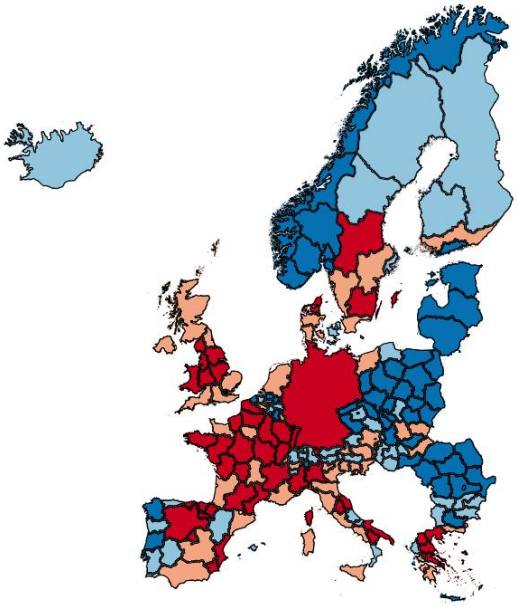
Sources: Eurostat, European Union Labour Force Survey; and authors' calculations.

Figure 11. Changes in Exposures to Routinization and Offshoring, 2000-2016

1. Change in Exposure to Routinization (index)



2. Change in Exposure to Offshoring (index)



Sources: Eurostat, European Union Labour Force Survey; and authors' calculations.

Norway, which may be characterized by more labor-intensive industries), or in turn highly exposed to routinization but not to offshoring (regions in Austria, Denmark, Switzerland, which may have seen an earlier offshoring of jobs already in the pre-2000 period). Figure 11 shows changes in the exposures to routinization and offshoring between 2000 and 2016 and, together with Figure 12,

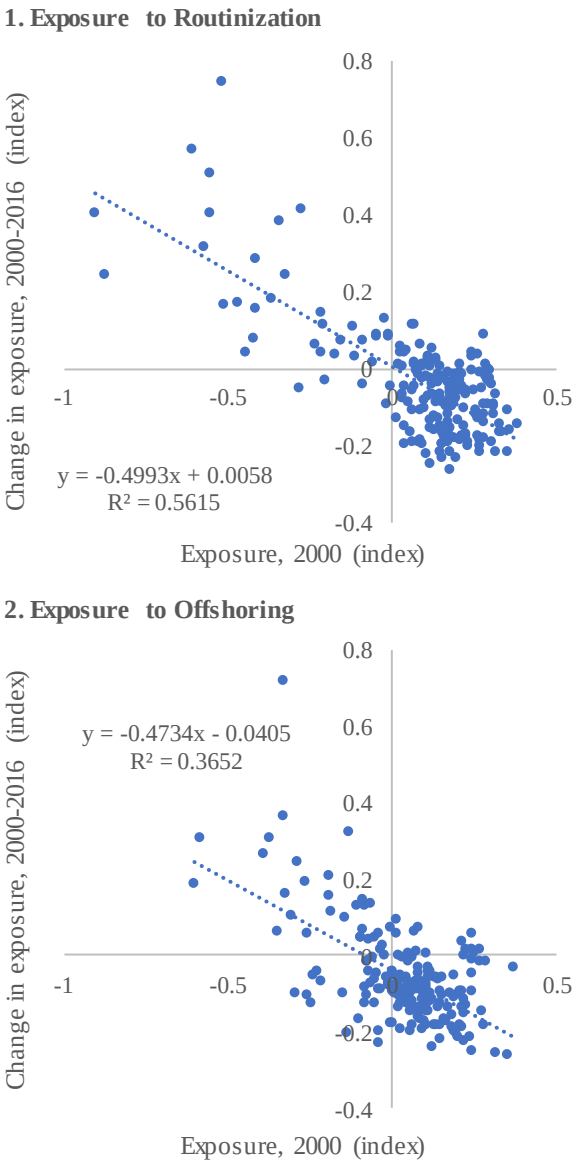
illustrates the negative correlation between initial exposures and subsequent changes in exposures.

Zooming in on the link between these initial exposures to trade and technology and subsequent changes in participation, Figure 13 illustrates the strong *positive* correlations between the two exposure measures and changes in labor force participation. In Europe, unlike in the United States (see Hilgenstock and Koczan 2018), regions with higher initial exposures to automation and offshoring saw larger subsequent *increases* in participation (rather than detachment from the workforce as a result of trade- or technology-related dismissals). Figure 14 illustrates correlations between additional drivers of changes in labor force participation rates considered in the empirical analysis: cyclical factors, aging, and changes in educational attainment.

Building on these correlations, cross-sectional regressions at the regional level examine the association between 2000–2016 changes in labor force participation rates and aging, cyclical conditions, education, as well as the impacts of initial exposures to routinization and offshoring. In particular, the following specification is estimated:

$$\Delta y_{ij} = \beta_1 \Delta dep\ ratio_{ij} + \beta_2 growth_{ij} + \beta_3 \Delta educ_{ij} + \beta_4 rout^0_{ij} + \beta_5 offsh^0_{ij} + \alpha_j$$

Figure 12. Exposures to Routinization and Offshoring and Subsequent Changes in Exposures



Sources: Eurostat, European Union Labour Force Survey; and authors' calculations.

where Δy_{ij} is the change in labor force participation between 2000 and 2016 in region *i* country *j*, $\Delta dep\ ratio_{ij}$ is the change in the old-age dependency ratio (one possible proxy for aging), $growth_{ij}$ is average real GDP growth and $\Delta educ_{ij}$ is the change in educational attainment. Initial exposures ($rout^0_{ij}$ and $offsh^0_{ij}$) are highly correlated and are thus included one at a time in the regressions. Specifications focus on long changes rather than annual data in order to allow for labor markets to adjust to shocks, examining if such shocks, including

those from automation and/or offshoring, have lasting effects on participation. Regressions also control for time invariant country characteristics α_j. Standard errors are adjusted for heteroskedasticity.[9]

The results point to significant effects of aging, cyclical conditions, and education on labor force participation (Table 1). Labor force participation declines were larger in regions, which experienced lower real GDP growth over this time period, although the coefficients are generally rather imprecisely estimated. Labor force participation declines were also larger in regions where the structure of population shifted more towards individuals older than 65. The sensitivity of participation to aging appears to be higher in Europe than in the United States, possibly related to more generous pensions or more avenues to early retirement. Educational gains are also strongly correlated with increases in participation at the regional level, though the effect is somewhat weaker than in the United States.

Table 1. Drivers of Labor Force Participation Rates in European Regions

Variables	(1)	(2)	(3)	(4)	(5)
Average Real GDP Growth			-0.178	-0.441	-0.348
			(0.240)	(0.275)	(0.277)
Change in Old-Age-Dependency Ratio			-0.275***	-0.288***	-0.295***
			(0.0627)	(0.0824)	(0.0844)
Change in Postsecondary Share			0.256***	0.308***	0.282***
			(0.0557)	(0.0703)	(0.0716)
Initial Exposure to Routinization	6.544***			7.058***	
	(1.484)			(1.428)	
Initial Exposure to Offshoring		6.770***			6.992***
		(1.686)			(1.642)
Observations	185	185	262	177	176
R^2	0.698	0.693	0.680	0.751	0.741

Source: Authors' calculations.

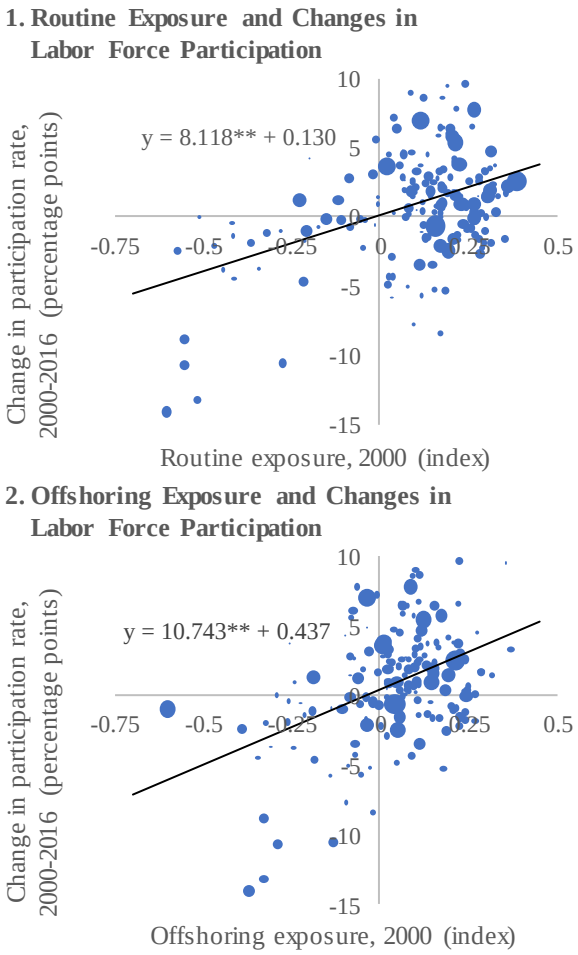
Note: Standard errors are in parentheses. The dependent variable is change in labor force participation rate.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

In contrast to the findings of the literature on the United States and in line with the bivariate correlations above, the effects of trade and technology are positive: regions with higher initial exposures to automation and offshoring due their occupational employment compositions saw larger subsequent increases in participation rates, even controlling for other factors. This effect is robust to controlling for population density and the inclusion of country-level policies (such as spending on active labor market programs, union density or the generosity of unemployment benefits) instead of country fixed effects.

[9] Baseline results do not include measures of population growth and migration, however, results for a smaller subsample are robust to their inclusion.

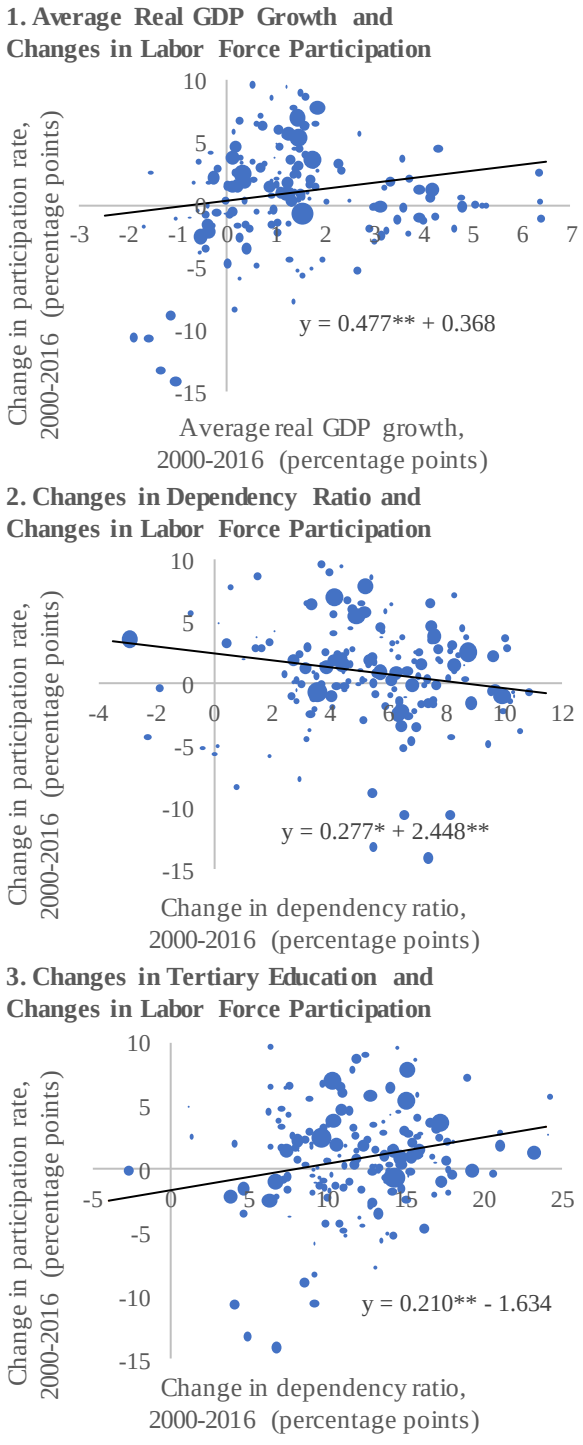
Figure 13. Drivers of Changes in Labor Force Participation Rates



Sources: Eurostat, European Union Labor Force Survey; and authors' calculations.
Note: Marker size is based on 2016 total population. Trend lines represent results of population-weighted bivariate regressions.

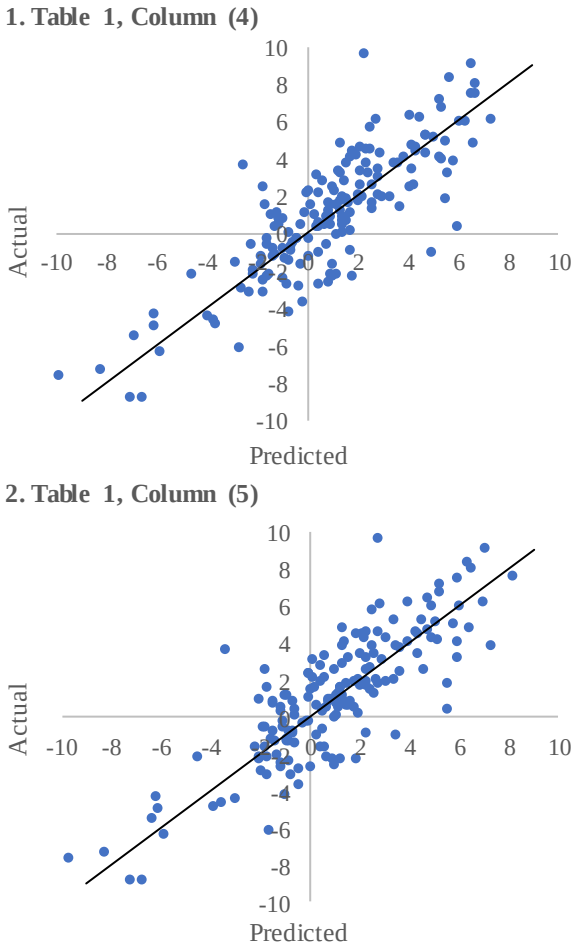
There are several possible explanations for this finding. Compared to US metropolitan areas, European countries experienced smaller changes in the occupational mix over this time period, which suggests that fewer jobs were automated or offshored than in the United States. The positive correlation might also signal an added second worker effects, where households may add a second worker

Figure 14. Additional Drivers of Changes in Labor Force Participation Rates



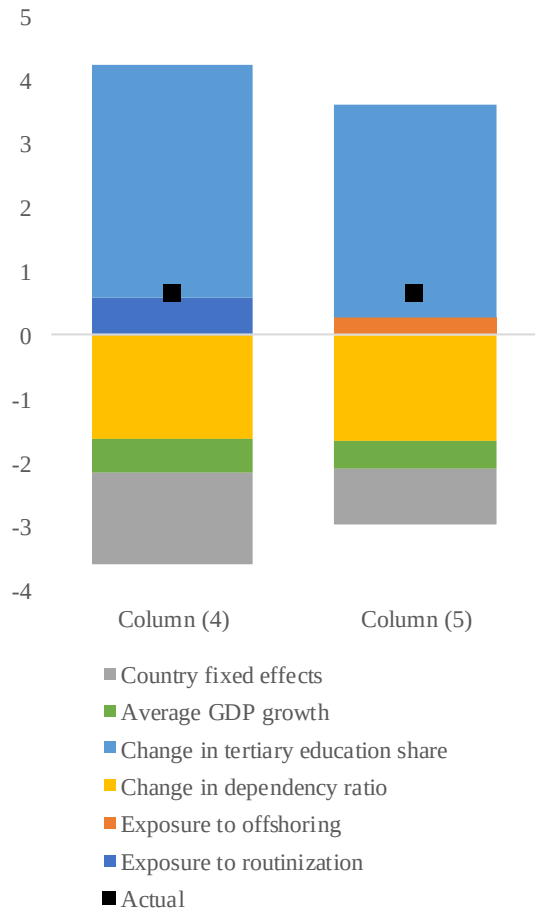
Sources: Eurostat; and authors' calculations.
Note: Marker size is based on 2016 total population. Trend lines represent results of population-weighted bivariate regressions.

Figure 15. Model Fit



Source: Authors' calculations.

Figure 16. Contributions to Changes in Labor Force Participation Rates, 2000-2016
(Percentage points)



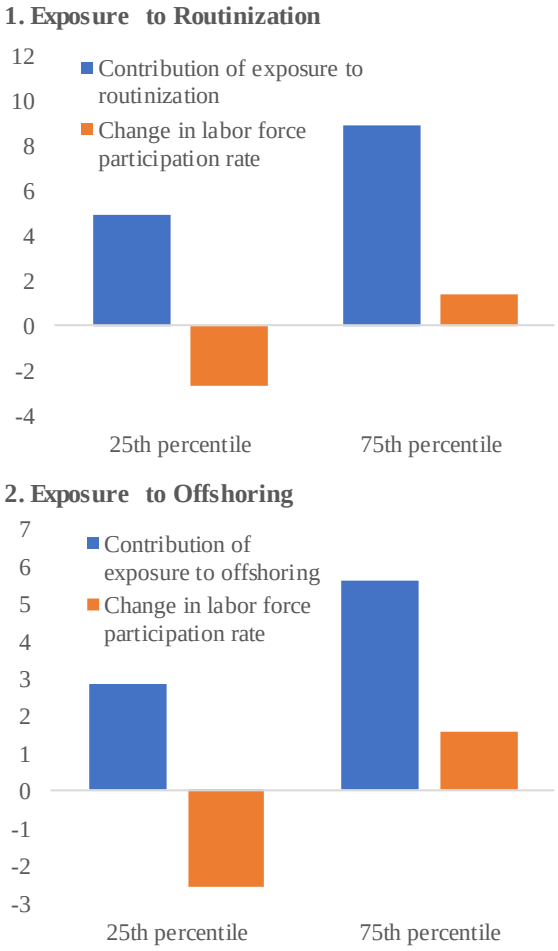
Source: Authors' calculations.

to make up for lost income of the first – a hypothesis discussed in greater detail in the following.

Figure 15 illustrates the fit of the regressions in Table 1, and Figure 16 shows the relative contributions of each of these factors to 2000–2016 changes in participation rates (the decompositions are based on columns 4 and 5 of Table 1). The decompositions point to significant drags from aging and cyclical factors, as well as time-invariant country characteristics. The most important contribution stems from changes in the share of the population with tertiary education. This component alone, driven by a striking 12 percentage point increase in the tertiary education share on average, would act to increase labor force participation by 3.3–3.6 percentage points, thereby more than offsetting the downward pressures resulting from aging and cyclical factors. This large effect of education is in line with the country-level findings in Chapter 3 of the April 2018 *World Economic Outlook*, and constitutes a further key difference between the evolution of participation in Europe versus the United States, where education increased earlier.

While on average, the quantitative contribution of trade and technology on participation was relatively small (Figure 16), for some European regions the effects are quite substantial. In order to examine the regional patterns underlying the positive effects of trade and technology noted above, Figure 17 examines effects for regions with high and low initial exposures to routinization and offshoring, respectively. Regions with high initial exposures to routinization (above the 75th percentile of the distribution, such as regions in France, Italy, and Hungary) experienced subsequent increases in labor force participation rates, while regions less exposed to routinization (below the 25th percentile of the distribution, such as regions in Poland, and Romania) experienced declines (Figure 17, panel 1). Similar results emerge for offshoring: regions with high initial exposures to offshoring (above the 75th percentile of the distribution, such as parts of the Czech Republic and Hungary) experienced increases in participation as they became more integrated in regional supply chains, while regions below the 25th percentile of the exposure to offshoring distribution (agricultural regions with low routinization scores, as mentioned above) saw declines in participation (Figure 17, panel 2).

Figure 17. Contributions of Exposures to Routinization and Offshoring and Changes in Labor Force Participation Rates



Sources: Authors' calculations.
Note: Bars in both panels show relative contributions of exposure to routinization and to offshoring respectively as well as changes in labor force participation rates for metropolitan areas below the 25th percentile and above the 75th percentile of the distribution regarding the respective exposure measure. Simple averages across metropolitan areas are shown.

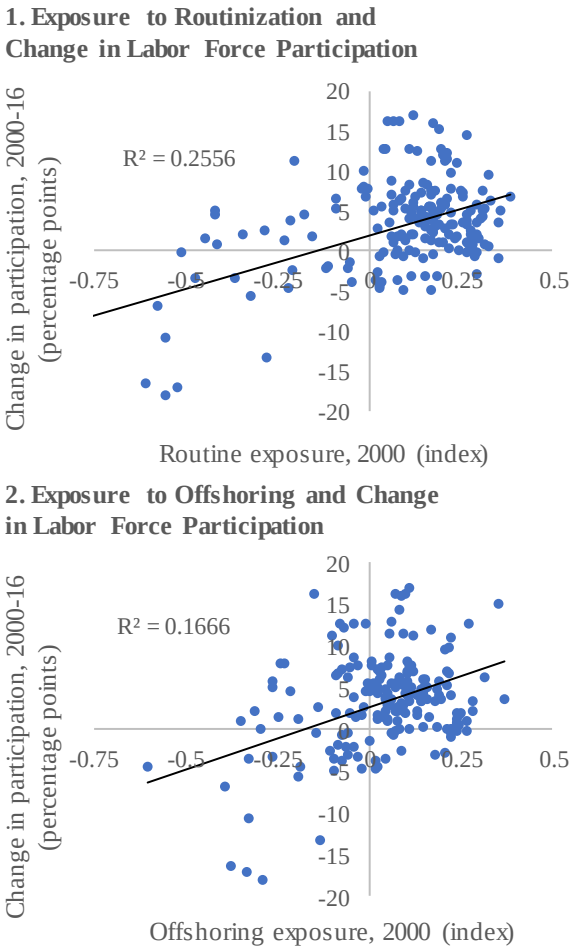
As discussed above, this points to still-positive effects of high initial exposures to routinization and offshoring in diverse urban regions (for instance London, Paris, Catalonia, Madrid), some 'old industrial regions' in advanced Europe (in Northern Italy, Sweden and Switzerland)[10] and regions benefiting from offshoring and increased supply chain integration in emerging Europe (for instance in the Czech Republic and Hungary),

[10] Some regions with high initial exposures to routinization did experience drops in participation, for instance in Central France and Southern Italy.

while other more sparsely populated, often more agricultural regions (in parts of Finland, Iceland, Norway, Romania, and Scotland) are lagging behind.

As noted above, the positive effects of initial exposures to routinization and offshoring on participation could be driven by an added second worker effect, where households may add a second worker to make up for lost income of the first. This would be consistent with the observed large increases in female participation in Europe, and could also explain differences relative to the United States, where female participation increased earlier and such gains are already plateauing. While testing this directly would require household-level data that allows us to match spouses, simple correlations suggest that female participation indeed increased more in regions that were initially more exposed to automation and offshoring, with strikingly strong correlations (Figure 18).[11] [12]

Figure 18. Exposures to Routinization and Offshoring and Change in Female Labor Force Participation



Sources: Eurostat, European Union Labour Force Survey; and authors' calculations.

VI. Conclusions

This paper documented tremendous heterogeneity in the evolution of participation rates across European regions. As in the United States, declines in participation are more pronounced in rural regions, while urban areas generally still see rising participation. However, unlike in the United States, trade and technology are not associated

[11] While regions with higher initial exposures to routinization are also those with lower initial female participation and we could thus be picking up a convergence effect (lower initial female labor force participation associated with larger subsequent increases), the correlation between initial routinization and initial female participation is very weak (with an R-squared of around 3 percent). Some of this effect would likely be mopped up by the included country fixed effects.

[12] Gender-specific regressions in line with those in Table 1 confirm large positive effects of exposures to routinization and offshoring on women's participation. We do not control for changes in the opposite gender's participation directly – while at the individual level we might expect a negative correlation, at the regional level these would be highly positively correlated due to common local labor market effects.

with displacement—regions with high initial exposures to routinization and offshoring, especially diverse cities, some ‘old industrial regions’, and those participating in the Central European supply chain benefited from these forces on average, likely driven by an added second worker effect, in line with the large increases in women’s participation. Further work in this area would, however, be useful, relying on individual-level data to examine the second earner effect in greater detail.

Striking within-country differences in the evolution of labor force participation, however, have important implications for policy—they call for more explicit recognition of the spatial dimension of economic vulnerability given that short- and medium-term costs are concentrated not only in particular sectors and occupations but also affect different places in different ways.

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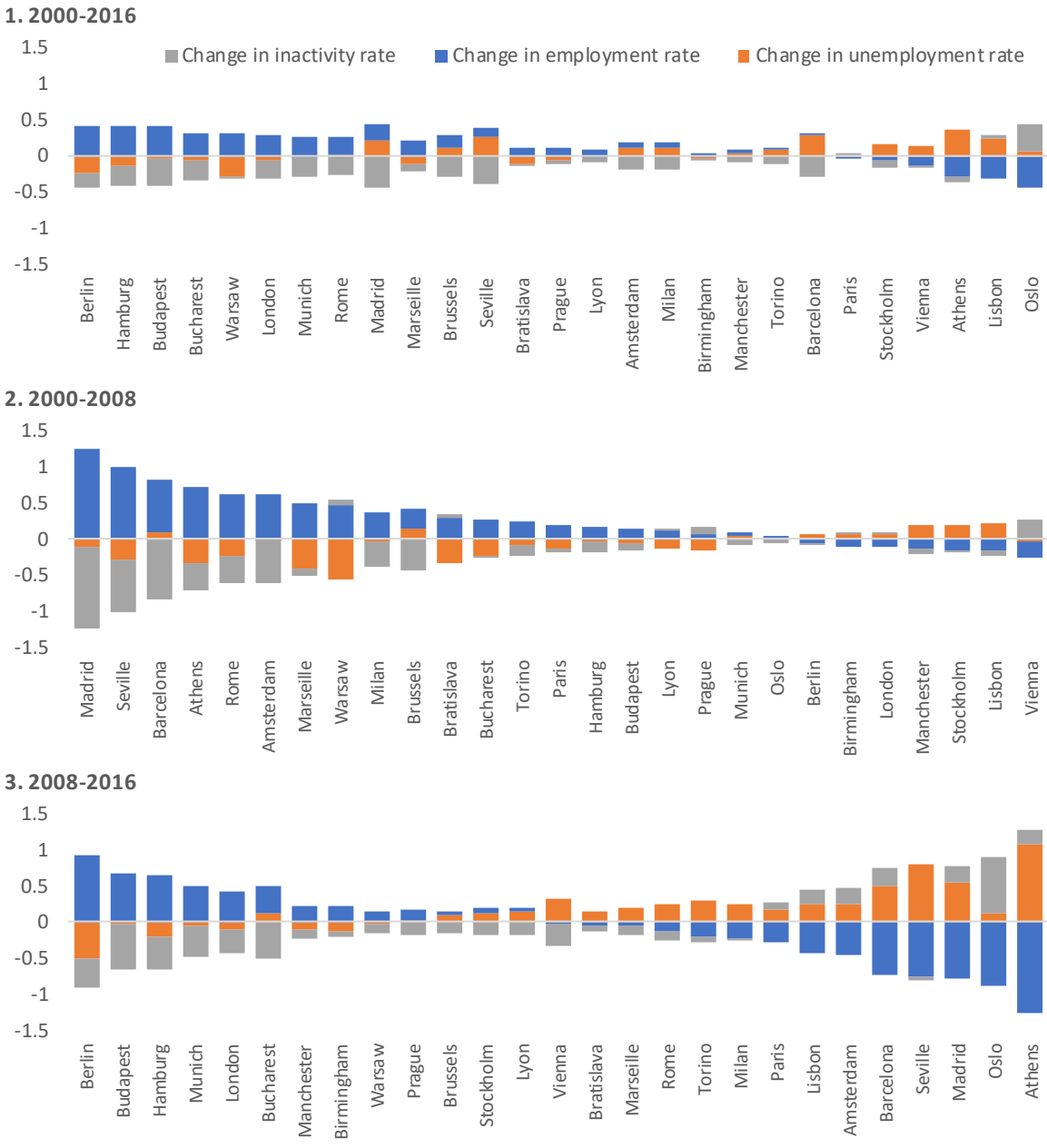
Appendix Figure 1. Changes in Labor Market Dynamics, Individual Regions



Sources: Eurostat; and authors' calculations.
Note: Employment rate, unemployment rate, and inactivity rate area defined as total employment, total unemployment, and total inactive population as a percentage of total population, respectively.

Appendix Table 1. NUTS Regions

Code	Name	Level
Austria (AUT)		
AT1	Ostösterreich	1
AT11	Burgenland (AT)	2
AT12	Niederösterreich	2
AT13	Wien	2
AT2	Südösterreich	1
AT21	Kärnten	2
AT22	Steiermark	2
AT3	Westösterreich	1
AT31	Oberösterreich	2
AT32	Salzburg	2
AT33	Tirol	2
AT34	Vorarlberg	2
Belgium (BEL)		
BE1	Région de Bruxelles-Capitale	1
BE2	Vlaams Gewest	1
BE21	Prov. Antwerpen	2
BE22	Prov. Limburg (BE)	2
BE23	Prov. Oost-Vlaanderen	2
BE24	Prov. Vlaams-Brabant	2
BE25	Prov. West-Vlaanderen	2
BE3	Région wallonne	1
BE31	Prov. Brabant Wallon	2
BE32	Prov. Hainaut	2
BE33	Prov. Liège	2
BE34	Prov. Luxembourg (BE)	2
BE35	Prov. Namur	2
Bulgaria (BGD)		
BG3	Severna i yugoiztochna Bulgaria	1
BG31	Severozapaden	2
BG32	Severen tsentralen	2
BG33	Severoiztochen	2
BG34	Yugoiztochen	2
BG4	Yugozapadna i yuzhna tsentralna Bulgaria	1
BG41	Yugozapaden	2
BG42	Yuzhen tsentralen	2
Switzerland (CHE)		
CH1	Région lémanique	2
CH2	Espace Mittelland	2
CH3	Nordwestschweiz	2
CH4	Zürich	2
CH5	Ostschweiz	2
CH6	Zentralschweiz	2
CH7	Ticino	2
CZ1	Praha	2
Czech Republic (CZE)		
CZ2	Strední Cechy	2
CZ3	Jihozápad	2
CZ4	Severozápad	2
CZ5	Severovýchod	2
CZ6	Jihovýchod	2
CZ7	Strední Morava	2
CZ8	Moravskoslezsko	2
Germany (DEU)		
DE1	Baden-Württemberg	1
DE11	Stuttgart	2
DE12	Karlsruhe	2
DE13	Freiburg	2
DE14	Tübingen	2
DE2	Bayern	1
DE21	Oberbayern	2
DE22	Niederbayern	2
DE23	Oberpfalz	2
DE24	Oberfranken	2
DE25	Mittelfranken	2
DE26	Unterfranken	2
DE27	Schwaben	2
DE3	Berlin	1
DE4	Brandenburg	1
DE5	Bremen	1
DE6	Hamburg	1
DE7	Hessen	1
DE71	Darmstadt	2
DE72	Gießen	2
DE73	Kassel	2
DE8	Mecklenburg-Vorpommern	1
DE9	Niedersachsen	1
DE91	Braunschweig	2
DE92	Hannover	2
DE93	Lüneburg	2
DE94	Weser-Ems	2
DEA	Nordrhein-Westfalen	1
DEA1	Düsseldorf	2
DEA2	Köln	2
DEA3	Münster	2
DEA4	Detmold	2
DEA5	Arnsberg	2
DEB	Rheinland-Pfalz	1
DEB1	Koblenz	2
DEB2	Trier	2
DEB3	Rheinhessen-Pfalz	2
DEC	Saarland	1
DED	Sachsen	1
DED2	Dresden	2
DED3	Leipzig	2
DED4	Chemnitz	2
DEE	Sachsen-Anhalt	1
DEF	Schleswig-Holstein	1
DEG	Thüringen	1
Denmark (DNK)		
DK1	Hovedstaden	2
DK2	Sjælland	2
DK3	Syddanmark	2
DK4	Midtjylland	2
DK5	Nordjylland	2
Spain (ESP)		
ES1	Noroeste (ES)	1
ES11	Galicia	2
ES12	Principado de Asturias	2
ES13	Cantabria	2
ES2	Noreste (ES)	1
ES21	País Vasco	2
ES22	Comunidad Foral de Navarra	2
ES23	La Rioja	2
ES24	Aragón	2
ES3	Comunidad de Madrid	1
ES4	Centro (ES)	1
ES41	Castilla y León	2
ES42	Castilla-la Mancha	2
ES43	Extremadura	2
ES5	Este (ES)	1
ES51	Cataluña	2
ES52	Comunidad Valenciana	2
ES53	Illes Balears	2
ES6	Sur (ES)	1
ES61	Andalucía	2
ES62	Región de Murcia	2
ES63	Ciudad Autónoma de Ceuta (ES)	2
ES64	Ciudad Autónoma de Melilla (ES)	2
ES7	Canarias (ES)	1
Finland (FIN)		
FI1	Manner-Suomi	1
FI13	Pohjois- ja Itä-Suomi	2
FI18	Etelä-Suomi	2

Appendix Table 1 (continued). NUTS Regions

Code	Name	Level
FI181	Helsinki-Uusimaa	3
FI19	Länsi-Suomi	2
FI2	Åland	1
France (FRA)		
FR1	Île de France	2
FR2	Bassin Parisien	1
FR21	Champagne-Ardenne	2
FR22	Picardie	2
FR23	Haute-Normandie	2
FR24	Centre (FR)	2
FR25	Basse-Normandie	2
FR26	Bourgogne	2
FR3	Nord - Pas-de-Calais	2
FR4	Est (FR)	1
FR41	Lorraine	2
FR42	Alsace	2
FR43	Franche-Comté	2
FR5	Ouest (FR)	1
FR51	Pays de la Loire	2
FR52	Bretagne	2
FR53	Poitou-Charentes	2
FR6	Sud-Ouest (FR)	1
FR61	Aquitaine	2
FR62	Midi-Pyrénées	2
FR63	Limousin	2
FR7	Centre-Est (FR)	1
FR71	Rhône-Alpes	2
FR72	Auvergne	2
FR8	Méditerranée	1
FR81	Languedoc-Roussillon	2
FR82	Provence-Alpes-Côte d'Azur	2
FR83	Corse	2
FR9	Départements d'outre-mer	1
FR91	Guadeloupe	2
FR92	Martinique	2
FR93	Guyane	2
FR94	La Réunion	2
FRA50	Mayotte	3
Greece (GRC)		
GR1	Voreia Ellada	1
GR11	Anatoliki Makedonia, Thraki	2
GR12	Kentriki Makedonia	2
GR13	Dytiki Makedonia	2
GR14	Thessalia	2
GR2	Kentriki Ellada	1
GR21	Ipeiros	2
GR22	Ionia Nisia	2
GR23	Dytiki Ellada	2
GR24	Sterea Ellada	2
GR25	Peloponnisos	2
GR3	Attiki	1
GR4	Nisia Aigaiou, Kriti	1
GR41	Voreio Aigaio	2
GR42	Notio Aigaio	2
GR43	Kriti	2
Croatia (HRV)		
HR03	Jadranska Hrvatska	2
HR04	Kontinentalna Hrvatska	2
Hungary (HUN)		
HU1	Közép-Magyarország	2
HU2	Dunántúl	1
HU21	Közép-Dunántúl	2
HU22	Nyugat-Dunántúl	2
HU23	Dél-Dunántúl	2
HU3	Alföld és Észak	1
HU31	Észak-Magyarország	2
HU32	Észak-Alföld	2
HU33	Dél-Alföld	2
Ireland (IRL)		2
IE1	Border, Midland and Western	
IE2	Southern and Eastern	1
Italy (ITA)		2
ITC	Nord-Ovest	2
ITC1	Piemonte	2
ITC2	Valle d'Aosta/Vallée d'Aoste	2
ITC3	Liguria	1
ITC4	Lombardia	2
ITF	Sud	2
ITF1	Abruzzo	2
ITF2	Molise	2
ITF3	Campania	2
ITF4	Puglia	2
ITF5	Basilicata	1
ITF6	Calabria	2
ITG	Isole	2
ITG1	Sicilia	2
ITG2	Sardegna	2
ITH1	Provincia Autonoma di Bolzano/Bozen	2
ITH2	Provincia Autonoma di Trento	2
ITH3	Veneto	2
ITH4	Friuli-Venezia Giulia	1
ITH5	Emilia-Romagna	2
ITI	Centro (IT)	2
ITI1	Toscana	2
ITI2	Umbria	2
ITI3	Marche	
ITI4	Lazio	1
Netherlands (NLD)		2
NL1	Noord-Nederland	2
NL11	Groningen	2
NL12	Friesland (NL)	1
NL13	Drenthe	2
NL2	Oost-Nederland	2
NL21	Overijssel	2
NL22	Gelderland	1
NL23	Flevoland	2
NL3	West-Nederland	2
NL31	Utrecht	2
NL32	Noord-Holland	2
NL33	Zuid-Holland	1
NL34	Zeeland	2
NL4	Zuid-Nederland	2
NL41	Noord-Brabant	
NL42	Limburg (NL)	2
Norway (NOR)		2
NO1	Oslo og Akershus	2
NO2	Hedmark og Oppland	2
NO3	Sør-Østlandet	2
NO4	Agder og Rogaland	2
NO5	Vestlandet	2
NO6	Trøndelag	
NO7	Nord-Norge	1
Poland (POL)		2
PL1	Region Centralny	2
PL11	Lódzkie	1
PL12	Mazowieckie	2
PL2	Region Poludniowy	2
PL21	Malopolskie	1
PL22	Slaskie	2
PL3	Region Wschodni	2
PL31	Lubelskie	2
PL32	Podkarpackie	
PL33	Swietokrzyskie	
PL34	Podlaskie	2

Appendix Table 1 (continued). NUTS Regions

Code	Name	Level
PL4	Region Pólnocno-Zachodni	1
PL41	Wielkopolskie	2
PL42	Zachodniopomorskie	2
PL43	Lubuskie	2
PL5	Region Poludniowo-Zachodni	1
PL51	Dolnoslaskie	2
PL52	Opolskie	2
PL6	Region Pólnocny	1
PL61	Kujawsko-Pomorskie	2
PL62	Warminsko-Mazurskie	2
PL63	Pomorskie	2
Portugal (PRT)		
PT1	Continente	1
PT11	Norte	2
PT15	Algarve	2
PT16	Centro (PT)	2
PT17	Área Metropolitana de Lisboa	2
PT18	Alentejo	2
PT2	Região Autónoma dos Açores (PT)	1
PT3	Região Autónoma da Madeira (PT)	1
Romania (ROU)		
RO1	Macroregiunea unu	1
RO11	Nord-Vest	2
RO12	Centru	2
RO2	Macroregiunea doi	1
RO21	Nord-Est	2
RO22	Sud-Est	2
RO3	Macroregiunea trei	1
RO31	Sud - Muntenia	2
RO32	Bucuresti - Ilfov	2
RO4	Macroregiunea patru	1
RO41	Sud-Vest Oltenia	2
RO42	Vest	2
Sweden (SWE)		
SE1	Östra Sverige	1
SE11	Stockholm	2
SE12	Östra Mellansverige	2
SE2	Södra Sverige	1
SE21	Småland med öarna	2
SE22	Sydsverige	2
SE23	Västsverige	2
SE3	Norra Sverige	1
SE31	Norra Mellansverige	2
SE32	Mellersta Norrland	2
SE33	Övre Norrland	2
Slovenia (SVN)		
SI3	Vzhodna Slovenija	2
SI4	Zahodna Slovenija	2
Slovak Republic (SVK)		
SK1	Bratislavský kraj	2
SK2	Západné Slovensko	2
SK3	Stredné Slovensko	2
SK4	Východné Slovensko	2
United Kingdom (GBR)		
UKC	North East (UK)	1
UKC1	Tees Valley and Durham	2
UKC2	Northumberland and Tyne and Wear	2
UKD	North West (UK)	1
UKD1	Cumbria	2
UKD3	Greater Manchester	2
UKD4	Lancashire	2
UKD6	Cheshire	2
UKD7	Merseyside	2
UKE	Yorkshire and The Humber	1
UKE1	East Yorkshire and Northern Lincolnshire	2
UKE2	North Yorkshire	2
UKE3	South Yorkshire	2
UKE4	West Yorkshire	2
UKF	East Midlands (UK)	1
UKF1	Derbyshire and Nottinghamshire	2
UKF2	Leicestershire, Rutland and Northamptonsh.	2
UKF3	Lincolnshire	2
UKG	West Midlands (UK)	1
UKG1	Herefordshire, Worcestershire and Warwicksh	2
UKG2	Shropshire and Staffordshire	2
UKG3	West Midlands	2
UKH	East of England	1
UKH1	East Anglia	2
UKH2	Bedfordshire and Hertfordshire	2
UKH3	Essex	2
UKI	London	1
UKI3	Inner London - West	2
UKI4	Inner London - East	2
UKI5	Outer London - East and North East	2
UKI6	Outer London - South	2
UKI7	Outer London - West and North West	2
UKJ	South East (UK)	1
UKJ1	Berkshire, Buckinghamshire and Oxfordshire	2
UKJ2	Surrey, East and West Sussex	2
UKJ3	Hampshire and Isle of Wight	2
UKJ4	Kent	2
UKK	South West (UK)	1
UKK1	Gloucestershire, Wiltshire and Bristol	2
UKK2	Dorset and Somerset	2
UKK3	Cornwall and Isles of Scilly	2
UKK4	Devon	2
UKL	Wales	1
UKL1	West Wales and The Valleys	2
UKL2	East Wales	2
UKM	Scotland	1
UKM2	Eastern Scotland	2
UKM3	South Western Scotland	2
UKM5	North Eastern Scotland	2
UKM6	Highlands and Islands	2
UKN	Northern Ireland (UK)	1