Cross-National and Sub-National Fertility across Europe

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Background

European fertility in the 20th century is often described through a pattern of national convergence. Over the last century, fertility has become more *similar* within countries but, at the same time, has become more *different* between countries. Similarities between adjacent provinces separated by borders have decreased in Europe in every examined country between 1870 and 1960 (Watkins 1991, 101). This can be attributed to national policies that facilitate diverging patterns between countries and similarities within countries (Klusener et al 2013) or increasing economic equality within countries (Watkins 1991, 85). Time series analysis suggests that, while the role of national borders increased throughout the 20st century, their influence relative to regions decreased at the turn of the century (Klusener et al 2013a).

However, certain differences persist within countries. One such disparity is the difference between fertility in urban places and rural places, where urban places have lower fertility and rural places have higher fertility. This has been demonstrated in a variety of countries using population density (Hank 2001 in Germany, Kulu 2006 in Austria and Poland, and Kulu & Washbrook 2014 in England and Wales). While the urban-rural dimension can be considered a proxy for various social, economic, and cultural factors (Coale & Watkins 1986, 236), population diffusion can be used to examine diffusion of new behaviours such as fertility within and across countries.

Diffusion theory argues that patterns in human behaviour – such as new concepts of behaviour or morality – spread from a cultural centre, often metropolitan areas, to the surrounding areas (Watkins 1991, 85). Empirical evidence was found for this theory in Prussian fertility transition, where nearby districts appear to have been an important predictor of fertility decline in a given region (Goldstein & Klusener 2013b). Vitali & Billari (2017) found evidence for the diffusion theory in a modern context by showing that provincial fertility rates were spatially related in Italy in 2010. However, this research omits the influence of cross-national effects that may stem from bordering regions. Of the few pan-European analyses of subnational fertility, evidence persists for variation in the face of national convergence. This research notes a weakening over time in the relationship strength between fertility and economic determinants (Fox et al 2018).

The aim of this paper is to contribute to knowledge on modern subnational fertility variation across Europe. I examine whether fertility in one European region is related to the fertility in adjacent regions through spatial modelling. I use smaller spatial units than previous European studies to best examine the evidence for diffusion, demonstrated in previous case studies, on a European level to transcend administrative border limitations. I utilize population density (urban-rural) contexts to discuss the spatial influence of known fertility determinants. I emphasize the importance of cross-national spatial clusters to contribute to our understanding of convergence theory in a high-movement context.

Data and Methods

I use aggregate level data for 1,134 NUTS (Nomenclature of Territorial Units for Statistics) level 3 regions in 20 European countries – Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Lithuania, Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, and the United Kingdom (England and Wales). The NUTS levels are statistical units designed by Eurostat to facilitate cross-national comparisons. The NUTS 3 level is a subnational level constructed using groups of local administrative units with populations between 150,000 and 800,000 persons.

I utilize 2010 fertility data, measured as Total Fertility Rate (TFR) for these regions from respective national statistical offices. Regional data comes from Eurostat and OECD regional databases. This includes data on population density as persons per square kilometre and divorce rate of persons aged 15 to 49. Data on regional Gross Domestic Product (GDP) is expressed as 2010 USD ($) per head. I use areal interpolation to estimate missing Eurostat data where possible. Where not possible, I utilize appropriate statistics from national statistical offices.

I begin by examining the relationship between population density and fertility on a European level. I use a spatial lag regression to determine if there is a global effect on fertility in one region from fertility in neighbouring regions. I use a First Order Queen weight matrix to assign spatial connections between adjacent regions. This spatial grouping transcends administrative borders and includes cross-national regions.

I then examine the regional trends and clusters of fertility that are indicated by spatial lag modelling to highlight areas of high and low fertility. I use geographically weighted and spatial autoregressive regressions to directly account for spatial connections that may not be captured through administrative groupings, as a multilevel approach may impose. Geographically weighted regression conducts many local regressions to demonstrate the local relationships between fertility and its determinants. This demonstrates where a determinant may be most effective in explaining fertility patterns and possible national or subnational trends. I first examine the effect of population density on fertility, then also include information on GDP and divorce rates as proxies for economic and social determinants. Lastly, I employ an autoregressive model to highlight regional clustering of effects and identify possible cross-national clusters of fertility after accounting for determinant effects. I include fixed effects in all modelling to account for the effect of national borders on observed fertility.

Results

Table 1 displays the results from a spatial lag regression of NUTS 3 fertility on population density. I include the results from a multilevel model using NUTS 2 (administrative borders) effects for reference. The Moran's I coefficient is a correlation coefficient for spatial autocorrelation between the fertility estimate residuals of NUTS 3 regions. From this coefficient we can see that autocorrelation is occurring, even after including the effect of country and NUTS 2 level groupings. This is resolved through the use of spatial modelling. There is moderate and significant influence from the fertility of neighboring regions on estimations of regional fertility (ρ = 0.4643). Although the effects of population density do not change between models, it is clear that there are spatial processes unaccounted for in the multi-level model.

Table 1. Regression Results of TFR on Population Density

Variable	Multi-Level (NUTS 2)	Spatial Lag
Intercept	1.5327 *** (0.0352)	0.8365 *** (0.0500)
Population Density (ln)	-0.0191 *** (0.0034)	-0.0127 *** (0.0030)
Lagged TFR (ρ)		0.4643 ***
AIC		-1732.90
Moran's I	0.2922 ***	0.0148

(standard error), All regression models control for country fixed effects
* p ≤ 0.05 ** p ≤ 0.01 *** p ≤ 0.001

Results from the geographically weighted regressions demonstrate national and subnational changes between the relationship for fertility and each determinant. The results for population density and GDP are very similar, suggesting that GDP is a strong determinant of urban-rural gradients in fertility. Figure 1 shoes the spatial clustering of fitted Total Fertility Rates from population density and country fixed effects. There are shifts from positive to negative relationships between fertility and its determinants in all countries, supporting arguments for weakening determinant relationships. These shifts are larger for some (France, Italy, Spain) than others (Czech Republic, Estonia, Latvia). One regional pattern is the gradient in the fertility-GDP relationship noted by Vitali and Billari (2017). Other clusters observed include a change in fertility-GDP relationship between north France (positive) and south France (negative), as well as a negative relationship in northwest Spain.

Table 2 shows the results from spatial autoregressive analysis. The spatial term (λ) is significant in both the general model with population density and the specific model with GDP and divorce rates. This indicates significant spatial effects on TFR estimations outside of spatial autocorrelation, as the Moran's I coefficient is low and not positive. On a global level, regional divorce rate is a stronger determinant of fertility than GDP. This again supports evidence that the relationship between GDP and fertility is weakening in modern Europe.

Table 2. Results from Spatial Autoregressive Regression (SAR)

Variable	Model 1	Model 2
Intercept	1.5592 *** (0.0329)	1.7181 *** (0.0377)
Population Density (log)	-0.0184*** (0.0035)	
GDP (square root)		-0.0005 *** (0.0000)
Divorce Rate		-0.0999 *** (0.0163)
λ	0.5346 ***	0.5558 ***
AIC	-1711.6	-1775.5
Moran's I	-0.0201	-0.0257

(standard error), All regression models control for country fixed effects
* p ≤ 0.05 ** p ≤ 0.01 *** p ≤ 0.001

Figure 2 shoes the spatial component for regional fertility estimations, after accounting for the effect of GDP, divorce, and national borders. Pink groupings in Figure 2 reflect clusters of low fertility and green groupings reflect clusters of high fertility. These clusters are relative to the country and surrounding trends. Prominent cross-border clustering occurs along the Belgium-Netherlands and France-Switzerland borders. These two groupings align with prior cross-boundary analysis of marital fertility, which demonstrates that regions along these borders were some of the most similar within Europe in 1960 and with the least amount of change since 1870 (Watkins 1991, 101). Other cross-border clustering includes regions along the Portugal-Spain border. These regions also displayed similarities in Watkins's analysis. There is also some evidence for clustering along Austrian border with Germany. German borders were omitted from Watkins's 1991 analysis but this support findings that German speaking countries have similar trends in fertility (Sobotka 2011). Lastly, there is clustering along the eastern borders of Austria. This may be due to commuting patterns to Vienna or other factors and requires more research.

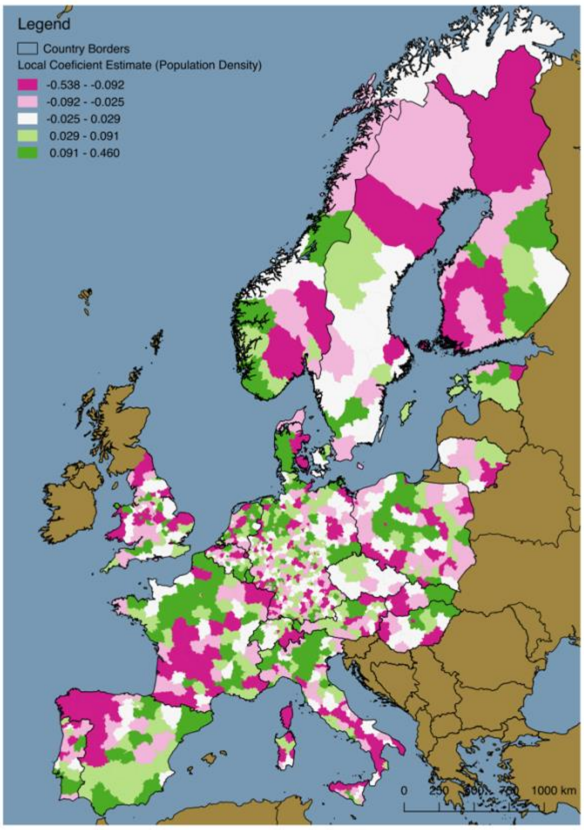

Figure 1. Local Coefficient Estimates of Population Density from Geographically Weighted Regression, by quintiles

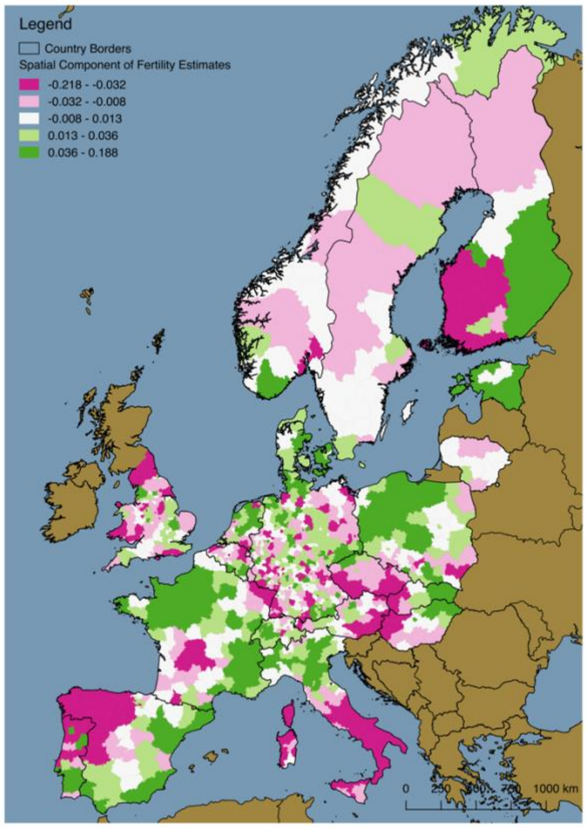

Figure 2. Spatial Component of Fertility Estimates from Spatial Autoregressive Model, by quintiles

Conclusions

It is known that spatial processes influence estimations in fertility research. The common multi-level modelling does not accurately account for spatial effects, since these can transcend administrative units used in this approach. After accounting for spatial ties and patterns in fertility determinants, spatial dependence of fertility persists throughout Europe, not just in Italy. Spatial dependencies can be trans-national in some region of Europe, requiring the inclusion of neighboring countries when performing case studies. These cross-border relationships are important in fertility study, especially in the European Union context that facilitates economic and social movements between countries. Further analysis of regional effects of fertility determinants will provide further direction for researchers to conduct informed analysis of modern fertility trends. The inclusion of individual-level analysis with spatial considerations will only strengthen our understanding.

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