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Abstract

Since 2010, some of the Nordic countries have experienced fertility declines down to unprecedented levels. Fertility decline in the Nordic countries was unexpected for most experts, considering that these countries were not heavily affected by the 2008 economic recession which was related to fertility declines in other European countries. Researchers have sought to understand why fertility is declining in these countries but have so far paid little attention to the spatial dimension of this process, despite evidence of large spatial variation of fertility. This paper contributes new understanding to the role of space in Nordic fertility changa and how the uncertainty perspective is related to spatial patterns of fertility. We apply advanced spatial panel models to data covering 1,099 municipalities in Denmark, Finland, Norway, and Sweden to separate out spatial variation and temporal variation. Our models use both economic (employment, income) and social (partnership dissolution, voting) measures of uncertainty to explore how uncertainty is related to fertility. Results show that fertility levels and trends by age vary substantially by level of urbanization. Differences in uncertainty by age appear essential to spatial variation – while social contexts are related to variation at all ages, economic measures are more related to fertility under age thirty than over age thirty. In addition, stability in fertility over age thirty seems to be an important buffer for the overall rate of total fertility decline, especially in rural municipalities.

Introduction

Total fertility rates (TFRs) in the Nordic countries have declined from relatively high levels in 2010 to new lows. Fertility declines after the 2008 economic crisis were common in European countries, especially those which were hit hard by the recession. However, the Nordic countries were not among these countries and fertility decline in the Nordic regime of established family support policies and high levels of gender equality are in stark contrast to relatively high period fertility throughout the 1990s and 2000s (Andersson et al. 2009; Hellstrand et al. 2020a). Decreases in first birth rates and fertility at younger ages appear to be driving these unprecedented changes in the Nordic countries (Hellstrand et al. 2020a) and research has proposed a number of factors to explain fertility change in the Nordic countries (Jalovaara et al. 2019; Nisén et al. 2020). Most importantly, many researchers have suggested that increasing economic and social uncertainty is negatively related to fertility (Goldstein et al. 2013; Comolli et al. 2019). Economic uncertainty arguments state that employment or income instability from high levels of unemployment encourage individuals to postpone fertility until a later time and thus can reduce period fertility levels. While the Nordic countries did not experience economic hardship during the 2008 crisis as much as other European countries (Goldstein et al. 2013), prolonged uncertainty may be related to the recent fertility decline (Comolli et al. 2019; Vignoli et al. 2020).

None of the current proposed explanations consider the role of geographic variation in fertility levels in the recent fertility changes. Geographic variation of fertility is a longstanding pattern in the Nordic countries; urban regions are characterized by relatively low fertility and rural regions by relatively high fertility (Kulu et al. 2007). Fertility variation between levels of urbanization continues to persist in the Nordic countries (Nisén et al. 2020; Campisi et al. 2020) and differences between regions can be quite large, even in these countries with relatively low socioeconomic variation of fertility (Jalovaara et al. 2019). For example, the socioeconomic differences in completed family size between women with high and those with low education is estimated at 0.05 children in Norway for women born between 1964 and 1970 but the geographic differences in cohort fertility between urban and rural regions (of women with the same education level) can be as large as 0.66 children (Nisén et al. 2020).

Furthermore, it is unclear whether the geographic fertility differences traditionally reflected between levels of urbanization are increasing or decreasing and what factors might account for change. From the uncertainty perspective, subnational regions may have varied in how their populations responded to uncertainty after 2008 and thus fertility levels may have varied between regions due to factors such as economic resilience (Blank 2005) or internal migration (Sabater and Graham 2018). Understanding differences between regional contexts may help us to also understand not only where fertility within the Nordic countries is changing the most but also how urbanization is related to both uncertainty and age-specific patterns of fertility. Social contexts (Vignoli et al. 2020) or overarching uncertainty about future conditions (e.g. Comolli et al. 2019) may be more relevant for understanding fertility in these countries, given that macroeconomic conditions did not greatly deteriorate.

This paper seeks to understand spatial variation in fertility in the Nordic countries (Denmark, Finland, Norway, and Sweden) and how spatial trends are related to fertility declines between 2005 and 2018. We examine how fertility variation between levels of urbanization has changed over time. In addition, we delve into geographic patterns by age and use the uncertainty perspective to understand how fertility has changed in the Nordic countries. To do so, we combine panel regression methods with novel spatial analysis and decomposition methods to disaggregate the relationships between fertility and uncertainty by space and time. By expanding the definition of uncertainty beyond economic indicators, we observe how different contexts are important for fertility at different ages. We use economic measures of economic activity and income, and social measures of partnership dissolution and voting sentiment as potentially important contexts for fertility variation. This allows us to reflect on aspects of how perceptions may be related to changing societal conditions and persistent uncertainty (Comolli 2017; Matysiak et al. 2020) within the Nordic countries, and to generate insights on how fertility might evolve in the future.

Background and previous research

Spatial variation in fertility

Spatial variation in fertility persists within the Nordic countries. This is not a new phenomenon as there have been long-standing differences in fertility levels between urban and rural regions. For example, geographic differences in demographic, economic, and social contexts contributed to faster fertility decline in Swedish urban centers than in rural areas during the 1880s (Klüsener et al. 2019), as well as to differences in fertility timing and the ultimate number of children between urban and rural regions at the end of the 20th century (Kulu et al. 2007). Women in cities postponed fertility to later ages, resulting in lower completed fertility, while women in rural regions had children at younger ages and displayed higher levels of completed fertility.

The relationship between the geographic context and fertility have become more complex over time. For example, higher levels of economic development were historically related to lower levels of fertility in the Nordic countries (Fox et al. 2019). But this relationship has disappeared in recent years in Norway and Sweden. Similarly, higher levels of female education were historically related to lower levels of fertility. Higher educational attainment helped women attain greater social and economic resources and greater ability to pursue life goals other than childbearing (Brewster and Rindfuss 2000; McDonald 2000; Myrskylä et al. 2009; McDonald 2013; Myrskylä et al. 2011). Recent research shows that this negative educational gradient no longer holds in some Nordic countries (Jalovaara et al. 2019). Despite changing, and in some cases reversed, relationships between fertility and specific contextual conditions, the pattern of lower fertility in urban regions and higher fertility in rural regions persists (Kulu et al. 2007; Nisén et al. 2020; Campisi et al. 2020).

Economic uncertainty

Economic uncertainty may be one contextual condition that contributes to persisting regional differences in fertility. Uncertainty was relevant for fertility in prior economic recessions (Comolli et al. 2019) and may have gained new relevance for fertility since the 2008 economic crisis (Goldstein et al. 2013; Comolli 2017; Örsal and Goldstein 2018; Matysiak et al. 2020; Vignoli et al. 2020). Economic uncertainty, such as unemployment or loss of income, can negatively impact fertility-related life plans such as childbearing intentions as individuals seek to protect themselves against further economic hardship until confidence returns (Comolli 2017).

Childbearing can compete with secure employment in multiple ways. First, children can be seen as a threat to finding employment (Adserá 2011). Having a child without secure employment may limit individuals' means of increasing employability, such as gaining additional skills or qualifications (Adserá 2004). Second, reentering the labor force full-time after childbirth may be difficult and may have negative consequences for careers and earning potentials (Rønsen and Sundström 2002). Third, persistent unemployment competes financially with having children by reducing long-term financial savings due to unearned or lost income (Adserá 2011; Brand 2015), thus reducing financial resources available for childbearing and childrearing. Temporary fertility postponement can contribute to a short-term depression in fertility levels or, if fertility is postponed indefinitely, a large decrease in total fertility (Fokkema et al. 2008; Sobotka et al. 2011).

Nordic fertility was not immediately affected by the 2008 recession as in other European countries (Goldstein et al. 2013). Welfare benefits may have protected these countries from initial fertility decline. The Nordic welfare regime provides support to reduce the opportunity costs of childbearing (Rønsen 2004; Bongaarts 2008). For instance, in Norway, the government provides cash benefits for families with young children. Research shows that households which accept this cash benefit display accelerated fertility transitions (Aassve and Lappegård 2009). Welfare benefits that reduced the trade-off between fertility and employment may have acted as alternative sources of income and allowed individuals to continue realizing their fertility intentions (Alderotti et al. 2019), in spite of macroeconomic difficulty.

However, stagnant incomes (OECD 2020) and stagnant economic growth since 2008 (World Bank 2020) may contribute to perceptions of prolonged economic instability. The longer individuals are unemployed, the less optimistic they may be about their future circumstances. While short periods of economic uncertainty are shown to have a negative impact on fertility, evidence also shows that this relationship becomes stronger when uncertainty is prolonged. For instance, long-term unemployment reduces childbearing intentions more than short-term unemployment (Busetta et al. 2019). We may expect lower fertility levels across a region if uncertainty is prevalent or prolonged across a large proportion of the population.

We can expect regions with higher levels of unemployment to display lower levels of fertility than regions with lower levels of unemployment (Puig-Barrachina et al. 2019). Urban regions tend to have larger, more resilient economies (Blank 2005) and thus be better protected from fertility decline than rural regions with rigid economies and fewer employment opportunities. Regional economic imbalances can be exacerbated by internal migration patterns if migrants move from high-unemployment regions to low-unemployment regions (Sabater and Graham 2018), especially if migrants are young. If internal or international migrants postpone childbearing until after a move (Andersson 2004; Kulu and Vikat 2007; Milewski 2007), receiving regions would witness less fertility decline as decreases are offset by migrant fertility. We expect urban regions to be these protected receiving regions if urban regions receive more migrants (Kulu et al. 2007). In this case, we may expect fertility rates in urban and surrounding commuter regions to be positively affected by these processes and fertility differences between regions to further increase.

Social aspects of uncertainty

Social aspects of uncertainty also contribute to long-term uncertainty about the future. Expectations, such as when economic stability will return (Comolli 2017), and perceptions, such as the impact of instability (Sanders 1999), contribute to impressions of future living conditions and, thus, to fertility decisions (Matysiak et al. 2020). Expectations and perceptions of current and future conditions may be shaped by broader societal expectations. Societal expectations may stem from religion (Sobotka and Adigüzel 2002; McQuillan 2004; Lehrer 2004; Zhang 2008) or family expectations (Liefbroer and Billari 2010) and be related to fertility-relevant events such as the occurrence or timing of family formation. Traditional expectations in highly individualized societies can include disapproval of cohabitation, disapproval of single parenthood, or disapproval of divorce (especially after children) (Liefbroer and Billari 2010; Lappegård et al. 2017). Individuals may rely more on societal expectations during times of uncertainty to return a sense of order (Jost et al. 2007) and individual-level fertility may be responsive to general social norms (Lappegård et al. 2017).

Differences in both the nature and strength of societal expectations and support may vary across space, and thus be related to fertility differences between regions.

Economic uncertainty contributes to added stress from unemployment or loss of income, which can increase partnership dissolutions (Fischer and Liefbroer 2006). Expectations on family structure and divorce can vary by region. Regions with higher populations of separated individuals are expected to have lower levels of fertility (Hart 2019) if separated individuals do not repartner (Kreyenfeld et al. 2017). The fertility of this non-partnered group is expected to be different from that of never-partnered individuals, since never-partnered individuals may vary depending on the share of persons who are not interested in a partnership. Furthermore, higher proportions of dissolved unions better reflects added stress and precarity from uncertainty impacts on partnerships.

Support for traditional family values also varies between regions and may be expressed in how individuals vote. Individuals may vote for parliamentary representatives in an attempt to return a sense of order (Lewis-Beck and Paldam 2000). Leaders who espouse a conservative stance on ideology or democratic freedoms, such as that children are a source of fulfillment in life (Lesthaeghe and Surkyn 1988; Pearce and Davis 2016), or a preference for traditional family structures (Anson and Meir 1996). If support for conservative ideologies and large families decrease, we would also expect general fertility to decrease. Further fertility-related impacts can emerge if support for conservative parties increases and elected officials pass pronatalist policies. For example, the Christian Democratic Party in Sweden supports both tax reductions to allow citizens to keep more of their incomes (Kristdemokraterna 2020) and keeping families together (Kristdemokraterna 2016). In Norway, a 1998 policy introduced by conservative parties granted cash benefits to parents with young children and directly contributed to accelerated fertility in couples who used the benefit (Aassve and Lappegård 2009). Votes for conservative parties may increase during times of uncertainty. This was the case in the United Kingdom during the 2016 referendum on leaving the European Union, where economically 'left behind' regions voted in favor of the conservative Brexit referendum (Johnston et al. 2018; Bromley-Davenport et al. 2019).

It is evident that fertility decline is a multifaceted and complex process. Fertility changes are comprised of both spatial and temporal patterns and are likely related to both economic and social contexts. We hypothesize that fertility variation across space will be evident within the Nordic countries and that fertility differences between levels of urbanization have grown during recent periods of fertility decline. The negative relationship between fertility and uncertainty is previously demonstrated over time but we believe it will also be important in explaining trends in fertility variation across space. Furthermore, we expect social contexts to be more important for fertility variation over space than over time, since we expect social differences between municipalities since differences currently but may take time to change within them. We also expect social contexts to be more important at older ages than younger ages, given that economic aspects of uncertainty have been demonstrated as important for fertility at younger ages and economic accumulation may be present at older ages.

Data

We use municipality-level data from national statistics offices (see Appendix A Table A1) from 2005 to 2018 for 1,099 municipalities from Denmark (98 municipalities), Finland (297 municipalities), Norway (420 municipalities), and Sweden (284 municipalities). Some municipalities (primarily outer islands) were combined with other municipalities or removed due to sparse data or geographic isolation. The boundaries of Danish municipalities changed from 270 to 98 regions between 2006 and 2007. We converted the Danish data to the new municipality boundaries using aggregation and areal interpolation assuming an equal distribution of the population to account for this change. Calculations for many indicators are not age-specific due to limitations on data published by age but where age specific indicators are used is noted. Data is calculated for each year.

Fertility variables

We analyze total fertility rates at the municipality level in each year. Total fertility rates are calculated by summing up the age-specific fertility rates. Age-specific fertility rates are calculated for each municipality by dividing the number of live births by the mid-year female population in the given 5-year age group between ages 15 and 49. In addition to calculating the total fertility rate, we also calculate age-specific contributions to the fertility rate as age-specific fertility rates for ages 15 to 29 ($ASFR_{15\text{-}29}$) and for 30 to 49 ($ASFR_{30\text{-}49}$) to investigate whether different indicators of uncertainty play a more important role for fertility at younger or older ages. The sum of the $ASFR_{15\text{-}29}$ and the $ASFR_{30\text{-}49}$ is equal to the TFR.

Explanatory variables

Below we provide information on the used explanatory variables. The presented expectation are derived from the discussion in the background section.

Economic indicators

Economic inactivity reflects the share of persons not in employment in each year and each municipality. It is calculated by dividing the mid-year number of employed persons (E) by the mid-year total population (N) as E/N. The complement of this employment ratio (1-E/N) is then used as the economic inactivity ratio. Municipalities with a higher share of students or individuals not seeking employment may have inflated unemployment ratios. The share of those not seeking employment will better reflect uncertainty if individuals enroll in further education or training to enhance their employable skills, a competing risk with childbearing. Populations by economic activity are published differently by different countries.[1] We expect economic inactivity to be negatively related to fertility.

Income per capita reflects the municipality-level gross income in 2010 Euros (in thousands) per inhabitant. Municipality-level gross income is calculated as the total gross income earned by employed inhabitants in the municipality in each year. Yearly gross income is converted from the national currency to Euros using Eurostat data on the yearly average exchange rate and is standardized to the 2010 value of Euros using Eurostat data on price index for GDP at market prices for the respective years. The yearly municipality-level gross income in Euros is then divided by the mid-year total number of inhabitants in the municipality. We expect income to be positively related to fertility.

Sociocultural indicators

The share of dissolved partnerships reflects the mid-year stock of separated individuals in each municipality in each year. It is derived as the ratio of individuals who are separated (either from marriage or from cohabitation[2]) to the total mid-year population in the municipality in each year. This variable reflects the share of those who have experienced union dissolution and did not repartner. Although no information is available for the levels of repartnering across regions, high levels of repartnering in a municipality are expected to lead to smaller shares of individuals with a dissolved, not repartnered partnership status. Nonetheless, this variable has been shown as related to regional fertility levels across Europe

[1] Data on the number of employed persons is published for ages 16-66 in Denmark, 18-64 in Finland, 20-66 in Norway, and 16-64 in Finland. This discrepancy between countries is not expected to have a considerable influence on regional variation in employment rate as the employed population is divided by the age-relevant risk population.

[2] Information on the dissolution of cohabiting unions is not available for Norway.

(Campisi et al. 2020). We expect the share of persons in dissolved partnerships to be negatively related to fertility.

The *proportion of votes for conservative parties* reflects the proportion of votes cast for conservative political parties in national parliamentary elections. Parliamentary elections are held every four years in each country. For non-election years[3], we imputed data from the previous election. We classified conservative political parties using a metric from the University of North Carolina Chapel Hill Expert Survey, which surveyed experts on party positions on topics such as European integration, ideology, and political issues. We combine data from the 2010 survey (Bakker et al. 2015) and the 2014 survey (Polk et al. 2017). Expert score assessments are assumed to be reasonably reliable (Hooghe et al. 2010) and cover topics such as overall ideological stance (extreme left to extreme right), ideological stance on economic issues (extreme left to extreme right), party position on democratic freedoms and rights (Libertarian or Postmaterialist to Traditional or Authoritarian), and position towards nationalism (strongly cosmopolitan to strongly nationalist). Parties with the highest ranked sum score across all topics and the highest score for overall ideological stance were classified as conservative. This reflects the level of conservatism relative to other parties in the country rather than absolute levels across countries.[4] The proportion of votes for conservative parties is calculated as the number of votes for conservative parties, divided by the total number of votes cast in the election. We expect the proportion of votes for conservative parties to be positively related to fertility.

[3] Election years include 2007, 2011, and 2015 in Denmark, 2003, 2007, 2011, and 2015 in Finland, 2001, 2005, 2009, 2013, and 2017 in Norway, and 2002, 2006, and 2010 in Sweden. Voting data for 2005 and 2006 in Denmark come from 2007.

[4] Political parties which were classified as conservative include the Danish People's Party and Conservative People's Party for Denmark, the Swedish People's Party and the Finns Party for Finland, the Progress Party and Christian Democratic Party for Norway, and the Christian Democratic Party and Sweden Democrats for Sweden.

Demographic and spatial data

Net migration rate reflects the change in yearly population attributable to both internal and international in- and out-migration. Net migration rate is calculated as the sum of a municipality's immigrants and emigrants per 1,000 mid-year inhabitants. We expect the net migration rate to be positively related to fertility.

The *share of females with postsecondary education* reflects the mid-year share of females with at least postsecondary educational attainment in each municipality. It is calculated as the ratio of the size of the female population with educational attainment above secondary education (ISCED rank 4 and above) to the total number of women.[5] We expect the share of females with postsecondary education to be negatively related to total fertility but positively related at older ages.

Population density is defined as the municipality mid-year total population per square kilometer. This is calculated using information on the size of the mid-year population in each municipality for each year and information on the area of municipalities from 2017. We expect population density to be negatively related to fertility and insignificant when other indicators are accounted for if population density serves as a proxy for other factors.

Variable change over space and time

Table 1 shows the mean and standard deviation of each variable used in the analysis. Variable means are calculated across all municipalities and time points within each respective country. Total variation of both municipality and yearly in the total fertility rate is highest in Finland and Norway, as observed from the standard deviations. Differences in variation between countries is not large between 2005 and 2018 for the share of economically inactive

[5] Information on educational attainment is available for females aged 15 to 69 in Denmark, 15 to 74 in Finland, 16+ in Norway, and 16 to 74 in Sweden. The share of females with postsecondary education is calculated using the respective risk population ages for each country.

population, share of votes for conservative parties, share of population in dissolved partnerships, and share of females with postsecondary education. However, there is a large amount of variation between countries for the net migration indicator; it is especially high in Norway and Sweden. The populations of Denmark and Finland have lower net migration as indicated by the much smaller variation in net migration over time. The incomes per capita and population densities are also different between countries.

All four countries experienced a decline in period TFR after 2010 (Figure 1). Danish fertility increased slightly between 2013 and 2016 but then declined again after 2016. Finland and Norway have experienced the most dramatic fertility declines of all four countries. Swedish fertility remained relatively stable during the period but has exhibited decreases within certain regions. Figure 2 shows the change over time in the values of select variables included in the temporal analysis. Change over time is calculated as each year's standard deviation from the country's mean value across all years observed in Table 1. Thus, the year's value is equal to the mean in Table 1 when the standard deviation value is equal to zero. Overall, the values of all indicators have increased since 2005 except for the value of TFR. The share of the population in dissolved partnerships and the share of females with postsecondary education displayed the largest change in standard deviation between 2005 and 2018. Population density and income per capita were excluded because they did not vary much over time.

Methods

Descriptive analysis

We study variation in TFR across municipalities for each country to understand how fertility varies by level of urbanization and if spatial variation has increased or decreased over time. We examine how fertility patterns have changed within countries and over time using municipality-level total fertility rates by year. We group municipalities based on population size thresholds to calculate TFR by different levels of urbanization. These classifications include rural municipalities (less than 50,000 inhabitants), town municipalities (50,000-100,000 inhabitants), city municipalities (100,000-500,000 inhabitants), and major city municipalities (more than 500,000 inhabitants). This approach may not accurately reflect country-specific urbanization levels but using alternative definitions, such as classifying urbanization using country-specific standard deviations, yield similar results (results not shown but available upon request). We examine how age-specific fertility patterns have changed within countries and over time using municipality-level age-specific fertility rates ($ASFR_{15-29}$ and $ASFR_{30-49}$).

Regression analyses

First, we use a random effects spatial panel regression model to investigate the relationship between fertility and uncertainty across all municipalities and years (Model 1). We utilize a random effects panel regression approach because we are interested in variation in the total fertility rate between municipalities and believe these to be theoretically important for changing fertility levels over time. A fixed effects panel regression would remove the municipality-level differences, omitting spatial variation from the regression estimation.[6]

We include a spatial lag of total fertility rates from neighboring municipalities in the models to account for spatial autocorrelation in our data (Appendix B Table B1). Spatial

[6] Results from Hausman tests for spatial models (Mutl and Pfaffermayr 2011; Millo and Piras 2012) suggest that the random effects models may violate regression assumptions (Appendix B Table B1). The Hausman test compares fixed and random effects estimators for panel models and tests whether orthogonal assumptions of correlation are violated by the random effects model (Hausman 1978). It is assumed that the random and fixed effects are similar if assumptions are violated, and a fixed effects approach is appropriate. Despite this, we proceed with a random effects model as we are explicitly interested in studying variation in fertility across space. As a robustness check, we estimated fixed effects spatial panel models (see Appendix B Table B3) to compare these estimates with those from the random effects approach. Although the results of the fixed effects models and the random effects models are very similar, the latter models yield results that are more consistent with the results of the disaggregated models and provide strong evidence for the prevalence of municipality-level variance in our data (ϕ) and for spatial dependence affecting our estimation (λ).

autocorrelation refers to the observation that total fertility rates of neighboring regions are likely to be more similar to each other than those of regions which are further apart. Not accounting for spatial autocorrelation may lead to biased regression estimates. Previous studies have shown that spatial models are better able to account for spatial autocorrelation than multilevel models or other commonly used non-spatial regression techniques (Baltagi and Li 2004; Campisi et al. 2020). The choice between different spatial models is largely dependent on the study aims and research questions. In this study, we use a spatial lag model because we are interested in understanding the contextual effects of fertility in surrounding regions.[7] The random effects spatial panel regression approach is outlined below:

$$y_{it} = \beta X_{it} + \lambda \sum_{j=1}^{N} w_{ij} y_{itj} + country_{it} + \phi_i + \varepsilon_{it}$$

Where total fertility rate (*y*) in municipality *i* and year *t* is regressed on independent variables *X* for each municipality and year. The spatial autocorrelation term λ is calculated by summing the product of TFR in neighboring municipalities (*j*) by their spatial weight, as defined by the spatial contiguity weight matrix *w* and is calculated as a total effect (space and time). We use a first-order queen contiguity weight matrix assignment, which weights adjacent municipalities and standardize weights within each region (i.e. row-standardized) in the weight matrix. There are an average 4.9 connected neighbors per municipality. ϕ_i is the municipality-level random effect and ε_{it} is the remaining error. We include fixed effects of the country in all models to control for systematic differences across countries.

Second, we disaggregate the overall relationships between fertility and the independent variables *X* (β) observed in Model 1 by decomposing the total relationship for

[7] We estimated a spatial autoregressive model with error (Appendix B Table B2, SARAR model) but found that the inclusion of two spatial terms does not improve model fit for additional variables and using a SARAR model in this case may lead to inefficient model estimates.

each variable by space and time (Model 2). Disaggregation allows us to directly assess fertility-variable relationships to understand how total relationships are simultaneously constructed by space and time. For each independent variable, we take the municipality's mean across all time points to estimate relationships *between* municipalities (across space) and the yearly deviation from the municipality's mean to estimate relationships *within* municipalities (over time) (Neuhaus and Kalbfleish 1998). We disaggregate the effects of the share of economically inactive, share of population in dissolved partnership, share of votes for conservative parties, and net migration. We do not disaggregate the effects of female postsecondary education, income per capita, and population density. Female postsecondary education does not vary much over space in these countries, and income per capita and population density do not vary much over time. For these indicators, the total effect best reflects their relationships with fertility and provides a simpler model. The formula for the disaggregated regression model is:

$$y_{it} = \beta_B \bar{X}_i + \beta_W (X_{it} - \bar{X}_i) + \lambda \sum_{j=1}^{N} w_{ij} y_{itj} + \beta X_{it} + country_{it} + \phi_i + \varepsilon_{it}$$

Where total fertility rate (y) in municipality i at time t is regressed on independent variables X between municipalities across space (β_B), within municipalities over time (β_W), and for non-disaggregated variables (β). The spatial between effect is estimated by generating municipality i's mean value of variable X across all time points. The temporal within effect is estimated by subtracting the municipality mean value of X from the observed value at time t. The disaggregated model also includes the spatial lag of total fertility rates from surrounding municipalities defined by the first-order queen weight matrix and fixed effects for country.

Third, we use the same disaggregated spatial panel model (Model 2) to instead analyze outcome variables of age-specific contributions to the total fertility rate ($ASFR_{15\text{-}29}$

and $ASFR_{30-49}$). The aim is to understand proportionality in the relationships between uncertainty indicators and fertility (Models 3 and 4).

Results

Urban-rural fertility gradients reverse at older ages

Fertility levels vary by level of urbanization in all four Nordic countries (Table 2). We find an expected urban-rural gradient in fertility levels: rural municipalities have higher TFR than major cities in all countries. However, while the urban-rural gradient exists for $ASFR_{15-29}$, this pattern is reversed for $ASFR_{30-49}$ in three out of the four countries. Fertility at older ages is higher in major city municipalities than in rural municipalities in Denmark, Norway, and Sweden. In these countries, major cities display both the lowest levels of $ASFR_{15-29}$ and the highest levels of $ASFR_{30-49}$.

The spatial variation in fertility becomes more evident when we examine fertility trends over time (Figure 3). Overall, variation in fertility exists between the most urban (major city) municipalities and the most rural (rural) municipalities. In some countries, such as Finland and Sweden, variation between the middle-level (city and town) municipalities is small. We compare $ASFR_{15-29}$ and $ASFR_{30-49}$ to further highlight the role age plays in the spatial variation of fertility. Spatial variation in fertility has generally grown since the beginning of the study period, but this varies for each age group. For $AFSR_{15-29}$, fertility variation by level of urbanization has remained relatively stable with some increase. For $ASFR_{30-49}$, spatial variation is much smaller over the years. $ASFR_{30-49}$ increased in spatial variation between 2005 and 2010 but variation has since declined.

In addition, fertility variation between the age groups is increasing, creating a pattern of divergence. While $ASFR_{15-29}$ has decreased in all countries and levels of urbanization since 2010, $ASFR_{30-49}$ has remained relatively stable in many levels of urbanization.

$ASFR_{30\text{-}49}$ is not stable, however, in major cities. Major cities experienced $ASFR_{30\text{-}49}$ increases at the beginning of the period, establishing them as the geography with the highest fertility levels. This inverted urban-rural gradient is not unreasonable if major cities experience later ages a birth, as is known to be the case, and have more births after age thirty than before age thirty. Finland is the exception to this trend, since $ASFR_{30\text{-}49}$ did not experience a large increase at the beginning of the period and major city $ASFR_{30\text{-}49}$ is about equal to rural $ASFR_{30\text{-}49}$. Furthermore, there is evidence that Finland is also experiencing declines in $ASFR_{30\text{-}49}$ across other levels of urbanization as well, maintaining low levels of fertility variation between the age groups and, as a result, not creating a pattern of divergence.

The role of uncertainty in fertility variation

The possible reasons for variation in fertility by age and geography over time become clearer in the regression analyses. Model 1 shows the standardized coefficients of the random effects spatial panel model, which estimates the total effects of social and economic indicators of uncertainty on municipality-level TFR across space and time (Table 3). In line with expectations from the economic uncertainty perspective, economic inactivity is negatively related to the TFR. However, this coefficient is rather small and smaller than the coefficients for partnership dissolution or income per capita. The negative relationship between dissolved partnerships and fertility is in line with our expectations. Voting for conservative political parties is positively related to fertility levels across space and time. This positive relationship reflects decreasing support for conservative ideology while fertility also declines over time. Municipalities with lower fertility are also those where support for conservative parties is low. In line with previous studies, we find a positive relationship between net migration and fertility. This may be related to migrants who wait to have a child until after the move. Lastly, the coefficients of the share of females with postsecondary education and income per capita are both negative. Population density is no longer significant when accounting for other covariates, as expected.

Disaggregating the relationships between fertility and uncertainty indicators by space (between effects) and time (within effects) reveals that all indicators are related to spatial variation of fertility (Model 2). However, not all indicators are related to fertility variation over time, most notably the proportion of economically inactive. In addition, most indicators are more related to fertility variation across space than over time. The exception is voting for conservative parties, which is equally related to fertility variation across space and over time but in opposite ways.

While conservative voting was positively related to fertility in Model 1, the complexity of the voting variable becomes clear in Model 2. Conservative voting is negatively related to fertility variation across municipalities but positively related to fertility change over time. While the positive relationship over time reflects decreasing support for (family centered) conservative ideology, the negative relationship may reflect increasing support for conservative leadership in the face of uncertainty (Lewis-Beck and Paldam 2000). Economic inactivity has a strong connection with fertility differences between municipalities. This reflects what prior research has shown in other European countries and on the individual level that populations postpone fertility during times of uncertainty. This is also the case for migration (as in Model 1), which has already been shown to be related to uncertainty in other countries if individuals migrate in search of employment opportunities (Sabater and Graham 2018). Lastly, the proportion of the population in dissolved partnerships is significantly related to fertility variation across both space and time. Municipalities with higher proportions of individuals who are in dissolved partnerships but have not repartnered also have lower levels of fertility. The role of female post-secondary education, income per capita, and population density are included as non-disaggregated, total effects in Model 2 for reasons outlined previously and are very similar to what was shown in Model 1.

The importance of space versus time is also evident when we analyze age-specific fertility rates (Models 3 and 4).[8] We find that social and demographic indicators have a similar relationship with fertility among younger and older age groups. For example, the association between partnership dissolution and fertility levels are the same for fertility at younger ($ASFR_{15-29}$) and older ($ASFR_{30-49}$) ages. This is also the case for the proportion of votes for conservative political parties and net migration.

However, some indicators have opposite relationships with fertility between the two age groups. For example, as the proportion of females with post-secondary education in a municipality increases, fertility under age thirty decreases and fertility over age thirty increases. The negative relationship is likely due to postponement during educational attainment at younger ages whereas the positive relationship reflects recuperation of fertility at later ages. The relationship between economic inactivity and $ASFR_{15-29}$ is twice as large as that for $ASFR_{30-49}$, in line with previous findings. Income per capita, while important at both ages, is also somewhat more important at younger ages. The association of population density varies across age: we detect a negative association between population density and fertility under age thirty but a positive association for fertility over age thirty. Thus, fertility at younger ages will be higher in rural regions but lower in urban regions while fertility at older ages will be lower in rural regions but higher in urban regions. This reflects important differences in the timing of childbearing between levels of urbanization.[9]

[8] Models 3 and 4 show the disaggregated results for age-specific fertility rates. Appendix B Table B4 shows the non-disaggregated random effects models comparable with Model 1.
[9] Estimating age-specific fertility rate outcomes for five-year age groups (Appendix B Table B5) do not suggest that one age group is driving the results observed in Table 3.

Lastly, we find that the spatial context of fertility is important for fertility variation across both space and time. Throughout all models, municipality-level fertility rates are positively related to fertility levels in neighboring municipalities (λ). Thus, fertility in a municipality is likely to be low if fertility levels in surrounding municipalities are also low. Adjacent municipalities are likely to be within the same geographic classification. This suggests that, while fertility levels between urbanization classifications can be quite different, fertility levels within classifications can be rather similar due to proximity. This does not, however, indicate whether municipalities that are not adjacent but belong to the same levels of urbanization are likely to have similar levels of fertility.

Conclusion

This paper introduced a geographic perspective on the recent fertility decline in the Nordic countries (Denmark, Finland, Norway, and Sweden). We used data from national statistics offices on municipality-level fertility to assess how geographic levels of urbanization are related to both economic and social indicators of uncertainty. We believed that uncertainty was relevant for geographic variation in fertility if regions disproportionately responded to or were protected against changes in uncertainty. We combined panel regression methods and spatial analysis in innovative ways that allowed us to better identify any relationships between fertility and proxy measures of uncertainty over time and space.

Our results highlighted distinct variation in the relationships between fertility and uncertainty indicators between Nordic municipalities. While all aspects of uncertainty were related to fertility levels across space and time, our results suggest that uncertainty is strongly related to spatial variation in fertility. Furthermore, results from spatial panel regressions identified that social aspects of uncertainty (e.g. partnership dissolution) are as, if not more, related to fertility variation as economic conditions (e.g. economic inactivity). This supports recent arguments that there is a need to consider a broader definition of uncertainty that extends beyond economic conditions when researching fertility (Comolli et al. 2019; Vignoli et al. 2020).

Results from spatial panel regressions also provided insights into how fertility differences between age groups are constructed. While prior research has shown that unemployment is more relevant for fertility under age thirty than above age thirty (Goldstein et al. 2013), our analyses suggest that this is not the entire story of uncertainty. Fertility in both age groups had a significant relationship with social aspects of uncertainty, such as conservative sentiment and partnership dissolution. However, the importance of economic inactivity for fertility variation across space under age thirty was twice that for over age thirty. This creates an added dimension of uncertainty for the younger age group that may not be as relevant for fertility over age thirty. Over age thirty, fertility may be less susceptible to economic uncertainty because individuals in this age group have had more time to accumulate financial capital and employment opportunities that can serve as resources during times of uncertainty. In addition, there are age-related limitations on how long individuals over age thirty can postpone fertility. Younger individuals may postpone fertility to enroll in further education or develop their careers (Kulu et al. 2007).

We also found persistent spatial dependence in municipality-level fertility across all regression models. While the descriptive results and the results related to population density demonstrate that differences in fertility exist between municipalities, we also found that municipality-level fertility is positively related to fertility levels in surrounding municipalities. While differences in fertility levels between municipalities can emerge as a result of differences in migration, economic conditions, or social norms, similarities between municipalities can be created through shared contexts. For instance, similarities in economic structures can contribute to similarities in municipality-level GDP or income. Daily movements between municipalities for economic or leisure purposes can also contribute to similarities in fertility levels through increased cultural or economic interaction. Not accounting for such spatial interdependencies in regression estimation will lead to biased estimates and different results.

Rural municipalities showed the largest change across both age groups. First, rural municipalities experienced the largest decline in fertility under age thirty. $ASFR_{15-29}$ declined in all urbanization classifications and fairly uniformly but declined the most in rural municipalities. Rural municipalities are likely those with least flexible economies and sparser employment opportunities, making economic uncertainty very important for fertility decisions in these regions.

At the same time, rural municipalities also exhibited the most stability in fertility over age thirty. As mentioned previously, individuals over age thirty likely have greater economic resources than their younger counterparts. Greater economic resources in rural municipalities, where the cost of living is less expensive than in urban regions, would allow older individuals to better withstand economic uncertainty than their younger counterparts or urban counterparts aged thirty or older. Because of these age-specific trends, rural municipalities displayed the most divergence between $ASFR_{15-29}$ and $ASFR_{30-49}$. $ASFR_{30-49}$ was stable in other classifications as well, but not as consistently across the countries.

It is evident that, while fertility below age thirty is driving total fertility declines in the Nordic countries, trends in fertility over age thirty remain important for total fertility levels. The relative stability of $ASFR_{30-49}$ contributes to the overall rate of decline of total fertility, especially when the population aged 30 to 49 is large. For example, $ASFR_{30-49}$ is declining in all levels of urbanization in Finland. Finland is also the country experiencing the most rapid total fertility decline. On the other hand, increases in $ASFR_{30-49}$ in Denmark contributed to low levels of decline at the national level. If $ASFR_{30-49}$ declines in Denmark, Norway, or

Sweden as it does in Finland, we can expect more rapid total fertility decline at the national level in the future.

Two main concessions were made to assess the importance of urbanization in fertility trends and uncertainty. First, we analyzed period fertility rates rather than cohort fertility rates. Period fertility rates are more susceptible to tempo distortions in fertility than cohort fertility rates. However, cohort fertility rates are less readily available across time and on the municipality level in all four countries. While results between the two measurements of fertility may differ, previous studies have shown that geographic variation exists in cohort fertility rates (Nisén et al. 2020) and that previously stable cohort fertility rates are now declining (Jalovaara et al. 2019; Hellstrand et al. 2020b). We cannot be certain if our investigated relationships between period fertility and measures of uncertainty would be similar if we conducted such analyses with cohort fertility data. Second, the uncertainty indicators used in this study cannot capture the full complexity of uncertainty. We argue that uncertainty extends beyond the economic dimension to the social dimension (see also Comolli et al. 2019; Vignoli et al. 2020) but our proxy variables are limited in definition and number due to data constraints but also inherently as proxies for social conditions. Fully understanding the social dimension of uncertainty and how it relates to fertility is not possible without survey or qualitative data that delves into individuals-level opinions of the future. We use proxy variables to identify as much of this dimension as possible, but we call for more nuanced research on this aspect of uncertainty.

Lastly, fertility by parity is important for understanding the relationship between uncertainty and space. Declines in first births before age thirty and declines in higher order births after age thirty are demonstrably related to recent fertility declines (Goldstein et al. 2013; Hellstrand et al. 2020a). Our analysis only accounts for total fertility by age. To fully understand spatial variation of fertility by age, it is necessary to also understand how uncertainty is related to fertility by parity. Further exploration into spatial variation of births by parity will provoke new questions. For instance, are uncertainty declines in higher order births limited to expensive urban regions or do these occur throughout levels of urbanization? Understanding these patterns might shed light on whether and where future declines will continue to occur.

To summarize, fertility variation across space is persistent in the Nordic countries. Our results highlight that age, reflective of progression across the life course, plays an important role in the relationship between uncertainty and fertility. Differences in uncertainty by age are important for differences in fertility trends across space and over time and, thus, how fertility declines differently across different levels of urbanization. The ways in which fertility converges and diverges between regions will be integral to understanding future fertility change in these countries and to our understanding of fertility dynamics in Europe. Future research should incorporate more holistic approaches to fertility that include both social and spatial dimensions of human behavior. The importance of social aspects of uncertainty are particularly relevant to the Nordic countries given the relatively small economic impact of the 2008 economic crisis. Emerging research has already begun to incorporate social aspects of uncertainty when assessing Nordic fertility patterns. This includes previous calls for social aspects (Comolli et al. 2019) and incorporating individual narratives of uncertainty (Vignoli et al. 2020) but have so far stemmed from economic perspectives. It will be useful for future research to directly take a social approach to uncertainty or incorporate psychological aspects of demographic behavior. Lastly, we highlight that the spatial component is critical not only for understanding where fertility has declined but also how it will decline in the future. Although projections for cohort fertility rates are available in the Nordic countries (Hellstrand et al. 2020b), we encourage researchers to incorporate the spatial perspective to better understand fertility trends both in the past and in the years to come.

Tables and Figures

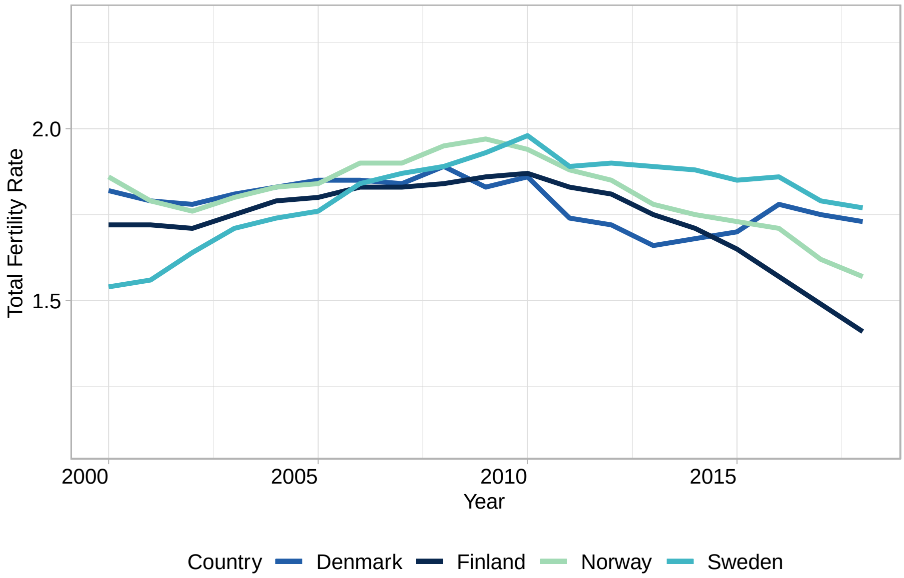

Figure 1. Total fertility rate by country, 2000-2018. Source: National statistics offices (see Appendix A Table A1), authors' own calculations.

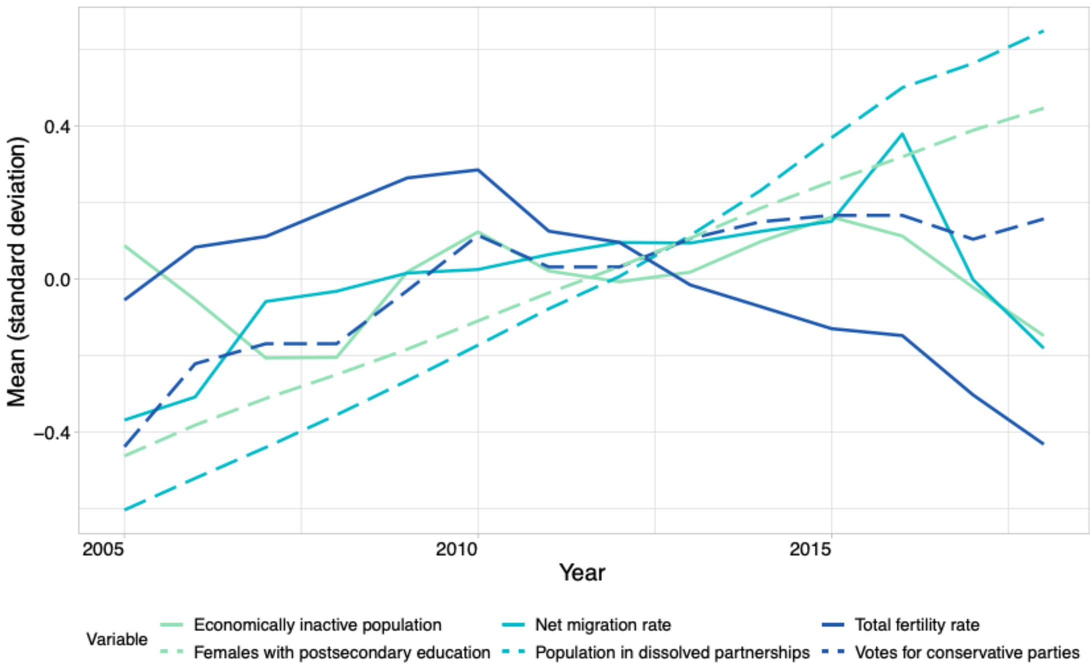

Figure 2. Change over time in the analyzed variables, 2005-2018. Source: national statistics offices (see Appendix A Table A1), authors' own calculations. Note: variable change over time is calculated as the variable's yearly standard deviation from its mean value across all years.

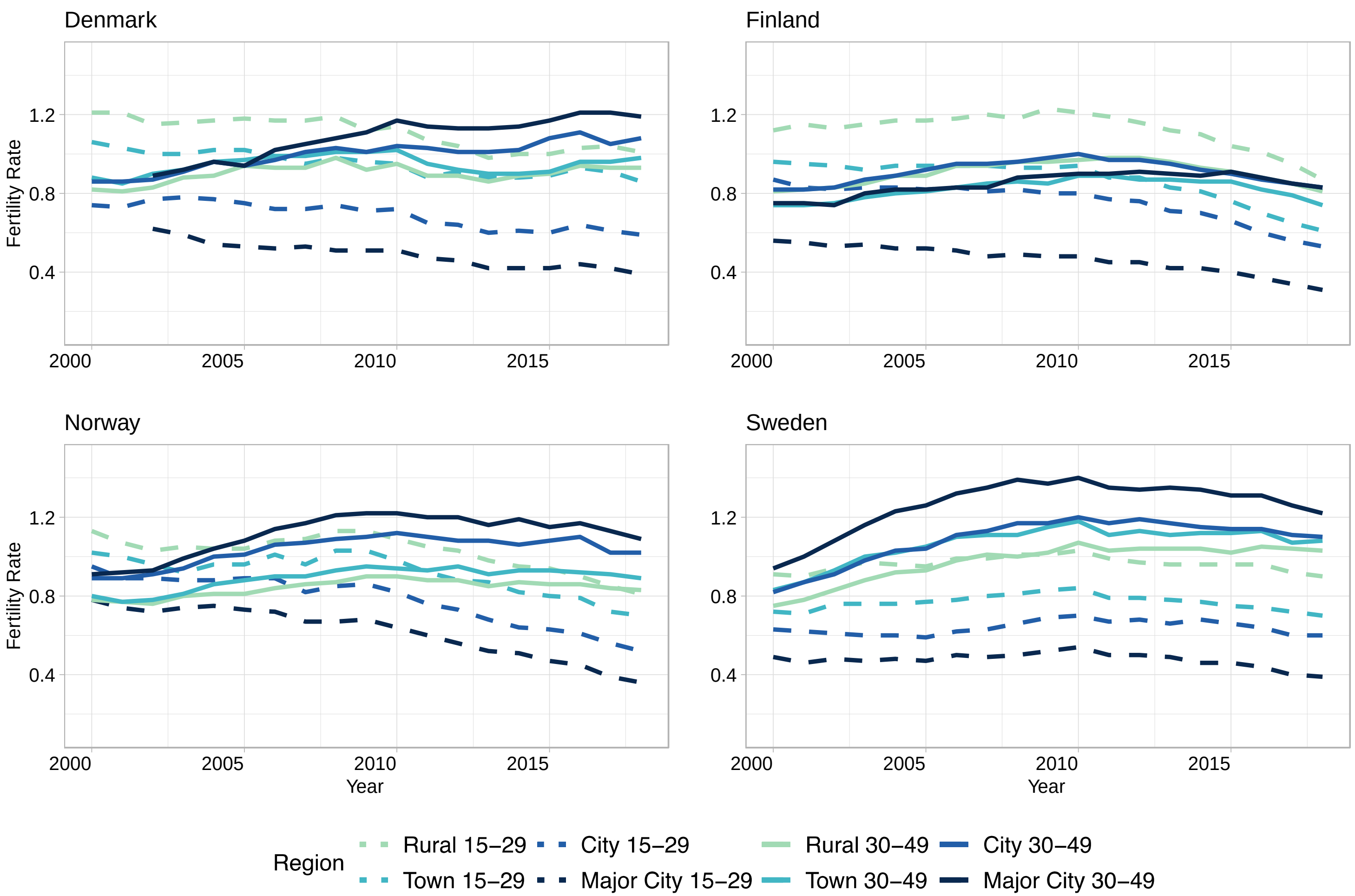

Figure 3. Age-specific contributions to the TFR by level of urbanization and year for Denmark, Finland, Norway, and Sweden, 2000-2018. Source: National statistics offices (see Appendix A Table A1), authors' own calculations.

Table 1. Variable means and standard deviations by country, 2005-2018.

Variables	Denmark n=98	Finland n=297	Norway n=420	Sweden n=284
Total fertility rate	1.96	2.07	1.84	1.98
	(0.23)	(0.54)	(0.41)	(0.23)
Share of economically inactive population	0.28	0.32	0.22	0.27
	(0.04)	(0.06)	(0.04)	(0.04)
Share of votes for conservative parties	0.24	0.18	0.34	0.31
	(0.05)	(0.15)	(0.10)	(0.10)
Share of population in dissolved partnerships	0.15	0.16	0.14	0.18
	(0.03)	(0.06)	(0.04)	(0.03)
Net migration per 1,000 inhabitants	3.63	1.78	3.11	4.54
	(2.43)	(2.46)	(11.4)	(7.43)
Share of females with postsecondary education	0.28	0.24	0.26	0.29
	(0.08)	(0.06)	(0.07)	(0.08)
Income per capita (2010 Euros, thousands)	31.38	19.20	33.45	19.93
	(4.74)	(2.89)	(3.92)	(2.33)
Population density (population per km^2)	569	60	55	142
	(1406)	(228)	(154)	(495)

Source: National statistics offices (see Appendix A Table A1), authors' own calculations.
Notes: N=15,386 observations across 1,099 municipalities and 14 years.

Table 2. Total and age-specific contributions to fertility rates by level of urbanization and country, 2005-2018.

Urbanization classification	Denmark	Finland	Norway	Sweden
TFR	1.77	1.73	1.80	1.86
Rural	2.00	2.05	1.86	1.99
Town	1.89	1.68	1.79	1.89
City	1.69	1.65	1.79	1.78
Major City	1.59	1.31	1.72	1.80
$ASFR_{15\text{-}29}$	0.80	0.83	0.86	0.75
Rural	1.08	1.12	1.00	0.97
Town	0.93	0.84	0.87	0.78
City	0.66	0.72	0.72	0.65
Major City	0.46	0.43	0.56	0.47
$ASFR_{30\text{-}45}$	0.98	0.90	0.94	1.11
Rural	0.92	0.93	0.86	1.02
Town	0.97	0.84	0.92	1.11
City	1.03	0.93	1.07	1.14
Major City	1.13	0.87	1.17	1.32

Source: National statistics offices (see Appendix A Table A1), authors' own calculations.
Notes: N=15,386 observations across 1,099 municipalities and 14 years.

Table 3. Results of the random effects spatial regressions on municipality-level total (Models 1 and 2) and age-specific (Models 3 and 4) fertility rates, 2005-2018.

Variables	Model 1	Model 2	Model 3	Model 4
Dependent variable	TFR	TFR	$ASFR_{15-29}$	$ASFR_{30-49}$
	Total effects	Between effects		
Share of economically inactive	- 0.02 **	- 0.06 ***	- 0.04 ***	- 0.02 **
Share of population in dissolved partnerships	- 0.11 ***	- 0.11 ***	- 0.06 ***	- 0.06 ***
Share of votes for conservatives	0.04 ***	- 0.03 **	- 0.01	- 0.02 ***
Net migration per 1,000 inhabitants	0.01 ***	0.04 ***	0.02 ***	0.02 ***
		Within effects		
Share of economically inactive		- 0.00	- 0.00	- 0.00
Share of population in dissolved partnerships		- 0.03 ***	- 0.01 ***	- 0.02 ***
Share of votes for conservatives		0.03 ***	0.02 ***	0.01 ***
Net migration per 1,000 inhabitants		0.01 *	0.00	0.00
Share of females with postsecondary education	- 0.02 **	- 0.04 ***	- 0.10 ***	0.06 ***
Income per capita	- 0.07 ***	- 0.07 ***	- 0.04 ***	- 0.03 ***
Population density (population per km^2)	0.00	0.01 #	- 0.01 **	0.03 ***
Spatially lagged fertility (λ)	0.19 ***	0.18 ***	0.12 ***	0.12 ***
Intercept	1.65 ***	1.65 ***	0.95 ***	0.81 ***
Municipality variance (ϕ)	0.31 ***	0.29 ***	0.30 ***	0.18 ***
AIC	10,811	10,691	1,711	- 3,677
BIC	10,918	10,828	1,848	- 3,540
Log Likelihood	- 5,392	- 5,327	- 837	1,857

Source: National statistics offices (see Appendix A Table A1), authors' own calculations.

Notes: N=15,386 observations across 1,099 municipalities and 14 years. Model 1: random effects spatial panel model using both spatial and temporal variation of TFR. Model 2: random effects spatial panel model with disaggregated between and within effects on TFR. Models 3 and 4: random effects spatial panel model with disaggregated between and within effects on age-specific fertility. Coefficients are standardized against variable mean and standard deviation. Models account for fixed effects of country. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

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Appendix A – Data sources

The data and variables analyzed in this paper primarily come from the websites of the respective national statistics offices (see Table A1). This excludes data on live births for Norway, which was purchased directly from Statistics Norway. Some regions, primarily islands, were combined with other regions. In Denmark, Christianso was combined with Bornholm. In Finland, the Åland Islands were combined into two regions: Mariehamn and the rest (Geta, Brändö, Eckerö, Finström, Föglö, Hammarland, Jomala, Kumlinge, Kökar, Lemland, Lumparland, Saltvik, Sottunga, Sund, and Vårdö).

Table A1. Data tables used to calculate municipality-level variables by country.

Variable	Country	Data tables reference codes	Access Date
Population (total, female)			
	Denmark	BY2, BEF1A, BEF1A07	14 June 2019
	Finland	030_11rz_2018	16 June 2019
	Norway	07459	13 June 2019
	Sweden	BE0101N1	13 June 2019
Live births			
	Denmark	FOD1, FOD107, FODIE	18 July 2019
	Finland	synt_006_201700	06 February 2019
	Norway	--	--
	Sweden	BE0101E2	06 February 2019
Share of employed population			
	Denmark	RASU2, RASB1, RAS302, RASB	06 May 2019
	Finland	022_115b_2017	06 May 2019
	Norway	11615	19 June 2019
	Sweden	AM0208A1	19 June 2019
Gross income			
	Denmark	INDKF122	27 June 2019
	Finland	001_118w_2018	30 June 2019
	Norway	03068, 08409	30 June 2019
	Sweden	AM0302K3	27 June 2019
Yearly average exchange rate			
	All countries	Eurostat table ert_bil_eur_a	04 July 2019
GDP Price index			
	All countries	Eurostat table nama_10_gdp	04 July 2019
Voting at national elections for Parliament			
	Denmark	FVKOM	08 May 2019
	Finland	020_evaa_120	11 June 2019
	Norway	08092	08 May 2019
	Sweden	ME0104B6	08 May 2019
Party classifications			
	All countries	https://www.chesdata.eu/our-surveys	07 June 2019

Marital status			
	Denmark	BEF10A7, FOLK1A	12 May 2019
	Finland	030_11rz_2018	12 May 2019
	Norway	03027	12 May 2019
	Sweden	BE0101N1	12 May 2019
Female postsecondary education			
	Denmark	HFU2, HFUDD10	13 June 2019
	Finland	vkour_011_201700	12 June 2019
	Norway	09429	12 June 2019
	Sweden	UF0506A1	06 May 2019
Net migration			
	Denmark	BEV1, BEV107	31 January 2020
	Finland	008_11a7_2018	31 January 2020
	Norway	09588	31 January 2020
	Sweden	BE0101AX	31 January 2020
Area			
	Denmark	ARE207	12 March 2019
	Finland	vaerak_011_201700	12 March 2019
	Norway	09280	12 March 2019
	Sweden	MI0802AA	12 March 2019

Notes: Data for 2018 was downloaded separately on 27 March 2020.

Appendix B

Table B1. Results of Lagrange Multiplier tests and Hausman tests.

	Lagrange Multiplier test for spatial autocorrelation	Hausman test for spatial models
Model 1	24.08 ***	56.52 ***
Model 2	24.16 ***	56.81 ***
Model 3	22.21 ***	57.97 ***
Model 4	22.15 ***	57.87 ***

Source: National statistics offices (see Appendix A Table A1), authors' own calculations.
Notes: All tests developed by Baltagi et al. (2003). * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table B2. Comparing results from different spatial approaches to the random effects panel model on municipality-level TFR, 2005-2018.

	Non-spatial model	Spatial lag model	Spatial error model	SARAR model
Economic inactivity	- 0.02 **	- 0.02 **	- 0.03 ***	- 0.01 *
Dissolved partnership	- 0.13 ***	- 0.11 ***	- 0.12 ***	- 0.09 ***
Votes for conservatives	0.06 ***	0.04 ***	0.04 ***	0.03 ***
Net migration	0.01 ***	0.01 ***	0.01 **	0.01 ***
Female postsecondary education	- 0.03 ***	- 0.02 **	- 0.03 ***	- 0.01
Income per capita	- 0.09 ***	- 0.07 ***	- 0.08 ***	- 0.06 ***
Population density	0.01	0.00	0.01	0.00
Spatially lagged fertility (λ)		0.19 ***		0.43 ***
Spatially lagged error (ρ)			0.19 ***	- 0.30 ***
Intercept	2.03 ***	1.65 ***	2.03 ***	1.16 ***
Municipality variance (ϕ)	0.36 ***	0.31 ***	0.30 ***	0.31 ***
AIC	11,092	10,811	10,825	10,773
BIC	11,191	10,918	10,932	10,888

Source: National statistics offices (see Appendix A Table A1), authors' own calculations.
Notes: N =15,386 observations across 1,099 municipalities and 14 years. Coefficients are standardized against variable mean and standard deviation. Models account for fixed effects of country. SARAR stands for spatial autoregressive model with autoregressive error model.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table B3. Results of fixed effects spatial panel regression on municipality-level TFR, 2005-2018.

	TFR
Economic inactivity	- 0.03 ***
Dissolved partnership	- 0.12 ***
Votes for conservative parties	0.00
Net migration	0.02 ***
Female postsecondary education	0.00
Income per capita	- 0.12 ***
Population density	0.01 ***
Spatially lagged fertility (λ)	0.22 ***
Intercept	1.59 ***
AIC	12,016
BIC	12,107
Log Likelihood	- 5,996

Source: National statistics offices (see Appendix A Table A1), authors' own calculations.
Notes: N=15,386 observations across 1,099 municipalities and 14 years. Coefficients are standardized against variable mean and standard deviation. Model accounts for fixed effects of country.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table B4. Results of random effects spatial panel regressions on municipality-level age-specific fertility rates, 2005-2018.

	$ASFR_{15-29}$	$ASFR_{30-49}$
Economic inactivity	- 0.02 **	- 0.00
Dissolved partnership	- 0.06 ***	- 0.06 ***
Votes for conservatives	0.03 ***	0.01 **
Net migration	0.01 **	0.01 ***
Female postsecondary education	- 0.08 ***	0.07 ***
Income per capita	- 0.04 ***	- 0.04 ***
Population density	- 0.02 ***	0.03 ***
Spatially lagged fertility (λ)	0.12 ***	0.12 ***
Intercept	0.96 ***	0.81 ***
Municipality variance (ϕ)	0.31 ***	0.19 ***
AIC	1,784	- 3,602
BIC	1,891	- 3,495
Log Likelihood	- 878	1,815

Source: National statistics offices (see Appendix A Table A1), authors' own calculations.
Notes: N=15,386 observations across 1,099 municipalities and 14 years. Coefficients are standardized against variable mean and standard deviation. Models account for fixed effects of country.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table B5. Results of random effects spatial regressions on municipality-level age-specific fertility rates, 2005-2018.

Dependent Variable	$ASFR_{15}$	$ASFR_{20}$	$ASFR_{25}$	$ASFR_{30}$	$ASFR_{35}$	$ASFR_{40}$	$ASFR_{45}$
Between effects							
Economic inactivity	0.0005 ***	- 0.0010	- 0.0072 ***	- 0.0037 ***	0.0005	0.0009 ***	0.0001 ***
Dissolved partnerships	0.0005 ***	- 0.0037 ***	- 0.0098 ***	- 0.0073 ***	- 0.0033 ***	0.0012 ***	- 0.0001 ***
Votes for conservatives	0.0003 *	- 0.0027 *	- 0.0006	- 0.0012 *	- 0.0017 ***	0.0007 ***	- 0.0000
Net migration	- 0.0003 **	0.0017 **	0.0027 ***	0.0031 ***	0.0011 **	0.0003 #	0.0000 *
Within effects							
Economic inactivity	- 0.0002 **	- 0.0002	- 0.0000	0.0000	- 0.0002	- 0.0000	- 0.0000
Dissolved partnerships	- 0.0006 ***	- 0.0001	- 0.0020 ***	- 0.0046 ***	- 0.0010 ***	0.0002 #	0.0000 *
Votes for conservatives	0.0001	0.0016 ***	0.0027 ***	0.0019 ***	0.0008 ***	0.0002 **	0.0000
Net migration	0.0000	0.0005 *	0.0003	0.0002	0.0004 *	- 0.0001 #	0.0000
Total effects							
Female postsecondary educ.	- 0.0009 ***	- 0.0096 ***	- 0.0087 ***	0.0065 ***	0.0057 ***	0.0015 ***	0.0001 ***
Income per capita	- 0.0015 ***	- 0.0059 ***	- 0.0032 *	- 0.0032 **	- 0.0018 *	- 0.0007 *	- 0.0001 #
Population density	0.0001	- 0.0030	- 0.0028 ***	0.0010 *	0.0029 ***	0.0011 ***	0.0001 ***
Spatially lagged fertility (λ)	0.1068 ***	0.0985 ***	0.0812 ***	0.0602 ***	0.0541 ***	0.0583 ***	0.0355 **
Intercept	0.0052 ***	0.0543	0.1402 ***	0.1189 ***	0.0450 ***	0.0070 ***	0.0003 ***
Municipality variance (ϕ)	0.0632 ***	0.2728 ***	0.1202 ***	0.0574 ***	0.1178 ***	0.0971 ***	0.0210 ***
Log Likelihood	52,307	32,871	27,97	31,145	37,042	49,918	73,508

Source: National statistics offices (see Appendix A Table A1), authors' own calculations.
Notes: N=15,386 observations across 1,099 municipalities and 14 years. Coefficients are standardized against variable mean and standard deviation. Models account for fixed effects of country.
# $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.