



# A Spatial Perspective on the Unexpected Nordic Fertility Decline: The Relevance of Economic and Social Contexts

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## Abstract

Since 2010, the Nordic countries have experienced substantial fertility decline. This was unexpected, as these countries have well-established systems of family support policies and they did not experience a fertility shock in the immediate aftermath of the 2008 economic recession like many other European countries. Previous studies paid little attention to the spatial dimension of this unexpected fertility change, despite evidence of large spatial variation in fertility. This paper aims to close this gap through a spatial perspective and deepen our understanding of how Nordic fertility change varies by economic and social contexts. We apply advanced spatial panel models on data for 1,099 municipalities covering Denmark, Finland, Norway, and Sweden. Next to analyzing total fertility rates, we also compare the relevance of economic and social contexts for spatial fertility variation at younger or older ages. We note distinct differences by levels of urbanization and differing trends between the age groups. We also find that measures of unemployment and union stability are associated with lower levels of fertility across space and time, while support for conservative parties is related to higher fertility. Age-specific analyses highlighted that economic conditions are more relevant for fertility variation under age thirty than over age thirty. Overall, our analysis provides support for the view that both economic and social factors are highly relevant for understanding spatial variation in the Nordic fertility decline. Given the strong spatial component in Nordic fertility change, policy initiatives would also benefit from a spatial dimension to effectively address fertility change.

**Keywords** Decline · Economic contexts · Fertility · Nordic · Social contexts · Spatial regression

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## Introduction

Total fertility rates have rapidly changed in many parts of Europe over the last 15 years. Particularly remarkable is the development in the Nordic countries, where fertility has declined from relatively high levels in 2010 to levels that constitute, for some of the Nordic countries, all-time lows. This fertility decline in the Nordic countries in the context of established family support policies (Rønsen, 2004; Rønsen & Sundström, 2002) and high levels of gender equality stands in stark contrast to the relatively high period fertility levels recorded throughout the 1990s and 2000s (Andersson et al., 2009; Hellstrand et al., 2020, 2021). Existing research has either proposed economic factors, such as unemployment (Comolli et al., 2019; Goldstein et al., 2013; Matysiak et al., 2020), or social factors, such as societal expectations (Lappegård et al., 2017; Miettinen et al., 2011), as key explanations behind changing fertility levels. However, these studies paid little attention to spatial variation in recent Nordic fertility decline. This paper aims to close this important research gap.

Geographic variation of fertility is a longstanding pattern in Europe; with urban regions often characterized by relatively low fertility and rural regions by relatively high fertility (e.g., Kulu & Washbrook, 2014 in Britain; Michielin, 2004 in Italy; Hank, 2001 in Germany; Campisi et al., 2020 across Europe). Even in countries with relatively low fertility differences between socioeconomic groups (Jalovaara et al., 2019), fertility differences between regions can remain quite large (Campisi et al., 2020; Nisén et al., 2020). Economic and social contexts not only shaped previous patterns of fertility across space, but likely also contributed to how these patterns developed in recent years. Regional fertility differences were likely exasperated by the 2008 economic crisis due to economic resilience (Blank, 2005) or internal migration (Bayona-i-Carrasco et al., 2018; Bonifazi & Crisci, 2013; Sabater & Graham, 2019). Furthermore, societal expectations and perceptions about future conditions (e.g., Comolli et al., 2019; Vignoli et al., 2020) may have further contributed to fertility differences between regions. The relationships between these contexts and fertility are further complicated by differences across age groups. For instance, fertility of younger women appears more susceptible to economic changes than fertility of older women (Goldstein et al., 2013).

The main goal of this paper is to deepen our understanding of how spatial variation in the fertility decline is related to spatial variation in economic and social conditions to inform societal stakeholders aiming to address the rapid Nordic fertility decline. To do so, we analyze fertility data for 1,099 municipalities covering Denmark, Finland, Norway, and Sweden between 2005 and 2018. We combine panel regression with spatial analysis and decomposition methods to disaggregate the relationships between fertility and its contexts into spatial and temporal trends. In addition to analyzing changes in total fertility rates, we also explore whether and how these relationships vary at different ages. Our findings provide support for the view that in order to design appropriate policy responses to address the Nordic fertility decline, spatial variation in economic and social conditions should be taken into account.

## Background and Previous Research

### Spatial Variation in Fertility

Fertility in the Nordic countries is characterized by substantial spatial variation (Campisi et al., 2020). 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 twentieth century (Kulu, 2013; 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 has become more complex over time. At the sub-national regional level, higher levels of economic development were long related to lower levels of fertility in Nordic countries (Fox et al., 2019). But this relationship has disappeared in recent years in Norway and Sweden. Similarly, it was a long-standing pattern that higher levels of female education were related to lower levels of fertility. This was relevant for spatial variation as highly educated women are particularly concentrated in urban contexts. Higher educational attainment helped women attain greater economic and social resources and a greater ability to pursue life goals other than childbearing (Brewster & 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) and educational differences in fertility across space are small (Nisén et al., 2020). 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 (Campisi et al., 2020; Kulu et al., 2007; Nisén et al., 2020).

### Economic Context of Spatial Fertility Variation

The economic context contributes to persisting regional differences in fertility. The 2008 economic crisis has reinvigorated research on economic conditions and fertility (Comolli, 2017; Comolli et al., 2019; Goldstein et al., 2013; Matysiak et al., 2020; Örsal & Goldstein, 2018; Vignoli et al., 2020). Theories of economic uncertainty suggest that uncertainty, through the loss of employment or income, can negatively impact fertility-related life plans such as childbearing intentions as individuals seek to protect themselves against further economic hardship.

Childbearing may compete with employment in multiple ways (Becker, 1960). First, children can be seen as a threat to finding employment (Adserá, 2011). Having a child without secure employment may limit women's means of increasing their employability, such as gaining additional skills or qualifications (Adserá, 2004).

Second, reentering the labor force full-time after childbirth may be difficult; this may have negative consequences for women's career and earning potential (Rønsen & Sundström, 2002). Third, persistent unemployment competes financially with having children by reducing long-term financial savings due to unearned or lost income (Ranjan, 1999; Adserá, 2011; Brand, 2015), thus reducing financial resources available for childrearing. Temporary fertility postponement can contribute to a short-term depression in fertility levels or, if fertility is postponed indefinitely, a decrease in total fertility (Fokkema et al., 2008; Sobotka et al., 2011).

Unlike in other European countries, fertility in the Nordic countries was not immediately affected by the 2008 recession at the national (Goldstein et al., 2013) or subnational (Matysiak et al., 2020) level. However, stagnant income (OECD, 2020) and economic growth since 2008 (World Bank, 2020) may have led to perceptions of prolonged economic instability. While short periods of economic uncertainty have a negative impact on fertility, this relationship becomes stronger when uncertainty is prolonged (e.g., Busetta et al., 2019). Expectations, such as when economic stability will return (Comolli, 2017), and perceptions, such as the impact of economic instability on employment or lifestyle (Sanders, 1999), also contribute to impressions of future living conditions and, thus, to fertility decisions (Matysiak et al., 2020). The longer individuals are unemployed, the less optimistic they may be about their future circumstances and hence, the more they may postpone childbearing. Unemployed individuals may reenter education to increase their employability (Adserá, 2004) further reducing their childbearing propensities.

The role of the economic context for fertility change may vary across urban and rural areas. Urban regions tend to have larger, more resilient economies (Blank, 2005), which may protect them from fertility decline unlike in rural areas with more rigid economies and fewer employment opportunities. Such regional economic imbalances can be exacerbated by internal migration patterns if migrants move from high-unemployment regions to low-unemployment regions (Bayona-i-Carrasco et al., 2018; Bonifazi & Crisci, 2013; Sabater & Graham, 2019). If internal or international migrants have higher fertility and/or postpone childbearing until after a move (Andersson, 2004; Kulu & Vikat, 2007; Milewski, 2007), receiving regions would witness reduced fertility decline as decreases are offset by migrant fertility.

## **Social Context of Spatial Fertility Variation**

The social context also contributes to spatial fertility variation. Societal expectations are one of the key factors that may influence fertility. These may stem from religion (Lehrer, 2004; McQuillan, 2004; Sobotka & Adigüzel, 2002; Zhang, 2008) or family expectations (Liefbroer & Billari, 2010), and might be related to the occurrence or timing of family events (Miettinen et al., 2011). Traditional expectations in highly individualized societies can include disapproval of cohabitation, single parenthood, or divorce (especially after having children) (Lappegård et al., 2017; Liefbroer & Billari, 2010). Individuals' fertility behavior is responsive to social norms (Lappegård et al., 2017) and individuals may rely more on such norms during times of uncertainty to return a sense of order (Jost et al., 2007).

The nature and strength of societal norms and social support may vary across space, and thus be related to fertility differences between regions. The share of separated or divorced individuals is an indicator of the strength of societal norms in a region. Regions with less traditional family norms, and thus, a higher acceptance of divorce are likely to have a higher share of separated individuals. Regions with a higher share of divorced individuals, in turn, have lower levels of fertility (Hart, 2019).

Support for traditional family values in a region may also be expressed in how individuals vote. Leaders who espouse a conservative ideology, for example, that children are a source of fulfillment in life (Lesthaeghe & Surkyn, 1988; Pearce & Davis, 2016), or a preference for traditional family structures (Anson & Meir, 1996) are likely to find support from individuals with traditional family values. If support for conservative ideologies and, thus, larger families decreases, fertility levels would decline. Votes for conservative parties may increase during times of uncertainty in an attempt to return a sense of order (Lewis-Beck & Paldam, 2000). 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 (Bromley-Davenport et al., 2019; Johnston et al., 2018).

### Policy Context in the Nordic Countries

Esping-Andersen (1990) suggested three categories of welfare regimes, which vary in their approach to delivering welfare support. Conservative regimes, such as Germany, tend to support traditional family values by focusing support on families instead of individuals. Liberal regimes, such as the United Kingdom, tend to grant less financial welfare than conservative regimes and support is targeted primarily toward low-income individuals. Social democratic welfare regimes, such as the Nordic countries, take a universal approach to welfare seeking to promote a high standard of equality. Although the level and coverage of welfare support has changed since the 1990s (Gauthier, 2002), the Nordic countries continue to provide the strongest welfare support in Europe (Moretti & Whitworth, 2020; Sobotka et al., 2019).

The Nordic social democratic welfare encourages women to be employed before childbirth. This means that those employed and with higher earnings are those who benefit most from Nordic welfare schemes, such as financial assistance for new parents. Parental leave in the Nordic countries is paid for all or most of the period at least at 66 percent of the earnings (Blum et al., 2018). Those who were not employed before childbirth are still entitled to financial assistance after childbirth in the Nordic countries, but this support either comprises of one-time payments, such as in Norway (Brandth & Kvande, 2018), or minimal allowances, such as in Finland (Salmi et al., 2018) or Sweden (Duvander & Haas, 2018). However, not all financial assistance is driven by income. For example, in Norway, the government offers cash benefits for families with young children, which can encourage accelerated fertility transitions to higher parities (Aassve & Lappegård, 2009).

Strong support for reentry into the workforce after childbirth is important for fertility levels (Rønsen & Sundström, 2002). Generous leave schemes, such as those available in the public sector (Adserá, 2004) in the Nordic countries are one component of this. Across Europe, countries with large public employment sectors are also those with faster transitions between births (Adserá, 2011). Employment contracts in the public sector tend to be more stable than those in the private sector, reducing fertility-work tradeoffs that may arise from taking away from work. Sweden, for example, has strong public sector employment of women (Rosen, 1996).

Finally, childcare availability can help reduce tradeoffs between employment and fertility. Sweden and Norway are two countries with widespread availability of childcare (Sobotka et al., 2019). For Norway, Rindfuss et al. (2010) estimated that increases in childcare availability can considerably increase fertility. Even in countries with widespread childcare availability, the spatial variation in applications of family policies is an important context (Neyer & Andersson, 2008). Despite national-level initiatives to provide more ubiquitous childcare in the Nordic countries, the placement of childcare facilities is often left to municipalities. As such, regions with more childcare availability tend to be those where fertility is higher (Rindfuss et al., 2007).

## Expectations

Bringing together the arguments and existing studies outlined in the previous sections, we expect municipalities with high levels of unemployment to have lower levels of fertility. To this mechanism contributes that public family support is strongly linked to employment. Economically disadvantaged municipalities are also likely to struggle more with providing services (e.g., childcare) to families. However, we anticipate income to mitigate the relationship between unemployment and fertility, and thus, we expect municipalities with higher levels of income per capita to have higher levels of fertility. We also expect that the economic context will be more important for younger women than older women, as older women are more likely to have accumulated resources that may help reduce the negative impact of unemployment or other types of economic uncertainty on fertility. They are also more likely to be already established on the labor market, which is also relevant for the access to public family support. Regarding the social context, traditional social expectations are assumed to contribute to higher levels of fertility. In this way, municipalities with higher levels of fertility are hypothesized to also be those with lower shares of dissolved partnerships and higher shares of conservative voting. While we expect both economic and social contexts to be important for fertility variation over space, we anticipate the economic context to be more relevant for fertility variation over time than the social context, as societal expectations take more time to change.

## Data

For our descriptive and spatial econometric analyses, we utilize a combination of economic, social, and spatial variables to examine differences across space and

over time in the Total Fertility Rate (TFR) and age-specific fertility rates in two age groups (ASFR<sub>15-29</sub> and ASFR<sub>30-49</sub>). We derived annual municipality-level data from national statistics offices (see Appendix 1 Table 4) covering the years 2005 to 2018 for 1,099 municipalities in Denmark (98 municipalities), Finland (297 municipalities), Norway (420 municipalities), and Sweden (284 municipalities). Municipalities (both between and within countries) are not directly comparable in terms of population counts but they fulfill the same function in all study countries, i.e., they are responsible for most public services for their constituents. Each national statistics office obtains these data through population registers and releases aggregations of microdata online. Gathered from population registers, data between the countries is generally comparable except for small differences in the construction of some variables (see Sect. 4).

Some municipalities (primarily outer islands) were combined with other municipalities or were removed due to sparse data or geographic isolation. Another issue was that 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 areal distribution of the population to account for boundary changes (Goodchild & Lam, 1980). Although more sophisticated approaches are available to account for boundary changes, which do not assume equal within area distribution (e.g., Norman et al., 2003), our data did not allow for using such methods due to a lack of spatial acuity.

## Variables

### Fertility

Our outcome variables are fertility rates at the municipality level in each year. TFRs 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 a given 5-year age group between ages 15 and 49. In addition to analyzing the total fertility rate, we are also interested in the role of spatial, economic, and social factors for fertility at younger (15–29) and older (30–49) ages. Thus, we also calculate age-specific fertility for ages 15 to 29 (ASFR<sub>15-29</sub>) and for ages 30 to 49 (ASFR<sub>30-49</sub>) by summing up the relevant age-specific fertility rates. The sum of the ASFR<sub>15-29</sub> and the ASFR<sub>30-49</sub> is equal to the TFR.

### Economic Context

*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). The complement of this employment ratio (1-E/N) is used as the economic inactivity ratio. The motivation for employing this measure instead of unemployment ratios is that municipalities with a higher share of students or individuals not seeking employment may have deflated



unemployment ratios. The share of those not seeking employment may better reflect economic conditions through hidden unemployment if individuals enroll in further education or training to enhance their employable skills, also a competing risk to childbearing. Populations by economic activity are available for slightly different age brackets in the four studied countries.<sup>1</sup> This discrepancy between countries is not expected to have a considerable influence on regional variation in the economic inactivity ratio as the employed population is divided by the age-relevant risk population.

*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.

## Social Context

*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 divorced from marriage or separated from cohabitation<sup>2</sup> 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, and has been shown to be relevant for understanding regional fertility variation across Europe (Campisi et al., 2020). It is important to note that this measure is affected by partnering and repartnering rates, which might vary between regions.

*The proportion of votes for conservative parties* reflects the proportion of votes cast for conservative political parties in national parliamentary elections. 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. 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). We combine data from the 2010 (Bakker et al., 2015) and the 2014 surveys (Polk et al., 2017). 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

<sup>1</sup> 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 Sweden.

<sup>2</sup> Information on the dissolution of cohabiting unions is not available for Norway.



levels across countries.<sup>3</sup> Parliamentary elections are held every four years in each country. For non-election years,<sup>4</sup> we imputed data from the previous election. 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.

## Demographic and Spatial Control Variables

*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 control for migration because migrants, especially young migrants, can influence municipality-level 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 4 and above) to the total number of women.<sup>5</sup> We control for education because young women may postpone fertility whilst being enrolled in education.

*Level of urbanization* is defined as the degree of urbanization of a municipality based on population size following Kulu et al. (2007) and Kulu (2013). Level of urbanization is classified as 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, yields similar results (results not shown but available upon request).

## Methods

### Descriptive Analysis

We study variation in TFR across municipalities for each country to understand if spatial variation has increased or decreased over time. Descriptive analysis examines how fertility patterns have changed within countries and over time using

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<sup>3</sup> 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.

<sup>4</sup> 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, 2010, 2014, and 2018 in Sweden. Voting data for 2005 and 2006 in Denmark come from 2007.

<sup>5</sup> 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 age-relevant risk population for each country.

municipality-level total fertility rates by year. Municipalities are grouped based on population size thresholds to calculate TFR by different levels of urbanization. We examine how age-specific fertility patterns have changed within countries and over time using municipality-level age-specific fertility rates (ASFR<sub>15-29</sub> and ASFR<sub>30-49</sub>).

## Regression Analyses

First, we use random effects spatial panel regression to investigate the relationships between fertility and economic or social context across all municipalities and years (Model 1). We use a random effects panel regression approach because we are interested in TFR variation across space and believe that fertility differences between municipalities are important for variation over time. A fixed-effects panel regression would remove general municipality-level fertility differences, omitting spatial variation from the regression estimation.<sup>6</sup>

We include a spatial lag of total fertility rates from neighboring municipalities in the models to account for spatial autocorrelation (Appendix 2 Table 5). Spatial autocorrelation refers to the observation that total fertility rates of neighboring regions are likely to be more similar to each other than to 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 & 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.<sup>7</sup> The random effects spatial panel regression approach is outlined below:

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

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

<sup>6</sup> Results from Hausman tests for spatial models (Millo & Piras, 2012; Mutl & Pfaffermayr, 2011) suggest that the random effects models may violate regression assumptions (Appendix 2 Table 5). 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 2 Table 7) 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 ( $\phi$ ) in our data and for spatial dependence ( $\lambda$ ) affecting our estimation.

<sup>7</sup> We estimated a spatial autoregressive model with error (Appendix 2 Table 6, 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.

$\lambda$  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 considers all regions adjacent by at least one point as neighbors. This approach ignores country borders and includes connections of island municipalities to mainland municipalities. Island municipalities were connected to the mainlands based on existing ferry or bridge connections. The weights are row-standardized so that the weights of all neighbors  $j$  of a region  $i$  sum up to 1. There are an average 4.9 connected neighbors per municipality.  $\phi_i$  is the municipality-level random effect and  $\varepsilon_{it}$  is the remaining error. We include fixed effects for the countries in all models to control for systematic differences across countries.

Second, we disaggregate the overall relationships between fertility and the independent variables observed in Model 1 by decomposing the total relationship for each variable by space and time (Model 2). 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 & Kalbfleisch, 1998). We disaggregate the effects of the share of economically inactive, share of population in dissolved partnerships, share of votes for conservative parties, and net migration. We do not disaggregate the effects of female postsecondary education, income per capita, and level of urbanization. Female postsecondary education does not vary much over space in these countries, and income per capita and level of urbanization 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:

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

where the total fertility rate ( $y$ ) in municipality  $i$  at time  $t$  is regressed on independent variables  $X$  between municipalities across space ( $\beta_B$ ), within municipalities over time ( $\beta_W$ ), and non-disaggregated variables ( $\beta$ ). The spatial effect is estimated by generating municipality  $i$ 's mean value of variable  $X$  across all time points. The temporal 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 ( $\text{country}_{it}$ ).  $\phi_i$  is the municipality-level random effect and  $\varepsilon_{it}$  is the remaining error.

Third, we estimate a disaggregated spatial panel model to analyze age-specific fertility rates (ASFR<sub>15-29</sub> in Model 3 and ASFR<sub>30-49</sub> in Model 4). The aim is to understand whether the role of economic and social factors is equally important for fertility at younger and older ages. Age 30 is used to differentiate the age groups because the mean age of first birth in the analyzed countries in 2018 was around 30; 29.3 in Denmark (Statistics Denmark, 2022), 29.4 in Finland (Statistics Finland, 2020), 29.5 in Norway (Statistics Norway, 2022), and 29.4 in Sweden (Statistics Sweden, 2022).

**Table 1** Variable means (and standard deviations) for continuous variables and distribution of categorical variables by country, 2005–2018

Variables	Denmark n = 98	Finland n = 297	Norway n = 420	Sweden n = 284
Total fertility rate	1.96 (0.23)	2.07 (0.54)	1.84 (0.41)	1.98 (0.23)
Share of economically inactive population	0.28 (0.04)	0.32 (0.06)	0.22 (0.04)	0.27 (0.04)
Share of votes for conservative parties	0.24 (0.05)	0.18 (0.15)	0.34 (0.10)	0.31 (0.10)
Share of population in dissolved partnerships	0.15 (0.03)	0.16 (0.06)	0.14 (0.04)	0.18 (0.03)
Net migration per 1,000 inhabitants	3.63 (2.43)	1.78 (2.46)	3.11 (11.4)	4.54 (7.43)
Share of females with postsecondary education	0.28 (0.08)	0.24 (0.06)	0.26 (0.07)	0.29 (0.08)
Income per capita (2010 Euros, thousands)	31.38 (4.74)	19.20 (2.89)	33.45 (3.92)	19.93 (2.33)
Distribution of municipalities (count)				
Level of Urbanization				
Major City	1	1	1	2
City	6	8	4	13
Town	30	12	10	32
Rural	62	277	406	124

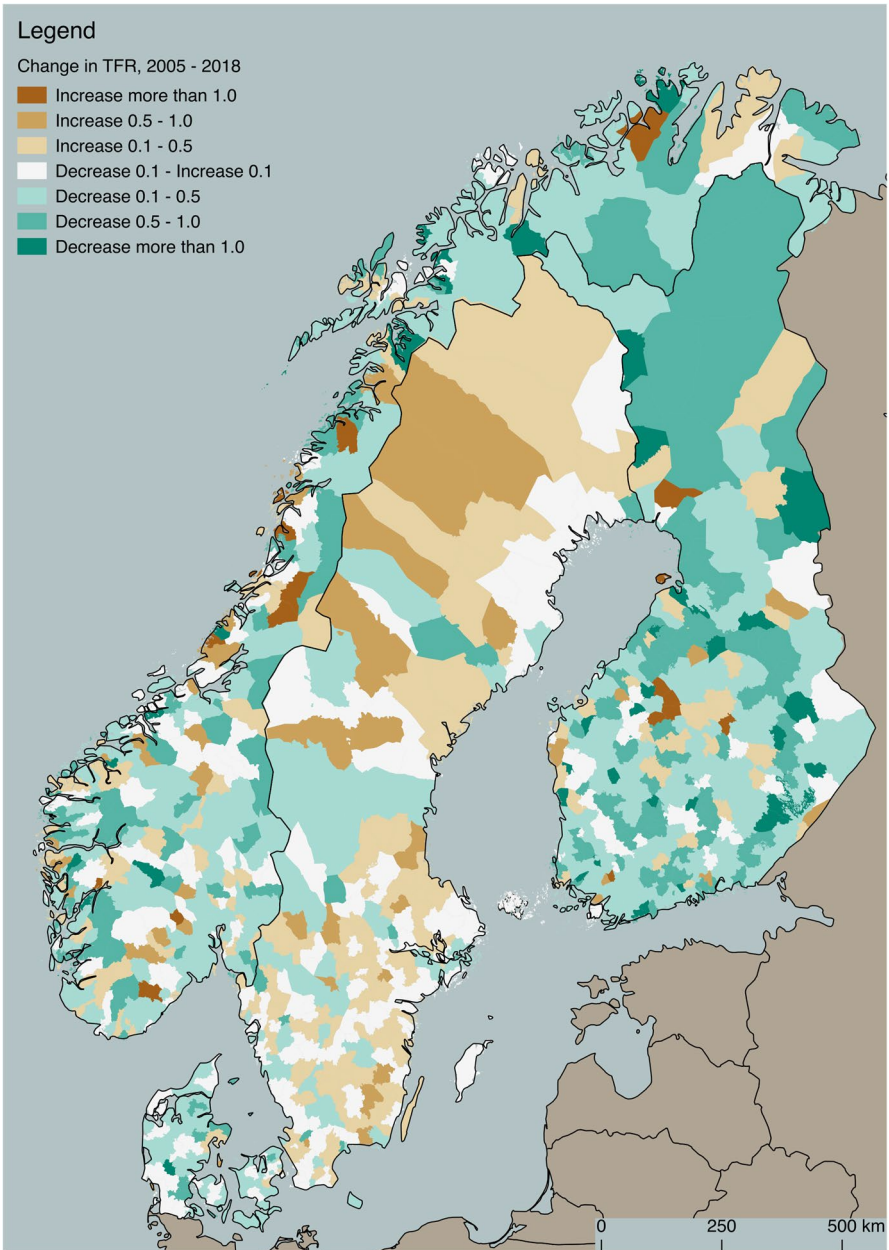
Source: National statistics offices (see Appendix 1 Table 4), authors' own calculations

Notes: N = 15,386 observations across 1,099 municipalities and 14 years. Variable means are calculated across all municipalities and time points within each country

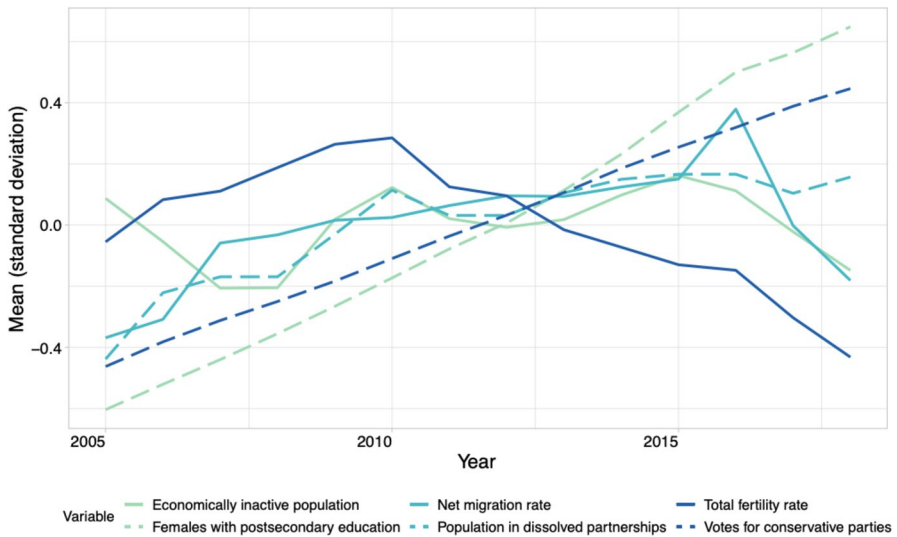
## Results

We first assess the variation in total fertility rates across municipalities and years during the period. Spatial variation of fertility is highest in Finland and Norway (Table 1). Between 2005 and 2018, Finland and Norway experienced the most dramatic fertility decline and had the largest number of municipalities where TFR decreased by more than 1 (Fig. 1). At the same time, Sweden had the largest number of municipalities where the TFR has increased between 2005 and 2018. However, many municipalities in Sweden did not experience large changes in TFR. Lastly, although municipalities in Denmark did not experience a drastic fertility change, a decline in TFR is observable throughout the country.

Next, we explore whether and how the variables in our analyses have changed during the study period (Fig. 2). Level of urbanization and income per capita were excluded because they did not vary much over time. TFR is the only variable that has not increased over time. The share of the population in dissolved partnerships and the share of females with postsecondary education displayed the largest increase in standard deviation between 2005 and 2018. From Table 1 it is clear that differences



**Fig. 1** Change in the Total Fertility Rate (TFR) across municipalities, 2005–2018. Source: National statistics offices (see Appendix 1 Table 4), authors' own calculations



**Fig. 2** Change in the analyzed variables over time, 2005–2018. Source: National statistics offices (see Appendix 1 Table 4), authors' own calculations. Note: variable change over time is calculated as the variable's yearly standard deviation from its mean value across all years and municipalities (Table 1). A year's standard deviation is equal to zero when its value is equal to the mean in Table 1

in variation for each variable of analysis between the countries is not large during the period for most variables. Notably, the variation in net migration differs between the countries and is largest in Norway and Sweden. This is likely related to larger levels of net migration in these countries.

### Fertility by Level of Urbanization

Looking in more detail at the spatial differences in fertility between levels of urbanization and countries (Table 2), we find an expected urban–rural gradient in fertility levels: rural municipalities have the highest TFR in all countries. While total fertility rates in town and city municipalities are similar, fertility rates in town municipalities are still generally higher across each of the four countries than in city municipalities. The TFR is lowest in major cities (except in Sweden, where it is somewhat higher than in city municipalities). While the urban–rural gradient is also present for ASFR<sub>15-29</sub>, we observe a reversed pattern for ASFR<sub>30-49</sub> in three countries. Fertility at older ages is highest in major city municipalities in Denmark, Norway, and Sweden. In Finland, however, there is overall little urban–rural variation in ASFR<sub>30-49</sub>.

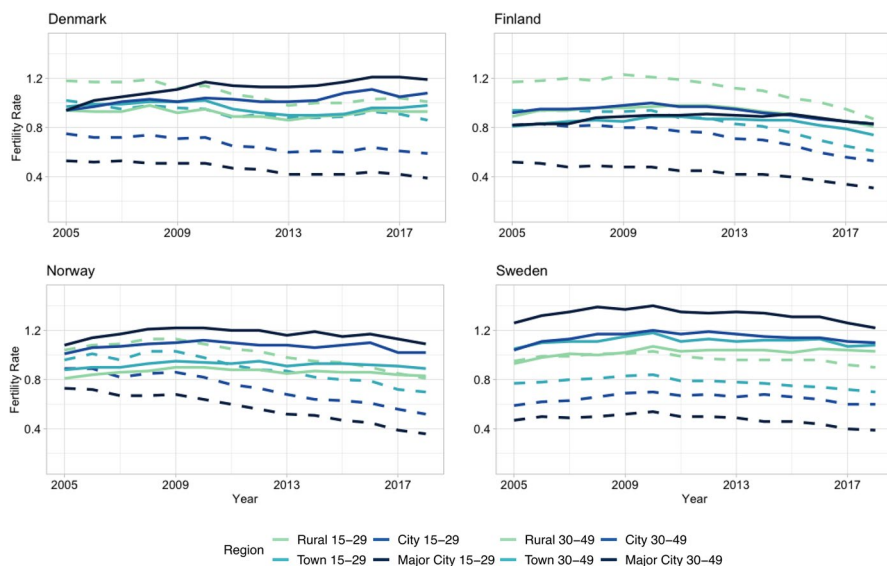
Next, we explore whether the urban–rural variation in fertility has changed over time (Fig. 3). To do so, we compare ASFR<sub>15-29</sub> and ASFR<sub>30-49</sub>. Generally, urban–rural variation in fertility has remained stable or even increased since the beginning of the study period, but this varies by age group. For AFSR<sub>15-29</sub>, fertility variation by level of urbanization has remained relatively stable with some

**Table 2** Total and age-specific fertility rates by level of urbanization and country, 2005–2018

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

Source: National statistics offices (see Appendix 1 Table 4), authors' own calculations

Notes: N=15,386 observations across 1,099 municipalities and 14 years



**Fig. 3** Age-specific fertility by level of urbanization and year for Denmark, Finland, Norway, and Sweden, 2005–2018. Source: National statistics offices (see Appendix 1 Table 4), authors' own calculations



divergence in Norway. For  $ASFR_{30-49}$ , urban–rural variation is much smaller. This variation increased between 2005 and 2010 but 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.

$ASFR_{30-49}$  in major cities increased at the beginning of the period, establishing them as the level of urbanization with the highest fertility levels at these ages. This inverted urban–rural gradient indicates that women in major cities have children at later ages. Finland is the exception to this trend as  $ASFR_{30-49}$  did not increase as much as in the other countries. Additionally,  $ASFR_{30-49}$  in major city municipalities remained similar to that in other municipalities throughout the period, as  $ASFR_{30-39}$  remained relatively stable in all municipalities during the period.

### The Economic and Social Context of Fertility Variation

The possible reasons for variation in fertility by age and level of urbanization over time become more clear in the regression analyses. Model 1 (Table 3) shows the standardized coefficients of the random effects spatial panel model, which estimates how indicators are related to municipality-level TFR across space and time. During the period, level of urbanization was not related to TFR in the way we expected. Once controlling for all variables in the model, differences between levels of urbanization are removed. In line with the economic uncertainty perspective, economic inactivity is negatively related to the TFR. In areas where the share of economically inactive individuals is higher, TFR tends to be lower. However, this coefficient is relatively small. The relationship between the share of dissolved partnerships and fertility is also negative, indicating that in municipalities with a larger share of separated individuals, fertility is lower. Voting for conservative political parties is positively related to fertility levels across space and time. This positive relationship reflects that in areas where support for conservative ideology is larger, fertility tends to be higher. 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 signaling that fertility is lower in municipalities with more highly educated women and higher income per capita.

Disaggregating the relationships between fertility and indicators of economic and social context 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 individuals. In addition, most indicators are more strongly related to fertility variation across space than over time. The exception is voting for conservative parties, which is equally strongly related to fertility variation across space and over time but in opposite ways.

Economic inactivity has a strong negative connection with fertility differences between municipalities, reflecting that fertility is postponed during times of economic uncertainty. Net migration is the only covariate positively related to fertility variation between municipalities. Last, the proportion of the population in a

**Table 3** Results of the random effects spatial panel 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 <sub>15-29</sub>	ASFR <sub>30-49</sub>
	Total effects		Between effects	
Share of economically inactive	- 0.02 **	- 0.05 ***	- 0.03 ***	- 0.02 **
Share of population in dissolved partnerships	- 0.11 ***	- 0.10 ***	- 0.06 ***	- 0.05 ***
Share of votes for conservative parties	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 conservative parties		0.03 ***	0.02 ***	0.01 ***
Net migration per 1,000 inhabitants		0.01 *	0.00	0.00
	Total effects			
Share of females with postsecondary education	- 0.01	- 0.03 ***	- 0.09 ***	0.06 ***
Income per capita	- 0.08 ***	- 0.08 ***	- 0.05 ***	- 0.03 ***
Level of urbanization	Major City	Ref	Ref	Ref
	City	- 0.08	- 0.08	0.02
	Town	- 0.14	- 0.04	0.08
	Rural	0.05	0.02	0.15 *
Spatially lagged fertility ( $\lambda$ )	0.19 ***	0.18 ***	0.13 ***	0.12 ***
Municipality variance ( $\phi$ )	0.30 ***	0.28 ***	0.29 ***	0.19 ***
Intercept	1.62 ***	1.65 ***	0.82 ***	0.96 ***
AIC	10,798	10,687	1,686	- 3,632
BIC	10,920	10,840	1,839	- 3,479
Log Likelihood	- 5,383	- 5,324	- 823	1,836

Source: National statistics offices (see Appendix 1 Table 4), 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. \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

dissolved partnership has a significant, negative relationship with fertility variation across both space and time, however this relationship is stronger across space. Female post-secondary education, income per capita, and level of urbanization are included as non-disaggregated, total effects in Model 2 for reasons outlined previously and these estimates are very similar to those in Model 1.

The importance of space versus time is also evident when we analyze age-specific fertility rates (Models 3 and 4).<sup>89</sup> We find that the role of social and demographic

<sup>8</sup> Models 3 and 4 display the disaggregated results for age-specific fertility rates. Appendix 2 Table 8 display the non-disaggregated random effects models comparable with Model 1.

<sup>9</sup> Estimating age-specific fertility rates for five-year age groups (Appendix 2 Table 9) does not suggest that one age group is driving the results observed in Table 3.

context for understanding spatial and temporal fertility variation is similar among younger and older age groups. For example, the association between partnership dissolution and fertility levels are comparable for fertility at younger (ASFR<sub>15-29</sub>) and older (ASFR<sub>30-49</sub>) ages. This is also the case for the proportion of votes for conservative political parties and net migration.

However, some variables have rather different and, in some cases, even opposite relationships with fertility between the two age groups. For example, the coefficient of economic inactivity is slightly larger but also stronger for ASFR<sub>15-29</sub> than for ASFR<sub>30-49</sub>, in line with previous findings. Income per capita, while important at both ages, is also somewhat more important at younger ages. Furthermore, fertility under age thirty decreases as the proportion of females with post-secondary education in a municipality increases whereas fertility over age thirty increases. The negative relationship is likely due to postponement during educational enrolment at younger ages whereas the positive relationship reflects recuperation of fertility at later ages.

After controlling for fertility-related factors, differences in fertility persist between the levels of urbanization. Spatial variation of fertility under age thirty largely disappears, but not completely. The remaining difference in ASFR<sub>15-29</sub> between the levels of urbanization are for rural municipalities and major city municipalities, the two extremes of the urbanization classification. For fertility over age thirty, on the other hand, differences between levels of urbanization remain, even after accounting for economic, social, and contextual factors. In this way, fertility over age thirty is highest in major city municipalities.

Finally, we find that spatial autocorrelation is important for spatial and temporal fertility variation. Throughout all models, municipality-level fertility rates are positively related to fertility levels in neighboring municipalities ( $\lambda$ ). This implies that, even after controlling for economic, social, and demographic aspects, fertility in neighboring municipalities is positively related to fertility in municipality  $i$ . This might be related to spatial interaction effects in which, for example, low fertility in neighboring municipalities  $j$  has a lowering influence on fertility in municipalities  $i$ .

## Discussion

The main goal of this paper was to support societal stakeholders aiming to address the rapid Nordic fertility decline by focusing on a so far largely neglected dimension: the spatial dimension of the fertility decline. We used municipality-level data for Denmark, Finland, Norway, and Sweden and put a special emphasis on fertility variation by level of urbanization. We also focused on the role of the economic and social context for fertility variation across space and time. To do so, we combined panel regression methods and spatial analysis to better identify the relationship between the economic and social context and fertility change over space and time.

Rural municipalities showed the largest divergence in fertility levels between age groups; they experienced the largest decline in fertility under age thirty while fertility over age thirty remained relatively stable. Rural municipalities are likely to have the least flexible economies and sparser employment opportunities, making economic uncertainty very important for fertility decisions in these regions.

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, might allow older individuals to better withstand economic precarity than their rural younger or urban counterparts over age thirty.

While fertility decline 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 in total fertility, especially when the population aged 30 to 49 is large. For example,  $ASFR_{30-49}$  has declined across all levels of urbanization in Finland. Finland is also the country experiencing the most rapid decline in total fertility. On the other hand, increases in  $ASFR_{30-49}$  in Denmark contributed to lower levels of fertility decline at the national level. If  $ASFR_{30-49}$  declines in Denmark, Norway, or Sweden as it does in Finland, we can expect a more rapid decline in total fertility at the national level in the future.

While all economic and social indicators were related to fertility levels across space and time, our results suggest that the role of the economic context is less relevant for fertility variation over time than variation across space. In line with our expectations and prior findings (Goldstein et al., 2013), economic inactivity was negatively related to municipality level fertility. While we found that economic conditions are somewhat more relevant for fertility under age thirty than above age thirty, contrary to our expectations, increasing income per capita was not related to increasing fertility levels. This was surprising given the large spatial variation identified in Fig. 3. Nonetheless, our findings suggest that these contextual factors help to explain fertility differences across space for the younger age group.

However, economic and social contextual factors were not as helpful for explaining spatial differences in fertility over age thirty. Over age thirty, fertility may be less susceptible to economic conditions because individuals in this age group have had more time to accumulate financial capital and employment opportunities, which can serve as resources during times of economic inactivity. In the Nordic context of social democratic welfare regimes, more secure employment or higher salaries at later ages may also grant these individuals better parental leave to have children, further contributing to this trend.

Furthermore, results from spatial panel regression identified that the social context (e.g., partnership dissolution) is as, if not more, related to fertility variation as the economic context (e.g., economic inactivity). This supports recent arguments that theories of fertility change should consider factors beyond economic conditions when studying fertility variation (Comolli et al., 2019; Vignoli et al., 2020). Fertility in both age groups had significant relationships with indicators of the social context, such as conservative sentiment and partnership dissolution. This creates an added dimension of fertility conditions for the younger age group, in which fertility is most related to the economic context. In addition, there are age-related limitations on how long individuals over age thirty can postpone fertility while younger individuals may postpone fertility to enroll in further education or to develop their careers (Kulu et al., 2007).

The results for the role of partnership dissolution fit our expectations but the results regarding conservative voting sentiment were more complex. While conservative voting was negatively related to fertility variation across municipalities, it was positively related to fertility change over time. The positive relationship fits our expectations that decreasing fertility over time would be related to decreasing support for traditional values. The negative relationship may also reflect increasing support for conservative leadership in the face of uncertainty (Lewis-Beck & Paldam, 2000).

We found persistent spatial dependence in municipality-level fertility across all regression models. While the descriptive results and results from regression analysis demonstrate that differences in fertility exist between municipalities, we also found that municipality-level fertility is positively related to fertility levels in surrounding municipalities. Differences in fertility levels between municipalities can emerge as a result of differences in migration, economic conditions, or social norms, while similarities between municipalities can be created through shared contexts. For instance, similarities in economic structures can contribute to similarities in municipality-level incomes per capita. Daily movements between municipalities for economic or leisure purposes can also contribute to similarities in social norms and fertility levels through increased cultural or economic interaction. Nonetheless, positive spatial spillover suggests that there are connections between municipalities related to fertility that we still did not capture. Not accounting for such spatial interdependencies in regression estimation will likely lead to biased estimates and outcomes.

Two main concessions were made to assess the importance of spatial variation in fertility trends. First, we analyzed period 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 at the municipality level in all four countries. A cohort approach would also reduce the relevancy of our period economic and social context controls. 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., 2020). Second, the indicators used to measure the economic and social contexts of fertility cannot capture the full complexity of uncertainty. Although our proxy variables are limited in definition and number due to data constraints, our analysis provides an indication that not only the economic but also the social context needs to be accounted for when studying spatial and temporal fertility change. However, we acknowledge that fully understanding the social context of fertility variation is not possible without survey or qualitative data that delves into individual-level opinions of the future. We used proxy variables to identify as much of these dimensions as possible, but we call for more nuanced research on the social context of fertility variation.

This aggregate level analysis is a first step to deepen our understanding of the Nordic fertility decline on the spatial dimension. One limitation of not using individual-level data is that we cannot study life courses and the interdependencies of events in the life course, nor can we look at micro–macro interactions. However,

our macro-level results are in line, in part, with findings of individual-level research. This includes that economic factors are less relevant for fertility at older ages (Miettinen & Jalovaara, 2020). As our outcomes underline the importance of the so far under-investigated spatial dimension, future research should try to analyze individual-level data whilst explicitly incorporating the spatial dimension. The register data available in the Nordic countries offer rich potential for such approaches. Such research will likely result in even more-refined policy recommendations.

This paper demonstrated that economic, social, and spatial contexts should all be considered by policy makers when designing policies aimed at mitigating the fertility decline in the Nordic countries. Economically, fiscal support may reduce levels of economic uncertainty, especially for younger individuals among whom fertility is declining the fastest. Socially, helping individuals to balance work and home lives may reduce the opportunity costs of fertility. For example, this may be done through flexible working structures. Spatially, focusing initiatives on major cities or regions with high levels of unemployment may help prevent the rapid declines in these municipalities, even among older individuals. Continued commitment to fertility-related policies may help mitigate the fertility decline in the Nordic countries (Rønsen, 2004) or other countries with low fertility levels (Žamac et al., 2010).

To summarize, our research underlines that taking a spatial perspective can deepen our understanding of the Nordic fertility decline. Further insights can be gained by looking at fertility changes in different age groups over space and time. Differences in the economic and social context of fertility by age are important for differences in fertility trends across space and over time and, thus, for 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 more generally (Bleha, 2020). Future research should incorporate more holistic approaches to fertility that include both social and spatial dimensions. Our findings suggests that the spatial component is critical not only for understanding where fertility has declined but also how it will change in the future. We encourage researchers to more explicitly incorporate the spatial perspective to better understand fertility trends both in the past and in the years to come.

## Appendix 1

### Data Sources

The data and variables analyzed in this paper primarily come from the websites of the respective national statistics offices<sup>10</sup> (see Table 4). 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 4** 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	07,459	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	11,615	19 June 2019
	Sweden	AM0208A1	19 June 2019
Gross income	Denmark	INDKF122	27 June 2019
	Finland	001_118w_2018	30 June 2019
	Norway	03,068, 08,409	30 June 2019
	Sweden	AM0302K3	27 June 2019
Yearly average exchange rate	All countries	Eurostat table ert_bil_eur_a	04 July 2019
	All countries	Eurostat table nama_10_gdp	04 July 2019

<sup>10</sup> Statbank Denmark: <https://www.statbank.dk/statbank5a/default.asp?w=1920>  
 Statbank Finland: <https://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/>  
 Statbank Norway: <https://www.ssb.no/en/statbank/>  
 Statistics Sweden: <https://www.scb.se/en/finding-statistics/>



Table 4 (Continued)

Variable	Country	Data tables reference codes	Access Date
Voting at national elections for Parliament			
	Denmark	FVKOM	08 May 2019
	Finland	020_cvaa_120	11 June 2019
	Norway	08,092	08 May 2019
	Sweden	ME0104B6	08 May 2019
Party classifications			
	All countries	<a href="https://www.chesdata.eu/our-surveys">https://www.chesdata.eu/our-surveys</a>	07 June 2019
Marital status			
	Denmark	BEF10A7, FOLK1A	12 May 2019
	Finland	030_11rz_2018	12 May 2019
	Norway	03,027	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	09,429	12 June 2019
	Sweden	UF0506A1	06 May 2019
Net migration			
	Denmark	BEV1, BEV107	31 January 2020
	Finland	008_11a7_2018	31 January 2020
	Norway	09,588	31 January 2020
	Sweden	BE0101AX	31 January 2020

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

**Table 5** Results of Lagrange Multiplier tests and Hausman tests

Models	Lagrange Multiplier test for spatial autocorrelation	Hausman test for spatial models
Model 1	23.70 ***	54.81 ***
Model 2	23.78 ***	55.24 ***
Model 3	22.04 ***	54.81 ***
Model 4	21.92 ***	54.93 ***

Source: National statistics offices (see Appendix 1 Table 4), authors' own calculations

Notes: All tests developed by Baltagi et al. (2003). \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

**Table 6** Comparing results from different spatial approaches to the random effects panel model on municipality-level TFR, 2005–2018

Variables	Non-spatial model	Spatial lag model	Spatial error model	SARAR model
Economic inactivity	-0.02 **	-0.02 **	-0.03 ***	-0.01 *
Dissolved partnership	-0.12 ***	-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	-0.02 **	-0.01	-0.02 *	-0.00
Income per capita	-0.10 ***	-0.08 ***	-0.09 ***	-0.06 ***
Level of urbanization	Ref	Ref	Ref	Ref
Major City				
City	-0.10	-0.08	-0.09	-0.06
Town	-0.06	-0.01	-0.02	-0.00
Rural	-0.01	0.05	-0.03	-0.08
Spatially lagged fertility ( $\lambda$ )		0.19 ***		0.44 ***
Spatially lagged error ( $\rho$ )			0.19 ***	-0.31 ***
Municipality variance ( $\theta$ )	0.35 ***	0.30 ***	0.30 ***	0.30 ***
Intercept	2.07 ***	1.63 ***	2.03 ***	1.11 ***
AIC	11,089	10,798	10,816	10,753
BIC	11,204	10,920	10,939	10,883

Source: National statistics offices (see Appendix 1 Table 4), 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 7** Results of fixed effects spatial panel regression on municipality-level TFR, 2005–2018

Variables	TFR
Economic inactivity	- 0.02 ***
Dissolved partnership	- 0.12 ***
Votes for conservative parties	0.00
Net migration	0.02 ***
Female postsecondary education	0.01 **
Income per capita	- 0.12 ***
Level of urbanization	Major City Ref
	City - 0.12 *
	Town - 0.05
	Rural - 0.01
Spatially lagged fertility ( $\lambda$ )	0.22 ***
Intercept	1.63 ***
AIC	11,993
BIC	12,100
Log Likelihood	- 5,982

Source: National statistics offices (see Appendix 1 Table 4), 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 8** Results of random effects spatial panel regressions on municipality-level age-specific fertility rates, 2005–2018

Variables		ASFR <sub>15-29</sub>	ASFR <sub>30-49</sub>
Economic inactivity		- 0.01 **	- 0.01
Dissolved partnership		- 0.06 ***	- 0.06 ***
Votes for conservatives		0.03 ***	0.01 **
Net migration		0.01 **	0.01 **
Female postsecondary education		- 0.07 ***	0.07 ***
Income per capita		- 0.05 ***	- 0.03 ***
Level of urbanization	Major City	Ref	Ref
	City	0.02	- 0.11 *
	Town	0.10	- 0.12 **
	Rural	0.19 **	- 0.15 **
Spatially lagged fertility ( $\lambda$ )		0.13 ***	0.13 ***
Municipality variance ( $\phi$ )		0.30 ***	0.20 ***
Intercept		0.79 ***	0.96 ***
AIC		1,749	- 3,556
BIC		1,872	- 3,433
Log Likelihood		- 859	1,194

Source: National statistics offices (see Appendix 1 Table 4), 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 9** Results of random effects spatial regressions on municipality-level age-specific fertility rates, 2005–2018

Variables	ASFR <sub>1,5</sub>	ASFR <sub>20</sub>	ASFR <sub>2,5</sub>	ASFR <sub>30</sub>	ASFR <sub>35</sub>	ASFR <sub>40</sub>	ASFR <sub>45</sub>
<b>Between effects</b>							
Economic inactivity	0.0005 **	- 0.0010	- 0.0065 ***	- 0.0038 ***	0.0003	0.0008 ***	0.0001 ***
Dissolved partnerships	0.0005 ***	- 0.0024 ***	- 0.0097 ***	- 0.0071 ***	- 0.0029 ***	0.0010 ***	- 0.0001 ***
Votes for conservatives	0.0003 *	- 0.0015 *	- 0.0004	- 0.0012 *	- 0.0018 ***	0.0007 ***	- 0.0000
Net migration	- 0.0003 **	0.0019 ***	0.0028 ***	0.0031 ***	0.0011 ***	0.0003 *	0.0001 **
<b>Within effects</b>							
Economic inactivity	- 0.0002 **	- 0.0002	- 0.0001	0.0000	- 0.0003	- 0.0001	- 0.0000
Dissolved partnerships	- 0.0006 ***	- 0.0003	- 0.0021 ***	- 0.0046 ***	- 0.0012 ***	0.0001	0.0000
Votes for conservatives	0.0001	0.0015 ***	0.0027 ***	0.0018 ***	0.0007 ***	0.0002 *	0.0000
Net migration	0.0000	0.0005 *	0.0003	0.0002	0.0004 *	- 0.0001	0.0000
<b>Total effects</b>							
Female postsecondary educ	- 0.0010 ***	- 0.0087 ***	- 0.0074 ***	0.0065 ***	0.0059 ***	0.0017 ***	0.0001 ***
Income per capita	- 0.0014 ***	- 0.0064 ***	- 0.0046 ***	- 0.0029 **	- 0.0012	- 0.0004	- 0.0001
Level of urbanization	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Major City							
City	- 0.0003	- 0.0048	- 0.0097	0.0033	- 0.016 ***	- 0.0080 ***	- 0.0010 ***
Town	- 0.0009	- 0.0010	- 0.0190 *	0.0031	- 0.018 ***	- 0.0083 ***	- 0.0010 ***
Rural	- 0.0013	- 0.0056	- 0.0280 ***	0.0011	- 0.019 ***	- 0.0084 ***	- 0.0010 ***
Spatially lagged fertility ( $\lambda$ )	0.1065 ***	0.1016 ***	0.0879 ***	0.0618 ***	0.0584 ***	0.0608 ***	0.0366 **
Municipality variance ( $\phi$ )	0.0631 ***	0.2650 ***	0.1146 ***	0.0575 ***	0.1271 ***	0.1036 ***	0.0217 ***
Intercept	0.0064 ***	0.0510	0.1134 ***	0.1174 ***	0.0653 ***	0.0160 ***	0.0013 ***
Log Likelihood	52,309	32,881	27,980	30,143	37,011	49,893	73,504

Source: National statistics offices (see Appendix 1 Table 4), 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

\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

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