Spatial diffusion of fertility decline in northern Sweden, 1850-1950

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Abstract

This article studies how married couples' fertility behaviours were related to the behaviours of their married neighbours, in northern Sweden from 1850 to 1950. The relationship is studied at two geographical scales, as aggregate level autocorrelations between neighbourhoods and as individual level diffusion effects between neighbours. This is done using longitudinal individual-level demographic data with detailed spatial information. The results show that couples in adjacent neighbourhoods had similar fertility at the onset and during the fertility transition and not after or before. Similar patterns were found for the effects of long-term changes in neighbour fertility while short-term effects showed to opposite patterns. Short-term effects did only affect fertility before or after and not during the fertility transition. The results suggest that couples fertility was affected by social interaction mechanisms within networks of neighbours not only during but also before and after the European fertility transition.

1 Introduction

One of the most compelling evidence for the role of normative changes for the fertility transition is the spatial patterns of decline in marital fertility that has been observed in Europe during the late 19th and early 20th century (Watkins, 1986). One interpretation of this pattern is that people who live near each other know each other, and through social interactions create and diffuse new norms about family and fertility which made people strive for smaller families (Knodel and van de Walle, 1979; Lesthaeghe and Surkyn, 1988; Watkins, 1986). However, the empirical evidence of what causes these patterns are inconclusive. Was it caused by social interaction mechanisms, and the diffusion of new attitudes and behaviours (Goldstein and Klüsener, 2014; Klüsener et al., 2016; Watkins, 1990), or was is it an effect of social and economic structural differences between locations (Barnes and Guinnane, 2012; Brown and Guinnane, 2007), caused by the clustering of similar people in the same location (McPherson et al., 2001; Palloni, 2001)? This study attempts to address these issues by measuring diffusion effects at a much smaller geographical scale than previous studies, using longitudinal demographic data from the Skellefteå region in northern Sweden from 1850 to 1950.

Specifically, this study investigates how married couples' fertility behaviours were affected by the behaviours of their married neighbours and how this effect changed over time. The relationship is studied at two geographical scales, between neighbourhoods and between couples within and across neighbourhoods. Neighbourhood effects occur as couples display similar fertility behaviours within a small geographical area, a neighbourhood, which is independent of other similarities, such as age or occupation. Additionally, if these behaviours are diffused among neighbours, couples in adjacent neighbourhoods would display similar behaviours. By measuring spatial autocorrelations between adjacent neighbourhoods, we can get insights into the development of spatial diffusion effected at an aggregate level. Between neighbour effects occur as couples' birth control decisions are influenced by the attitudes and behaviours of their neighbours. This effect is analysed by measuring how neighbours fertility changed for a couple over their reproductive life course and how they, in turn, responded to these changes. By analysing spatial diffusion effects at two geographical scales within the same population, it is possible to separate different forms of diffusion mechanisms. Also, by measuring the diffusion effects on couples' reproductive behaviours, it is possible to control for both individual-level as well as contextual level confounding factors over the course of couples' life courses. Finally, by analysing the relationship before, at the onset of the fertility transition as well as during the transition, it is possible to determine the role spatial diffusion had at different points in time.

In the following section, I will discuss the different explanations of spatial fertility patterns. The next section will present the hypothesis that is tested and the research design applied in this study. After discussing the setting and data, the analysis is presented. First, the methods and results of the analysis of between neighbourhood effects are presented, followed by the analysis of between couple diffusion effects. Finally, the result of these analyses is combined into a concluding discussion where the limitations and implications of this study are discussed.

2 Explanations of spatial fertility patterns

The diffusion hypothesis asserts that fertility change is not solely an adaptation to economic, demographic of social structural changes but also a reflection of the spread of attitudes and behaviours (Casterline, 2001). Diffusion was most notably identified as important for the historical fertility transition by the conclusions of the European fertility project (EFP) which found that the variations in fertility followed linguistic and cultural boundaries rather than economic or demographic developments (Knodel and van de Walle, 1979; Watkins, 1986). Cleland and Wilson (1987) draws the conclusions of the EFP even further, dismissing all economic determinants of fertility in place of diffusion of birth control. Casterline and collaborators (Montgomery and Casterline, 1993; Rosero-Bixby and Casterline, 1993) have a more inclusive perspective in their analysis, arguing that diffusion mechanisms work to spread both ideational and economic effects in Taiwan. Bongaarts and Watkins (1996) research on high-fertility regions follows in line with these conclusions, fertility decline is dependent on the diffusion of knowledge, more specifically how social interactions within network spread knowledge about birth control and attitude towards small families.

On an individual level Palloni (2001) argues that fertility decisions change due to an alteration of preferences. While economic and social structural effects would affect an individual through their social position, diffusion would affect decisions as people reevaluated their behaviours in light of others attitudes and behaviours and adopted new birth control practices. New attitudes and behaviours are thus assumed to be diffused through social interactions. Studies of post-industrialised population have shown that people's fertility practices are affected by social interactions (Bernardi, 2003; Bernardi and Klaerner, 2014; Keim, 2011). People's decision to become a parent (Balbo and Barban, 2014) or have another child (Keim et al., 2009) is associated with the fertility behaviours of friends and peers.

Social interactions would also create spatial fertility patterns. This is based on the assumption that proximity increases the probability that individuals have face-to-face meetings (Hedström, 1994; Marsden and Friedkin, 1994). Distance is also one of the best predictors of whether or not individuals know each other (Zhang and Pang, 2015; Marsden and Friedkin, 1994). A number of studies find spatial diffusion effect while controlling for economic structural effects. Spatial analysis of the transitions in Brazil (Schmertmann et al., 2008), Egypt (Bonneuil and Dassouki, 2006) and Great Britain (Bocquet-Appel and Jakobi, 1998) has similarly provided evidence for diffusion effects. In an analysis of the European transition, Watkins (1990) argues that differences in the diffusion of fertility decline were influenced by differences in the geographical extent of social networks. As these networks grew from local communities to national ones, the geographic homogeneity of fertility behaviours increased.

However the diffusion hypothesis has been criticised, Brown and Guinnane (2007) have shown that the EFP results were biased by the high aggregation level, missing economic effects which work at a disaggregated level, leading to an ecological fallacy. This literature draws upon microeconomic theory, which asserts that the socioeconomic differences were caused by a substitution effect. The hypothesis is that there is a trade-off between the quantity and quality demand for children. As the cost of child quality decreases through structural changes such as cheaper education, demand for child quality increases at the cost of lowering the demand for child quantity (Becker, 1960; Guinnane, 2011). Socio-economic differences were created because the higher classes were the first to gain from a lower cost of child quality. A number of studies have shown the importance of structural economic changes, primarily through an increase in differences between socio-economic groups (Dribe et al., 2014; Dribe and Scalone, 2014). Galloway et al. (1994) argue that the Prussian fertility decline was driven by structural economic changes rather than ideational and diffusion mechanisms. However, an updated analysis of the Prussian transition by Goldstein and Klüsener (2014) has shown substantial spatial patterns. Fertility levels within sub-regions were more likely to decline if they were near a region where fertility decline had already started.

In his analysis of the British fertility decline, Szreter (1996) argues that reproductive practices were shared within communication communities during the demographic transition. Within the nexus of class, gender and community the perceived relative cost of childrearing was created, diffused and reproduced to be a part of individuals identities, shaping family formation. By communication communities, Szreter refers to social network communities who share the same "sociocultural environment of language, values, and roles" (Szreter, 2015, p. 177), often created from a combination of class and neighbourhood. However, contrary to Szreters results, Barnes and Guinnane (2012) have shown that the majority of the variations in fertility during the decline can be explained by socio-economic differences rather than spatial ones. Dribe et al. (2015) come to the same conclusions in their analysis of the Swedish fertility transition. However, both of these analyses are limited to panel data, thus measuring spatial patterns of fertility at specific points in time, rather than across time over the reproductive life courses of couples.

Spatial patterns of fertility have thus, been theorised to be linked to social interactions as well as spatial clustering of socioeconomic similarities However, the pattern can also be an effect of social network homophily. Homophily refers to the tendency of individuals to associate with others who are similar to themselves. It is easier for people who share some form of characteristics such as age, class or attitudes, to form relationships (McPherson et al., 2001) and thus, would be more likely to live near each other. People who live near each other would, therefore, display similar reproductive behaviours because of their attitudes and values which were independent of the attitudes of others (Palloni, 2001). The hypothesis is that they only live near each other because they already were similar, not that they became similar because they lived near each other.

3 Research design

As previously mentioned, this study aims to investigate how couples' fertility behaviours were affected by the behaviours of their neighbours and how this effect changed over time. The assumption is that couples' decision to limit their fertility during the transition was influenced by the attitudes and behaviours of their neighbours. Thus, couples who lived in proximity to other couples who practised fertility limitation would be more likely to limit their fertility themselves as they would be influenced by the action of their neighbours. The initial hypothesis in this study is, (1) that there were spatial correlations in marital fertility between adjacent neighbourhoods and (2) that a couples' fertility was affected by the fertility of their neighbours. Additionally, it is easy to assume that the spatial diffusion effect would be stronger as more people adopted new fertility behaviours; thus another hypothesis is (3) that these effects varied over time.

However, as seen in the previous section, neighbours could also display similar behaviours because they live in the same location and were exposed to the same social and economic structures, or because people who were similar in the form of age or socioeconomic status tended to move near each other. Thus, the similarities of neighbours fertility outcomes could be independent of any social interaction effects. The research design applied in the current study aims to adjust for contextual differences and selection bias by controlling for social and economic factors at a neighbourhood and couple-level using event history regression models. After controlling for these confounders, the remaining associations in fertility between neighbours and neighbourhoods will be interpreted as evidence for other factors, such as the diffusion of norms and values through social interactions.

These issues are further addressed in this study through a set of strategies. Diffusion effects are often modelled as time-lagged autocorrelations, where the action of an individual is dependent on previous practices of relevant others. However, specifying spatial-time lagged effects in longitudinal models are difficult, especially when trying to compare how they change over time. This study tries to overcome this problem by separately estimating the practices of others – neighbours or couples within adjacent neighbourhoods – and then afterwards analysing the effects on couples' fertility outcomes. As neighbourhood-level effects and neighbour effects work at different spatial levels, they are investigated in two separate analyses.

Similarities in fertility for couples in adjacent neighbourhoods is measured by subdividing each parish into smaller areas, or neighbourhoods, consisting of adjacent villages and towns, by estimating fertility within each neighbourhood as random-effects in Cox regressions and then measuring spatial autocorrelation in fertility between adjacent ones. By using couple-level data, it is possible to estimate neighbourhood-level spatial autocorrelations while controlling for both individual-level as well as neighbourhood-level confounding factors.

The effect of neighbours reproductive practices on couples' fertility outcomes is also investigated in two steps. The first step was to estimate changes in fertility of neighbours to each couple across their reproductive life courses. Diffusion effects during the transition are usually measured at a decade timescale (Dribe et al., 2015; Goldstein and Klüsener, 2014; Watkins, 1986). However, diffusion effects between individuals in post-transitional societies have shown a bell-shaped pattern with time, where the effect of others behaviours increases in the first few years and then decreases over time (Balbo and Barban, 2014). To separate these two forms of effects, changes in neighbour fertility were measured at two timescales, a long-term change over ten years and a short-term change over five years. In the second step of the analysis, the neighbour fertility changes were incorporated as couple-level features into a Cox proportional hazard regression model were we estimate the effect on couples' fertility outcomes while controlling for both individual-level as well as neighbourhood-level confounding factors.

4 Data and setting

The study is made possible by the use of the longitudinal database POPLINK, which contains longitudinal individual-level data for the Skellefteå region from the mid 18th century until the 1960s (Westberg et al., 2016). The Skellefteå regions consist of parishes which were once a part of the original Skellefteå parish up until 1810. By 1950 the region had been subdivided into eight parishes, six of which is included in the database: Skellefteå lands, Skellefteå stads, Byske, Bureå, Norjsö and Jörn (Westberg et al., 2016). The region did not experience the same rapid industrialisation as other coastal regions in Northern Sweden such as Sundsvall. The only town, Skellefteå, at the mouth of the Skellefteå river at the shores of the Botnian Bay, served primarily as an administrative centre. This was a small town with a population of less than 2000 up until the 1910's. Until 1940 the majority of the adult population worked in agriculture, and industrialisation was limited to a few sawmills, established from the 1870's primarily at the coast near the rivers. However, the level of industrialisation was relatively low until the mining industry took off in the 1930's (Gaunitz et al., 2002).

In comparison to Sweden at large, fertility started to decline in the region relatively late. Period fertility rates started to decline continuously after 1900 in Västerbotten county, which the Skellefteå region was a part of, as seen by the total fertility rates in Figure 1. Also, fertility rates in the region were higher than the average Swedish rates, both before and after the transition.

POPLINK consists of information on births, deaths, marriages and migration linked at an individual-level across parishes within the region. It also has linked information gathered from the Catechetical examinations, containing recurrent information on who lived in each household, their occupation, and place of residence. As the information is linked we can follow an individual across their lifetime as their lives change such as when and where they move between locations, marry, change occupations, have children or their spouse die.

The dataset contains reliable information on the onset of risk which in historical Sweden can be set to the timing of marriage (Carlsson, 1966; Coale, 1986), and the end of their reproductive careers, which is the timing of emigration from the region, their or their spouses death or that the onset of menopause set to age 50, whichever comes first. For this analysis, the sample consists of all married women who had at least one child and their families, who married between 1850 and 1950, a sample of 20 439 married

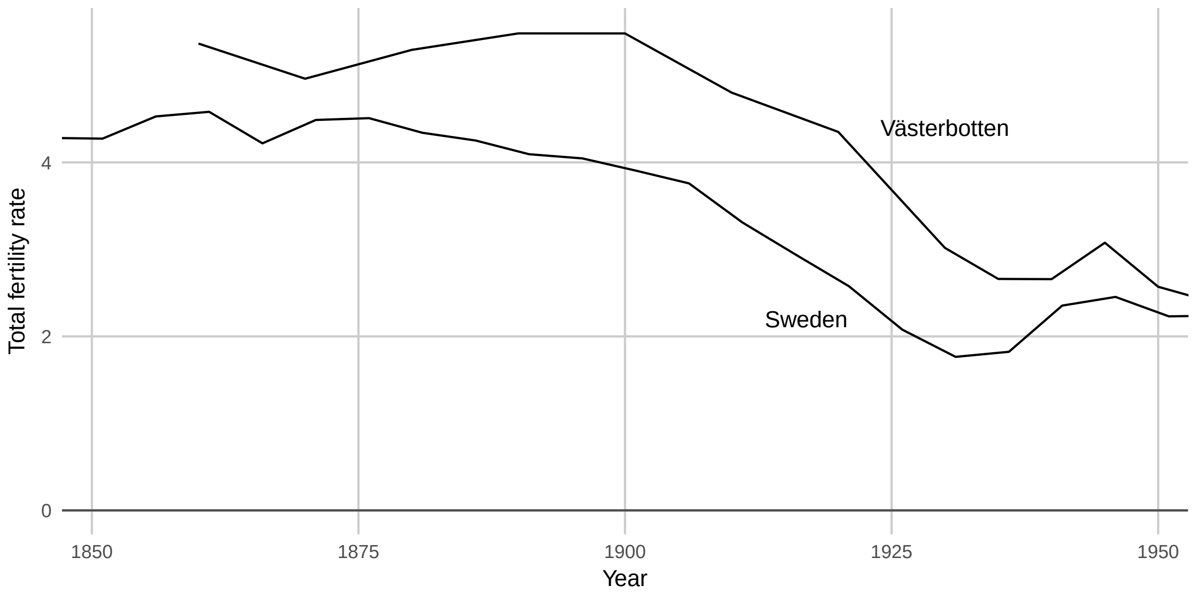

Figure 1: Total fertility rates (TFR) in the Skellefteå region, 1850-1950.

women within 706 places of residence.

Places of residence have been geocoded, and due to the detailed information on migration, it is possible to determine who lived near each other at each moment in time with high accuracy. For ethical reasons the anonymity of individuals needs to be ensured, thus, no personal identifiers are included in the dataset. Also, as many of the villages in the region were very small, the smallest places of residence are aggregated to ensure anonymity of individuals in the population. The aggregation is performed at all point in time when a place had a population smaller than ten individuals. These places were then combined with the closest village or town; the procedure was iterated over the dataset until all places of residence at each year had a population larger than ten individuals.

Socioeconomic status is derived from occupational information. Occupational data was recorded at most of these life events for men, and more infrequently for women, even rarer for married women. Thus, the husband's occupation is used as a proxy for the couples' social position. These occupations have been coded into HISCO codes (Mandemakers et al., 2013; Van Leeuwen et al., 2004) which in turn was used to classify occupations using the HISCLASS schema (Van de Putte and Miles, 2005). As the sample population is relatively homogenous in terms of socioeconomic status the 12 classes in the schema was condensed into six.

Although the region was sparsely populated there were differences in population density between areas; the detailed geographical information allows for calculations of population density at different points in time at a fine-grained geographical level. This also allows for the calculation of yearly migration rates at a neighbourhood-level in addition to the individual-level migration history, and neighbourhood-level socioeconomic structure. The combination of these factors captures both contextual-level and individual-level socioeconomic differences and changes in the region, structural factors which in turn could explain spatial patterns of fertility.

5 Neighbourhood level correlations

5.1 Method

Both before and during the fertility transition, fertility control within marriage was limited to higher order parities. Any effect of deliberate fertility limitation is seen only after a couple had their first child. Whether or not the limitation was performed by waiting longer until they had another child or if they decided to stop having children, the practice would affect the timing of another birth, the outcome of interest in this study. Fertility is measured as the risk of having another birth, estimated using Cox proportional hazard regressions.

On an aggregate level, diffusion effects would create correlations in fertility for couples in adjacent neighbourhoods. In this analysis, a neighbourhood (a "small area") consists of all married couples who live near each other in adjacent villages and towns within a parish. On average, these couples were more likely to have regular face-to-face meetings with each other than with more distant couples. Ideally, the boundaries of a neighbourhood would be based on people's perceptions of community (Diez Roux, 2001); however, as this is not possible the geographical space was divided into small areas based on the proximity of places of residence. The POPLINK data contains geographical information at two levels, parish and place of residence, which is the location of the village or town in which the couple resides. The six parishes in the Skellefteå region are large, up to 1,935 km2, and an average village is too small for calculations of neighbourhood level fertility risks. Instead, neighbourhoods were created by subdividing each parish into smaller areas consisting of adjacent villages and towns, and the area surrounding them.

The procedure starts by partitioning the geographical space of a parish by calculating the Voronoi tessellation based upon the coordinates of all places within the parish. The tessellation algorithm assigns each point within the geographical space of the parish to the place which it is closest to (Lee and Schachter, 1980). This results in a partitioning of the parish into N smaller areas, where N is equal to the number of unique places within the parish. The next step of the procedure was to cluster the places into larger groups of locations which are close to each other. The number of clusters was dependent on the average yearly married population in a parish. In the parish with the highest population density, Skellefteå stad, the ratio of clusters is 0.5/1000 per married women, and in the other parishes, it is 4/1000. Each place was allocated into a sub-region

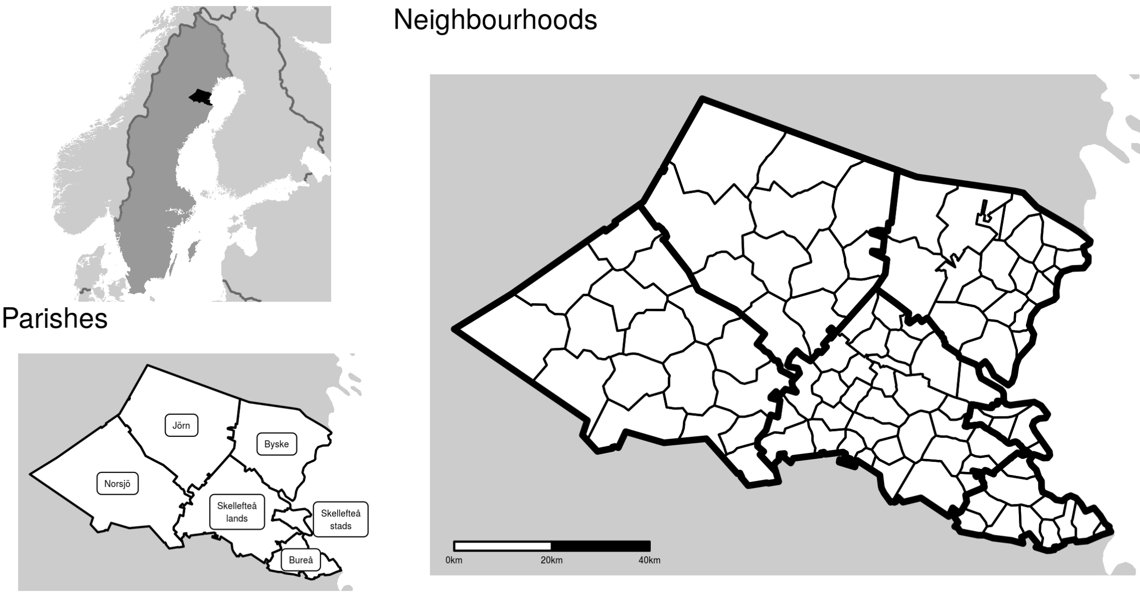

Figure 2: Neighbourhood division of the six parishes in the Skellefteå region.

through K-means clustering, which maximises the geographical distance between groups while minimising the distance within each group. The final step was to combine each area created by the Voronoi tessellation according to its cluster assignment, into one neighbourhood. The process results in a spatial partition of the region (see Figure 2) that makes it possible to measure differences between neighbourhood fertility risks while controlling for both individual-level and neighbourhood level characteristics.

The variation in fertility at a neighbourhood-level and the spatial correlations in fertility between adjacent neighbourhoods were estimated in two separate steps. The first step was to estimate differences in fertility between neighbourhoods using event history analysis, namely mixed effects Cox proportional hazard regressions. The outcome of interest is the timing of another birth, estimated as differences in hazard of having another birth for couples in different neighbourhoods. However, as the region consists of 98 neighbourhoods, it is difficult to estimate fixed effects for each one. Instead, the neighbourhood effects are modelled as random effects, assumed to be drawn from a Gaussian probability distribution. As the analysis includes all higher order parities, the risk of having a child was stratified by parity, to assure that the risk group was restricted to couples who had experienced a similar number of births (Prentice et al. 1981). The full model includes both fixed effects, such as the age of the wife and a neighbourhood random-effect.

(1)

$$\lambda(t) = \lambda_0(t)e^{\beta X + Zb}$$

The risk of an event at time t $\lambda(t)$ is determined by the baseline hazard function $\lambda_0(t)$ and the exponentiated predictors $e^{X\beta+Zb}$. Within the predictors, X is a model matrix, and β is the corresponding matrix of fixed effect coefficients, Z is a model matrix of random effect variables and b a matrix of random effects.

The second step of the analysis is to estimate how these neighbourhood-level random-effects correlate between adjacent neighbourhoods. If couples in adjacent neighbourhoods were affected by each other's behaviours, the hazard ratios for these neighbourhoods would be similar, even after adjusting for confounding factors. These spatial correlations were measured and tested for using Moran's I, an index of spatial autocorrelation. To assess how the autocorrelations change over time, the sample was divided into four periods, 1850-1874, 1875-1899, 1900-1924 and 1925-1950. The first period occurs before the transition, and the second period captures the initial fertility decline of vanguard groups. The majority of the decline occurred during the third period and the last period captures the end of the fertility transition.

The neighbourhood level effects were estimated while controlling for couple-level and neighbourhood-level characteristics. At a neighbourhood level, it was possible to calculate yearly population density and migration rates, which functions as proxies for urbanisation. Socioeconomic structural differences were controlled for by calculating how the population was distributed according to the social status schema for each year and then clustering the neighbourhoods into four groups with similar socioeconomic distributions using K-means clustering. In this way, it was possible to differentiate between neighbourhoods with a predominant farmer population from those with a working-class population. A number of couple-level characteristics were used as controls; these were the age of the wife, the wife and the husband's migration status, the husbands socioeconomic status and calendar time.

5.2 Results

The spatial patterns of fertility are visualised by extracting the neighbourhood random-effects for each period and drawing them a series of maps. The hazard ratios are estimated using Cox proportional hazard models, without any controls. As seen by the maps in Figure 3 there were substantial spatial differences, differences which increased over time. This is also evident by the increase in the standard deviation of the neighbourhood hazard ratios, see Table 1. The map also indicates some spatial clustering of hazard ratios, as adjacent neighbourhoods display similar hazards. This clustering is measured by calculating Moran's I for spatial autocorrelation. A positive correlation (>0) indicates that similar locations where near each other while a negative correlation (<0) indicates that similar locations repelled each other.

Table 1 shows that there were positive autocorrelations in all periods, and the highest correlations were found in 1875-1899. These measurements are tested against the expected values of Moran's I without any spatial autocorrelations. The p-values of the test indicate that there were significant spatial autocorrelations in all periods. This

Table 1: Summary statistic of Moran's I test for spatial autocorrelation of neighbourhood random-effects.

	Unadjusted			Adjusted		
Period	Hazard ratio SD	Moran's I	P-value	Hazard ratio SD	Moran's I	P-value
1850-1874	1.16	0.217	0	1.12	-0.028	0.619
1875-1899	1.15	0.453	0	1.08	0.186	0.001
1900-1924	1.15	0.212	0	1.14	0.163	0.002
1925-1950	1.23	0.292	0	1.10	0.031	0.216

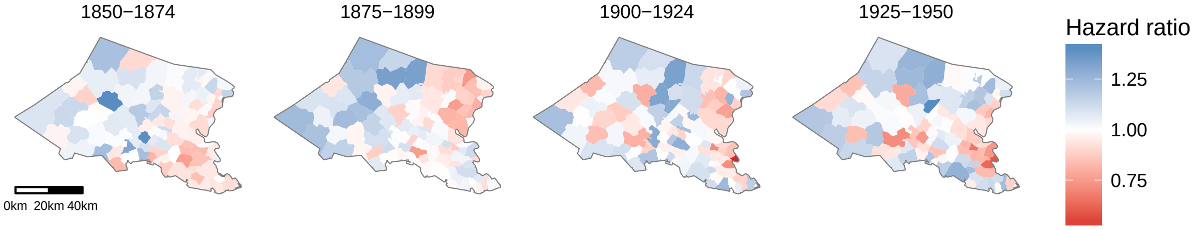

Figure 3: Spatial distribution of hazard of another birth from estimated neighbourhood-level random effects from a Cox proportional hazard model, 1850-1950.

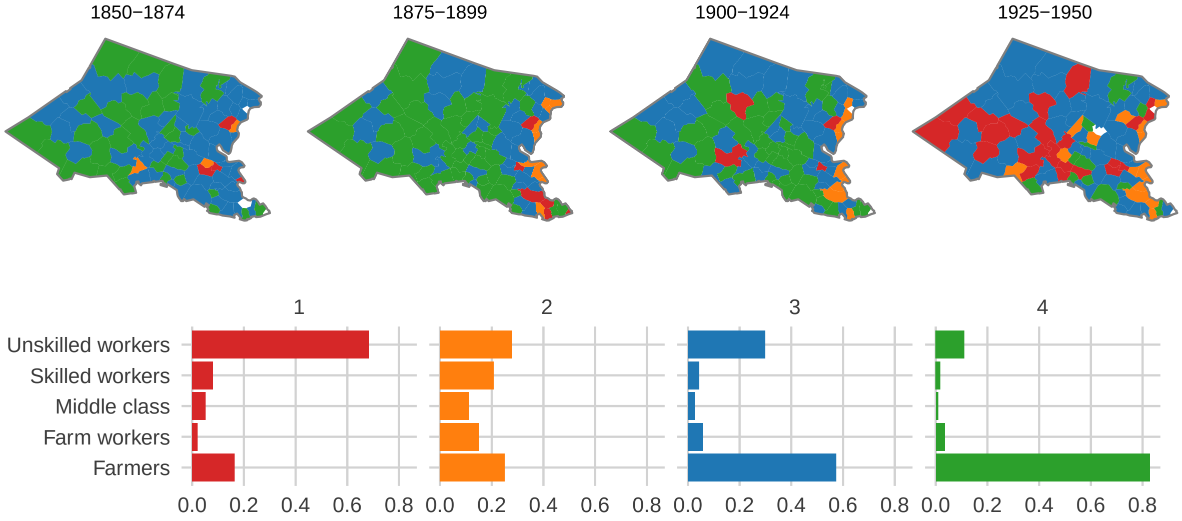

Figure 4: Social class distribution by neighbourhood 1850-1950.

shows that couples in adjacent neighbourhoods had similar fertility behaviours, before, during and after the fertility transition. However, this does not mean that fertility practices were shared between neighbourhoods through social interactions. These spatial patterns could be an effect of correlations in structural changes. Urbanisation, industrialisation and socio-economic development were seldom spatially independent.

To investigate the spatial patterns of socioeconomic structures, the distribution of socioeconomic status of married couples in neighbourhoods at each year was grouped into four groups with similar distributions. As the Elite group is very small they were combined into the middle-class group in this step of th analysis. Figure 4 shows the average proportions of couples by socioeconomic status within each cluster. The four clusters had distinct socioeconomic structures. However, two distinct patterns are visible. Neighbourhoods in cluster 3 and 4 were dominated by farmers while cluster 1 and 2 had a low proportion of farmers. Although the two farmer clusters were similar neighbourhoods in cluster 4 were distinct by a higher proportion of unskilled worker families. Neighbourhoods in both cluster 1 and 2 are representative of urban and industrialised areas, a majority of couples in cluster 1 were unskilled worker families, while the couples in cluster 2 showed a much more diverse socioeconomic structure.

Figure 4 also shows the spatial distribution of these clusters. The farmer clusters (3 and 4) dominated the region up until 1924. Only the town of Skellefteå and a few neighbourhoods with larger settlements showed any substantial social changes. Cluster 1 and 2 are found in a few inland neighbourhoods and the coastal area. After 1925 the socioeconomic structure of the region was transformed, much more neighbourhoods display socioeconomic structures representative of an urban or industrialised area.

The spatial distribution of socioeconomic structure over time also appear to correlate with fertility differences, when comparing the two figures. It is easy to deduce that some amount of the spatial patterns could be due to differences in socioeconomic structure rather than diffusion. In addition to differences in social structure, the spatial pattern could also be affected by population density, migration rate, individuals socioeconomic status, age and migration history.

By controlling for these confounding factors we can estimate adjusted neighbourhood hazard ratios, the full regression model can be viewed in Table 3 in the Appendix. Even after controlling for confounders substantial spatial differences remain. The regression models indicate that a proportion of the variation between neighbourhoods can be explained by similarities in neighbourhood-level and couple-level characteristics, as the variance in neighbourhood effects are smaller in all periods. The adjusted model shows that the variation between neighbourhoods was largest in 1900-1924. The model also indicates that the autocorrelations between adjacent neighbourhoods before (1850-1874) and after (1925-1950) the transition was related to structural similarities, as Moran's I is close to zero and not statistically significant, as shown in Figure 5. Additionally, a portion of the autocorrelations in the period 1875-1899, the onset of the

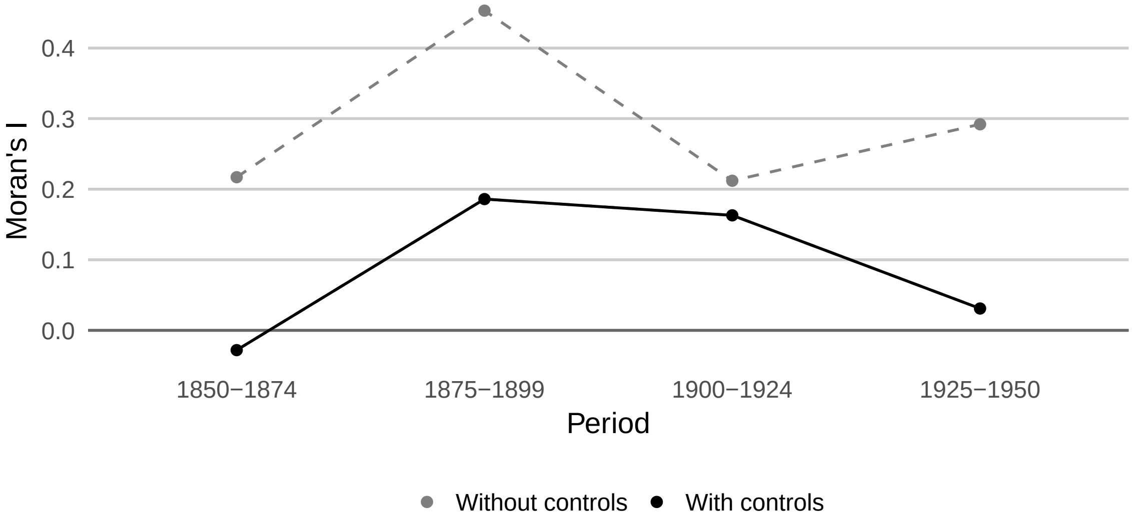

Figure 5: Morans'I of neighbourhood hazard ratios by period, with and without controls.

transition, was also related to structural similarities; however significant autocorrelations remained after controlling for confounding factors. For the period 1900-1924, the level of autocorrelation remains at approximately the same level, after controlling for confounders, as Moran's I is similar in size in both the adjusted and the unadjusted models, and the autocorrelations are statistically significant.

The results of this analysis suggest that fertility practices were shared between couples in adjacent neighbourhoods through social interactions at the onset of the fertility transition and during the transition, and not before or after. However, these differences could be caused by selection effects, by network homophily. It is possible that individuals who had already started to adopt low fertility behaviours were more likely to move near others where this behaviour was accepted and promoted (Palloni, 2001). Which in turn would lead to spatial autocorrelations which were independent of any social interaction effects. To account for this reverse causation, the next section presents an analysis that separates the timing of practices of couples to that of their neighbours – the time lag between events.

6 Between neighbour effects

6.1 Method

To test whether neighbours fertility practices had an effect on couples' risk of having a child, we first estimated changes in fertility of neighbours for each couple for every year in their reproductive life course and then estimated the effect of these changes on the couple's risk of having a child.

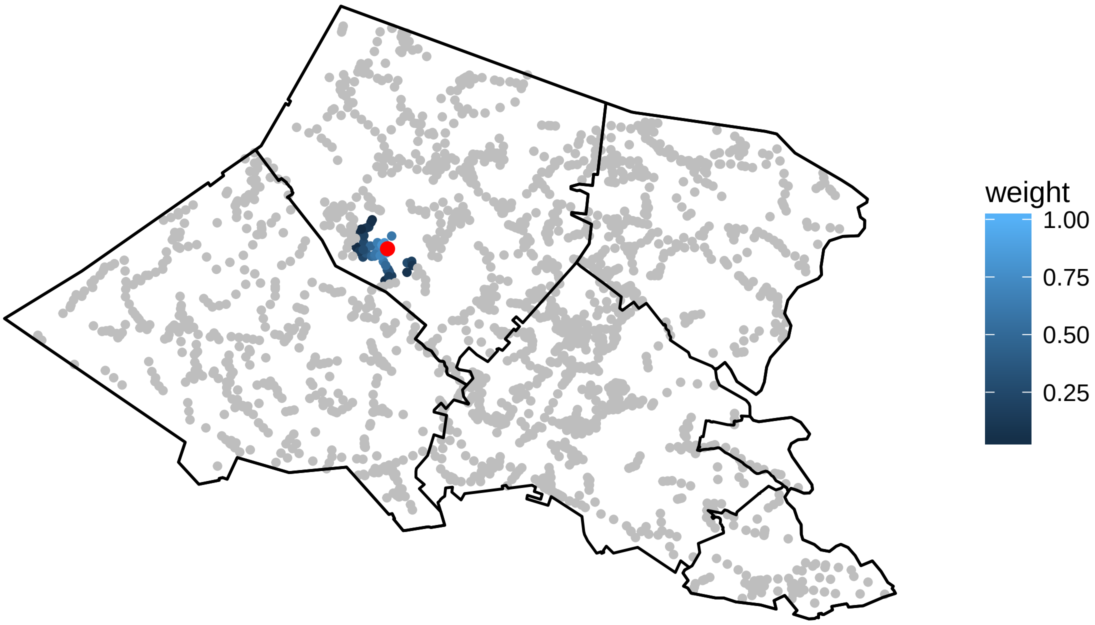

Figure 6: Example of location based weights for one individual and their neighbours in the Skellefteå region.

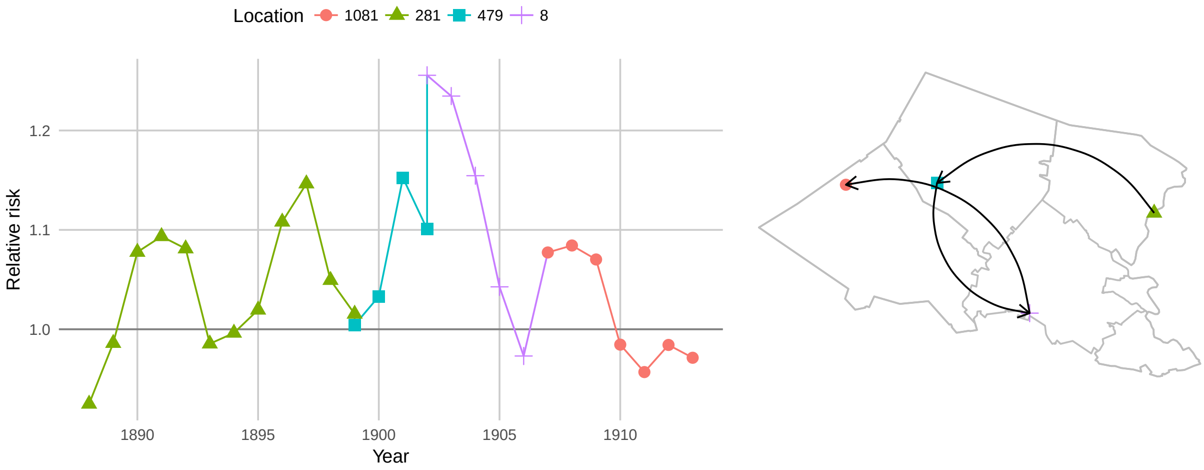

Figure 7: Example of long-term neighbour fertility change over the course of one couples reproductive life course.

Neighbours of a married couple consist of all other couples who live within five km. Changes in neighbour fertility are measured for each year in a couples' life course; this makes it possible to measure how fertility changes as new couples move into their neighbourhood and as the couple moved between locations in the region. As discussed in the research design section, to separate long-term and short-term changes in neighbour fertility, fertility change is measured over two time periods, over ten and five years.

Long-term and short-term changes in neighbour fertility of a couple at a given time point is measured by subsetting all other couples within five km, and estimating the average yearly change in the risk of having another child over the past five and ten years for these neighbours, using Cox proportional hazard regression. Similarly to previous models, the analysis is limited to higher order births, and the onset of risk of having another birth is set to the time of the previous birth. Additionally, the average strength of the relationship between couples and neighbours would depend on the distance between them; thus, the effect of each neighbour is weighted by their distance from the couple. The weight is presumed to be linear in relations to distance, for example, neighbours who lived in the same location has a weight of 1 and neighbours who lived two km from the couple has a weight of 0.8, see Figure 6.

How the risk of having a child changed over the time period is attained by calculating the predicted relative risk (RR) of having a child for a neighbour at the end of the period compared to the risk at the beginning of the period, 5 or 10 years ago. Long-term changes in neighbour fertility for a couple in 1880 is thus:

(2)

$$RR = \frac{\lambda_0 e^{X_{year}\beta}}{\lambda_0 e^{X_{year-10}\beta}}$$

The process is repeated for each year in the reproductive life course of a couple, creating a couple-level time series of changes in neighbour fertility. The long-term change in neighbour fertility for one individual is seen in Figure 7. As the individual moved between locations, their neighbour group changed and therefore, their neighbour fertility shifted. Even though changes in neighbour fertility has large variations, the overall trend is stable and show the fertility transition, and as seen in Figure 8, averages in both long-term and short-term changes in neighbour fertility continuously decline after 1915. Also, we can see the large variations in short-term neighbour fertility before the transition, most notably the reactions to the hunger crisis in the late 1860's.

The effect of changes in neighbour fertility on couples' risks of having a birth is estimated using mixed effects Cox proportional hazard regressions, similar to equation 1. Once again the outcome of interest is the average risk of having a birth across couples' reproductive life courses, and the analysis includes all birth intervals after the first birth. The model includes a random effect for each neighbourhood to control for unobserved heterogeneity for couples in the same neighbourhood, caused by ideational, social or

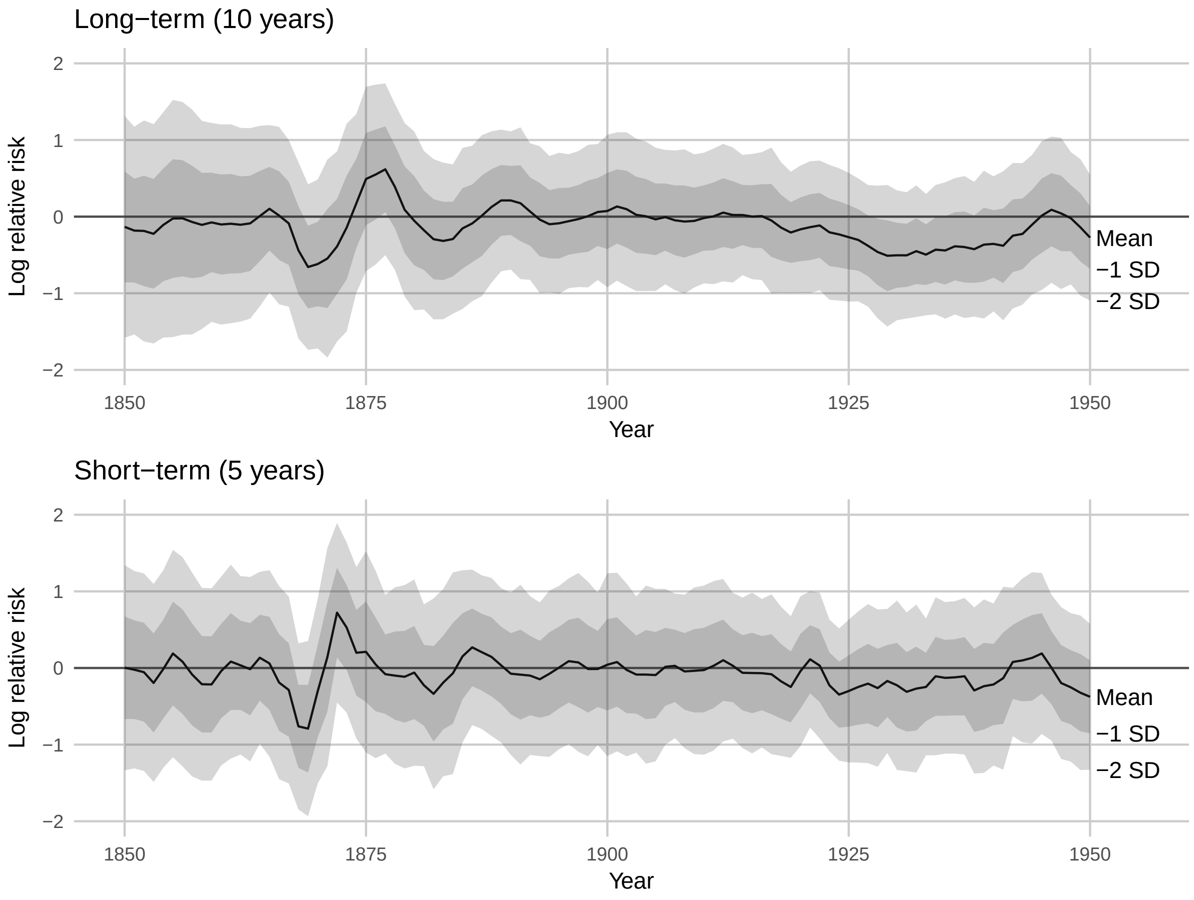

Figure 8: Distribution of 5-year and 10-year neighbour fertility change.

economic differences. Also, as the analysis is based on multiple births per couple, the risk of having a birth is stratified by parity (Prentice et al., 1981). To ascertain how the effect changed over time the sample is split into four time periods, 1850-1874, 1875.1899, 1900-1924 and 1925-1950, similarly to the previous analysis. To disentangle selection effects and contextual effects from diffusion effects the models control for a number of couple-level and neighbourhood level confounders. The models were constructed and evaluated using the statistical programming language R (R Core Team, 2014) and the package coxme: Mixed-effects Cox models (Therneau and Mayo Clinic, 2016; Therneau, 2012).

Although the analysis is made possible by separately estimating changes in neighbour fertility and the effect of these changes on couples' fertility, the research design underestimates the variation in neighbour fertility. Neighbour fertility change is only based on the predicted relative risk, which is an average change, the total variation in neighbours fertility is not included in the estimation of couples' responses to these changes. However, some of this variation is captured in aggregate across the whole population, as the accuracy of the estimation is in itself prone to variation. This becomes evident when looking at the distribution of changes in neighbour fertility, see Figure 8. The total variation is large enough that it always includes changes in neighbour fertility which were both positive (> 0)and negative (< 0), even though the trend is negative after 1915.

6.2 Results

As mentioned previously, neighbour fertility change is measured as the predicted relative risk of having a child for neighbours compared to 10 or 5 years earlier. To capture an average change in neighbour fertility, the measurement was standardised by dividing it by the negative standard deviation of the log of the total variance of neighbour fertility. This means that a one unit change in neighbour fertility is equal to a decrease in neighbour fertility as large as one standard deviation (SD), see Table 2. The SD of the log of neighbour relative risk (RR) is just above 0.5 which is equivalent to approximately 45 % lower risk of having a child. A change of one SD is also relatively common, 72.9 percent of couples experienced a long-term change in neighbour fertility of this size, and 79.3 percent a one SD change in short-term neighbour fertility change. However, as the relationship is assumed to be linear, any association to a change in neighbour fertility could be both positive and negative. Thus, a significant effect could indicate that couples postponed having another child when neighbour fertility declined by one unit or was more likely to have another child when fertility increased by one unit. However, during the fertility decline, we can assume that in most cases, any significant relationship between hazards of having another birth and neighbour fertility is negative.

Table 2: Descriptive statistics of neighbourhood fertility change measured as standard deviations (SD) of relative risks (RR), and the proportion of all couples who experienced a change of one SD.

Measurement	Period length	SD of log RR	SD in RR	Proportion of couples
Long-term	10	0.541	0.582-1.718	0.729
Short-term	5	0.569	0.566-1.766	0.793

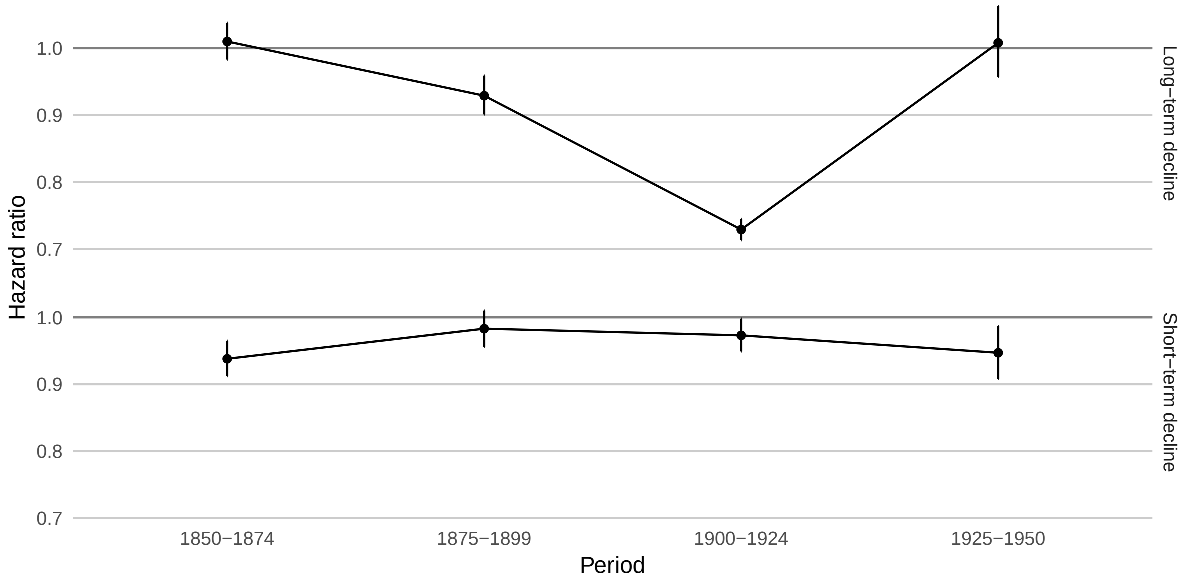

Figure 9: Unadjusted differences in hazard of having another birth when neighbours fertility declines by one standard deviation over the past 10 or 5 years. Hazard ratios and 95 % confidence intervals from Cox proportional hazard regressions, seen in Table 4 in Appendix.

Figure 9 shows the unadjusted effect of a one SD decline in neighbour fertility on the risk of having a birth for couples during the four different time periods. The effect is estimated using Cox proportional hazard regression and is stratified by parity; however, no other controls are used in these models. The unadjusted hazard ratios show a U-shaped pattern for long-term changes in neighbour fertility. There was no significant effect before 1875, then the effect is negative in the period 1875-1899, even stronger in 1900-1924, and disappears again in the period 1925-1950. The opposite pattern is shown for short-term changes in neighbour fertility. There was a significant negative effect before and after the transition and not during the transition (1875-1899 and 1900-1924); however, the size of these effects are much smaller. However, these patterns were also affected by underlying differences in confounders.

Figure 10 shows the adjusted hazard ratios of having another birth. These effects are estimated using mixed-effects Cox proportional hazard regressions while controlling

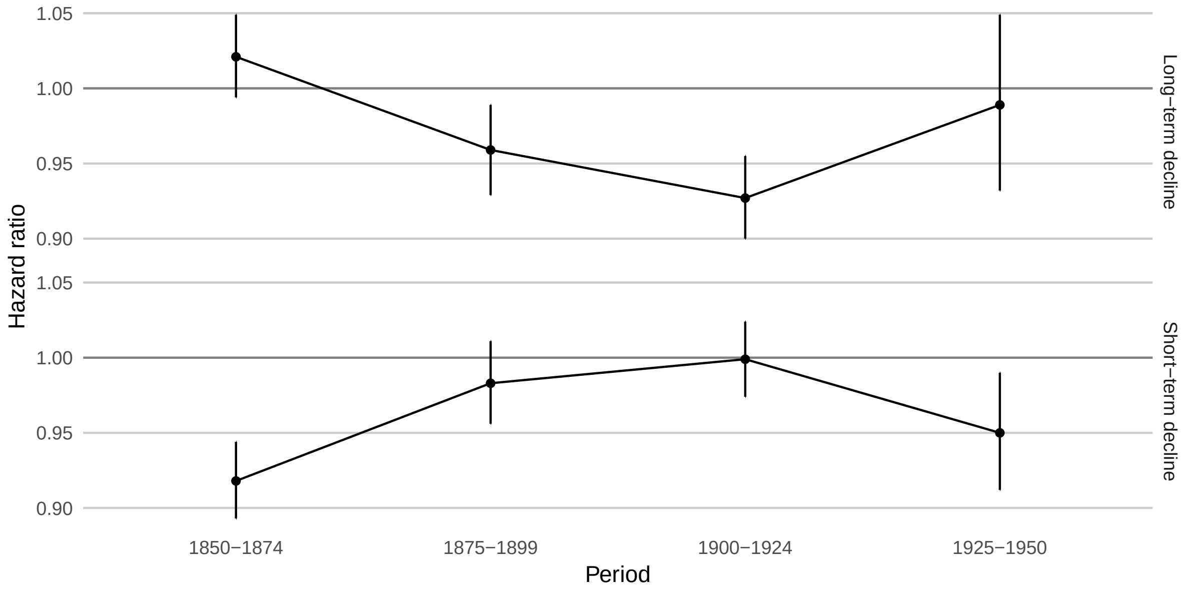

Figure 10: Adjusted differences in hazard of having another birth when neighbours fertility declines by one standard deviation over the past 10 or 5 years. Hazard ratios and 95 % confidence intervals from mixed-effects Cox proportional hazard regressions, seen in Table 5 in Appendix.

for both neighbourhood-level and couple-level characteristics, and for unobserved heterogeneity at a neighbourhood-level through the introduction of random-effect. As seen, some of the effects were caused by underlying factors, as the effects sizes of long-term neighbour fertility are smaller than in the unadjusted models. However, the pattern is similar, long-term changes in neighbour fertility affected couples' risks of having a child during the transition, and the effect grew over time, while short-term changes only affected fertility before and after the transition.

The majority of the difference in the estimates between the adjusted and the unadjusted models is caused by the control for calendar time. This can be seen by the models without calendar time in Table 6 and 5 in the Appendix. Additionally, the difference is largest for long-term changes in neighbour fertility in 1900-1924 during which the majority of the fertility decline occurred. These seem intuitive; it was during this time that fertility declined in most areas. Therefore, a majority of couples would have experienced declines in neighbour fertility. However, even when controlling for the overall decline in fertility through the control for calendar time, the effect of neighbour fertility remains in 1900-1924. The pattern of response to long-term neighbour fertility is also similar to that of the correlations between neighbourhoods. It is visible just at the onset of the transition and continuous during the decline and then disappeared again after the transition.

Interestingly we see the opposite pattern for short-term changes; the effect is only visible before and after the transition. This short-term effect could be an adaptation to short-term economic stress. Before the transition people responded to short-term economic stress, which was most distinct among landless families. These families foresaw coming economic hardship and were much more likely to postpone another birth, which has been seen by the lengthening of birth intervals in response to changes in prices of food (Bengtsson and Dribe, 2006; Kolk, 2011; Hammel and Galloway, 2000; Van Bavel, 2004). The result of this analysis indicate that the response to aggregate level economic stress was accompanied by a diffusion effect among neighbours. It suggests that the knowledge of coming economic hardships was spread through social interactions, not only by families adaptation to economic changes. However, the effect is also visible after the transition, which suggests that fertility responses to neighbours fertility over the short-term is not only a part of the pre-transitional demographic regime but a pattern distinct for stable demographic-regimes in general.

In addition, the hazard of another birth was not only associated with social interaction effect but also with structural differences. This is evident by the larger differences in hazard ratios between socioeconomic groups, shown in Table 5. Before the transition, it was the higher classes (Elite and middle class) who showed the highest fertility, during the transition the relationship was reversed. After 1900 the middle class had the lowest fertility followed by the skilled working class and the Elite. Findings which is in line with general patterns across world populations (Skirbekk, 2008). Additionally, couples in neighbourhoods with a low population density, a low proportion of migrant or with a population dominated by farmers had lower fertility than more densely populated and socially diverse neighbourhoods. This suggests that fertility decline was associated with socioeconomic development during the transition.

7 Conclusions

The results of this study suggest that patterns in spatial marital fertility can be explained by both social interaction effects as well as social and economic structural differences between locations. However, these effects varied across time and space. The results show that there were spatial autocorrelations at a neighbourhood-level in the Skellefteå region from 1850-1950. Before the transition (1850-1874) and after (1925-1950) these patterns were associated with social and economic structural differences. Just before and during the transition (1875-1924) the autocorrelations in fertility of adjacent neighbourhoods were independent of confounding factors. Similar patterns were found for the effect of long-term changes (over ten years) in neighbour fertility on couples' fertility behaviours. Between 1875 and 1924 couples' risks of having another child was associated with the past behaviours of their neighbours, and not before or after. The opposite pattern was found for the effect of short-term neighbour fertility change (over five years). Couple's fertility was associated with their neighbour's past behaviours only before 1875 and after 1924. This supports previous research which has found spatial correlations at a provincial or country level during the European fertility transition (Goldstein and Klüsener, 2014; Klüsener et al., 2016; Watkins, 1990). The findings of the current study suggest that spatial diffusion mechanisms were also in effect at a smaller geographical scale and that it was not limited to periods when fertility declined.

The three different forms of social interaction effects, between neighbourhoods, long-term neighbour effects and short-term neighbour effects, are in turn related to different social interaction mechanisms. Couples would be more likely to form strong social ties to other couples who live in their neighbourhood rather than couples who live in other neighbourhoods. Strong social ties are in turn associated with stronger social pressures to conform to communal norms. The results of this study suggest that the effect on a couples' reproductive practices grew stronger as more and more couples in their surrounding changed their behaviour. As more people adopted fertility limitation the social pressure to conform to these practices and norms increased, and individuals were, therefore, more inclined to adopt new behaviours to gain approval or to avoid sanctions from their neighbours (Bernardi and Klaerner, 2014). This would explain the increased effect of long-term neighbour fertility change. Additionally, as the effect is visible already before 1900, the results suggest that social pressure mechanisms were part of the diffusion of new fertility behaviours already at the onset of fertility transition, spreading birth control practices from vanguard groups to their neighbours.

Another explanation is the increased opportunities for social learning. This would mean that as a greater share of neighbours adopted new behaviours, the opportunities to observe these practices by others increased. By observing others and evaluating the perceived net benefits of the outcome, a couple would reject or adopt the behaviour (Casterline, 2001). Social learning could, through social interactions, spread the perceived benefits of low fertility incentivised by social and economic structural changes (Kohler, 2001; Montgomery and Casterline, 1993). Although industrialisation and urbanisation were relatively modest in the Skellefteå region, intra-regional migration and industrialisation did increase during the period 1875-1925 (Gaunitz et al., 2002). Increased mobility would lead to an increase of social connections with weak ties (Watkins, 1990). Granovetter (1983) argues that weak ties, in turn, creates potential bridges between social groups, and as the number of weak ties increases the diffusion of new ideas would become easier. According to Granovetter, over time new networks stabilise and create strong transitive ties, which are less suitable for social learning; instead, these networks enable stronger effects of social pressure and social support. This could explain the sudden increase in spatial correlations just before the transition, the diffusion of low fertility practices was enabled by many weak ties between neighbourhoods. As spatial mobility increased in the region the number of weak ties in people's social networks increased, this strengthens social learning and led to the diffusion of new fertility behaviours. Over time, people started to form more stable networks and fitting into a community became increasingly important. What was considered appropriate behaviour within one's community became more important when the ties to that community were stronger, and birth control practices became a mean to conform to community ideals. At the same time, the results indicate that social interactions also perpetuated existing behaviours, creating a resistance to fertility change in some neighbourhoods, which could explain why the difference between neighbourhoods peaks when fertility declined most rapidly.

This interpretation is also in line with Watkins and Danzi (1995) who argues for the importance of the strength of weak ties for the low fertility of Jewish women in the US in the early 19th century. Socially diverse networks are more inclined to adopt new practices than others. In a later study, Bongaarts and Watkins (1996) argues that the networks would become more and more homogenous, across the nation, through the creation of imagined communities via mass media. Thus, the effect of social interaction between neighbours would decrease over the course of the transition. The results of the current study do find that the autocorrelations related to social interaction effects between neighbourhoods disappear after the transition; however, at a couple-level, short-term social interaction effect is visible after the transition.

This suggests that the social interaction effects were not only related to the spread of new norms about family and fertility. Effects of short-term changes would be relatively immediate. They could function as channels of diffusion of information in response to short-term economic stress (Bengtsson and Dribe, 2006; Kolk, 2011), or as channels of social support where couples synchronize childbirth with their neighbours to gain access to social support that arises when neighbours have children at the same time, in line with results of studies on contemporary populations (Balbo and Barban, 2014; McDonald, 2000). Thus, the response to short-term changes would not be a reflection of the spread of new norms but rather an adaptation of individuals to others behaviours within stable demographic regimes.

Although this study has measured spatial diffusion effect at a much more detailed geographic scale than previous studies, at both a neighbourhood and a couple-level, the research design has some limitation. As the neighbour effects were estimated separately, the total variance in neighbour behaviours was underestimated, and the effect of this underestimation is uncertain. This is a limitation which could be overcome in future studies by incorporating neighbour effects as time-lagged spatial autocorrelation in a joint probability model. Developments in Bayesian spatial survival models could be extended to fit these forms of problems (Zhou and Hanson, 2017). Another issue is that individuals communities were not necessarily spatially dependent during the late 19th and early 20th century. The landscape of social relations was transformed during the period, and social relations were not solely dependent on proximity (Watkins, 1990). Although other forms of demographic behaviours such as marriage partner selection were often limited to spatial proximity in the Skellefteå region, the spatial patterns were not always spatially uniform (Brändström, 2002). Fertility has also been shown to be dependent on social interactions external to spatial communities. Becoming a member of a temperance association, a union or a free church affected peoples fertility behaviours during the transition (Junkka, 2018; Junkka and Edvinsson, 2016).

Despite these limitations, the current study has provided evidence in support for spatial diffusion of fertility behaviours through social interactions. This suggests that fertility decline was not solely dependent on structural changes but also affected by the diffusion of new norms about family and fertility. Or rather, the combination of these factors; structural ideational, economic, demographic and social changes shifted the incentives for having another child, while social interactions diffused these new ideas, creating spatial fertility patterns.

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Appendix

Table 3: Hazard of having another birth estimated using Cox proportional hazard models.

	1850-1874			1875-1899			1900-1924			1925-1950		
Variable	HR	SE	P-value	HR	SE	P-value	HR	SE	P-value	HR	SE	P-value
Parish												
Skellefteå (ref.)	1.000			1.000			1.000			1.000		
Byske	1.090	0.056	0.130	0.747	0.039	0.000	0.913	0.052	0.081	1.259	0.056	0.000
Norsjö	0.967	0.053	0.520	0.929	0.045	0.099	0.976	0.050	0.630	1.168	0.049	0.001
Jörn	1.063	0.058	0.290	0.941	0.051	0.230	0.992	0.062	0.900	1.244	0.058	0.000
Socioeconomic cluster												
One (ref.)	1.000			1.000			1.000			1.000		
Two	1.100	0.083	0.250	1.088	0.048	0.079	1.090	0.043	0.043	0.876	0.045	0.003
Three	1.083	0.026	0.002	0.972	0.023	0.220	1.072	0.021	0.001	1.235	0.051	0.000
Four	1.115	0.052	0.037	1.013	0.043	0.760	1.047	0.041	0.260	0.815	0.039	0.000
Log of population desnity	0.945	0.017	0.001	0.926	0.015	0.000	0.814	0.019	0.000	0.973	0.016	0.081
Log of proportion migrants	0.937	0.027	0.013	1.028	0.027	0.310	0.855	0.022	0.000	1.052	0.034	0.130
Wife's age squared	0.999	0.000	0.000	0.999	0.000	0.000	0.999	0.000	0.000	1.000	0.000	0.000
Wife a migrant	1.006	0.028	0.820	0.989	0.019	0.540	0.991	0.014	0.530	0.991	0.024	0.690
Husband a migrant	0.964	0.026	0.160	0.965	0.020	0.072	0.899	0.017	0.000	0.968	0.028	0.250
HISCLASS												
Farmer (ref.)	1.000			1.000			1.000			1.000		
Elite	1.143	0.096	0.160	0.926	0.070	0.280	0.864	0.046	0.001	0.991	0.066	0.900
Farm worker	0.939	0.035	0.071	0.916	0.036	0.014	0.951	0.044	0.250	0.830	0.049	0.000
Middle class	1.279	0.065	0.000	1.013	0.044	0.780	0.791	0.034	0.000	0.764	0.047	0.000
Skilled worker	1.029	0.041	0.490	0.975	0.032	0.430	0.811	0.026	0.000	0.796	0.035	0.000
Unskilled worker	0.870	0.023	0.000	0.932	0.019	0.000	0.968	0.015	0.034	0.986	0.030	0.630
Calendar time in years	1.010	0.001	0.000	1.021	0.001	0.000	0.992	0.001	0.000	1.019	0.002	0.000
Summary statistics												
N observations	26257.000			45870.000			76879.000			47579.000		
N events	12289.000			18500.000			27986.000			9617.000		
P-value	0.000			0.000			0.000			0.000		
N neighbourhoods	95.000			98.000			96.000			94.000		
SD of neighbourhood random-effect	1.116			1.097			1.244			1.094		

Table 4: Hazard of having another birth when neighbour fertility declines by one unit, without any controls. Estimated Hazard ratios (HR), standard errores (SE) and p-values from Cox proportional hazard regressions.

	1850-1974			1875-1899			1900-1924			1925-1950		
Variable	HR	SE	P-value	HR	SE	P-value	HR	SE	P-value	HR	SE	P-value
10 year neighbour fertility change	1.010	0.014	0.465	0.929	0.016	0.000	0.729	0.011	0.000	1.008	0.027	0.752
5 year neighbour fertility change	0.938	0.014	0.000	0.983	0.014	0.214	0.973	0.013	0.034	0.947	0.021	0.010
N observations	48037.000			86980.000			212857.000			144454.000		
N event	12548.000			19101.000			28961.000			8633.000		
P-value	0.000			0.000			0.000			0.037		

Table 5: Hazard of having another birth when neighbour fertility declines by one unit. Estimated Hazard ratios (HR), standard errores (SE) and p-values from Mixed effects Cox proportional hazard regressions.

	1850-1974			1875-1899			1900-1924			1925-1950		
Variable	HR	SE	P-value	HR	SE	P-value	HR	SE	P-value	HR	SE	P-value
10 year neighbour fertility change	1.021	0.014	0.130	0.959	0.016	0.009	0.927	0.015	0.000	0.989	0.030	0.700
5 year neighbour fertility change	0.918	0.014	0.000	0.983	0.014	0.220	0.999	0.013	0.920	0.950	0.021	0.014
Calendar time in years	0.998	0.001	0.200	1.005	0.001	0.000	0.981	0.001	0.000	0.985	0.003	0.000
Age of wife squared	0.999	0.000	0.000	0.999	0.000	0.000	0.999	0.000	0.000	0.999	0.000	0.000
Wife is a migrant	1.029	0.027	0.300	1.013	0.018	0.490	1.026	0.014	0.077	0.968	0.026	0.210
Husband is a migrant	0.961	0.026	0.130	0.950	0.019	0.008	0.914	0.017	0.000	0.982	0.031	0.560
HISCLASS												
Farmers (ref.)	1.000			1.000			1.000			1.000		
Elite	1.089	0.092	0.360	0.894	0.068	0.100	0.921	0.045	0.069	1.082	0.069	0.260
Farm workers	0.933	0.035	0.047	0.928	0.036	0.036	0.955	0.043	0.280	0.873	0.056	0.014
Middle class	1.143	0.063	0.034	1.000	0.044	1.000	0.803	0.034	0.000	0.821	0.051	0.000
Skilled workers	1.026	0.040	0.530	0.952	0.032	0.130	0.807	0.026	0.000	0.799	0.037	0.000
Unskilled workers	0.878	0.023	0.000	0.937	0.018	0.000	0.932	0.015	0.000	0.834	0.031	0.000
Neighbourhood Socioeconomic structure												
SES cluster 1 (ref.)	1.000			1.000			1.000			1.000		
SES cluster 2	1.088	0.075	0.260	1.119	0.046	0.014	0.981	0.035	0.590	0.879	0.043	0.003
SES cluster 3	1.060	0.026	0.027	0.976	0.022	0.270	1.063	0.019	0.001	1.165	0.052	0.003
SES cluster 4	1.153	0.052	0.006	1.003	0.040	0.930	1.010	0.037	0.780	0.872	0.041	0.001
Log of population density	0.965	0.016	0.030	0.996	0.015	0.790	0.975	0.013	0.063	0.990	0.017	0.530
Proportion migrants	0.628	0.183	0.011	0.670	0.190	0.035	0.494	0.137	0.000	0.537	0.248	0.012
Parish												
Skellefteå lands (ref.)	1.000			1.000			1.000			1.000		
Skellefteå stad							0.842	0.051	0.001	1.022	0.073	0.760
Byske	1.201	0.058	0.002	0.836	0.039	0.000	0.895	0.035	0.001	1.002	0.051	0.960
Bureå							1.166	0.050	0.002	1.232	0.089	0.019
Norsjö	0.995	0.052	0.920	1.100	0.042	0.023	0.985	0.036	0.690	1.082	0.048	0.100
Jörn	1.075	0.059	0.220	1.118	0.049	0.022	1.085	0.043	0.055	1.124	0.056	0.037
Summary statistics												
N observations	48037.000			86980.000			212857.000			144454.000		
N events	12548.000			19101.000			28961.000			8633.000		
P-value	0.000			0.000			0.000			0.000		
N neighbourhoods	95.000			98.000			96.000			94.000		
SD of neighbourhood random-effect	0.104			0.083			0.104			0.064		

Table 6: Hazard of having another birth when neighbour fertility declines by one unit, without control for calendar time. Estimated Hazard ratios (HR), standard errores (SE) and p-values from Mixed effects Cox proportional hazard regressions.

	1850-1974			1875-1899			1900-1924			1925-1950		
Variable	HR	SE	P-value	HR	SE	P-value	HR	SE	P-value	HR	SE	P-value
10 year neighbour fertility change	1.020	0.014	0.150	0.962	0.016	0.015	0.811	0.013	0.000	1.052	0.028	0.066
5 year neighbour fertility change	0.919	0.014	0.000	0.980	0.014	0.140	0.985	0.013	0.250	0.944	0.021	0.005
Age of wife squared	0.999	0.000	0.000	0.999	0.000	0.000	0.999	0.000	0.000	0.999	0.000	0.000
Wife is a migrant	1.030	0.027	0.270	1.014	0.018	0.440	1.015	0.015	0.320	0.968	0.026	0.200
Husband is a migrant	0.963	0.026	0.140	0.947	0.019	0.005	0.918	0.017	0.000	0.985	0.031	0.620
HISCLASS												
Farmers (ref.)	1.000			1.000			1.000			1.000		
sesElite	1.091	0.092	0.340	0.893	0.068	0.098	0.919	0.045	0.064	1.076	0.069	0.290
sesFarm workers	0.933	0.035	0.046	0.928	0.036	0.035	0.938	0.044	0.140	0.845	0.055	0.002
sesMiddle class	1.142	0.063	0.035	1.003	0.044	0.950	0.801	0.034	0.000	0.814	0.051	0.000
sesSkilled workers	1.026	0.040	0.530	0.952	0.032	0.120	0.793	0.026	0.000	0.790	0.037	0.000
sesUnskilled workers	0.878	0.023	0.000	0.939	0.018	0.001	0.929	0.015	0.000	0.841	0.031	0.000
Neighbourhood Socioeconomic structure												
SES cluster 1 (ref.)	1.000			1.000			1.000			1.000		
SES cluster 2	1.090	0.075	0.250	1.126	0.046	0.011	0.936	0.044	0.130	0.880	0.044	0.004
SES cluster 3	1.060	0.026	0.027	0.982	0.022	0.410	1.093	0.021	0.000	1.190	0.053	0.001
SES cluster 4	1.150	0.052	0.007	0.995	0.041	0.900	0.910	0.041	0.022	0.840	0.041	0.000
Log of population density	0.963	0.016	0.020	1.014	0.015	0.340	0.747	0.023	0.000	0.992	0.017	0.640
Log of migration rate	0.630	0.183	0.012	0.545	0.187	0.001	0.420	0.149	0.000	0.570	0.254	0.027
Parish												
Skellefteå lands (ref.)	1.000			1.000			1.000			1.000		
Skellefteå stads							0.867	0.052	0.006	0.997	0.074	0.970
Byske	1.174	0.055	0.004	0.865	0.039	0.000	0.927	0.066	0.250	1.037	0.052	0.490
Bureå							1.009	0.053	0.860	1.211	0.092	0.036
Norsjö	0.988	0.052	0.810	1.154	0.041	0.001	0.991	0.059	0.880	1.109	0.049	0.035
Jörn	1.065	0.059	0.290	1.186	0.048	0.000	1.001	0.075	0.990	1.149	0.057	0.016
Summary statistics												
N observations	48037.000			86980.000			212857.000			144454.000		
N events	12548.000			19101.000			28961.000			8633.000		
P-value	0.000			0.000			0.000			0.000		
N neighbourhoods	95.000			98.000			96.000			94.000		
SD of neighbourhood random-effect	0.105			0.088			0.343			0.071		

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