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Unlocking the Complex Patterns of Fertility and Family Formation in Western Europe. An Exploration through Spatial Analysis

by

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Abstract

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The thesis explores changes in demographic behaviours altering family life in Europe across two demographic transitions between 1851 and 2011 through a spatial perspective. In doing so, the thesis combines geographical data sources and indicators which have previously not been studied and thereby offers new insights into spatial demographic patterns.

The first empirical analysis examines the spatial distribution of changing marital fertility during the initial phases of the fertility transition in England and Wales from 1851 to 1911 using maps and spatial lag models. The results of spatial lag models suggest that districts with a high prevalence of *New Dissenters* witnessed an earlier and faster decline in fertility than other districts between 1851 and 1881. Analysing the change in fertility over time helped identify Cornwall and Wales as leading regions in fertility change prior to 1881. After that time, middle-class population and urbanisation are most important in explaining fertility change.

The second empirical analysis identifies associations between the historical fertility decline in the 19th century and subsequent increase in non-marital births in the 20th century through maps and geographically weighted correlation. The study highlights areas with early demographic changes during both transitions. Spatial continuities were detected in the majority of Local Authority Districts, suggesting adoptive behaviour. Spatial patterns of labour force participation patterns among mothers may have triggered early adoption of these new behaviours.

The third empirical chapter explores how non-marital fertility has increased in Germany between 1994 and 2014 and how it is linked to voting behaviour using geographically weighted correlation. The results suggest that associations of non-marital childbearing and its correlates are heterogeneous across space. Non-marital childbearing in Germany can be linked to liberal values, represented by *Left* party voting behaviour especially in the 1990s. Male unemployment started to gain explanatory power by 2004, reflecting the economic instability during the mid-2000s and the subsequent rise in non-marital childbearing. The importance of these indicators tends to converge over time.

Overall, the thesis highlights the importance of a long-term perspective to understand recent demographic behaviour and suggest that spatial diffusion mechanisms are crucial in changing families in Europe over more than 150 years.

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Research Thesis: Declaration of Authorship

Print name: Stephanie Thiehoff

Title of thesis: Unlocking the Complex Patterns of Fertility and Family Formation in Western Europe. An Exploration through Spatial Analysis

I declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. None of this work has been published before submission.

Signature: ....

Date: 10/09/2024

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Definitions and Abbreviations

AIC .... Akaike Information Criterion

ASFR............................. Age-specific Fertility Rate

AWI.............................. Areal weighted interpolation

BKG .... Bundesamt für Kartographie und Geodäsie

bw .... Bandwidth

CDU/CSU .... Christlich Demokratische Union/Christlich Soziale Union

CGG .... Chair for Geodesy and Geoinformatics, University of Rostock

CV .... Cross-validation

FDP .... Freie Demokratische Partei

FDT.............................. First Demographic Transition

GIS .... Geographical Information System

GBHGIS .... Great Britain Historical GIS

LAD .... Local Authority District

LGD .... Local Government District

MAUP .... Modifiable Area Unit Problem

MPIDR .... Max Planck Institute for Demographic Research

NMR .... Non-Marital (Birth) Ratio

ONS.............................. Office for National Statistics

PDS .... Partei des Demokratischen Sozialismus

RD .... Registration District

RSD .... Registration Sub-District

SDT.............................. Second Demographic Transition

SED .... Sozialistische Einheitspartei Deutschlands

SPD .... Sozialdemokratische Partei Deutschlands

TFR .... Total Fertility Rate

TMFR .... Total Marital Fertility Rate

Chapter 1 Introduction

In the previous 170 years, Europe has witnessed a range of major demographic changes substantially altering families and family life (Coale and Watkins, 1986; Lee, 2003; Lesthaeghe, 2010b). The majority of European countries seem to have followed similar trajectories in fertility decline in the long run, even though onset and tempo differed across the continent and even within countries (Lesthaeghe, 1977; Coale and Watkins, 1986; Sobotka, 2008; Billari and Liefbroer, 2010). After centuries of high fertility levels, total fertility started to decrease with different onsets between 1850 and 1950 across most of the continent. Eventually, fertility levels reached only two children per couple in most places. Almost seamlessly, other important changes to family lives and family life course trajectories emerged, including a diversification of union formation and dissolution together with changes in childbearing behaviour (Van Winkle, 2020). Whereas the start of a relationship until the 1960s in Europe was characterised with marrying, pre-marital cohabitation became common among younger couples. Similarly, elderly couples who were widowed or possibly left a previous partnership often cohabit nowadays (Hiekel and Castro-Martín, 2014; Perelli-Harris *et al.*, 2014; Sassler and Lichter, 2020). As one of these developments, non-marital childbearing which can mostly be attributed to childbearing within cohabitation increased substantially in the recent decades in Europe and in other places in the world (Perelli-Harris *et al.*, 2010; Klüsener, Perelli-Harris and Sánchez Gassen, 2013; Klüsener, 2015; Vitali, Aassve and Lappegård, 2015; Lesthaeghe and Esteve, 2016; Kuang, Perelli-Harris and Padmadas, 2019; Lesthaeghe, 2020).

There is a long tradition of studying reasons for fertility decline (Coale, 1973; Coale and Watkins, 1986; Haines, 1989; Mason, 1992; Casterline, 2001a). In the context of England and Wales, the *Cambridge Group for the History of Population and Social Structure*'s reconstruction of England's population history has contributed important knowledge to the understanding of historical demographic processes in general but especially fertility (Wrigley and Schofield, 1989; Garrett *et al.*, 2001). Similarly, demographers in the UK and other western contexts have tried to explain non-martial childbearing and its geographical variation for decades (Knodel, 1967; Shorter, Knodel and Van De Walle, 1971; Laslett and Oosterveen, 1973; Adair, 1996). But what are the social dynamics that contribute to changes in fertility and family formation behaviour besides socio-economic determinants? The 'diffusionist' theory of fertility suggests that the diffusion of new ideas is an important, possibly independent component of structural and cultural conditions for the adoption of new fertility behaviour and attitudes such as low fertility and non-marital childbearing (Coale and Watkins, 1986; Cleland and Wilson, 1987; Mason, 1992; Casterline, 2001a; Cleland, 2001). The prominent theory of the *Diffusion of Innovation* by Rogers explains how innovations diffuse through communication channels over time within social systems (Rogers, 1995). The idea that a 'new' fertility behaviour, just like other innovations, might diffuse spatially over time was first articulated by Carlsson in the 1960s (Carlsson, 1966). The diffusionist perspective is now widely accepted in demographic studies of fertility and family formation behaviour (see e.g. Montgomery and Casterline, 1993; Casterline, 2001b; Vitali, Aassve and Lappegård, 2015; Klüsener, Scalone and Dribe, 2017; Vitali and Billari, 2017).

Ideally, diffusion mechanisms can be studied using individual level data containing information about social networks. Empirical evidence suggests that social networks such as siblings, parents, friends but also colleagues are the driver of diffusion through various forms of social interaction (Bernardi, Keim and von der Lippe, 2007; Keim, Klärner and Bernardi, 2009; Balbo and Mills, 2011; Balbo and Barban, 2014; Bras, 2014; Buyukkececi and Leopold, 2020; Buyukkececi *et al.*, 2020). From a theoretical perspective, diffusion processes on the individual level are influenced through different social dynamics or effects such as social learning, social influence but also social contagion and social pressure (Casterline, 2001a; Bernardi and Klärner, 2014). However, a lack of suitable data sources often does not allow to investigate these social dynamics in detail or at all. The understanding of underlying mechanisms of how a new fertility behaviour spreads among a population through individual networks is therefore still limited.

On the aggregate level, diffusion mechanisms can be traced across space (Montgomery and Casterline, 1993, 1996; Klüsener, Perelli-Harris and Sánchez Gassen, 2013; Vitali, Aassve and Lappegård, 2015, 2015; Caltabiano *et al.*, 2019; Doignon, Eggerickx and Rizzi, 2020). Therefore, the sub-national level is equally important for understanding changes in fertility and family formation behaviour both in historical and contemporary societies (Basten, Huinink and Klüsener, 2011; Klüsener, Perelli-Harris and Sánchez Gassen, 2013; Costa, 2015; Klärner, 2015; Vitali, Aassve and Lappegård, 2015; Lappegård, Klüsener and

Vignoli, 2018; Caltabiano *et al.*, 2019; Klüsener, Dribe and Scalone, 2019; Campisi *et al.*, 2020a). Additionally, other research discoveries analysing small scale geographical data using geographically weighted regression revealed that associations of fertility and family formation behaviour with its determinants are not necessarily homogeneous across space (Işik and Pinarcioğlu, 2007; Vitali and Billari, 2017; Evans and Gray, 2018; Haque, Das and Patel, 2019). When comparing multiple cross-sections, changes in the sign of associations in some areas might even suggest how a new behaviour diffuses through space by observing how a reversal in associations started in some areas before it seems to spread towards neighbouring areas (Vitali and Billari, 2017).

This thesis aims to explore the spatial and spatiotemporal dimensions of family life together with its changes over time and seeks to understand its correlates and possible changes in associations during the First and Second Demographic Transition. Even though a spatial approach does not allow conclusions to be drawn about individual level social dynamics, the existence of spatial diffusion mechanisms or even clustering of similar demographic behaviour within space suggest that social dynamics might play a role in changing demographic behaviour. The immediate geographical space within which individuals interact is likely to contain parts of one's social network such as friends, colleagues, or family members. In addition, the geographical space consists of local institutions such as religious communities, voluntary organisations and political parties all of which possibly shape local norms, attitudes or social identity (Klüsener, Szoltysek and Goldstein, 2012; Junkka and Edvinsson, 2016; Junkka, 2018).

Even though the importance of norms in increasingly individualised societies has been questioned, research showed that norms are still of high importance in most individualised contexts (Liefbroer and Billari, 2010). Another critique might be that over the course of the last two centuries, a more globalised world and new possibilities to communicate also shape demographic behaviour. Historical research on the fertility decline in England and Wales already suggests how the distribution of certain topics through newspapers have led to a decrease in fertility in areas with larger coverage (Beach and Hanlon, 2020). Billari et al. (2019) showed for the case of Germany that highly educated women in the presence of a broad band connection have higher fertility. However, even though nowadays individuals can easily communicate with other people around the globe, empirical studies on networks of human interactions provide evidence that most of the communication still takes place on a local scale measured through phone calls in Great Britain (Ratti *et al.*, 2010). Such insights support the idea that small-scale geographical data are a valuable source to understand contemporary spatial patterns of demographic behaviour in the light of social dynamics and interactions. Accordingly, I assume that cultural indicators are crucial in explaining changes in demographic behaviour across space.

The field of Demography has since its origins had a spatial component: Demographic patterns were compared across different geographic units as in the Princeton European Fertility Project conducted in the 1960s and 1970s (Coale and Watkins, 1986; Voss, 2007). Such an approach already showed the importance of a geographical approach. During the time when such studies were conducted, however, appropriate statistical modelling techniques to identify spatial mechanisms were only being developed. In addition, computing power did not allow to run such complicated models. With the cultural turn, the large parts of demographic enquiry shifted its focus to the individual (Voss, 2007; Goodchild and Janelle, 2010; Ruggles, 2021). In the recent two decades, however, demography witnessed a revival of a spatial perspective (Lesthaeghe and Neels, 2002; Voss, 2007; Gutmann *et al.*, 2011; Klüsener, Szoltysek and Goldstein, 2012; Bell, 2015; Howell, Porter and Matthews, 2016; Raymer, Willekens and Rogers, 2019). Driven by accessibility of new and enhanced geographical data sources, advances in spatial statistical methods and computing power, new enquiries into the sub-national are now possible. Such new and unique insights in demographic processes from both old and new data sources enables researchers to inform supportive policy implementation, enhance demographic knowledge and existing theories (Voss, 2007; Goodchild and Janelle, 2010; Sweeney, 2011; Howell, Porter and Matthews, 2016). A variety of academic journals which emerged since the middle of the 1990s highlight how a spatial perspective in demographic and other social science research increasingly attracted more interest in previous decades: *Population, Space and Place* was first published in 1995, *Applied Spatial Analysis and Policy* in 2008 or *Spatial Demography* in 2013.

In many contexts such as England and Wales, analyses using spatial modelling techniques to explain long-term demographic developments have been absent from the current literature for both historical and contemporary time periods. In other context, for instance Germany, obvious demographic differences between East and West Germany in family formation have been studied more intensively. However, it seems surprising that previous research has not considered that apparent complexities do not follow one explanation but heterogenous associations might contribute to varying spatial patterns. Therefore, another aim of the study is to investigate different ways in which taking a spatial perspective and analysing geographical data through various spatial modelling techniques might yield additional knowledge about demographic processes and mechanisms compared to common statistical methods.

1.1 Objectives and Research Question

The thesis examines changes in fertility and family formation behaviour at the sub-national level in different temporal and geographical contexts. The three empirical chapters present case studies for the two contexts England and Wales and Germany. Both contexts are extremely interesting cases in Europe in terms of spatial patterns, as they both seem to represent different extremes of spatial variation in the European context. On the one hand, it has been suggested that England and Wales show little variation in geographical patterns of demographic behaviour. This assumption has been challenged in recent years, giving rise to the Populations Past project (Garrett and Reid, 2018). On the other hand, it has been shown that Germany has extreme geographical differences in all kinds of social, economic and cultural factors (Klüsener and Goldstein, 2016; Becker, Mergele and Woessmann, 2020). Understanding how space and spatial mechanisms shape demographic processes in these two contexts will enhance the general understanding of such connections in the European context.

The analysis uses small-scale geographical data to understand processes of change over time and space. Therefore, it seeks to unravel how cultural and socioeconomic factors are associated with sub-national changes in demographic behaviour ultimately transforming families across Europe in the last two centuries.

The objective of this thesis is to explore the significance of various elements of space in demographic studies, particularly those concerning family demographics. It underscores the importance of considering spatial dependence from adjacent regions as they typically exhibit similar trends in both stability and shifts in fertility and family formation patterns. Accordingly, I assume that demographic behaviour around fertility and family formation in one area is dependent on the same behaviour in nearby areas. Additionally, the analysis acknowledges that associations of family formation behaviour and its determinants might differ across space and associations of demographic behaviour and its correlates may be heterogeneous across space.

The first analytical chapter seeks to apply a spatial perspective to understand how norms led to a decline in fertility in England and Wales during the First Demographic Transition. Thereby, I examine the role of religion, specifically that of the so-called *New Dissent* religions in England and Wales between 1851 and 1911. To undertake this research, previously incomparable data of different census years and data sources were harmonised to explore the role of religion for the English and Welsh fertility decline. I analyse this harmonised small-scale geographical data on the Registration District and Registration Sub-District level provided through a novel data set created by the Population Past project (Day, 2016; Reid *et al.*, 2018, 2020) in combination with the 1851 Census of Religious Worship (Ell & Southall, 2020). Geographical differences in fertility levels were already observed by contemporaries (Szreter, 1996).

Previous research has mainly focussed to explain fertility variations by socioeconomic and social class differences within England and Wales. However, this line of research still struggles to explain varying spatial patterns of fertility. Therefore, it seems necessary for historical fertility research in this context to move beyond the overriding focus on socio-economic and social class explanations which seem to have reached an impasse. Well known determinants of the fertility decline from other context such as religion or education need to be considered as explanations as well (Szreter, 2011). Additionally, this chapter adds to the existing literature about the fertility decline in England and Wales because it takes a long-term perspective. It does not only compare fertility levels at different points in time (cross-sections) during the fertility transition as done by previous research (Garrett *et al.*, 2001; Jaadla *et al.*, 2020). This analysis considers the small-scale change in fertility from pre-transitional periods throughout the fertility decline by creating comparable geographical units to measure percentage change in fertility over time. I thereby acknowledge the existence of geographical differences in fertility levels before the onset of the fertility decline. The chapter asks the following questions: Where are the forerunner areas of the fertility transition in England and Wales? How is the rise of *New Dissent* religions associated with changing fertility patterns between 1851 and 1911? To analyse these questions, descriptive maps of the change in fertility are created over the course of the fertility transition to identify forerunner areas. In addition, I estimate spatial lag models for two distinct time periods: forerunner years (1851-1881) where only a few areas of England Wales witnessed a decline in fertility and main decline years (1881-1911) where most areas experience a rapid fertility decline.

In the second empirical chapter, I investigate spatial continuities in forerunner areas of innovative demographic behaviour right before the historical fertility decline in 1851 in England and Wales compared to the increase in non-marital childbearing a century later. In a further step, the study seeks to link spatial patterns of non-marital childbearing in the mid-20th century to recent patterns. Research already recognises the importance of historical spatial patterns of demographic behaviour for understanding both current as well as future trends in demographic behaviour (Vitali, Aassve and Lappegård, 2015; Klüsener and Goldstein, 2016; Vitali and Billari, 2017; Doignon, Eggerickx and Rizzi, 2020; Doignon, Ambrosetti and Miccoli, 2021). In addition, studies found that some areas seem to be more receptive to innovative demographic behaviour (Lesthaeghe and Neels, 2002; Lesthaeghe and Lopez-Gay, 2013). To analyse the research question, I create comparable data over more than 150 years; all data has been interpolated through areal weighted interpolation to match 2011 Local Authority Districts of England and Wales. Due to a lack in availability of data for meaningful explanatory factors in the mid-20th century, I conduct a semi-systematic literature review to compare theories explaining low fertility during the Fertility Transition before linking these to theories explaining the increase in non-marital fertility. Afterwards, I explain possible mechanisms that link low historical fertility to non-marital childbearing through the prevalence of labour force participation among mothers – an explanatory factor coming up as a likely link from the literature review. Through the detailed study of geographical patterns of historical fertility levels as well as the share of non-marital births after 1951 alongside Spearman's rank order correlation, continuities in forerunner areas as well as subsequent persistence in childbearing outside marriage are determined. Through estimating geographically weighted Spearman's rank order correlation, I determine possible heterogeneous patterns of strength of (dis)continuities.

The third empirical chapter seeks to understand spatially heterogeneous associations of non-marital childbearing and how this form of family formation behaviour might relate to liberal norms. Thereby, I analyse district level data of non-marital births in the context of Germany and link it to left-wing voting behaviour. Germany was divided into two countries after World War II, the Federal Republic of Germany with a social market economy and the socialist German Democratic Republic. In contrast to previous research, this chapter acknowledges that regional disparities in family formation behaviour cannot only be explained by differences in local characteristics but might be related to heterogeneous associations across space. Reunified in 1990, this context seems an ideal setting to investigate how associations of non-marital fertility with values and norms measured through voting for left-wing parties might vary in different areas. Support for left-wing parties are chosen as these seem to be most supportive of diverse family formation patterns (Valkonen *et al.*, 2008; Janotta, 2012). Therefore, non-marital fertility might be especially high in areas with high support for such parties. In this chapter, I elaborate a detailed conceptual framework to capture how liberal values measured through left-wing voting for the two main left-wing parties *The Left* (Die Linke) and *Greens* (Bündnis 90/Die Grünen) relate to non-marital childbearing. This chapter seeks to answer the following research questions: Do associations between non-marital childbearing and related factors vary across space and over time in Germany? How important are liberal values measured through voting in explaining sub-national levels in non-marital fertility? To answer these research questions, I use geographically weighted regression to identify heterogeneous associations of non-marital births in 1994, 2004 and 2014 with voting for the *Left* and *Greens* together with other socio-economic factors such as male unemployment and female labour force participation. Using these results, I then determine the variable with the highest explanatory power for each cross-section and districts.

1.2 Contribution

The thesis is a further illustration for the importance of a spatial or spatiotemporal perspective to gain a deeper understanding of demographic processes and change around family and historical demography. In particular, it thereby especially builds on previous findings of Klüsener (Klüsener, Szoltysek and Goldstein, 2012; Klüsener, 2015; Klüsener and Goldstein, 2016; Lappegård, Klüsener and Vignoli, 2018; Klüsener, Dribe and Scalone, 2019) and his pioneering work in spatial demography. Taking a spatiotemporal perspective of English and Welsh family demography for more than 150 years, the thesis provides new insights into spatial (dis)continuities of demographic behaviour affecting the size, composition as well as the definition of families in Western Europe through case studies for England and Wales as well as Germany. Therefore, the study makes an important contribution to the growing area of social science and demographic research on historical persistence by analysing the emergence of 'new' demographic behaviour across two waves of demographic innovations. It does so by building on various research findings from the *Cambridge Group for the History of Population and Social Structure* (Garrett and Reid, 1994, 2018; Szreter and Garrett, 2000; Garrett *et al.*, 2001; Garrett, Reid and Szreter, 2010; Schürer *et al.*, 2018; Jaadla *et al.*, 2020) by extending their research and looking at yet unanswered questions such as the role of religion. Exploring if and how long-term demographic developments in the past altered recent demographic behaviour does not only enhance our understanding of recent demographic patterns but might similarly inform forecasting of demographic processes and patterns in the future.

From a theoretical standpoint, the thesis elaborates how cultural factors in demographic analysis are an interplay of norms and values enforced through social identity and institutions such as certain parties or religion. On the local level a predominant set of norms and values can be especially influential in either promoting or discouraging new forms of fertility and family formation behaviour. Thereby, it is an important part of the local discourse and possibly influences social interactions in the form of social influence, pressure, or contagion. Results of the analysis highlight the continuity in importance of cultural factors for changes in fertility and family formation behaviour both in England and Wales as well as Germany. Especially during forerunner years of such demographic changes, certain norms seemed to accelerate these shifts in regions where they proved particularly strong. Whereas religion in relation with fertility studies has usually been operationalised to explain high fertility, the thesis sheds new light of other dimensions religion. Religious norms are not only associated with high fertility but may as well be associated with low fertility as in the case of the *New Dissent* in England and Wales.

Therefore, the thesis demonstrates how important it is to consider norms and values particularly in the context of spatial demography. However, it highlights as well that research needs to be cautious when interpreting variables used as a measure of certain values as these might have different meanings in different areas as suggested by the analysis of non-marital childbearing and left-wing voting in Germany.

To pursue long-term perspective of demographic change, this thesis produced a new data set to analyse both the fertility decline as well as increase in non-marital fertility in England and Wales. I used areal weighted interpolation to create new harmonised data sets which create comparable data over multiple decades for both the First as well as Second Demographic Transition in this context. Due to various changes of administrative boundaries similar inquiries were impossible as to this point in time.

From a methodological perspective, the thesis highlights how especially small-scale geographical data and simple visualisations such as maps allow to identify forerunner areas of new demographic behaviour and provide more detailed insights into spatial diffusion mechanisms than previously shown with larger geographical units. Additionally, spatial statistical models should be the models of choice for demographers when analysing geographical data. Both fertility and family formation behaviour are highly clustered within space and spatial models deal better with violation of independence imposed through spatial data compared to regular linear regression models and therefore produce more reliable estimates.

1.3 Outline of Thesis

Following the introduction in Chapter 1, Chapter 2 builds the theoretical foundation of the thesis and elaborates a comprehensive literature review and the conceptual framework underlying the analyses in Chapters 4 to 6. After describing changes in fertility behaviour during the First Demographic Transition and changes in family formation behaviour since the 1970s, the chapter discusses different theoretical explanations for these changes in demographic behaviour. In a last part of this chapter, I discuss the importance of space in social science and demographic research with a special focus on family demography.

Chapter 3 outlines specific features of spatial data and describes statistical models which are used throughout the thesis. When working with spatial data in social science the presence of spatial autocorrelation and spatial dependence is highly likely and explains the need to use spatial statistical models. Afterwards, a variety of spatial statistical techniques is presented, going from Local Indicators of Spatial Associations, over geographically weighted regression and to spatial econometric models such as spatial lag and Spatial Durbin Models. Finally, the chapter seeks to link theories discussed in Chapter 2 with these spatial modelling techniques.

Chapter 4 identifies forerunners of the fertility decline in England and Wales and investigates how religion shaped the change in fertility during Victorian and Edwardian era (1851-1911). To investigate these topics, I use descriptive maps of change in Total Marital Fertility Rates and model fertility change during forerunner (1851-1881) and main decline (1881-1911) years using spatial lag models.

In Chapter 5, I investigate the continuities in forerunner areas of innovative demographic behaviour in England and Wales. To shed light on this relationship, I use both descriptive techniques as well geographically weighted correlations to compare spatial patterns of fertility in 1851 with patterns on non-marital fertility in 1951 up to 2011.

The last empirical chapter, Chapter 6, investigates how norms measured through voting behaviour might be associated with non-marital childbearing in Germany. It also seeks to answer the question if associations between non-marital childbearing and its determinants might differ across space. To answer these questions, I use geographically weighted regression which is suitable to detect spatially varying associations.

Chapter 7 is the final chapter of the thesis and a synthesis of its main findings in relation to the proposed research questions. Additionally, it covers the limitations of the analyses and suggests pathways of future analyses around changing fertility and family formation behaviour in Europe and spatial demography.

Chapter 2 Literature Review

2.1 The Historical Fertility Decline

The Demographic Transition Theory proposes that along with a decline in mortality and other demographic transformations, fertility levels drop (Thompson, 1929; Notestein, 1945; Kirk, 1996), also referred to as First Demographic Transition or the Historical Fertility Transition/Decline. In Europe, these developments essentially started in the 19th century and ended in the mid-20th century with vastly varying spatiotemporal patterns (Coale and Watkins, 1986; Costa, Bocquier and Eggerickx, 2021). Before the Fertility Transition, fluctuations in fertility were primarily a consequence of nuptiality (Woods, 2000; Dribe *et al.*, 2017). Thomas Malthus observed and theorised temporarily lower fertility levels due to the postponement of marriage in the late 18th century and referred to this behaviour as a *preventive check* (Malthus, 1798). In the mid-20th century, scholars such as Louis Henry proposed the concept of 'natural fertility', believing couples did not limit fertility before the fertility transition. Later, research on pre-transitional fertility in various contexts in Europe, including England, indicated that couples deliberately limited fertility through the spacing of births intervals (Friedlander, 1992; Van Bavel, 2004; Bengtsson and Dribe, 2006; Dribe and Scalone, 2010, 2014). This form of fertility behaviour was mainly practised during short-term economic stress.

With the onset of the Fertility Transition, couples began to deliberately limit family size leading to an unprecedented, sustained and rapid decline in (marital) fertility over only a few decades (Coale and Watkins, 1986). The primary method of limiting the number of offspring was *stopping*, which meant that couples ended their reproduction earlier. The seminal *Princeton European Fertility* Project was the first to investigate how spatiotemporal patterns of the Fertility Transitions differed substantially by country (Figure 2.1) but as much on the regional level (Coale and Watkins, 1986). Figure 2.1 demonstrates how Total Fertility Rates varied across different European countries throughout the last two centuries. Whereas fertility was declining in France throughout the 19th century already, most other countries (e.g. Germany, Sweden, United Kingdom) only witnessed a change to lower fertility around 1880.

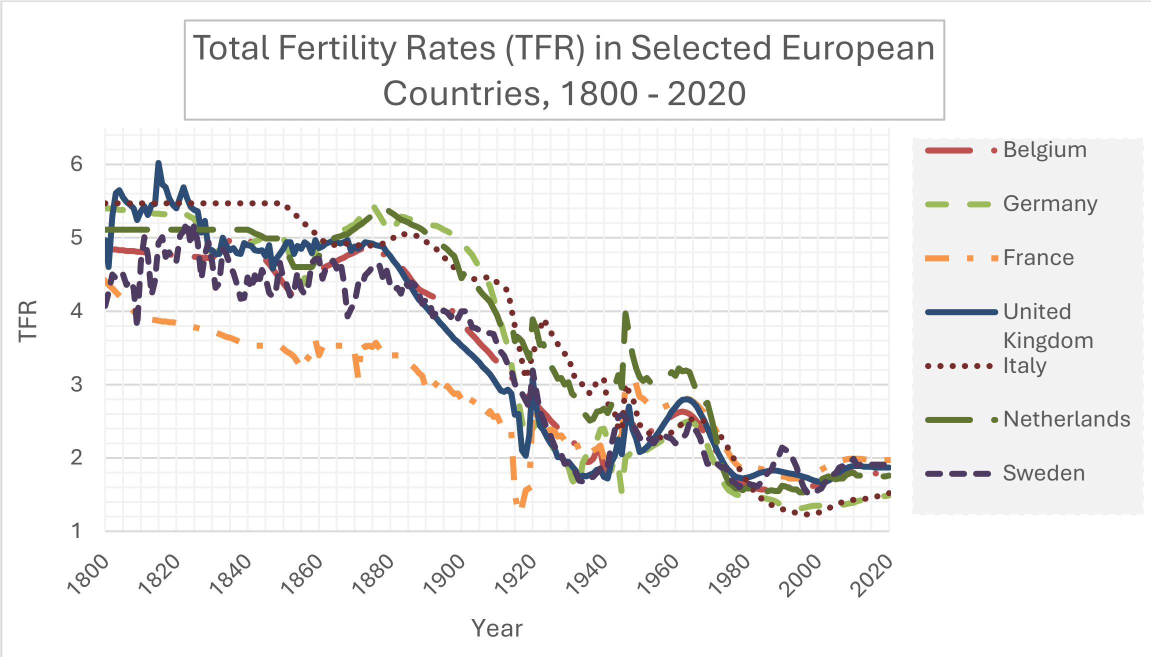

Figure 2.1. *Total Fertility Rates (TFR) in Selected European Countries, 1800 to 2020 (Source: World Bank, 2022.)*

The graph also captures other major events in Europe. Countries actively involved in World War I such Germany, France, United Kingdom exhibit a steep decline in fertility during wartime with an increase in fertility immediately after the war. Such a development can be explained through absence of men but also psychological and economic stress on the whole population suffering from war. After this short peak and recuperation of fertility rates, fertility steeply declined further across the whole continent while Europe suffered economically from the depression of the early 1920s and Great Depression in the late 1920s. Most countries then present a stabilisation of fertility rates at comparatively low levels (below TFR 2) during the 1930 and World War II before another surge towards the end or right after the world war. Especially couples who married right before World War II, had much lower levels of fertility in the subsequent five years (Glass, 1968).

Even though the developments of fertility or non-marital childbearing between 1911 and the 1950s are not subject of the analysis, they are vital events to understand Europe's history and long-term trends in demographic behaviour.

2.1.1 The Case of England and Wales

As early as the late 19th century, contemporaries in England and Wales observed that fertility was declining in the whole country. They also noticed that textile areas and middle-class towns were among the regions with the lowest fertility nationwide. On the contrary, fertility in agricultural districts and particularly in mining areas remained high, and these areas were therefore considered laggards of the fertility transition. Figure 2.2 shows the geographical distribution of different types of places according to their occupation structure in 1881. Registration Districts with a high share of professional occupations such as doctors, lawyers or accountants can be considered middle-class areas. The West of London, areas surrounding London, towns in Southeast England such as Brighton, Southampton or Oxford and larger towns in other areas such as Warwick or Manchester contained such districts. Textile areas concentrated geographically around Lancashire and adjacent parts of Yorkshire and Manchester up until Cheshire. Other centres existed in and around Leicester and Nottingham.

On the national level, England and Wales witnessed a sustained decline in marital fertility after 1881, as shown in Figure 2.3. Additionally, the figure reveals the differences in marital fertility and its decline by type of place. These aggregate measures corroborate the observations by contemporaries. Registration Sub-Districts dominated by textile and professional employment opportunities witnessed lower fertility levels. Textile areas also exhibited a more rapid fertility decline after 1881. Mining and agricultural areas show higher marital fertility throughout the whole period.

To understand these changes in family size at the turn of the century, the 1911 census – often called the *Fertility Census* – incorporated an additional questionnaire asking about the duration of the marriage and married women's whole fertility histories (see citations in Woods, 1996). The earliest analysis of the fertility transition suggested that differences in occupational structure and social class constituted the most crucial determinant of varying fertility levels and different geographical patterns of decline (Stevenson, 1920; Innes, 1938). Ever since, occupational structure and social class have been the overriding focus of studies on the fertility decline in England and Wales (Woods and Smith, 1983; Woods, 1987; Haines, 1989; Garrett, 1990; Garrett *et al.*, 2001; Garrett and Reid, 2018; Jaadla *et al.*, 2020).

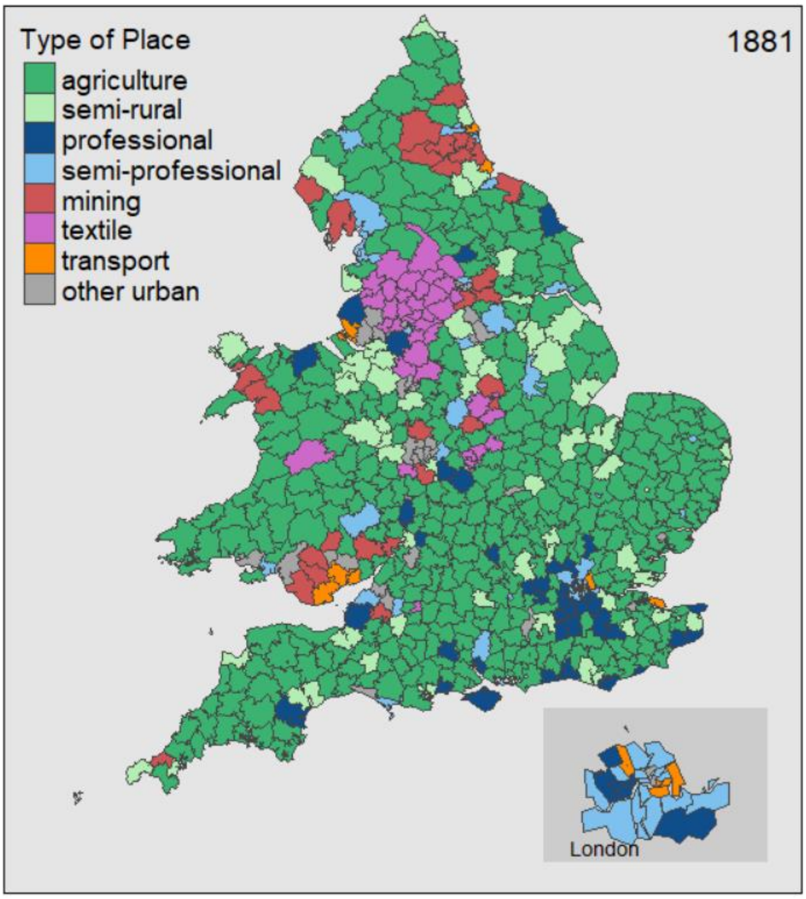

Figure 2.2. *Registration Districts of England and Wales in 1881 according to Type of Place (Sources: data - Classification and data: Reid et. al., 2018; boundary - Day, 2016).*

Some research has already targeted geographical differences on various levels of administrative geographies, such as Registration Districts and Registration Counties (Teitelbaum, 1984; Woods, 1987, 2000). This line of research was still only related to the occupational group analysis in that it tended to conclude that geographical variations in fertility were mainly the consequence of occupational variations in fertility and geographical variations in occupational structure (Figure 2.3). Thus, the county of Durham had high fertility because coal miners had high fertility, and county Durham had a large proportion of coal miners.

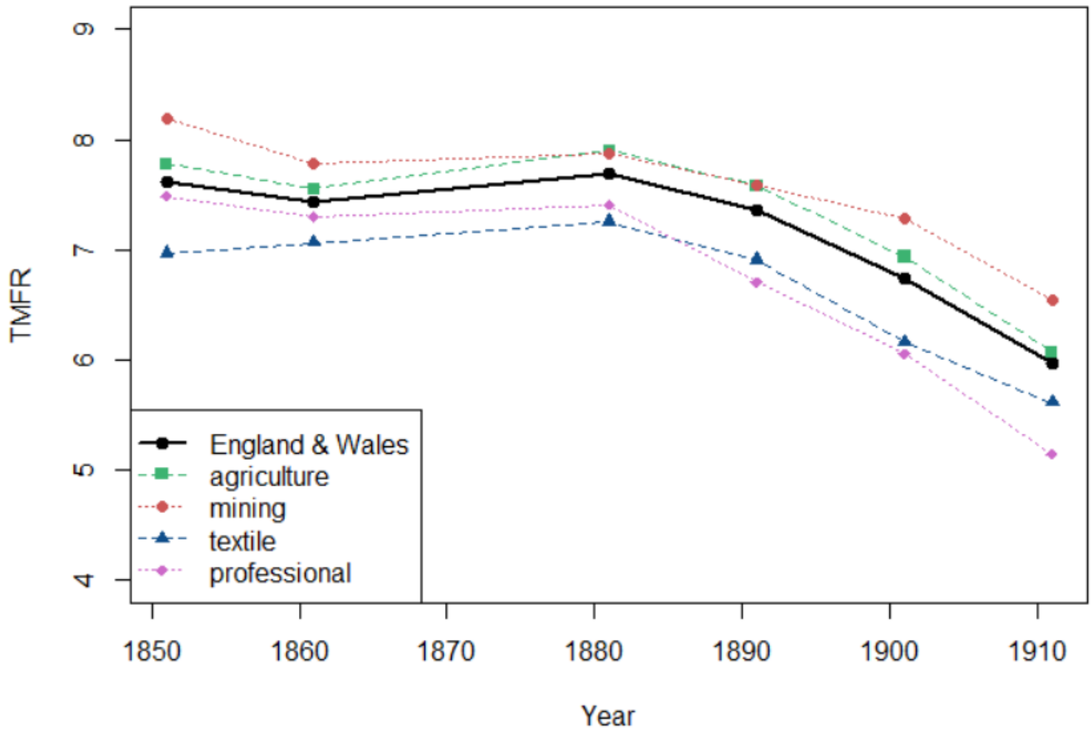

Figure 2.3. *Mean Total Marital Fertility Rate (TMFR) by Type of Place of Registration Sub-Districts, England and Wales, 1851 to 1911 (Source: data - Reid et. al., 2020; note: excludes some types of places [semi-rural, semi-professional, transport, other urban]).*

Garrett et al. (2001), in their book *Changing Family Size in England and Wales,* were the first to seriously consider the idea that geographical variations in fertility were to some extent independent of the occupational and economic structure. Using individual-level data, this study illustrated that the social environment was a crucial factor in explaining the fertility transition: Professional couples living in working-class areas were slower than their counterparts in predominantly professional areas to achieve a smaller family size. Vice versa, unskilled workers living in areas of primarily professional occupations achieved comparatively smaller families earlier than unskilled workers in rural areas. These arguments align with Szreter's elaborations on 'communication communities', proposing that couples observe how other couples in their community formed their families and adjusted their fertility according to the local social norm of family size (Szreter, 1996).

Nevertheless, even for this line of research using individual-level data (Garrett *et al.*, 2001), locations under study were often chosen according to the longstanding interest in occupational structure (Garrett, 1990, 1998; Garrett *et al.*, 2001). Therefore, research for some areas in England and Wales, especially in more peripheral areas, has been neglected. Most recent research by Jaadla et al. (2020) stressed once more the existence of fertility differences by social class and how these widened during the fertility transition. The increasing availability of new data sources released in recent years (Schürer and Higgs, 2014; Reid *et al.*, 2018) enables researchers to investigate new research questions and highlight previously hidden features of the fertility decline in England and Wales. It seems likely that questions regarding occupational structure, including female employment, have been sufficiently studied in the context of England and Wales. This intense focus on the occupational structure was already imposed by contemporary observers of the fertility decline and seemed to have remained the main focus in England and Wales after that (Stevenson, 1920; Szreter, 1996; Garrett *et al.*, 2001; Jaadla *et al.*, 2020). Other determinants, such as religion (Szreter, 2011), essential for the fertility transition in other contexts are missing in the previous debate. One reason was that occupation was collected throughout every census. Therefore, it was readily available for analysis for each census, whereas other data sources could not be combined across censuses.

All previously mentioned studies analysed fertility at specific points in time; they only used a cross-sectional approach. Given that geographical data for England and Wales is available for multiple points in time, a longitudinal perspective seems much more appropriate to capture and explain the geographical patterns of the fertility transition. Except for the study by Bocquet-Appel and Jakobij (1998) aiming to explore the diffusion of contraception in Great Britain, research adopting long-term perspective of the English and Welsh fertility decline seems with directly comparing data scarce. Using Teitelbaum's county data, they produced quasi-continuous fertility measures by kriging, a geostatistical technique to interpolate spatial point data to a continuous function. The uptake of Bocquet-Appel's and Jakobij's research (1998) about English and Welsh historical demography was low, possibly for two reasons: Estimated continuous geographical patterns of the fertility transition by Bocquet-Appel and Jakobij seem to be inconsistent with smaller administrative units of Registration Districts analysed soon after by Woods (2000). Wood's critical study of Victorian Demography provided a more detailed and accurate picture of fertility patterns in this context, making Bocquet-Appel's and Jakobij's research obsolete. Because the spatial fertility patterns were not accurately depicted by their method, their further statistical investigation of determinants was of little value as well, while also lacking a sound theoretical framework.

Accordingly, even though the fertility transition in England and Wales received much attention in the previous decades, essential questions remain unanswered. Given that researchers are interested in how fertility declined during the fertility transition, not considering fertility change over time but only fertility differences at various points seems to be a major omission of previous studies. Does the national picture of forerunners and laggards hold when taking a longitudinal rather than cross-sectional perspective? How did the fertility decline proceed in the so far neglected, often peripheral areas of England and Wales? What are the explanations other than the occupational structure that explain spatial patterns of the fertility transition?

2.1.2 Explaining the Historical Fertility Transition

Because this chapter only focuses on explaining the fertility transition in England and Wales, only the most important explanatory factors in this context are elaborated.

2.1.2.1 Social Class and Occupational Structure

In most European countries, higher social classes or socio-economic status couples are found to be forerunners of the fertility decline (Lesthaeghe, 1977; Coale and Watkins, 1986; Dribe *et al.*, 2017). They tend to be the first in the population to largen the interval between marriage and first birth and to stop childbearing before the end of the women's reproductive period. It is often believed that diffusion mechanisms contributed to the spread of family limitation.

Explanations for higher social class couples adjusting their family size earlier than the rest of the population are diverse. Many children used to be the family ideal before the fertility transition. A new family target, especially for upper- and middle-class couples, was now to have fewer but more educated or 'higher quality' children (Becker and Lewis, 1973). Industrialisation substantially altered family life through new working patterns, urbanisation and decreasing mortality, among other factors. New working conditions demanded higher skilled employees. Most likely, the middle-class population was early affected by these changes in working patterns. Investing in less but higher educated children was more beneficial for this social class at an earlier stage of demographic transition (Dribe *et al.*, 2017). Accordingly, the association between class and educational expansion in England and Wales will be investigated in *Chapter 4*. Other theories stress that new values and attitudes, such as secularisation, made the idea of limiting offspring more acceptable (Coale and Watkins, 1986; Casterline, 2001a; Cleland, 2001). More educated, higher social class couples were considered the early adopters of these ideas.

Also, higher social classes are found among the early adopters of limiting their family size in England. Here, one assumption is that the idea of smaller families diffuses predominantly through servants to the rest of the population (Woods, 2000). Pooley – by studying private letters and diaries from the mid-1900s – points out that especially elite fathers seemed to have favoured smaller families comparatively early (Pooley, 2013). They already articulated their worry about the cost implications of raising young men as early as the 1850s. To be considered respectable parents back then included providing a proper education for both sons and daughters, which was often a long and highly cost-intensive commitment. This development coincided with an increased expectation about the standard of living and demand for consumption among the elite population, such as employing servants and owning large properties. Easterlin and Crimmins ascribe this changed demand in children to a shift in preferences for other consumer goods and increasing costs for children, given that the supply, here real wages, did not change at such a high rate as consumption (Easterlin and Crimmins, 1985).

Similarly, through diaries and letters, elite women expressed in their writing a higher aspiration for non-maternal activities from the 1870s onwards (Pooley, 2013). Again, this can be interpreted as a shift in demand; however, the shift was not caused by a financial burden but by a desire for more time. Soon after, middle-class families started to articulate similar norms (Pooley, 2013). This combination might have contributed to an earlier fertility decline among higher social classes in England and Wales.

2.1.2.2 Motherhood and Employment

A counterargument for the diffusion of low fertility only starting among higher social classes in England and Wales is that fertility was equally low and rapidly decreasing in textile areas among women employed in textile mills. Explanations for the importance of paid employment among married mothers for fertility behaviour are manifold and often interrelated. Diverse demand and opportunities for mothers to participate in the paid labour force altered sub-national patterns of the fertility decline (Atkinson, 2010, 2012). Women in mining areas did not have employment opportunities and devoted their time to domestic work while having higher fertility. In contrast, if women were in paid work, their fertility was lower.

From an economic perspective, industrialisation, with its new opportunities for women to take up paid employment outside the household, increased the opportunity costs of raising children (Guinnane, 2011). Here, this new type of work did not allow to combine childcare and work as before in the cottage industry. Among women working in textile mills, the age of marriage was comparatively high (Crafts, 1989; Garrett, 1990; Atkinson, 2012). Long-distance migration to start paid employment in textile mills could have contributed to having smaller families on average through increasing age at marriage in the first instance. Findings by Jaadla et al. (2020) suggest that, most likely, the postponement of marriage due to migration resulted in the postponement of childbearing, leading to smaller families. Textile areas with the highest demand for female employment nationwide denoted the highest proportion of positive female net migration in England and Wales in 1881 (You, 2020). In some textile mills, owners were reluctant to hire married women, possibly incentivising a later marriage (Guinnane, 2011).

Garrett (1990) also points out that being in paid employment did not necessarily cause women to reduce their fertility. Vice versa, low fertility also allowed them to work (Garrett, 1990). Taking the financial need of couples into account is an essential factor to consider because, for a large number of working-class couples in textile areas, two incomes were an economic necessity (Tilly and Scott, 1978). *Chapter 5* will explain the importance of income from a family perspective in a more detailed way. Usually, male employment in the textile industry was less stable, and a female wage on its own was too low to provide for a family. Compared to husbands' earnings, the ratio of wives' earning opportunities likely explains a more rapid fertility decline in textile areas (Schultz, 1985). Especially with an increasing expectation of living standards among the working class population in 19th century England and Wales, parents possibly tried to increase their consumption by limiting their offspring (Atkinson, 2010). Again, these findings are consistent with Easterlin's supply-demand framework emphasizing that the consumption of other goods drives the demand of children (Easterlin and Crimmins, 1985).

In textile areas, the wife and husband participated in paid employment and unpaid domestic work. Both Atkinson (2012) and Pooley (2013) propose that this contributed to a higher degree of gender equality in these households leading to comparatively equal bargaining power about when and how many children to have. In addition, new expectations of caring duties for more minor children and school attendance increased parental burdens, especially for a dual-earner couple, possibly further encouraging family limitation (Ross, 1992). Pooley (2010, 2013) and Paul Atkinson (2010, 2012) argue that these new expectations were not only forced upon working class families but often couples shared a common expectation of creating a better future for their children than they had experienced themselves.

2.1.2.3 Diffusion and 'Communication Communities'

Diffusion theory proposes that innovations, including a new fertility behaviour, disseminate within the population and subsequently gain more prominence (Rogers, 1995). Both behavioural and ideational innovations are considered to diffuse this way. Empirical evidence suggests that such diffusion mechanisms shaped the historical fertility transition (Cleland, 2001; Van Bavel, 2004; Klüsener, Scalone and Dribe, 2017). Lesthaeghe and Vanderhoeft used Coale's Ready-Willing-Able (RWA) preconditions (Coale, 1973) in order to conceptualise when and how demographic innovations diffuse through a population (Lesthaeghe and Vanderhoeft, 2001; Lesthaeghe and Neels, 2002). This RWA framework is defined as follows: In order to adopt a new fertility behaviour, (a) it needs to be perceived as an advantage for individuals, such as the benefits of its adoption outweigh the costs (*ready*); (b) it needs to be acceptable from a moral and cultural perception (*willing*), and (c) there needs to be sufficient knowledge and means in order to implement innovation (*able*).

The elaborations about the interplay of fertility and social class, as well as employment among married women, already highlight the difficulty of determining one group as a forerunner of the fertility transition in England and Wales (Garrett *et al.*, 2001). Accordingly, Szreter (1996) suggested that the fertility transition in England and Wales did not follow a uniform pattern. Instead, there were multiple fertility declines (Szreter, 1996). These declines were dependent on local communities and their culture of communication. Szreter's so-called 'communication communities' were characterised by experiencing similar attitudes towards gender roles within and outside the household. Garrett et al. (2001) find some supporting evidence that the environment is a crucial factor for family size independent of occupational structure. However, evidence using proper quantitative methods to measure and evaluate the hypothesis of communication communities such as network or spatial analysis has been lacking.

The historical fertility transition in England and Wales took place well before the introduction of modern birth control (Szreter, 1996; Szreter and Garrett, 2000; Dribe *et al.*, 2017). Nevertheless, research confirms that married couples possibly consciously limited their fertility through increasing birth intervals in times of economic pressure before the 19th century (McLaren, 1984; Van Bavel, 2004; Bengtsson and Dribe, 2006; Dribe and Scalone, 2010). Accordingly, the diffusion of 'new' behavioural innovations such as new contraceptive techniques seems unlikely to be an essential driver and couples were not more *able* to reduce fertility than before. Additionally, it had always been possible for individuals in historical periods to observe couples without children and smaller families due to natural infertility (Szreter, 1996; Anderson, 1998). However, just because some couples had smaller families due to infertility does not mean that the conscious decision not to have a large family was not innovative. The likelihood that the *ready* (through structural changes) and *able* (through changes in attitudes) preconditions changed during the fertility transition in England and Wales seems, therefore, most reasonable.

Szreter highlights the importance of further investigations into the role of norms and attitudes about the fertility decline (Szreter, 2011). In the context of England and Wales, both have been widely understudied (Szreter, 1996). Somehow, research in previous decades focussed too much on the emphasis contemporary observers of the fertility decline put on the occupational structure. Even though the importance of cultural factors has been known and explored since the onset of the European Fertility Project in 1963 (Coale and Watkins, 1986), the publication focussing on Great Britain only again stressed occupational difference without sufficiently studying cultural factors (Teitelbaum, 1984). Even though data on religious affiliation has been available since the *Census of Religious Worship* in 1851, the lack of data comparable across changing administrative units probably discouraged researchers to further investigate cultural factors while occupational structure was readily available through each census.

2.1.2.4 Demographic Transition Theory: Infant Mortality and Urbanisation

Demographic Transition Theory, as developed by Davis and Blake (1955), is a form of modernisation theory that strongly emphasizes the causal link between economic modernisation and fertility decline. Improvements in the living standard, health and infrastructure eventually led to a decline in mortality and subsequently to population growth. Only then did fertility decline, although this decline occurred earlier in urban and industrialised areas compared to rural areas. Notestein's version of the Demographic Transition never posited a direct link between economic development and fertility decline. He proposed that fertility decreased because the economic and social support to maintain high fertility had been rendered unnecessary and gradually disappeared (Notestein, 1953).

One critique of Davis' and Blake's theory is that not all countries experienced this sequence of events; for instance, fertility declined in France before mortality (Alter, 1992). In addition, infant and child mortality often declined at a later stage of the fertility transition creating uncertainty for parents about the survival of their offspring. Even though mortality already declined during the 19th century in England and Wales, with life expectancy increasing in the second half of the 19th century (Woods, 2000), infant mortality stayed comparatively high across the whole century (Jaadla and Reid, 2017).

Another counterargument for low infant mortality is directly related to lower fertility in England and Wales; mothers working in textile mills experienced the highest infant and early childhood mortality rates in the country while simultaneously having the lowest fertility. Contemporaries blamed them for neglecting their infants and young children causing higher fatalities among this group (Garrett *et al.*, 2001). Later research demonstrated, however, that an industrial environment was more likely to be detrimental to infants' survival and health (Garrett and Reid, 1994; Garrett, 1998).

2.1.2.5 Education of Children

The sections about *Social Class and Occupational Structure* (2.1.2.1) and *Motherhood and Employment* (2.1.2.2) already touched on the importance of education for favouring fewer children. Even though a vast corpus of theoretical elaborations on the influence of education on fertility exists, quantitative empirical evidence for England and Wales is scarce. Like religion, data on the individual level is not as readily available as occupational structure. Mandatory primary education was introduced in this context in 1880 (Pooley, 2013), after the 1870 had already introduced nationwide education (UK Parliament, 2023).

Economists proposed that a driver of the fertility transition is parents wanting less but more educated children compared to more but less educated children (Becker and Lewis, 1973; Becker, 1986; Doepke, 2014). Investments in children increased dramatically through the prolonged period of education. This process is often referred to as the *quality-quantity trade-off*. Extending this theory to Easterlin's s*upply-demand* framework, the demand for children decreases if the preference for higher educated children or other goods increases in anticipation of a future income (Easterlin and Crimmins, 1985). John Caldwell, however, attributed the fertility decline to changes in intergenerational flows (Caldwell, 1980). While in pre-industrial times, parents directed the flow of wealth from children to parents, a high number of children was advantageous. With the shift in production, including mandatory schooling, the flow of wealth shifted from parents toward children. Hence, parents had smaller families to decrease the financial burden. Axinn and Barber (2001) found that not just sending children to school but the whole expansion of education, such as women living close to a school as a child, can accelerate the fertility transition.

The first quantitative findings analysing school attendance in England and Wales using the 1911 fertility census suggest that a larger sibship size slightly decreased school attendance in post-primary education (Fernihough, 2017). Pooley's observations from qualitative sources suggest that in some areas, the financial burden of educational provision for children might have discouraged couples from having large families (Pooley, 2013). Although primary education was compulsory, it was not free until 1891. School fees differed substantially by district. Some districts gave reductions if multiple siblings attended school; for others, full fees applied for every school-aged child.

In the 1920s, the United Kingdom reached replacement-level fertility of around two children per woman. While within a few decades, families here and across Europe had changed considerably in size, other changes altering the composition and definition were way on their way. These further changes are explained in the following chapter.

2.2 Changes in Family Formation Behaviour since the 1970s

In most European countries, the historical Fertility Transition reached its end around the 1960s with a Total Fertility Rate of around two children. However, other dramatic changes in European family demography waited in the wings. Getting married at a young age, having the first child soon afterwards, and a low share of people staying lifelong single: This family formation pattern was the norm in Europe in the 1960s in the *Golden Age of Marriage* (Sobotka, 2008; Cherlin, 2009; Billari and Liefbroer, 2010; Lesthaeghe, 2010b; Lappegård, 2014). Looking at previous and subsequent decades, this model of family formation was unprecedented. Already in the 1970s, it began to fade again (Perelli-Harris *et al.*, 2010; Lesthaeghe, 2020). Postponing marriage and cohabitation were suddenly possible stages in young adulthood (Perelli-Harris *et al.*, 2010; Lesthaeghe, 2020; Van Winkle, 2020), and fertility dropped to sub-replacement levels (i.e. below 2.1 children per woman). The rise in union dissolutions in the form of divorce and partnership break-up was another notable feature of the demographic changes starting in the 1970s (Härkönen and Dronkers, 2006; Lyngstad and Jalovaara, 2010; Härkönen, 2014). Single-parenthood (mostly single-motherhood) is the direct result of an increase in union dissolutions (Heuveline, Timberlake and Furstenberg, 2003; Caltabiano *et al.*, 2019), but also a rise in casual sex contributed to rising numbers of single parents. The Second Demographic Transition is the most commonly used term when referring to this myriad of changes in family formation patterns (Lesthaeghe, 2020). These ongoing changes have had a variety of implications for recent demographic and policy developments (Liefbroer and Billari, 2010; Perelli-Harris *et al.*, 2010; Lesthaeghe, 2020).

Before the unprecedented low of non-marital fertility during the Golden Age of marriage, non-martital fertility witnessed a continous decline between 1880 and 1940 (Shorter, Knodel and Van De Walle, 1971). Shorter et al. attribute this decline to the easier access and acceptability of to birth control techniques. After the economic crises in the 1920s, the drop in female labour force participation also made women financially more dependent on men and possibly more likely to choose marriage in the light of scarce labour market opportunities (Ruggles, 2015). Reasons for high rates of non-marital differed considerably in the 19th century. However, often they correlated with lower income and lower status (Kok, 2009). In parts of 19th-century-Germany, marriage restrictions were implemented to limit fertility of poorer people but did not prove successful (Knodel, 1967; Matz, 1980, pp. 244–51). In Southeast Bavaria one out of four children were born outside marriage in the 1830s and 1860s. However, in various parts of Europe a small percentage of children were always born outside marriage (Laslett and Oosterveen, 1973). Sexual intercourse was part of premarital courtship with the assumption this would lead to marriage which in some cases did not happen. In other parts of Europe such as Austrian Galicia Jews married religiously but di not register their marriage which inflated numbers of children out of wedlock (Klüsener, 2015). Here, people and the state define non-marital births differently (Kok and Leinarte, 2015).

In England and Wales, there was a peak of non-marital fertility rates and ratios towards the end of both World War I and World War II, possibly due to men not returning from the war or being absent for longer than expected (Hartley, 1966; Kiernan, 1971). Pre-marital courtship which usually led to marriage outside war time now ended in non-marital childbearing instead. Even though the historical trends in non-marital childbearing will not be analysed in the following empirical chapters, historical spatial patterns have been found to be important for recent geographies (Klüsener, 2015) and are hence important to understand such behaviour. To understand variations in spatial and temporal patterns of non-marital childbearing, why it is desirable for mothers and couples (Kok and Leinarte, 2015).

The onset and tempo of the Second Demographic Transition across Europe are far from uniform (Sobotka, 2008; Billari and Liefbroer, 2010; Perelli-Harris and Lyons-Amos, 2015). Scandinavian countries are often seen as the forerunners of rising cohabitation and childbearing within cohabiting unions. Other European countries, mainly in Eastern and Southern Europe and West Germany, were subject to a more recent increase in non-marital childbearing (Billari and Liefbroer, 2010; Klüsener, Perelli-Harris and Sánchez Gassen, 2013; Klüsener, 2015). These limitations result from data availability and are presented in section 3.1. Ideally, if possible, one would want to distinguish between the births to single mothers and cohabitors (Konietzka and Kreyenfeld, 2002; Sobotka, 2008; Perelli-Harris *et al.*, 2010). In most European contexts, information about births within cohabitation was only collected more recently, after an increase in such births had already occurred. Accordingly, this thesis will mainly focus on non-marital fertility, which comprises births to single mothers and cohabiting couples to capture the initial rise in these births. Because the actual increase in non-marital childbearing is driven by a rise in childbearing within cohabitation (Klüsener and Kreyenfeld, 2009; Perelli-Harris *et al.*, 2010; Klüsener, Perelli-Harris and Sánchez Gassen, 2013; Vitali, Aassve and Lappegård, 2015), the share of non-marital births is a suitable measure.

2.2.1 The Case of England and Wales

England and Wales encountered profound changes in family formation behaviour in the past 60 years. Whereas only a minority of births, with 5.1 %, were born outside marriage in 1951, as many as half of all births (52.8 %) occurred outside marriage in 2011. The rise in non-marital childbearing in England and Wales in the past decades did not occur evenly across the two countries but generated distinct geographical patterns. London and surrounding districts experience in the presence the lowest share of non-marital fertility in this context. What stands out is the gradual increase in the share of non-marital births rising by distance to the capital.

In the 1960s, contemporaries noted a dramatic increase in births to single (including widowed and divorced) women. Whereas only 3.5 in 1,000 unmarried women had a child outside marriage in 1938, this rate had increased to 17.4 in 1962. Considering that the population at risk had declined through a lower age at marriage in combination with higher marriage rates, the trend does not seem as sensational. Comparing births outside marriage to all births, one only observes a slight increase from 4.0 births out of 100 in 1938 to 6.6 in 1962 (ONS, 2014). Whereas in both years, most births occurred to women aged 15 to 24, the NMR increase was driven by women of all age groups, especially those aged 25 to 39. Kiernan (1971) reports that in the 1960s, one out of three births outside marriage even occurred to married women often separated and in a consensual union with a man other than their husband.

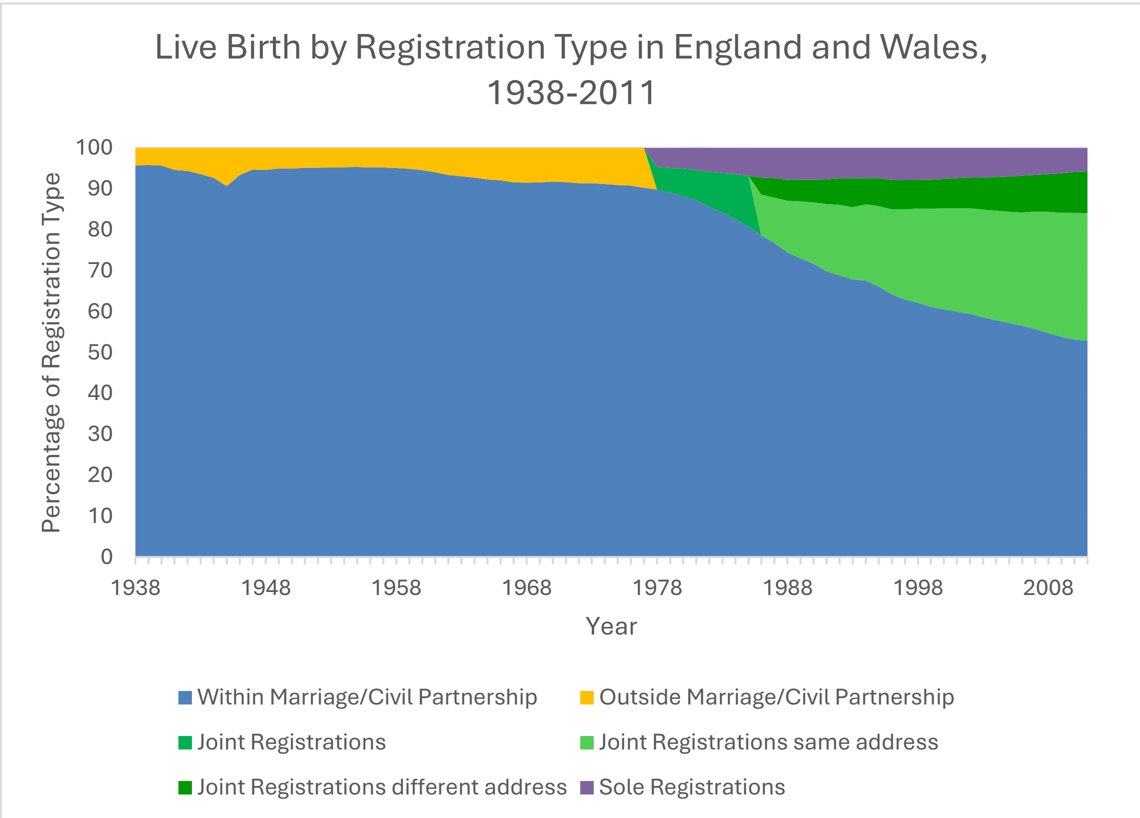

Figure 2.4*. Live Birth by Registration Type in England and Wales, 1938-2011 (Source: ONS, 2014).*

Before the 1950s and 1960s, it was a significant disadvantage for women to have children outside marriage in terms of economic and social conditions. Even when women worked full-time, their income was insufficient for their own household, not to mention feeding a family. With the implementation of the welfare state and the assumption that a mother had to care for her child instead of work, newly established state benefits allowed lone mothers to survive financially for the first time in history (Lewis, 1992). Whereas adoptions or staying with the mother's parents had been one of the few options for lone mothers before the 1950s, more mothers could keep their children and live with them instead of giving them away now.

The major increase in non-marital childbearing from the 1980s onwards can be attributed to the increase in childbearing within cohabitation. In England and Wales, these are mainly equitable to the *Joint Registration same address* registration type, introduced in 1986 (Figure 2.4).

Little is known about how spatial patterns in non-marital childbearing – comprising births to single mothers and cohabiting couples – have emerged over the past decades. Data collection distinguishing between registration to single mothers and joint registration with different and same addresses unfortunately only started in 1986 (published on the Local Authority District level only since 1990). However, the initial rise in births within cohabitation occurred before this date; accordingly, the data cannot be used here (OPCS, 1991; ONS, 2014). As discussed in the previous sub-chapter, different theories conceptualise changes in family formation behaviour. The Second Demographic Transition Theory attributes the rise in non-marital fertility to a rise in individualisation and secularisation (Lesthaeghe, 1998, 2020). It proposed that this change occurred first among the highly educated before diffusing through the whole population. The pattern of disadvantage hypothesis, however, assigns the increase in non-marital births to economic uncertainty (Perelli-Harris et al., 2010). For England and Wales, sociologists and population researchers have linked births to single mothers for more than a century and births to cohabiting couples since the 1990s to low education and economic uncertainty (Duncan and Smith, 2002, 2006; Kiernan, 2004). Especially for younger mothers from disadvantaged backgrounds, studies have found multiple times that a valued social role as a mother was one major reason for having children early, regardless of whether single or cohabiting (Coleman and Cater, 2006; Anwar and Stanistreet, 2015).

2.2.2 The Case of Germany

Cross-country comparisons constitute a significant area of study aiming to explain variations in non-marital fertility (Billari and Liefbroer, 2010; Perelli-Harris *et al.*, 2010; Perelli-Harris *et al.*, 2012; Klüsener, Perelli-Harris and Sánchez Gassen, 2013). Within-country differences are often equally pronounced (Lesthaeghe and Neels, 2002; Klüsener, Perelli-Harris and Sánchez Gassen, 2013). Germany is a fascinating case in Europe, displaying the most extreme regional variations of non-marital fertility (Kreyenfeld, 2004; Klüsener and Goldstein, 2016). After World War II, Germany was divided into two countries: In the East, the German Democratic Republic (GDR) was formed under the communist regime of the Soviet Union. In the West, the remaining allied forces founded the Federal Republic of Germany (FGR) based on the model of other Western states. Recent research points out that a variety of socio-economic indicators already reveal a large East-West divide prior to World War II (Becker, Mergele and Woessmann, 2020).

Reinforcing diverging developments, both parts of Germany were subject to opposing governmental forms, including different family policies before reunification in 1990 (Salles, 2006; Kreyenfeld and Konietzka, 2010; Salles, Rossier and Brachet, 2010; Klüsener and Goldstein, 2016). Figure 2.5 shows non-marital births as a percentage of all births between 1946 and 2015 for both parts of Germany (*destatis,* 2016a). In the GDR, the share of non-marital births reached 16% in the 1970s before increasing to 23% in 1980. This upsurge is often assigned to particular family policies in the East designed to support single mothers (Kreyenfeld and Konietzka, 2010; Salles, Rossier and Brachet, 2010). These policies included eligibility for one year of paid maternity leave combined with paid leave in case of child sickness and priority access to childcare and housing. In contrast, married mothers only had similar rights after giving birth to their second child. Policies only distinguished between married or unmarried mothers and hence did not account for unmarried women in a stable relationship. Research assumes these policies unintentionally discouraged couples from marrying and promoting non-marital childbearing (Salles, 2006). However, the qualitative work by Anne Salles is the only work explicitly targeting policies in the GDR and how this influences fertility. Other scholars assume still, that the comparatively high prevalence of non-marital childbearing increased in acceptability over the years (Konietzka and Kreyenfeld, 2002; Salles, 2006; Kreyenfeld, 2010).[1] By 1986, policies changed in favour of all mothers (Salles, 2006); by now, one-third of births in the GDR occurred to unmarried mothers (*destatis,* 2016a). Instead of generating an expected decline in shares of non-marital births, the development only stalled until reunification (Figure 2.5).

At the time of reunification in 1990, non-marital fertility levels were only at the 10% level in West Germany compared to 35% in the East (*destatis*, 2016a). Compared to previous decades, this number was still the highest one ever observed. Conservative family policies[2] combined with a taxation system favouring a one-earner-household – introduced in 1958 – are considered to be highly motivating for couples to get married before having children in West Germany (Kreyenfeld and Konietzka, 2010; Perelli-Harris and Gassen, 2012). Consequently, the male breadwinner model was and still is widely established. Women often dropped out of the labour force in favour of domestic work, including childcare responsibilities. Only when children grew older were women likely to take up part-time employment again (Wengler, Trappe and Schmitt, 2008; Grunow, 2013; Grunow, Schulz and Blossfeld, 2013). A meaningful reason for this divergent development was that marriage was considered the most secure partnership form for West German couples, conferring significant economic advantages.

After German reunification, German policy makers and politicians in the early 1990s expected convergence of Eastern non-marital fertility levels towards the West since both regions were suddenly subject to the same policy regime (Konietzka and Kreyenfeld, 2002). Against all expectations, the opposite happened. The share of non-marital births increased in both regions. In 2015, non-marital childbearing in West Germany constituted 30% of all births, although still not reaching the high levels of the East with 60% respectively (*destatis,* 2016a).

[1] This happened despite other family policies favouring the traditional family model.
[2] The German constitution (Grundgesetz) says that family and marriage are protected by the state (§6).

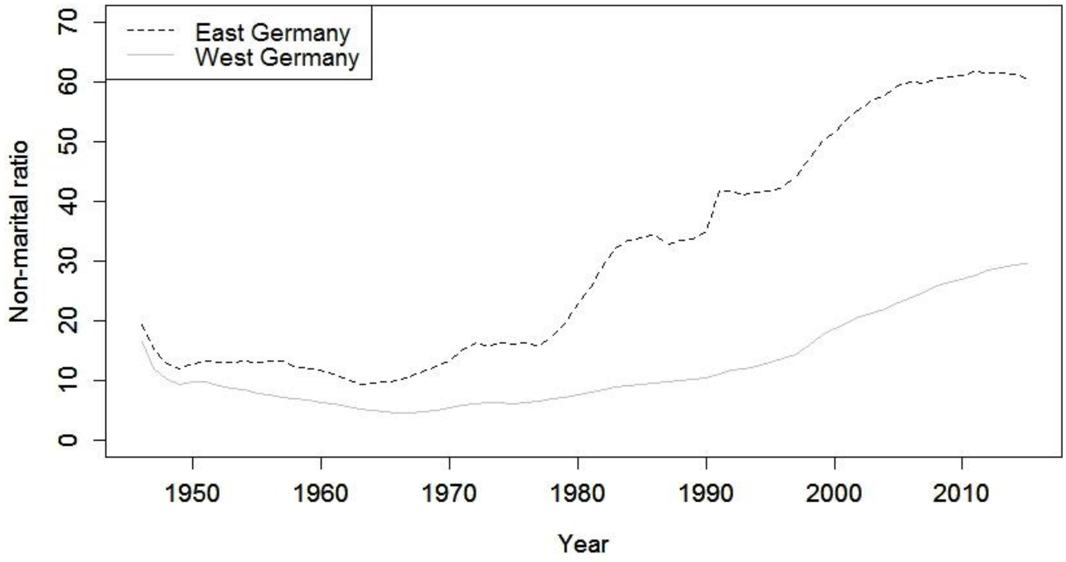

Figure 2.5. *Non-Marital live Births as a Percentage of All live Births (Non-Marital [Birth] Ratio) in East and West Germany. 1946 to 2015 (Source: destatis, 2016a)*

As early as 2000, non-marital births comprised most live births in the East (destatis 2016: see Figure 2.5). This development is particularly noteworthy since cohabiting unions are only granted a few benefits in Germany (Perelli-Harris and Gassen, 2012; Sánchez Gassen and Perelli-Harris, 2015). Research suggests that women's high labour force participation in the East is essential for understanding the differences compared to the West. In a dual-earner household where both partners have similar earnings, the advantages of the German tax system disappear (Konietzka and Kreyenfeld, 2002; Klärner, 2015). Considering the rise in both labour force participation and non-marital fertility since the 1990s in the West, this might also be a possible explanation for an increase in non-marital childbearing there. The disappearance of both economic and 'romantic' motives for individuals during the GDR system is considered by Klärner (2015) an additional explanation for making marriage less desirable. Having children and getting married were two different issues. This reasoning is supported by qualitative research, which demonstrates that in East Germany, people do not appear to see a difference between a married and cohabiting union (Perelli-Harris *et al.*, 2014; Klärner, 2015).[3]

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[3] Studying non-marital fertility rather than fertility within cohabitation has its limitations, though: It needs to be pointed out that non-marital childbearing comprises births to cohabiting unions as well as to single mothers as well. *Pairfam* data - *Panel Analysis of Intimate Relationships and Family Dynamics* - suggest that of all first

Much of the elaborations discussed in this section focused on the time after World War II when Germany was divided and clearly showed a diverging development of non-marital childbearing. This divide already existed before World War II, though, and has long-standing historical roots: In the second half of the nineteenth century, levels of non-marital fertility were considerably higher in the East (Klüsener, 2015; Klüsener and Goldstein, 2016). Klüsener and Goldstein (2016) speculate about possible reasons for the early and pronounced East-West variations: Historically, East Germany was more secularised throughout the past two decades. In addition, agricultural production with its large farms in the East implied less control by the local community and anonymity. Therefore, rural areas exhibited even higher shares of non-marital births than urban areas. An exception to low non-marital fertility in the South were the districts in the Southeast of Bavaria, which had high levels of non-marital fertility (although showing the lowest levels in Germany in recent times) (Knodel, 1967; Shorter, Knodel and Van De Walle, 1971; Klüsener, 2015). Similarly, high patterns of non-marital childbearing can be observed in Austria right across the border (Shorter, Knodel and Van De Walle, 1971). Here, children born outside marriage and their mothers benefitted from stronger legal protection as in the East of Germany (Klüsener and Goldstein, 2016). In Bavaria, but also in other parts of Germany, marriage bans existed in the 19th century for people whose income was considered too low and morally 'unsuitable' to form a family (Knodel, 1967; Matz, 1980). Nonetheless, these prohibiting population policies proved ineffective as they merely increased childbearing outside marriage without successfully reducing fertility among poorer people. They were therefore banded in the 1860s to 1870s.

births of mothers born between 1971 and 1973, 24% belonged to cohabiting partners or living-apart-together couples, whereas only 6% where born to single mothers in the West (Kreyenfeld and Bastin, 2010). In the East, both percentages are roughly twice as high with 53% of children born within cohabitation and 11% to single mothers (Kreyenfeld and Bastin, 2010). More recent analysis based on the German micro-census reveal a more detailed view on non-marital fertility using data for the years 1996 to 2012: In West Germany, the share of children between age 0 and 1 living with cohabiting parents increased from 5% to 15% and with single mothers from 5% to 9% within this period (Konietzka and Kreyenfeld, 2017, Tab. 2). In the East, the share of children living with cohabiting parents increased from 22% to 37% and with single mothers from 14% to 18% (Konietzka and Kreyenfeld, 2017, Tab. 2). Although the data is not completely comparable, the overall trend is the same: the share of births to single mothers is much higher in the East compared to the West of Germany and in recent times non-marital childbearing is mostly made up by fertility within cohabitation.

Even though East and West Germany[4] exhibited an increase in non-marital childbearing after reunification in 1990, the share of non-marital childbearing in both populations seems far from convergence: Simulations covering scenarios where the whole country shows similar levels of secularisation and economic performance did not even reveal a convergence of non-marital fertility soon (Klüsener and Goldstein, 2016). Other socio-economic indicators disclose similar long-term persistence (Becker, Mergele and Woessmann, 2020). Hence, there seem to be long-standing substantial differences in non-marital fertility in East and West Germany and considering different associations of non-marital childbearing across space might help to understand these differences further and discuss spatial variations beyond the East-West divide.

2.2.3 Explaining Changes in Family Formation Behaviour Ideational Change

2.2.3.1 Ideational Change

Lesthaeghe and Van de Kaa (1986; Lesthaeghe, 2010b, 2020) propose that a new demographic pattern emerged in Europe in the 1970s. This pattern included the decline of fertility to sub-replacement levels, the emergence of a variety of new living arrangements alternative to marriage and disconnection between marriage and childbearing (Lesthaeghe, 2014). Following the First Demographic Transition, which started in Europe at the end of the 19th century (see section *2.1*), Lesthaeghe and Van de Kaa called this demographic change the Second Demographic Transition (from now on: SDT). Although they acknowledged a connection of the new shifts with structural changes on the macro level and individual calculus on the micro level, the SDT theory especially emphasizes the role of ideational change and cultural shifts from conservative to more liberal and progressive values and attitudes (Surkyn and Lesthaeghe, 2004; Lesthaeghe, 2020). These include more tolerant attitudes towards homosexuality or bodily autonomy, such as the right to

[4] So far, it might sound like both East and West are comparatively homogeneous in itself. Whereas this has been actually found to be the case in East Germany for fertility, West Germany demonstrated comparatively heterogeneous spatial patterns of fertility between 1970 and 1987 (Basten, Huinink and Klüsener, 2011).

abortion and suicide. Even though the SDT theory does not argue that ideational change is sufficient to explain new developments in fertility and family formation patterns thoroughly, it recognises it as a necessary and exogenous driver (Lesthaeghe, 2020). Lesthaeghe and Van de Kaa argue that a combination of rising secularisation, the emancipation of women combined with individualisation gave rise to a stronger focus on self-realisation and a rejection of established institutions, including marriage (Lesthaeghe and Van de Kaa, 1986; Lesthaeghe, 1998, 2010b). The rise of cohabitation and the increase in non-marital childbearing is one outcome. According to the SDT theory, the emergence of non-marital childbearing as a new behaviour does not appear randomly within populations. It is driven by ideational change and cultural shifts among the young and highly educated population. This new family formation pattern gradually diffuses throughout the population (Lesthaeghe, 1998, 2020).

2.2.3.2 Economic Uncertainty: The Role of Male Unemployment

Ideational change as the driver behind the increase of childbearing within cohabitation is not without its critics. Alternative theories suggest that economic uncertainty, mostly found among the lower educated groups, is crucial in explaining non-marital childbearing (Oppenheimer, 1988; Sweeney, 2002). In Oppenheimer's theory of marriage timing, she concludes that a prolonged education period relates to the postponement of marriage and family formation. In particular, highly educated women only opt for equally educated partners considering those more suitable for a secure and stable relationship (Oppenheimer, 1988; Sweeney, 2002). Enhancing this theory, Oppenheimer argues that during early career developments, young men with lower education are not considered auspicious partners (Oppenheimer, Kalmijn and Lim, 1997; Oppenheimer, 2003; Kalmijn, 2013). High uncertainty during the early life course complicates the decision-making process about long-term commitments like family formation and fertility intentions in young adulthood (Mills and Blossfeld, 2003; Kurz, Nikolei and Golsch, 2006). In particular, young adults living in more precarious conditions have fewer resources to cope with this uncertainty (Blossfeld *et al.*, 2006). Empirical findings for the United States underline this argument and point out that the chances of stable employment are higher for more educated men and decrease with a lower degree of education (Oppenheimer, Kalmijn and Lim, 1997; Oppenheimer, 2003). Hence, rising numbers of young men with insecure jobs and little chances of stable employment in the future perform poorly in the partner market. Therefore, less educated men are more likely to end up in cohabiting unions as a looser form of partnership rather than marriage (Oppenheimer, 2003).

A typical pattern in Europe is the so-called pattern of disadvantage characterised by a negative educational gradient of childbearing within cohabitation, as described by Perelli-Harris et al. (2010). Forgoing partnership and sometimes parenthood seems to be a life-long option in case of permanent economic uncertainty. Even though this alternative family formation pattern is initially found among the highly educated in some European countries, it soon shifts to the group of lower educated in most countries studied (Perelli-Harris *et al.*, 2010). These less educated groups are more vulnerable to insecure employment and unemployment.[5] Recent research based on German micro-census data from 1996 to 2012 reports a negative association between educational attainment and childbearing within cohabitation (Konietzka and Kreyenfeld, 2017). In the 1990s, this relationship between education and childbearing for couples outside marriage was still reversed. Therefore, highly educated couples seem to be the forerunners of family formation within cohabitation in the initial years but are more likely to have children within marriage over time (Konietzka and Kreyenfeld, 2017). Accordingly, areas with a high share of highly educated women tend to be forerunner areas. These findings are in line with Oppenheimer's reasoning (Oppenheimer 2003). In East Germany, highly educated women continuously chose marriage over cohabitation to start a family, whereas less educated men and women often selected family formation outside marriage (Konietzka and Kreyenfeld, 2017).

[5] Unemployment on the individual level does not necessarily have the same implications than living in a context with high unemployment. Although research conducted with individual level data often points out that individuals postpone decisions like having children in case of unemployment (Mills & Blossfeld 2003; for Germany: Konietzka & Kreyenfeld 2017) the variable male unemployment does not depict the same relationship. Using this indicator on the aggregated level shows a more general picture of economic uncertainty for all individuals. It is very likely that in case of high unemployment the whole labour market is less stable. The employment situation of many others is or becomes unstable accordingly which affects everyone.

2.2.3.3 Female Labour Force Participation

Female labour force participation and female educational attainment are considered essential variables in understanding fertility and partnership behaviour. Interpreting the link between these factors often turns out to be very complex. Depending on the spatio-temporal context, empirical evidence elaborating on the association between female employment and non-marital childbearing differs. As explained in the following paragraphs, female employment or education can be viewed as an economic or ideational measure.

According to Lesthaeghe, female education leading to female independence is a critical driver of the Second Demographic Transition (Lesthaeghe 2010, 2014). A rise in female education fosters individual autonomy and an urge for self-fulfilment (Lesthaeghe, 1998). These changes relate to an increase of childbearing within cohabitation among highly educated women and an increased willingness to divorce or separate in the case of marital or relationship dissatisfaction. Lesthaeghe (2010b, 2020) proposed that the SDT starts among the highly educated and then diffuses through the population, with more educated women less likely to marry.

The economist Gary Becker argues that female education supports a decline in marriage and a rise in non-marital childbearing through the new economic independence of women (Becker, 1981, 1986). Increasing opportunity costs for children result from women spending more time in education and the labour market. Opportunity costs increase with increasing education; women might sacrifice career perspectives or similarly self-actualisation when having children. In addition, they lost a higher income than women in previous generations with lower wages. In addition, educated women participating in the labour force have greater economic autonomy decreasing economic gains of marriage. From an economic point of view, Becker argues that the relationship between female education and fertility outside marriage is closely related to Van de Kaa's and Lesthaeghe's expectations. All foresee a decline in marriage and a rise in childbearing within cohabitation. However, instead of female independence, female employment can easily be interpreted as an economic necessity depending on the individual's household and family context (Tilly and Scott, 1978; Dex, 1988; Lewis, 1992).

Oppenheimer (1988) presents a counterargument to Becker's theory based on economic reasoning. She advocates that men are more drawn to employed women able to provide financially for a family's income, especially in times of increasing economic uncertainty (Oppenheimer, 1988). This development is related to assortative mating; women select partners with a similar educational background (Sweeney, 2002). Consequently, family formation, including marriage and childbearing, is postponed until a suitable partner is found (Oppenheimer, 1988; Kalmijn, 2013). As empirical evidence suggests, Germany recently seems to follow this pattern (Konietzka and Kreyenfeld, 2017).

2.3 The Importance of Space in Social Science and Demographic Research

2.3.1 Space and Diffusion Mechanisms

> "The key elements of spatial diffusion are phenomenon and spread: some phenomenon is somehow brought into existence; that phenomenon moves or is spread beyond the origin to alter, even temporarily, the character of other places."
> **(Morrill, Gaile and Thrall, 1988, p. 7)**

Spatial diffusion has been a widely used term in the social sciences since the second half of the 20th century. The term was initially used by Torsten Hägerstrand in 1953 (Hägerstrand, 1953) and describes space-time processes of innovation in a broad sense. Spatial diffusion occurs through agents that transfer phenomena such as new ideas or innovative behaviour (immaterial phenomena) but also material phenomena such as machines (Morrill, Gaile and Thrall, 1988). However, the phenomenon could also be a contagious disease spread within a population through agents. In the social sciences, these agents are people who transfer phenomena. This thesis is only concerned with immaterial phenomena that spread within space, such as new ideas and behaviour.

How do these phenomena diffuse? Individuals interact and communicate directly or indirectly within time and space. The central assumption in spatial thinking is that proximity is associated with similar behaviour and the spread of ideas (Logan, Zhang and Xu, 2010). Especially within social networks, diffusion occurs through various social mechanisms such as social learning and imitation, social contagion, social pressure, or social support (Bernardi and Klärner, 2014). Even though the majority of networks are in proximity even in historical times, social networks of some, often higher status groups, operated at more considerable distances (Klüsener, Dribe and Scalone, 2019).

However, there are other examples through which spatial diffusion mechanisms have increased over time: the (geographical) expansion of newspapers and news coverage have reinforced information flows already in the 19th century (Peris, Meijers and van Ham, 2021). Whereas human interaction was geographically more limited in historical times, it has increased through various means over the past two centuries (Costa, Bocquier and Eggerickx, 2021; Peris, Meijers and van Ham, 2021). Such new ways of facilitating interaction across longer distances were the expansion of the transport network in the 19th century (Alvarez, Franch and Martí-Henneberg, 2013; De Sapio, 2013), the phone and mobile phone in the late 20th century (Ratti *et al.*, 2010; Grauwin *et al.*, 2017) as well as social media in recent years (Gandica *et al.*, 2020). Even the diffusion of new technologies such as prenatal sex determination might alter fertility behaviour and sex ratios (Kashyap and Villavicencio, 2016)

2.3.2 A spatial Perspective of Fertility and Family Formation Behaviour

The field of demography has a longstanding tradition of studying space. Notably, early demographic research focussed on analysing spatial data mainly on the aggregated level, as Voss points out (Voss 2007). Space is vital in understanding the diffusion of demographic behaviour, especially fertility. Since individuals are connected and interact within space, they tend to share common knowledge and values and adopt new behaviours (Casterline, 2001a).

Empirical evidence on historical and recent fertility behaviour suggests that diffusion mechanisms shape fertility patterns (Montgomery and Casterline, 1996; Casterline, 2001b; Bernardi, 2003; Van Bavel, 2004; Bernardi and Klärner, 2014). Diffusion theory proposes that innovations disseminate through the population and gain more prominence (Rogers, 1995) – in this case, innovation is a new demographic behaviour (Casterline, 2001a; Cleland, 2001).

On the individual level, social networks are the driver of the diffusion mechanism (Bernardi, Keim and von der Lippe, 2007; Keim, Klärner and Bernardi, 2009; Balbo and Mills, 2011; Balbo and Barban, 2014; Bras, 2014; Buyukkececi and Leopold, 2020; Buyukkececi *et al.*, 2020). On the aggregate level, diffusion mechanisms can be traced across space (Montgomery and Casterline, 1993, 1996; Klüsener, Perelli-Harris and Sánchez Gassen, 2013; Vitali, Aassve and Lappegård, 2015, 2015; Caltabiano *et al.*, 2019; Doignon, Eggerickx and Rizzi, 2020). Current patterns of Total Fertility Rates can be explained by spatial proximity (Campisi *et al.*, 2020b, 2020a).

Further empirical evidence highlights the importance of space in understanding long-run geographical patterns of fertility and family formation behaviour. Persistent cultural factors – like voting behaviour – are associated with both the First Demographic Transition and the SDT in Belgium (e.g. through language borders), Switzerland, France and Spain (Lesthaeghe and Neels, 2002; Lesthaeghe, 2010a; Lesthaeghe and Lopez-Gay, 2013). In those contexts, spatial diffusion mechanisms seem to shape specific clusters of regional demographic behaviour (Lesthaeghe & Neels 2002; Lesthaeghe 2010b; Lesthaeghe & Lopez-Gay 2013). Therefore, fertility behaviour does not occur randomly in space. Lesthaeghe and Neels suggest that the evolution of geographical fertility patterns in Belgium, Switzerland and France are associated with regional subcultures, for instance, defined through language borders as in Belgium (Lesthaeghe & Neels 2002). There, the increase in non-marital childbearing is associated with secularisation. In Spain, childbearing within cohabitation is positively associated with female employment and education regardless of changes in spatial patterns over time (Lesthaeghe & Lopez-Gay 2013). More research on childbearing within cohabitation by Klüsener, Perelli-Harris and Sanchez Gassen (2013) using individual-level data in the European context between 1960 and 2007 suggests that subnational differences in non-marital childbearing rise between

1990 to 2007. In addition, the state is essential in shaping national fertility levels through policies that influence between-country variations. Even though a reunited Germany has been subject to the same family policies since 1990, regional variations in non-marital childbearing remain without a sign of convergence (Klüsener, Perelli-Harris & Sanchez Gassen 2013). Other spatial perspectives of fertility behaviour suggest that norms and attitudes are more important in explaining between-country differences (e.g., through national legislation, media), whereas the pattern of disadvantage is more relevant in understanding subnational regional and individual level variations (Låppegard, Klüsener & Vignoli 2017).

Another main interest of this thesis is whether the associations of family formation behaviour, such as non-marital childbearing, vary across space and time. These associations might not just change spatially, but we observe changing associations in the same regions across different cross-sections. This line of reasoning offers the possibility of a diffusionist perspective, as Vitali and Billari (2017) proposed. A change in sign of a correlation between two variables over time usually indicates a change in behaviour or norms; a new behaviour has diffused, e.g., if non-marital childbearing. This association change can be detected earlier and linked to specific areas on the spatial level. Geographically weighted regression is a suitable exploratory analysis to trace such changes across space (Vitali and Billari, 2017). Empirical evidence revealing that the association of low fertility and its determinants differ across space exists for Italy (Vitali & Billari 2017), Turkey (Işik & Pinarcioğlu 2007), Brazil (Muniz 2009), Australia (Evans & Grey 2018), China (Wang & Chi 2017) and South Korea (Jung et al. 2019). Considering that these countries are not exceptions and Germany's significant regional differences in non-marital childbearing, it seems plausible to assume that its determinants, such as voting behaviour and female labour force participation, vary spatially. German fertility research incorporating space often focusses on an East-West divide (Konietzka & Kreyenfeld 2002; Kreyenfeld 2004; Goldstein et al 2010; Klüsener & Goldstein 2014). These elaborations reveal the importance of considering space when analysing fertility and family formation patterns.

2.3.3 Forerunners, Tipping Points and Diffusion

Identifying forerunners areas as the origin of new fertility behaviour is vital to understand the subsequent transition (see examples for Norway: Vitali, Aassve and Lappegård, 2015; and for Italy: Vitali and Billari, 2017). Determinants and mechanisms of declining fertility might as well differ depending on the point in time the researcher considers when studying the fertility transition. Within this line of thought, cultural anthropologist Heidi Colleran describes the need to acknowledge time and timing as follows: "I suggest that researchers divide their labour between three distinct phases of fertility decline—the origin, spread and maintenance of low fertility—each of which may be driven by different causal processes, at different scales, requiring different theoretical and empirical tools." (Colleran, 2016, p. 1)

After forerunner areas of a new demographic behaviour have emerged, this new behaviour spreads to neighbouring areas – the 'spatial diffusion' of a demographic 'innovation' (Carlsson, 1966; Rogers, 1995; Cleland, 2001). On the national level, such an evolution of forerunners might be muted at first. Only after a sufficient number of areas have adopted the 'innovation' the trend becomes visible nationally. This time can be referred to as the 'tipping point'. Tipping point models offer a helpful framework to conceptualise the point in time where behaviour changes in relation to cultural and normative developments (Helmke and Levitsky, 2004; De *et al.*, 2018). Even though cultural evolution is assumed to lead to a slow and gradual change, updating beliefs can involve a rapid transition with a distinct 'tipping' in behaviour (Helmke and Levitsky, 2004). Updating beliefs can lead to a rapid pattern of cultural change, especially in tight community structures or highly connected networks (Jung *et al.*, 2021).

Accordingly, the idea of forerunners in spatial analysis is defined through the dimensions of space, time, and an interplay of both (diffusion). Describing the pre-transitional behaviour in line with the demographic 'innovation' is necessary to define forerunners measurably. Table 2.1 explains in a simplified way how spatial forerunners are defined in this chapter and how the appearance of forerunners will be identified using national and subnational data. It describes pre-transitional behaviour, demographic 'innovation' and suitable indicators to measure changes in fertility and family formation behaviour.

Table 2.1. *Conceptual Framework to Define Forerunner Areas for Historical Fertility Transition and Changes in Family Formation since the 1970s*

	First Demographic Transition	**Second Demographic Transition**
Pre-transitional behaviour	Absence of fertility control/limitation and high fertility levels	Childbearing within marriage (despite small share of births to single mothers)
Innovation	Fertility control within marriage	Changes in marriage and childbearing patters
Indicators	→ Decline in (marital) fertility rates • Total Fertility Rate (*TFR*) • Total Marital Fertility Rate (*TMFR*)	→ Childbearing within cohabitation • Percentage of births within cohabitation • Non-Marital Ratio (NMR)

A general point to bear in mind is that analysing the spatial pattern of change may not necessarily help us to understand the underlying factors driving the change, as there may be a time lag before populations respond with their demographic behaviour to changing socio-economic circumstances. As a result, the spatial pattern of fertility change may tell us more about the process of adaptation at the population level (which is often related to communication) than about the underlying changes in structural conditions that are usually at the root of these behavioural changes. This is further complicated by the fact that the process of adaptation among early adopters often creates additional structural incentives for change among late adopters.

Chapter 3 Data and Methodology

3.1 Spatial Data

Walter Tobler already articulated the necessity to incorporate space into the analysis in 1970 in his first law of geography: “Everything is related to everything else. But near things are more related than distant things.” (Tobler, 1970, p. 234).[6]

Spatial data does not only measure variables X at a certain point in time t but similarly at location i. Data across space does not change from one place to the next; accordingly, one can make inferences from one area to a neighbouring area, similar to data across time, which shows certain continuities. The following sections will explain what aspects of and how this particular spatial data features influence statistical analysis.

3.1.1 Spatial Clustering and Spatial Autocorrelation

Spatial clustering refers to a set of close-by areas with similar characteristics compared to distant areas (Fortin and Dale, 2009; Moraga, 2023). If spatial clustering is apparent, this is likely a sign of positive spatial autocorrelation: hence, observations are not independent in space (Fortin and Dale, 2009). In basic linear regression – often referred to as global regression in spatial statistics – independence of residuals is one of the most critical assumptions. A linear regression model is specified as follows:

$$y_i = X_i\beta + \varepsilon_i \qquad 3.1$$

[6] Already in 1889, Ernst G. Ravenstein stated in his *Law of Migration* that migration occurs most often to nearby places (Ravenstein, 1889). Possibly, people tend to migrate to nearby places where they know people.

Where y_i represents the dependent variable in a specific location i, X_i denotes the vector of explanatory variables, and β captures the parameter estimate. The residual or error term is defined as ε_i.

If the assumption of independent observations is violated through the existence of spatial clustering and hence spatial autocorrelation, parameter estimates can be biased (Fotheringham and Rogerson, 2009; Haining, 2009). If this is the case, residuals ε_i will also reveal to be correlation within space. Thus, it is necessary to account for spatial clustering in statistical modelling to obtain robust and reliable model estimates.

3.1.2 Areal Weighted Interpolation

Analysing geographical data from a single country through a longitudinal rather than solely cross-sectional approach frequently encounters challenges, given that administrative divisions tend to evolve over time. This issue that areas commonly referred to as polygons in GIS do not match is referred to as the polygon overlay problem (Goodchild, 1978). Therefore, it is frequently necessary to create data sets using one time-consistent set of boundaries (Comber and Zeng, 2019). This technique will be used in Chapter 4 and Chapter 5 to derive time constant geographical units for each analysis. Over the last decades, various new spatial data sources have emerged and become accessible for research. Simultaneously, many interpolation techniques using areal features have been developed to tackle difficulties caused by administrative boundary changes (Comber and Zeng, 2019). A commonly used way of interpolating spatial data is areal weighted interpolation (AWI), with the possibility of interpolating both count data as well as rates or percentage, respectively referred to as either *extensive* or *intensive* AWI (Goodchild and Lam, 1980; Goodchild, Anselin and Deichmann, 1993; Prener and Revord, 2019a).

To determine the degree of polygon overlay, a matrix $\boldsymbol{W}$ with weights w_{ts} needs to be defined as follows:

$$w_{ts} = \frac{a_{ts}}{\sum_{s=1}^{n} a_{ts}} \qquad 3.2$$

Where a_{ts} is the area of overlap of source area s and target area t (Goodchild and Lam, 1980). In case of an extensive AWI, matrix $\boldsymbol{W}$ is standardised by column which provides information of the proportion of source area s later located in target area t. In contrast, for an intensive interpolation matrix $\boldsymbol{W}$ is standardised by row providing information on the proportion of target area t being located in source area s. The value for the target zone $\boldsymbol{V}$ can then be estimated as follows:

$$\boldsymbol{V} = \boldsymbol{W} * \boldsymbol{U} \tag{3.3}$$

Where source values $\boldsymbol{U}$ are multiplied by the matrix of weight $\boldsymbol{W}$.

This method of interpolation is utilised for spatial data that has been aggregated to polygonal data, with boundaries that cross over each other, rather than fitting perfectly together, causing areas to be non-identical. This use of AWI enables the smooth translation of values from one boundary set (the source) to a separate boundary set (the target), utilizing polygon overlay operations (Markoff and Shapiro, 1973). The central assumption and simultaneously disadvantage is that the technique assumes that the population is spread homogeneously across space. In reality, populations are rarely spread evenly. Especially in large, aggregated polygons consisting of both urban and rural areas, the homogeneity assumption is likely to be violated if population density varies across space. The estimation error stemming from the AWI might cause biases in AWI estimates and further data analysis. However, if polygons are small and the geographical detail of the source areas is high, an AWI to considerably larger target units in which the smaller source units fit well causes low bias. Recent explorations of using AWI to interpolate election results using AWI only found estimation errors between 2% and 3% (Gropelud, 2016) for a variety of countries.

AWI was recently implemented as an R package called *areal* (Prener and Revord, 2019a, 2019b), performing both extensive and intensive AWI from a source to a target area. This package has been used in the following empirical chapters to interpolate areal data. The further specifications will be described in both Chapter 4 and Chapter 5.

3.1.3 Modifiable Areal Unit Problem

A common challenge in processing spatial data involves the definition of regions by their boundaries and/or degree of aggregation. In both cases, spatial patterns of variables of interest are likely to change, and accordingly, further analyses of such variables are subject to analytical issues referred to as the modifiable areal unit problem (MAUP) (Wong, 2009). Openshaw and Taylor established the term in 1979, finding inconsistencies in correlation coefficient values according to different spatial data aggregation levels (Openshaw and Taylor, 1979; Openshaw, 1984). Two sub-problems can lead to inconsistencies in an analysis of spatial data: the zoning problem and the scale problem (Wong, 2009). The first issue, the zoning problem, refers to keeping geographic units comparatively stable or even fixed but rearranging how boundaries are drawn. The scale problem refers to analysing data at different scales of aggregation.

In their 1979 experiment on data from distinct spatial aggregations, Openshaw and Taylor discovered that increased aggregation disclosed a greater correlation coefficient between two variables than at lower spatial aggregations (Openshaw and Taylor, 1979). This issue is referred to as the scale problem. The reason is that small-scale areal units are usually more dispersed and have more variability. If aggregated, however, outliers are removed, and the values at a higher level of spatial aggregation reveal reduced variability, becoming more averaged out overall (Wong, 2009). Accordingly, correlation coefficients at higher spatial aggregation are larger than at lower aggregation. It can be anticipated that associations of variables at higher spatial aggregation will be stronger in other forms of spatial and general statistical analysis as well. To test if or by how much analysis are subject to severe MAUP, one might carry out statistical analyses at different spatial aggregations if possible.

It is crucial to remember that spatial data is always aggregated and accordingly in addition subject to ecological fallacy. Different compositions of individual-level characteristics within spatial units and similarly different social processes might still manifest in the same aggregated values. Small geographical units are most valuable for capturing a more detailed spatial variation, whereas higher ones tend to mask such pronounced spatial variations by averaging the values contained within smaller ones.

3.2 Spatial Statistical Methods

Considering spatial proximity in statistical analysis is essential to spatial analysis (Fortin and Dale, 2009; Fotheringham and Rogerson, 2009; Haining, 2009). In the following three subsections, I will discuss three different possibilities of how spatial features might be incorporated into statistical analysis. These methods range from descriptive approaches such as Moran's I statistics to geographically weighted regression as an exploratory analysis to more sophisticated spatial econometric models, such as a spatial lag model. What all these methods have in common are spatial weighting matrices which will be discussed prior to this chapter.

3.2.1 Spatial Weight Matrices

Spatial data can come in many different types (geographies, networks etc.) and is usually presented as areas or points. A spatial weight matrix is a fundamental concept in spatial analysis that summarises how one observation of spatial data is related to neighbouring areas or points (Dubin, 2009; Anselin, 2021; Moraga, 2023). The neighbouring observations are commonly referred to as lagged terms in spatial analysis. Each row in the weight matrix represents one observation's relationship to all the other observations in the data set. Therefore, its dimension is always NxN, with N being the number of observations in the data set. The numbers in the weight matrix can indicate whether a relationship is present.

It is common to row-normalise the weight matrix, meaning that each of the rows sums to one (Dubin, 2009; Elhorst, 2014). Given that W is nonnegative, this establishes that all weights fall within a 0 and 1 range. This in turn, implies that the process of allocating weights can be viewed as a means of averaging the values that are in proximity. This gives the weight matrix some theoretical benefits by allowing for better comparison between different weight schemes. All the weights in the following empirical chapters are therefore row normalised.

Most often the relation of spatial data in a weighting matrix is defined through contiguity or distance. For contiguity, Queen's or Rook's contiguity matrices are commonly used to define neighbours (Figure 3.1).[7] Both matrices capture a relation through sharing of a boundary. The Queen's contiguity matrix defines neighbours in addition to that through a sharing at least one common point or corner. In reality, both Queen's and Rook's contiguity matrices rarely differ unless borders are defined on a grid. Still, all analysis in the following chapter (see Chapter 3.2.2 about Local Indicators of Spatial Associations and Chapter 3.2.4 about Spatial Econometric Models) use Queen's contiguity matrices.

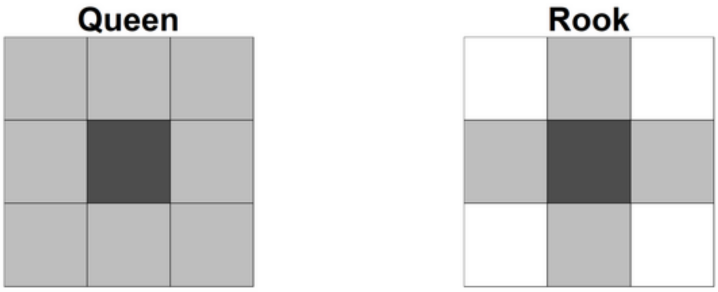

Figure 3.1. *Queen and Rook Contiguity (Source: Moraga, 2023 Fig. 7.1)*

Another form of spatial weight matrix for point data, identifies neighbours through distance. Distance can be defined as strength but may also operate to define a certain set of k-nearest neighbours (without ranking these by distance). The weight matrix $\boldsymbol{W}(i)$ then takes the following form:

$$\boldsymbol{W}(i) = \begin{bmatrix} w_{i1} & 0 & 0 & \cdots & 0 \\ 0 & w_{i2} & 0 & \cdots & 0 \\ 0 & 0 & w_{i3} & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & w_{in} \end{bmatrix} \quad 3.4$$

[7] Here, first order contiguity matrices are presented. These capture contiguity by being a direct (first order) neighbour. Higher order contiguity matrices also exist. As such, a second order contiguity matrix defines contiguity by being a direct neighbour (first order) and the direct neighbours of those (second order).

All locations comprised in the kernel are included in the weight function. Additionally, the neighbouring locations are weighted depending on their distance to the location i; the weight is calculated by taking the distance compared to the overall radius of the kernel. Some assumptions are involved for areal data (such as in geographically weighted correlation and regression, see Chapter 3.2.3), assuming the distance is centroid to centroid.[8] There are different ways to specify a spatial weight matrix $\boldsymbol{W}(i)$ for distances (Fotheringham, Brunsdon and Charlton, 2003; Fotheringham, 2009; Gollini *et al.*, 2015). Whereas a fixed kernel includes points within a defined distance, an adaptive kernel choses a certain number k of nearest points or neighbours. If the density of areal centroids varies considerably, a Gaussian weight function with an adaptive kernel is most often chosen to specify a spatial weight matrix. Akaike Information Criterion or Cross-Validation are common ways to specify the statistically 'best' distance matrix.

In general, spatially lagged terms can be included in spatial econometric models for the dependent variable, explanatory variable or even the error term (Anselin, 2021). To sum up, the weight matrix is a versatile and powerful tool in spatial analysis for summarizing how data is related spatially. It can be used in a variety of ways to analyse spatial relationships between different types of spatial data.

3.2.2 Local Indicators of Spatial Associations

To identify spatial autocorrelation in a dataset, a measure called Global Moran's I can be calculated:

$$I = \left(\frac{n}{\sum_i \sum_j w_{ij}}\right) \frac{\sum_i \sum_j w_{ij} z_i z_j}{\sum_i z_i^2} \tag{3.5}$$

[8] When analysing areal data with GWR, the centroid of each polygon needs to be determined to calculate a spatial weight matrix that accounts for distance. The centroid is the centre of gravity of an area. Even though this procedure allows to reliably calculate distances between areas in most cases, the centroid might be less meaningful in case of a complex area shape.

where z_i and z_j are observations at location i and j measured in units of deviation from the mean (Moran, 1950). A commonly used spatial weight matrix W is a First Order Queens Contiguity which takes all neighbours sharing a border into account as described in the previous chapter. The matrix takes the value 1 when location i and location j are adjacent either by border or corner and 0 otherwise. Subsequently, the spatial weight matrix is row standardised; hence, each row is divided by the number of neighbours so that the sum of each row is 1. By definition, all Moran's I values are between -1 and 1. A value close to -1 displays repulsion meaning units of dissimilar values are close to each other. A value close to 0 reveals spatial randomness and close to 1 spatial clustering. Spatial clustering reveals that units with similar values are near to each other (Fortin and Dale, 2009; Bivand, Pebesma and Gómez-Rubio, 2013).

To explore where high and low values of a variable cluster are within space or where to find outliers, Local Moran's I[9] is calculated for each spatial unit and mapped afterwards. These are also referred to as *Local Indicators of Spatial Associations*, often called LISA statistics (Anselin, 1995). Locations with high values surrounded by units of high values are referred to as 'high-high'; accordingly, locations of low values are surrounded by units of low values 'low-low'. Outliers are locations of low values with adjacent units of high values ('low-high') and the other way around ('high-low') (Fortin and Dale, 2009; Bivand, Pebesma and Gómez-Rubio, 2013).

3.2.3 Geographically Weighted Regression

Geographically weighted regression (hereafter: GWR) performs local regression for each spatial unit in a data set. This model allows regression coefficients to vary across space (Fotheringham, Brunsdon and Charlton, 2003; Fotheringham, 2009; Gollini *et al.*, 2015). Thereby, the strength of GWR is that, in addition to taking space into account and hence

[9] Where the local version of Moran's I is defined as follows (Anselin, 1995):

$$I_i = \frac{n(Y_i - \bar{Y})}{\sum_j (Y_j - \bar{Y})^2} \sum_j w_{ij}(Y_j - \bar{Y}).$$

relax the hypothesis of independence among spatial units assumed by linear regression, it also allows us to estimate heterogeneous associations among variables.[10] This feature is essential when analysing spatial data if a given X is expected to be positively associated with Y in some locations but negatively in others. A model for a GWR regression can be described as follows:

$$y_i = \beta_{0i} + \beta_{1i}x_{1i} + \beta_{2i}x_{2i} + \cdots + \beta_{ni}x_{ni} + \varepsilon_i \tag{3.6}$$

Where $x_{1i}, x_{2i}, \ldots\ x_{ni}$ constitute the different observations for all explanatory variables taken at a location i. This way, for each location i an own intercept β_{0i} and own regression coefficients $\beta_{1i}, \beta_{2i}, \ldots, \beta_{ni}$ are estimated. The local error term ε_i comprises the local variability, which cannot be explained by the model (Fotheringham, Brunsdon and Charlton, 2003). The parameter estimates are calculated using the following formula:

$$\beta_i = (\boldsymbol{X}^T\boldsymbol{W}(i)\boldsymbol{X})^{-1}\ \boldsymbol{X}^T\boldsymbol{W}(i)\boldsymbol{y} \tag{3.7}$$

The inclusion of a spatial weight matrix $\boldsymbol{W}(i)$ reveals the difference between the estimator of simple linear regression and GWR (Fotheringham, Brunsdon and Charlton, 2003; Fotheringham, 2009; Gollini *et al.*, 2015). In other words, the GWR runs a separate regression for each location based on a kernel function which determines how many observations of neighbouring locations and the weight of these observations by distance are used to calculate the coefficients. A spatial weight matrix's function can be specified as a fixed or adaptive kernel (Fotheringham, Brunsdon and Charlton, 2003; Fotheringham, 2009; Gollini *et al.*, 2015). The fixed form takes all observations of other districts into account, which are within a fixed distance of the location's centroid. An adaptive weight function

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[10] Another issue in statistical analysis resulting from the scale effect discussed in sub-chapter 3.1.3 about the modifiable areal unit problem are heterogeneous (MAUP) associations among variables within space. Even though not being a solution for the MAUP, geographically weighted regression can possibly handle and depict heterogeneous associations (Fotheringham, Brunsdon and Charlton, 2003) and accordingly overcome the scale problem.

also takes the density of nearby districts into account. For an adaptive kernel, the optimal bandwidth determines how many neighbouring observations are used to calculate the coefficient while minimising the standard error. Each location i is assigned its spatial weight matrix. All locations comprised in the kernel are included in the weight function as discussed in chapter 3.2.1 about spatial weight matrices.

All explanatory variables $x_{1i}, x_{2i}, \dots x_{ni}$ are standardised according to their mean μ and standard deviation σ:

$$Z = \frac{x_i - \mu}{\sigma} \qquad 3.8$$

The original units are kept for the response variable y_i. This way, all regression coefficients $\beta_{1i}, \beta_{2i}, \dots \beta_{ni}$ but the intercept will show how much change in the same unit as the response y_i will occur if the explanatory variables $x_{1i}, x_{2i}, \dots x_{ni}$ change by one standard deviation. Standardisation allows to compare the coefficients of the different explanatory variables $x_{1i}x_{2i}, \dots x_{ni}$ to directly. Therefore, GWR using standardised explanatory variables makes it possible to determine if the relative importance of different explanatory variables $x_{1i}, x_{2i}, \dots x_{ni}$ changes geographically. In addition, it reveals which of these variables contribute the most to an increase in the response y_i for each location.[11] Other summary statistics, such as mean or correlation, can be produced in the same way in their geographically weighted form.

3.2.4 Spatial Econometric Models

Instead of geographically weighted regression, spatial econometric models are suitable for modelling spatial data.

[11] The openly available statistical software *R* is used to implement all descriptive and statistical analysis. The GWR model is fitted using the package *GWmodel* written by Binbin Lu.

A spatial lag model allows to include a spill-over effect from the dependent variable of neighbouring regions by estimating the average impact of the dependent variable in neighbouring regions (Anselin, 1988b, 2009; Elhorst, 2014). Including this additional specification, a spatial lag model following Anselin (2009) is defined as follows:

$$y_i = \rho \sum_j w_{ij} y_j + x_i \beta + \varepsilon_i \quad 3.9$$

where ρ is the parameter estimate to determine the spatial spill-over also known as the spatial autoregressive term. This term is calculated by summing the dependent variable in neighbouring areas weighted by w_{ij}.

In matrix notation, equation of the spatial lag model is written as follows:

$$\boldsymbol{y} = \rho \boldsymbol{W} \boldsymbol{y} + \boldsymbol{X} \beta + \varepsilon \quad 3.10$$

The spatial weights matrix $\boldsymbol{W}$ has a dimension of NxN. In every row i of $\boldsymbol{W}$ for which column j is a neighbouring region according to the first order queen criterion, elements w_{ij} are defined as one at first and are subsequently row-standardised by dividing through the number of neighbours to receive correct weights. The following analytical chapters will use this specification throughout the spatial econometric modelling process.

The analysis in the following analytical Chapter 4 is concerned with estimating the change in the dependent variable between time t_0 and t_1 by two sets of models including either explanatory variables measures at t_0 or change variables between t_0 and t_1 Accordingly, the first model – from now on referred to as precondition-model - needs to be specified in the following way:

$$\Delta y_i = \rho \sum_j w_{ij} \Delta y_j + x_i \beta + \varepsilon_i \quad 3.11$$

Where Δy_i now denotes the change in the dependent variable over a specific period, Δy_j captures the change in the dependent variable in neighbouring locations, while the remaining explanatory variables x_i represent the preconditions and are set at their values in time t_0.

Acknowledging that a change in explanatory variables might as well be related to a change in the dependent variable, the second set of models – from now on called change-model – will be defined as:

$$\Delta y_i = \rho \sum_j w_{ij} \Delta y_j + \Delta x_i \beta + \varepsilon_i \qquad 3.12$$

Where Δx_i now also denotes the change in the vector of explanatory variables rather than the precondition mentioned in model *3.11*.

In the last step, a Spatial Durbin model extends the spatial lag model by including spatially lagged explanatory variables (Elhorst, 2014). The underlying assumption is that not only the value of y but in addition the vector of all or specified explanatory variables x_i might be related to the dependent variable y in a neighbouring region. The precondition-model then takes the following form:

$$\Delta y_i = \rho \sum_j w_{ij} \Delta y_j + x_i \beta + \theta \sum_j w_{ij} x_j + \varepsilon_i \qquad 3.13$$

And the change-model takes the form as follows:

$$\Delta y_i = \rho \sum_j w_{ij} \Delta y_j + \Delta x_i \beta + \theta \sum_j w_{ij} \Delta x_j + \varepsilon_i \qquad 3.14$$

Where θ is defined as the parameter estimate for the average of the weighted sum of the explanatory variable in neighbouring locations.

Spatial error models do not use spatial lag variables as an extra variable. Instead, it changes how the random errors connect with each other. This usually happens because unseen effects spread between different spatial units, causing the errors to relate in a spatial way (Anselin, 2009). The spatial error model is specified the following way:

$$y_i = x_i\beta + \lambda \sum_j w_{ij}\varepsilon_j + \xi_i \qquad 3.15$$

Where λ is the coefficient for the spatially lagged error terms ε_j and ξ_i is an uncorrelated error term.

3.2.5 Linking Theory and Statistical Models

In the previous sub-chapters, demographic theories of fertility, family formation and space, and different spatial modelling techniques have been discussed. Before continuing with the empirical analyses, these theories and models which detect spatial autocorrelation, spatial heterogeneity or spatial spill-over effects need to be linked. Spatial econometric models, as an example, can assess both magnitude and significance of spatial spill-over effects. Therefore, these models are highly important to understand sub-national population processes (Vega and Elhorst, 2013).

Various forms of statistical tests such as the Lagrange Multiplier Test Diagnostics allow to choose the most appropriate spatial econometric model according to the provided data (Anselin, 1988a). What is equally, if not even more important is choosing a suitable model based on the underlying assumptions of one's research (Vega and Elhorst, 2013). Social scientists are faced with the task of selecting suitable models for their research, which corresponds to the underlying assumptions and the processes that need to be modelled. The mathematician Patrick Doreian already argued 1980 for a theory rather than data driven approach for choosing an appropriate model (Doreian, 1980). A consistent theme throughout many research sectors is the uses of spatial models, with Chi and Zhu in 2008 supporting the use of spatial regression models for demographic analyses. However, it is important to recognise that models based on geographical units rely on assumptions that may not reflect underlying population processes or dynamics.

One main assumption in this thesis is that fertility (Empirical Chapter 4 & Chapter 5) and family formation behaviour (Chapter 5 & Chapter 6) in one area is dependent on the behaviour in a neighbouring area. Hence, demographic behaviour diffuses across space as already explained in the previous elaborations about space in social science research (sub-chapter 2.3). A corresponding spatial econometric model is the spatial lag model assumes that the dependent variable is correlated across space and will therefore be used in the context of this thesis.

What is important to consider when analysing space is that in the field of social science, when the term ‘space’ is used, it often implies a continuous measure. However, when social scientists analyse space, they rely on fixed geographical units usually determined through the sometimes-random definitions of administrative units. These administrative units may even be created based on a set of variables such as socioeconomics, race, and ethnicity, amongst others. Although these units are fixed, human interactions and fluctuations impact them over time, making them more dynamic.

Chapter 4 Religion and Forerunners: Shaping the Fertility Transition in England and Wales, 1851-1911

Abstract

This chapter aims to investigate and explain the role of forerunners and religion during the Fertility Transition in England and Wales using small- and medium-scale geographical data. In addition, it conceptualises and analyses the importance of New Dissent religions for changing spatial fertility patterns over time. Descriptive findings illustrate that besides middle-class towns and textile areas, Cornwall and North Wales districts were forerunners of the fertility decline. The analysis highlights how processes on the sub-national level shaped fertility change during different phases of the First Demographic Transition. Results of the spatial lag models reveal that the fertility change during the forerunner years is strongly shaped by the presence of New Dissent religions, while more conventional explanations related to social class and married women's employment are influential during the main decline years. These new findings demonstrate the vital role of New Dissent religions' norms, institutions, and social identity acting through a complex interaction with increasing education and changing gender roles in the early fertility transition in 19th-century England and Wales. The culture associated with New Dissent promoted early fertility decline. This culture was strong enough to foster early fertility decline even in some areas, such as Cornwall, that were otherwise unpropitious because of mining activity and high infant mortality. Its impact could, however, be counteracted by a strong collective culture of high fertility, such as existed in the south Wales valleys. In addition to the content-related finding, this work adds to the increasing literature highlighting the importance of space in the explanation of geographical patterns of demographic behaviour, as demonstrated by the statistical models.

4.1 Introduction

Whereas the average married woman in England and Wales had almost 7.5 children in the 1870s, her counterpart in the 1930s had only three children (Woods, 2000). The underlying processes of this rapid decline in fertility in England and Wales are still controversially discussed. At the end of the 19th century, contemporaries observed that family size was declining within middle-class towns and textile areas of England and Wales. Most of the research investigating the fertility decline in England and Wales has heretofore focussed on disentangling the relationship of fertility behaviour with social class and female employment (Szreter, 1996; Woods, 2000; Garrett et al., 2001).

Religion has never been considered a determinant of fertility decline in this context. Data on religious worship and places of worship are available for 1851 and have been available ever since. However, data on subsequent censuses were not comparable due to administrative boundary changes. Given that social historians consider the rise of *New Dissent* religions – mainly Methodists - during the 19th century as a major cause of cultural and social change (Gay, 1971; Thompson, 1972; Hempton, 1996, 2005; Snell and Ell, 2000; Tombs, 2014), the lack of investigation into the role of religion seems surprising. The *New Dissent* surmounted the popularity of the Church of England – also referred to as Established Church – especially in peripheral and industrialised areas of England and the whole of Wales. Most importantly, this new religion strongly emphasized different social norms and conventions compared to the Established Church. Given that the daily life and the context of most 19th-century contemporaries were embedded in a local rather than national context, it is essential to understand how sub-national cultural developments shaped local and, ultimately, national fertility patterns.

While previous studies only analysed different fertility levels at various times of the transition, spatial differences already present before the onset of the decline and the subsequent change in fertility are unknown. Therefore, I analyse the change in Total Marital Fertility Rates using geographical data on the Registration District and Registration Sub-District level provided through the Population Past project (Reid et al., 2018) in combination with the 1851 Census of Religious Worship (Ell and Southall, 2020) both described in *Chapter 4.3*. Two sets of models – one using precondition explanatory variables and the other model employing a change in those variables over time – estimate the percentage change in marital fertility for the forerunner (1851-1881) and main decline (1881-1911) years using a spatial lag model described in *Sub-Chapter 4.5.2*.

This chapter is structured as follows: It starts with the conceptual framework developing the link between *New Dissent* religions and fertility behaviour. This framework draws from McQuillan's elaborations on how religion influences fertility (McQuillan, 2004). A description of data sources and indicators used in the analysis follows. Descriptive maps and spatial lag models will be examined and reviewed considering theories and previous literature before ending with concluding remarks.

4.2 Religion and Fertility

4.2.1 The Absence of Religion in English and Welsh Historical Demography

Religion and religiosity seem to be widely absent in the study of English and Welsh historical demography, especially fertility studies. One possible reason might be that the countries have been, for a long time, seen as comparatively homogeneous within themselves or even secularised compared to other European countries. Most of the population belonged to Protestant denominations, including a variety of presumably smaller religious groups besides the Church of England (Snell and Ell, 2000). In a short section, Robert Woods (2000) only explores religion by discussing secularisation and adopting birth control. The European Fertility Project led by Ansley Coale and Susan Cotts Watkins (Coale and Watkins, 1986) obtained valuable new insights about the influence of cultural factors on the European fertility transition for some European countries such as Belgium (Lesthaeghe, 1977), Italy (Livi-Bacci, 1977) and Germany (Knodel, 1974). However, Teitelbaum's elaborations on Great Britain lacked a thorough conceptualisation and analysis of cultural factors (Teitelbaum, 1984).

In the context of England and Wales, the *Cambridge Group for the History of Population and Social Structure's* reconstruction of England's population history has contributed important knowledge to the understanding of historical demographic processes in general but especially fertility. In *Changing family size in England and Wales,* Garrett et al. (2001) shed light on the association between fertility and religious denomination in England and Wales in a short section outside of the general Catholic-high-fertility-discourse. Evidence from the county Lancashire, widely dominated by the textile industry, showed that not all communities with a high share of women working had low fertility. Whereas predominantly Catholic exhibited larger family sizes, communities with a high share of nonconformist religions witnessed the smallest families. Possibly, nonconformism did not oppose female employment outside the home and families in textile areas might have identified more easily with those denominations. Garrett et al. (2001) conclude that to understand fertility behaviour, it is essential to understand how the teaching of different churches relates to it. Therefore, this chapter aims to explain religious teaching concerning (1) social norms and conventions, (2) the extent of an individual's responsibility for his or her well-being along with that of his or her immediate family, and (3) the extent to which the well-being of individuals is a communal responsibility.

4.2.2 The Rise of the *New Dissent* Religions: 1750-1900

Social historians have already pointed out the new social force of religious Dissenters in the late 18th and 19th centuries: "The explosion of 'New Dissent' (especially Methodism) from the 1770s to 1840s marked one of the most dramatic social and cultural changes in the country's history." (Robert Tombs, 2014, p. 459).

While the Church of England and its followers perceived themselves as comparatively progressive by separating from the established primacy of the Roman Catholic Church, many dissenters only saw another religious monopoly in the new arrangements (Gay, 1971; Tombs, 2014). The *New Dissenters* is a term for various religious groups dissenting from the Church of England around the end of the 18th century. They consisted mainly of Methodists, although a precise percentage cannot be determined. The numerous groups, some small, others bigger, had similar histories of origins and, at the same time, similar values, and burdens. Still, numerous differences distinguish the various movements; not all would have considered themselves part of one large group. The *Old Dissenters* emerged with the Reformation in the 16th century but already lost influence in the late 17th century.

In the early 18th, most of England's population resided in the South, where the Church of England remained strong (Gay, 1971). Industrialisation brought significant urbanisation and an increasing population in large geographical areas, especially the North of England. Here, the population density was previously low in line with the Established Church's limited presence. At the same time, the so-called *New Dissent* emerged, reaching out to the areas with a weak Church of England and Old Dissenters (Gay, 1971). The observation (Snell and Ell, 2000) of a weakening Church of England seems to be emphasized by the 1851 census of religious worship findings. Over half of the attendances occurred in Nonconformist chapels – including *Old* and *New Dissent*. Therefore, the Established Church missed reaching out to the newly industrialised and peripheral areas.

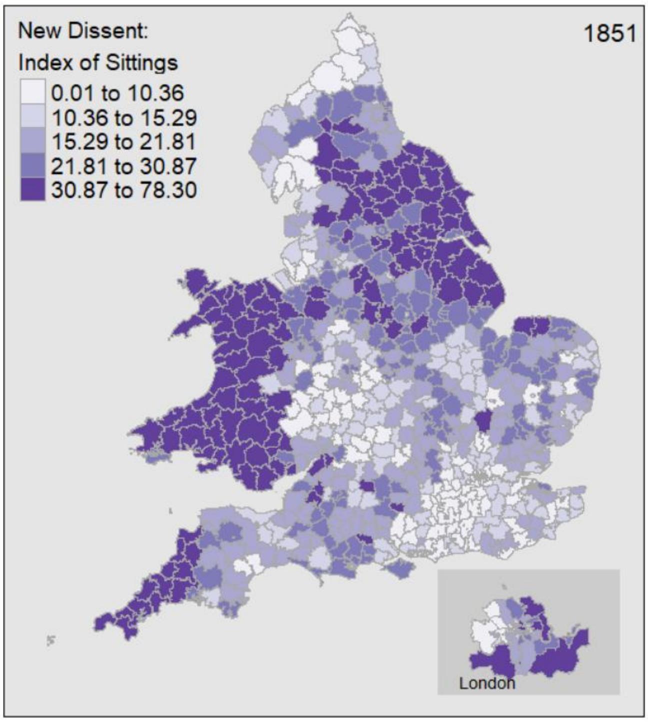

Figure 4.1. *Quintiles of Index of Sitting of New Dissent in 1851 according to Census of Religious Worship (Sources: own calculations; data: Ell and Southall, 2020; boundary: Day, 2016)*

Figure 4.1 displays a map of the geographical distribution of the *Index of Sittings* of all *New Dissent* religions (as described in Chapter 4.4) as classified by Snell & Ell (2000): a measure providing information about the number of seats in a church building for this religious group per 100 in the population The high prevalence of the *New Dissenters* in the population in the whole of Wales along with Cornwall is undeniable. Other centres of *New Dissent* were in the North Midlands and Yorkshire. Nevertheless, strong support also appeared in parts of East Anglia, Dorset in the Southwest or the Isle of Wight. In London, those Registration Districts with a lower share of professional occupations in the East also had a higher share of *New Dissent* sittings at the 1851 census. Accordingly, the first hypothesis is:

4.2.3 Religion's Influence on Fertility Behaviour and the *New Dissent*

Given the geographical differences in the prevalence of different religious denominations, it seems surprising that religion has never been considered a determinant of the English and Welsh fertility decline. Since Methodist fertility has been found to be comparatively low in other historical Anglo-Saxon contexts, such as Canada (Gauvreau, 2006), this lack of research is even more astonishing. Therefore, this chapter aims to elaborate a conceptual framework seeking to link the *New Dissent* and fertility behaviour in England and Wales. McQuillan (2004) has developed a helpful framework for conceptualising religious affiliation as a determinant of fertility behaviour, partially based on Calvin Goldscheider's work on religion (Goldscheider and Uhlenberg, 1969; McQuillan, 2004). Most importantly, McQuillan identified three conditions that need to be satisfied for religion to influence fertility behaviour:

1) First, a religion must enunciate important behavioural or social **norms** for fertility behaviour and outcomes. These behavioural norms can be as explicit as opposing or prohibiting contraception or abortion, as is the case for the Catholic Church[12] up until now. Norms and rules do not necessarily need to forbid contraception per se but can also advocate for large families, as is the case for Mormons.

[12] Sometimes, practice of demographic behaviour seems to be disconnected from the preaching of the Catholic Church as shown for marriage in Italy (Vignoli and Salvini, 2014). Also, Latin America has gone through the fertility transition using contraception even though being strongly influenced by the Catholic Church.

2) A second important feature is communicating and enforcing these values through religious **institutions**. Besides social pressure or punishment, such means can also be rewards. These religious institutions need to be well established and reach out to society, community and individuals, such as the Roman Catholic Church in late 19th-century Quebec controlling essential factors of social life (e.g., public education, health care provision, vital registration).
3) Lastly, the association between fertility and religious affiliation are linked and regulated through social **identity**. If most people identify with a religion, they are more likely to accept and possibly enforce their teaching, rules, and values. Again, an example is French Roman Catholics in Quebec, who strongly distinguished themselves from British Anglicans, and Polish Catholics.

How do *New Dissenters* meet these three conditions in England and Wales?

4.2.3.1 Norms

The *New Dissent* discourse strongly emphasized self-improvement in spiritual education and literacy and self-education in the sciences or maths (Stephens and Roderick, 1974; Hempton, 2005; Anderson, 2012). As the improvement philosophy did not just include the self and the society, it seems likely that the same idea applied to the offspring. Such assumptions align well with general demographic theories explaining the relationship between education and fertility, such as the 'quality-quantity trade-off' by Becker (Becker and Lewis, 1973; Becker, 1986) or the *supply-demand* framework by Easterlin and Crimmins (Easterlin and Crimmins, 1985) (section *2.1.2.5*). Accordingly, I assume that the emphasis on self-conscience and the expectation of self-improvement might have indirectly promoted the idea of having smaller families and encouraged couples to limit family size comparatively early.

The prominence of individualism in the *New Dissent* theology and culture was critical to the distinctiveness of *New Dissenter*. The accentuated role of the individual is stressed in 19th-century hymn books which emphasize the relationship between the worshipper as an individual and God, as shown in this one citation out of many in *The Methodist Sunday*

School Hymn-Book published in 1870: “My God, I thank Thee, who has planned – A better lot for me; - And placed me in this happy land, - Where I can hear of Thee.” (Wesleyan Methodist Sunday School Department, 1870, p. 42). Improving society was considered a moral duty. If a religious denomination such as the Methodists advocates personal responsibility for individual well-being, it is likely to favour individual investment in human capital and self-improvement, e.g., attendance at evening or weekend educational classes. It also implies a weaker discounting of the future, with the present value of anticipated future benefits being accorded greater weight, as described by Max Weber in *The Protestant Ethic and the Spirit of Capitalism* in 1904/05 (Weber, 2006). I hypothesise that a denomination which downplays the value of consumption in the present in favour of consumption in the future is likely to be sympathetic to restraining current childbearing and having fewer, ‘higher-quality’ children.

In the mid-18th century, Susanna Wesley, the mother of John Wesley, founder of the Methodist church, already wrote about the importance of education for girls and boys through their mother (Prisco, 2020). *New Dissent* women received an education in their childhood much earlier than the average English and Welsh woman. The mother’s role was vital to providing religious education within the home. Callum Brown (2009) argued for Victorian Britain that a new morality among the *Dissenters* was built upon the idea that the faithful woman was only respectable if she followed a self-disciplined and abstinent life. This new role of mothers (Brown, 2009) might have enforced the new ideal of smaller families among *New Dissenters*. Pooley’s qualitative analysis of the northern textile district emphasizes the existence of such a disciplined family idea (Pooley, 2013).

In addition, *New Dissenters’* new social norms and conventions might have contributed to the earlier adoption of contraception. Campbell (1960) presents evidence that Nonconformist Churches, a title comprising both Old and *New Dissent*, were among the first Christian religions to speak out in favour of birth control (Campbell, 1960). Their advocacy for freedom of self-conscience possibly included conscious decision-making about family size or even contraception (Campbell, 1960). *The Christian World* published an editor’s reply to a letter from a Methodist Minister’s wife in 1893 after she had complained about the struggle of large families:

> "There was a time when any idea of voluntary limitation was regarded by pious people as interfering with Providence. We are beyond that now and have become capable of recognising that Providence works through the common sense of individual brains [...]."
>
> **(cited from Campbell, 1960, p. 134)**

This statement underlines the assumption that controlling the number of offspring was articulated and considered acceptable among *New Dissenters* comparatively early. The Anglican Church, in contrast, refused to comment on family limitation until 1930 (Campbell, 1960).

4.2.3.2 Institutions

While in 1770, the Methodist Church in Great Britain, the central force of the *New Dissent*, counted 26,282 members; numbers rose to 518,156 in 1850 and even 841,294 members in 1910 (Hempton 2005). A vital breakthrough was their greater flexibility in newly developed, industrialised towns and peripheral areas such as Cornwall or northern rural areas (Gay 1971). Most importantly, to reach out to as many as possible, Methodism relied on itinerant, lay and women preachers (Hempton 2005). Methodist preaching was conducted within and outside their chapels, such as private houses, schools or outside premises (Hempton 2005). Methodists practised different types of worshipping and preaching than the Church of England, making religious life accessible to a broad audience.

Most important in conveying their message to their members was the institution of societies, making members an active part of the running of the Methodists movement. The Church of England had a more hierarchical structure. Another critical institution was the Sunday school (Snell, 1999). In addition to teaching literacy skills, they were established to convey religious norms and values to the young generation and tie them to the chapel and community as early as possible. Especially in areas with a high prevalence of child labour, such as textile mills or agriculture, Sunday schools might have been the only or most frequent type of education children received.

The range of institutions utilised by the *New Dissent,* together with their community-based worshipping, seemed to have conveyed their strength as a religious entity. Moreover, these institutions generated a willingness to comply with norms and fostered strong cohesion among their members.

4.2.3.3 Identity

In the early days of the late 18th century, the *New Dissent* movement was opposed by the Established Church (Hempton 2005). Even though aiming to discourage their believers, primarily members with a lower-middle-class and working-class background (Field, 1994, 2012, 2013a), this opposition might have even encouraged a more vital group identification among *New Dissenters*.

The *New and Old Dissent* faced various discrimination throughout the 19th century (Gay 1971; Tombs 2014). To name a few examples, only in 1828 were *Dissenters* allowed to hold official offices and be elected to parliament. Four years later, in 1832, they were permitted to vote. Paying church tithes to the Established Church was still compulsory for them until 1868 (Gay 1971; Tombs 2014). These payments led to a double burden as *New Dissent* members had to fund their own chapels based on voluntary payments. As a result, encouraged by the opposition of the Anglican establishment, I assume that *New Dissenters* developed a deep sense of social identity necessary to uphold rules and norms related to fertility within their group of believers. However, I did not find any direct evidence about rules or norms regarding family-building practices among dissenters.

This chapter assumes that districts with a high prevalence of followers of the *New Dissent* experienced a faster and more significant decline in fertility than other districts. Accordingly, the main hypothesis of this chapter is as follows:

H 4.1: Geographical patterns of prevalence of *New Dissenters* correspond with historical geographical patterns of fertility change.

They advocated new norms and values for self-improvement and self-discipline. These norms strongly emphasize children's education, where the mother is the vital provider of (religious) education while being a pious example for her children.

4.3 Data

The current chapter uses data from the project *Populations Past – The Atlas of Victorian and Edwardian Population* (Reid *et al.*, 2018, 2020). This data set comprises population data for every decade from 1851 to 1911 for the administrative units of Registration Sub-Districts and Registration Districts. The data were calculated using the individual level census data from the *Integrated Census Microdata (I-CeM) 1851-1911*. As the 1871 census data were incomplete, the Populations Past data only give a limited number of variables for the same year and is therefore excluded from this study.

Between 1851 and 1911, England and Wales witnessed several administrative boundary changes. Therefore, I interpolated all the data to the 1851 set of administrative boundaries (Day 2016) using areal weighted interpolation (see section *3.1.2*) for both RSD and RD-level to create a comparable data set over time. This step allows to calculate change variables. A drawback of the RD level data is that the data are calculated from the RSD data, which are only provided as rates or ratios. To aggregate RSD level data to the higher administrative level of RDs, I used population size as a weight. However, depending on the variable, population size might not be the most accurate weight for aggregation. Even though it might make the data slightly less accurate as population age and sex structure differs in RSDs this was the only feasible way to extrapolate the data and receive the whole set of variables also available on the RSD level. Accordingly, for each variable X, the RSD data were aggregated as follows:

$$X_{RD} = \sum \left[X_{RSD\ i} * \frac{Population_{RSD\ i}}{\sum Population_{RSD}} \right] \quad 4.1$$

Another data source used in this analysis is the *Census of Religious Worship* from 1851 (Ell and Southall, 2020). The regular census did not record religion in England and Wales as it was common in other countries during the same time. The *Census of Religious Worship*, initiated by the government and conducted by the Registrar General (Snell and Ell, 2000), took place to quantify the geographical distribution, define the strength of different denominations and possibly detect the onset of secularisation.

Table 4.1. *Population Size in Registration Districts and Registration Sub-Districts 1851, 1881 and 1911 : Minimum, Mean and Maximum*

Year	Population Size							
	Registration District				**Registration Sub-District**			
	Min	*Mean*	*Median*	*Max*	*Min*	*Mean*	*Median*	*Max*
1851	2,493	28,776	20,173	258,236	413	8,186	6,096	69,542
1881	2,329	41,660	23,075	358,939	362	11,933	6,907	160,941
1911	2,097	57,898	25,607	704,158	320	17,954	9,159	184,904

Source: own calculations; data – Reid *et al.*, 2018.

Therefore, I only have a measurement of religion in 1851 and cannot trace change over time until 1911. The geographical distribution of all Methodists in England – making up the largest group within the *New Dissent*, is still broadly similar in the 1961 census to 1851, according to maps in Gay (1971). Accordingly, Gay (1971) assumed that the distribution of religious affiliation was mainly constant between the middle of the 19^{th} and 20^{th} centuries. In addition, analysis reveals a strengthening of the *New Dissent* during the Edwardian era (1901 to 1914) (Field, 2013b) before numbers started to decline again.

Boundary data for all census years for both Registration Districts and Registration Sub-Districts were created by Joseph Day (2016) and provided through a GIS database stored in Microsoft Access. Data has been extracted from the database and subsequently merged according to administrative units using the R package areal (Prener and Revord, 2019b). Registration Districts and Sub-Districts varied considerably in population size (Table 4.1). One Sub-District was, on average, a small to middle-sized town. Larger towns and cities consisted of multiple Sub-Districts; London, e.g., had 135 RSDs in 1881.

4.4 Indicators

All but one indicator in this study have been derived by and provided through the Populations Past project (Reid et al., 2018, 2020). The data on religion were provided through the UK Data Archive repository of Ell and Southall (2020). The first project already provides different population measures in its Atlas of Victorian and Edwardian Population, which have been defined and calculated using individual-level census data. The variables' description and calculation refer to data documentation by Reid et al. (2018). Table 4.2 gives information about how the different variables were calculated.

Dependent variable

Marital Fertility. The dependent variable in this analysis is the percentage change in Total Marital Fertility Rate (TMFR) of women aged 20 to 49. This TMFR measure can be interpreted as the children a married woman would give birth to on average if she was married by age 20 and remained married until age 50. The TMFR is chosen instead of the TFR as it is assumed that the innovation in fertility behaviour occurs within married couples and cannot be attributed to an increase in celibacy or non-marital childbearing. As the average woman in England and Wales did marry around her mid-20s, she did not necessarily experience this exact fertility trajectory.

The TMFR is a combination of Age Specific Marital Rates (ASMFR) for five-year age groups determined through the individual-level data in the census enumerator books. For married women, children under the age of five listed in the census have been identified to calculate the ASMFRs. There are some downsides of TMFRs as they overestimate the number of children born to younger cohorts when based on five-year age groups for ASMFR (Hoem and Mureşan, 2011). However, because I am ultimately interested in change, this limitation will not be an issue for the analysis. Reid et al. (2018) adjusted the number of identified children to potential influential factors such as infant and early childhood mortality, as the census cannot account for this. They inflated the births using local infant and child mortality rates to account for the children that would have been born in the five years preceding each census but died before the census date. This procedure involves multiplying the observed number of births by the inverse of the life table function ${}_5L_0/5*l_0$.

Explanatory variables

New Dissent. The definition from Snell and Ell (Snell and Ell, 2000) has been used to identify religious groups belonging to the *New Dissent*.[13] The 1851 *Census of Religious Worships* provides information both on *attendance* and *sittings*. These data were recorded through the census of religious worship and provided through the UK Data Archive repository of Ell & Southall (2020). *Sittings* give information about the number of sittings/seats provided in each church and chapel. *Attendance* refers to the attendance of all Sunday services (often more than once on a Sunday) and Sunday School. It does not refer to individual attendants. Accordingly, individual attendants might be counted multiple times under *attendance* if attending more than one service in addition to Sunday School. Worshipers of *New Dissenting* religions tended to participate in services more than once per Sunday. To avoid overcounting, the variable of choice in this analysis is the *sittings* (seats) measure. Even though some other denominations like the Church of England and Roman Catholic Church[14] struggled to fill their sittings and attendance was low, similar reports do not exist for *New Dissenters*. Accordingly, the *New Dissent* might have provided a more accurate number of *sittings* (seats) for their members and calculating an Index of Sittings might be a more accurate measure than an Index of Attendance if one wants to capture the proportion of *New Dissenters* within the population. Accordingly, the measure s*ittings* probably give a better indication of the strength of non-conformism of the *New Dissent* variety within a given locality. It is this cultural influence that the analysis is trying to capture, and it could extend beyond the people who attended *New Dissent* chapels.

The so-called *Index of Sittings* is calculated by dividing the number of *sittings* through the population for each Registration District.[15]

[13] Even though these groups had their distinct features these seemed to be rather theological than ideological. All of them emerged from the same movement and certainly advocated similar norms as described in section 4.2.3. This fact makes them distinct from the so called "Old Dissent" although there is some overlap as well.

[14] Because previous research suggested that bot catholic couples but also areas with a higher prevalence of Roman Catholics experienced higher fertility levels (Teitelbaum, 1984), I estimated models including the Index of Sittings for Roman Catholics as an additional measure for religious groups as well as the only variable for religious groups. However, even though both models estimate a small positive association with the change in TMFR it has not been statistically significant. Accordingly, the variable has not been considered in further analysis.

[15] The *Index of Attendance* is calculated accordingly and as a robustness check, models will be presented in Appendix A.15 using this variable. The correlation of sittings and attendance is for the larger groups within the *New Dissent* around 0.8 (Snell and Ell, 2000).

Occupational class. The analysis includes two indicators for two different social class groups with presumably low and high fertility, as provided by Reid et al. (2018). **Professionals and Managers** are the variable of choice to measure the local middle-class population. The *professional and managerial class* is Social Class I in the social class scheme as classified by the Registrar General in 1911. It is the percentage of all men aged 14 to 64 in this class compared to all men aged 14 to 64. This class includes occupations such as doctors, lawyers, or accountants, all considered middle-class occupations. **Miners and Agricultural Labourers** is the second occupational class variable. This variable is based on a combination of Social Class VII and VIII of the 1911 Registrar General Classification. Both groups are combined as they have comparatively high fertility levels. As in class I *professionals and managers*, it is the percentage of all men from age 14 to 64 in these classes compared to all men aged 14 to 64. Both social class variables included are negatively correlated; however, they are not the inverse of each other.
Even though there are similarities to socio-economic status based on HISCLASS – an international historical class scheme created to compare different periods, countries, and languages- the Registrar General's classification has some unique features. Besides a core group of five classes, it has three additional classes for textile workers, miners, and agricultural labourers. Previously, it has been discussed that this form of classification has some drawbacks and is not without critique: Szreter (1996) points out that the Registrar General has only created the different groups for the 1911 census by their fertility behaviour. Still, using it, the results will be comparable to previous research conducted in England and Wales (e.g. Garrett *et al.*, 2001).

Married Women Working. The variable gives information about all married women 15 or older with a recorded occupation as a percentage of all married women aged 15 or older, derived by Reid et al. (2018). Those women who have 'housewife' or 'house duties' recorded as an occupation have not been considered in this measurement as it is not considered paid employment. Women were identified through the individual-level census data using the combination of information on age and sex, marital status, and occupation. Between 1851 and 1911, female employment declined considerably. Partially, this might be attributed to changes in how questions were asked and how employment was classified. Nevertheless, home-based work, such as the cottage industry, decreased during the same decades in favour of factories.

Number of Teachers per 100 children. The variable measured educational provision and was calculated by Reid et al. (2018) as children per teacher. Here, the measure has been transformed to Teacher per 100 children for a more straightforward interpretation of parameter estimates. T*eacher per 100 children* gives information about the number of teachers in a Registration Sub-District divided through the number of children aged 5 to 13. The number of teachers was identified through individuals with the occupation 'teacher' listed in the census. Nationwide education was introduced through the 1870 Education Act (UK Parliament 2023) while compulsory primary education was only introduced in 1881. Accordingly, it is somewhat unclear what the teachers per capita variable really measures before 1870. In addition, not all children went to school regularly for different reasons. Therefore, this variable can be considered a measure of educational provision or, when analysing its change over time, as educational expansion. Considering that provision of education has been viewed for over thirty years, the increase in education could be influential for the education of the mother and child. It does not give information about the size of classes or individual schooling. In 1851 there were six RSDs without teachers present.

Infant Mortality. The variable *Infant Mortality Rate* gives information about the deaths below age 1 per live birth multiplied by 1,000 and has been derived by Reid et al. (2018). This measure was calculated for the year leading up to the census as transcribed from the Registrar General's Quarterly Returns of Births, Deaths and Marriages by Reid et al. (2018). For smaller geographical areas, calculations used deaths below age one and live births of the five years leading up to the next census to avoid random fluctuations. As the Registrar General's Quarterly Returns were only published after 1869, the data assume that the Infant Mortality Rate was stable between 1851 and 1869.

Early Childhood Mortality. The variable *Early Childhood Mortality Rate* (ECMR) gives information about the death of children aged 1 to 4 of all children aged 1 to 4 times 1,000. The ECMRs on the RSD-level are derived from a model relating ECMR to infant mortality on the RD-level and a set of various other variables for the five years leading up to the census, as presented in Jaadla and Reid (2017). Even though levels are highly correlated, the change over time, which is also of interest, is not highly correlated.

Sex Ratio. Possible migration is captured by calculating the *sex ratio,* which compares the male and female working age population in different areas derived by Reid et al. (2018). The variable is defined as all men aged 14 to 64 years divided by all women 14 to 64 times 100. This information is taken from the individual level census data using the information on age and sex. Values of 100 show a balanced sex ratio, whereas higher values imply a larger population of working-age males and possibly in-migration of men, such as in mining areas.

Mean Age at Marriage. To account for TMFR being subject to and possibly influenced by differences in nuptiality regimes, I will account for the mean age at marriage for women. As no data source provides information about age at marriage, the information has been derived from the census data using the measure Singulate Mean Age at Marriage (SMAM) by Reid et al. (2018). Using the information on the proportion of single women below age 50, this measure considers the average number of person-years lived for those not married. The SMAM is not a direct measure of age at marriage but gives an approximate age close to the real average age at marriage, given that migration is widely absent and nuptiality patterns are comparatively stable.

Population Density. Urbanisation can be measured through *population density*. From a theoretical perspective, more urbanised areas are more likely to experience lower fertility levels and possibly a faster fertility decline (Davis and Blake, 1955). The number of people in each Registration Sub-District has been recorded for every census year in the census reports. Here, the variable is calculated using the interpolated count data for the population as provided by Reid et al. (2018) and dividing it through the Registration District or Registration Sub-District area in square kilometres. The area has been derived from the boundary data (Day 2016). As *population density* differs considerably for rural and urban areas, it can be considered a measure of urban-rural difference. Especially when considering the change variable, it also captures the urbanisation process.

Table 4.2. *Indicators: Description, Type of Variable, Calculation and Further Explanations.*

Indicator	Variable	Type of variable	Formula	Explanations
Marital fertility	Total Marital Fertility Rates	Dependent	$\sum_{a=20-24}^{45-49} \frac{births\ to\ married\ women\ (a)}{married\ women\ (a)}$	The term a refers to an age group.
New Dissent	a) Index of Sitting b) Index of Attendance	Explanatory	$a)\ \frac{number\ of\ sittings}{population}$ $b)\ \frac{number\ of\ attendance}{population}$	Sittings refer to the overall number of sittings in *New Dissent* places of worship. Attendance refers to attendance at all Sunday services and Sunday School. It does not refer to individual attendants. Accordingly, attendants might be counted multiple times under attendance if attending more than one service plus Sunday School.
Middle-Class Population	Professional and Managerial Class (Registrar General's Social Class I)	Explanatory	$\frac{men\ (15\ to\ 64)\ in\ Social\ Class\ I}{men\ (15\ to\ 64)}$	
Married Women Working	All married women aged 15 and above with recorded occupation	Explanatory	$\frac{Married\ women\ (15 =<)\ with\ occupation}{Married\ women\ (15 =<)}$	
Educational Provision	Teacher per 100 children	Explanatory	$\frac{Teacher\ in\ district}{Children\ (5\ to\ 13)} * 100$	
Infant Mortality	Infant Mortality Rate (IMR)	Explanatory	$\frac{Deaths\ (> 1)}{Live\ Births} * 1{,}000$	
Early Childhood Mortality	Early Childhood Mortality Rate (ECMR)	Explanatory	$\frac{Deaths\ (1\ to\ 4)}{Children\ (1\ to\ 4)} * 1{,}000$	
Miners and Agricultural Labourers	Combination of Registrar General Social Class VII and VIII	Explanatory	$\frac{men\ (15\ to\ 64)\ in\ Social\ Class\ VII\ and\ VIII}{men\ (15\ to\ 64)}$	

Table 4.2. *Indicators: Description, Type of Variable, Calculation and Further Explanations.*

Indicator	Variable	Type of variable	Formula	Explanations
Migration	Sex Ratio	Explanatory	$\frac{men\ (15\ to\ 64)}{women\ (15\ to\ 64)}$	
Nuptiality	Singulate Mean Age at Marriage	Explanatory	$\frac{A - 50 * singles\ (40\ to\ 49)}{1 - \ singles\ (45\ to\ 49)}$, where $A = 20 + \ \sum_{a=20-24}^{45-49} singles_a$	A is the number of person-years lived in a single (never married) state for each age group a.
Urbanisation	Population Density	Explanatory	$\frac{population}{area}$	Area is measured in square kilometres (km^2)

4.5 Results

4.5.1 Descriptive Results

This chapter identifies forerunners of the fertility transition by describing national and sub-national trends in England and Wales between 1851 and 1911. Districts experiencing at least a 10% decrease in the Total Marital Fertility Rate (TMFR) after 1851 are considered forerunners. For each Registration Sub-District (RSD) the percentage change in TMFR is computed from 1851 to all census years between 1881 and 1911 (Figure 4.4). By defining 1851 as the baseline year[16], I acknowledge that England and Wales already witnessed diverse patterns of marital fertility before the fertility decline.

National trends (Figure 4.2) suggest that forerunner areas can be identified before 1881: TMFR was stable before 1881. In 1881, we can observe the tipping point of the transition. Now, fertility has begun to decrease rapidly. However, the onset of the fertility transition on the national level does not necessarily constitute the onset of the fertility decrease in all RSDs. Some RSDs might have experienced an earlier decline. Within the same time, the number of Methodist members- the critical majority of the *New Dissent* – increased and almost doubled from 455,323 members in 1851 to 843,785 members in 1906 (Currie *et al.*, 1977).

[16] To test if depicted results are robust, the same calculations have been carried out using 1861 as the baseline year. Spatial patterns remain the same and only show slight changes.

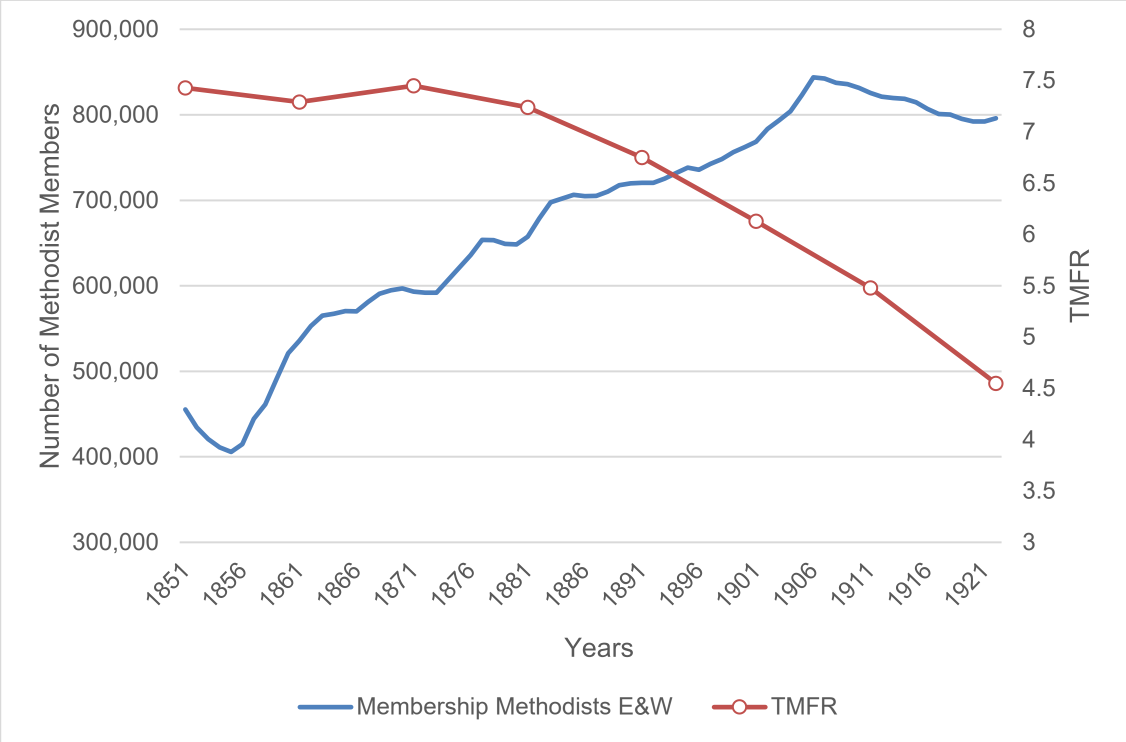

Figure 4.2. *Forerunners at the national level: Total Marital Fertility Rates and Number of Methodists Memberships 1851 to 1922 (Sources: Currie et al., 1977; Woods, 2000)*

The correlation of the two variables *change in the Total Marital Fertility Rate between 1851 and 1881*, and the *Index of Sitting for the New Dissent* in 1851 reveals a significant negative Pearson correlation coefficient of -0.32. Where the prevalence of *New Dissenters* was high, the TMFR declined faster and more considerable between 1851 to 1881. Even though places with more *New Dissenters* witnessed an accelerated fertility transition on average, RDs with a low share (Index below 25) of *New Dissenters* appear to experience diverse patterns of fertility declines (Figure 4.3). The type of place (Figure 2.2) according to its occupational structure does not seem important for the change in TMFR and does not seem a confounding factor. Another important finding is that even though places with more *New Dissenters* witnessed a faster and more significant decline in TMFR on average, RDs with a low share (Index below 25) of *New Dissenters* appear to have very diverse fertility declines. Marital fertility in these districts may have dropped or increased between 1851 and 1881. Accordingly, even though *New Dissenters* appear to be associated with an early fertility decline, other factors outside the *New Dissent* and type of place are likely necessary factors.

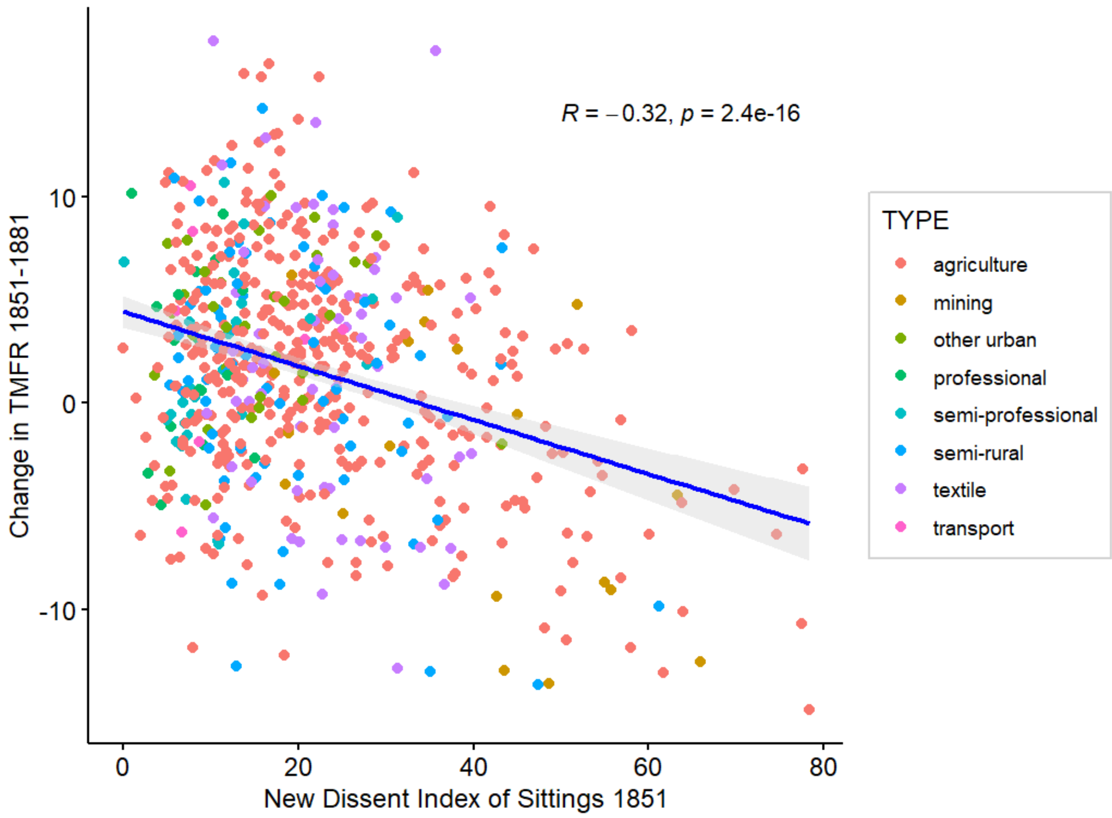

***Figure 4.3**. Correlation plot of Change in TMFR between 1851 and 1881 and Index of Sitting for the New Dissent in 1851 (Sources: own calculations; data - Reid et al. 2018; Ell & Southall 2020).*

Only small-scale geographical data can reveal the spatial origin of the fertility transition to determine the forerunners of declining fertility. To account for spatial variations in fertility levels before the tipping point in 1881, it makes sense to consider percentage change in TMFR over absolute change.

Figure 4.4 displays the percentage change from 1851 to 1881, 1891, 1901 and 1911. The grey areas constitute Registration Sub-Districts (RSDs) with a change of less than (+/-) 10%, possibly only random fluctuations. Areas ranging from yellow to dark red have witnessed a sustained fertility decline from at least 10% to more than 35%. Not all RSDs experienced a decline; in some, fertility increased, indicated through blue colouring. These areas were the laggards of the transition.

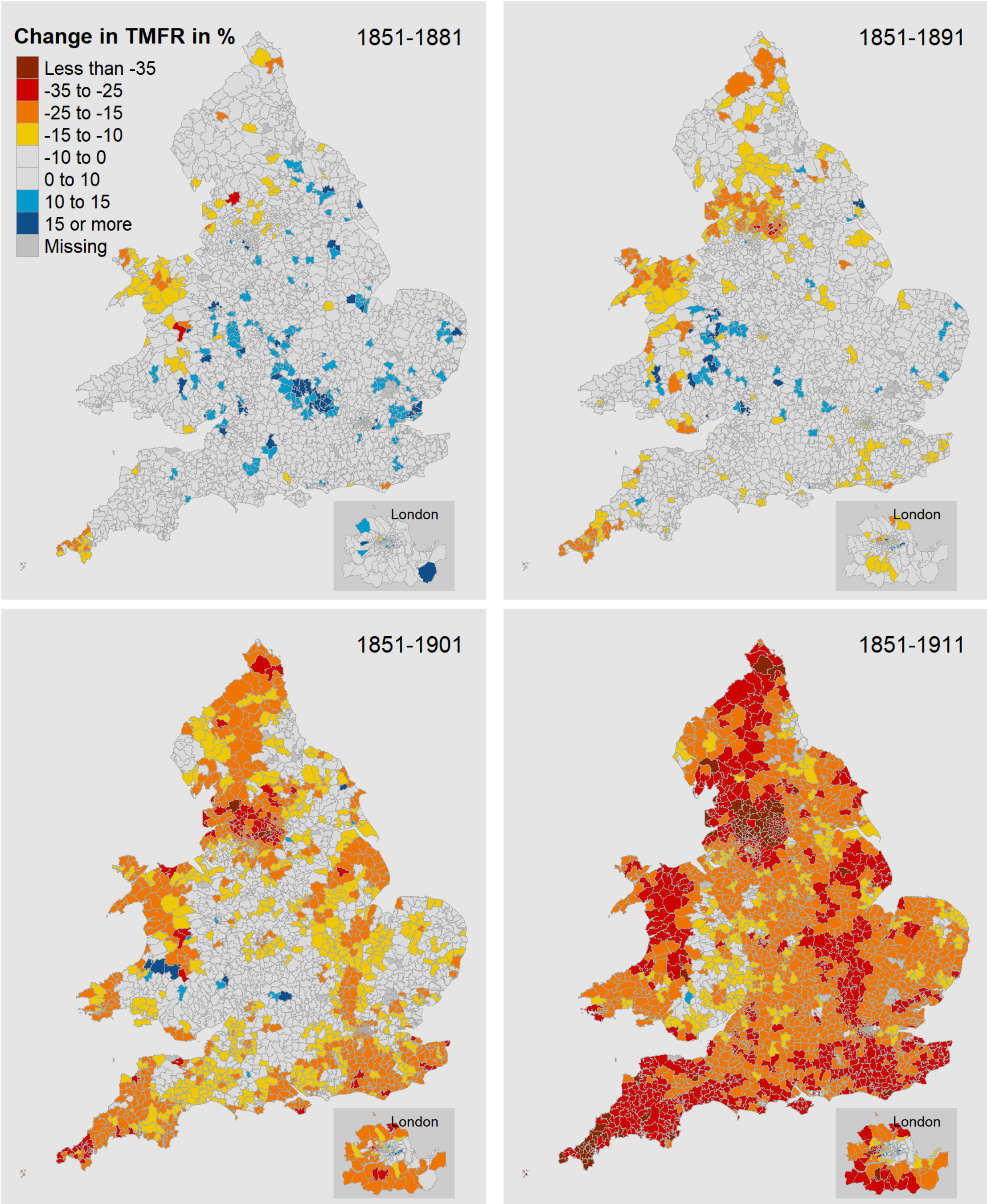

Figure 4.4. *Forerunners at the Local Level: Percentage ecline of TMFR in Registration Sub-Districts (Sources: own calculations; data - Reid et al., 2018; boundaries – Day, 2016).*

By 1881, only a minority of RSDs had witnessed a significant fertility decline. Some coastal areas and middle-class towns in the South of England displayed a TMFR decline between 10% to 20%. Similarly, some RSDs in Lancashire appear as forerunners of the fertility decline. Here, the RSD of Slaidburn had already exhibited a change of more than 30% in the thirty years before 1881. These were textile areas that had already been considered forerunners by contemporaries and the previous literature. Areas that had never been identified as a forerunner are parts of North-West Wales with RSDs such as Caernarvonshire and Cornwall's South as the RSDs of Penzance, Helston, and Redruth.[17] One striking feature is that Cornwall was a forerunner even in the mining districts, which one might have expected to be laggards. The simple but new technique of displaying small-scale geographical change now detects this meaningful early change in fertility which was muted at the national level.

In the following decade to 1891, RSDs, which were already witnessing a decline in fertility in the early years, continued their decline. Simultaneously, surrounding areas seem to join. Such an observation might support a diffusionist perspective of the fertility transition. The first areas in London and others in Southeast England present the first drop in fertility. By 1901, around half of the RSDs had entered the transition. The textile areas in Lancashire and parts of the West Ridings were the leading areas of the fertility transition. Some of these had experienced a decline of more than 35%. Most of the Southwest and Southeast, North and Northwest of England, and parts of the North Midlands had now entered the fertility transition.

In 1911, the majority of England and Wales had witnessed a decline in marital fertility with the Northern textiles, Cornwall but now also Sussex and Surrey in the Southeast still leading the transition. Laggards of the transition were the coalfields from the South to mid-Wales, the Tyneside, areas around Nottingham and parts of the West Midlands. The East of London did not experience a fertility decline between 1851 and 1911. These parts of London already had the highest fertility levels within London in 1851, being close to the high national average of marital fertility. In contrast, West London had the lowest TMFRs in 1851 nationwide, sometimes even below replacement fertility. Still, these RSDs witnessed a significant decline in fertility.

[17] To avoid that TMFR are just a product of randomness due to small population size and accordingly a low number of women in childbearing ages, all RSDs which revealed a significant drop in fertility have been manually checked to confirm that they do not belong to RSDs on the lower range of the population size.

This novel approach to examining long-term trends in marital fertility to identify forerunner areas using geographical data proves valuable in obtaining new insights into the fertility transition in England and Wales. Northern Wales and Cornwall appeared to have already been forerunners of the fertility decline. However, previous observations and assumptions of declining fertility in the English and Welsh context relying predominantly on occupational structure do not seem very promising to explain declining fertility in these areas. Both were shaped by agriculture, tin and copper mining in Cornwall, and iron mining in North Wales. However, they were dominated by the so-called *New Dissent*, as depicted in Figure 4.1. The following section aims to fill this gap by exploring the association of the *New Dissent* and the early onset of the fertility transition.

4.5.2 Spatial Lag Model

This section presents the modelling results. Spatial lag models estimate the percentage change in Total Marital Fertility Rates (%ΔTMFR) as a function of the *New Dissent* religions and all other explanatory variables, such as occupational structure or infant mortality, as discussed in section 4.4. Both the significant decrease in the AIC versus the linear model, the disappearance of spatial autocorrelation of model residuals measured through Moran's I and the results of Lagrange multiplier tests (Appendix A.9) indicate that the spatial approach and the spatial lag model are justified for this analysis. Analyses are separated into forerunner years ranging from 1851 to 1881 (Table 4.3) and the main decline years from 1881 to 1911 (Table 4.4). The effect of a change in x_i on y_i in the spatial lag models will likely be larger than the coefficient on $x_{i,}$: The direct and indirect marginal effects resulting from the spatial spillover effect (ρ) introduced by a spatial lag model as explained in section 3.2.4are presented in order to receive information on the total marginal effects of each explanatory variable.

For both periods, two sets of models are calculated. The so-called precondition-models use explanatory variables (X) from the onset of the period to determine how the conditions at the onset of both periods might relate to the subsequent decline in marital fertility. These are presented on the left-hand side of Table 4.3 for the forerunner and Table 4.4 for the main decline years. For the precondition-models, all explanatory variables are standardised according to their mean and standard deviation. The standardisation of explanatory variables allows us to interpret the parameter estimates for the precondition-models as follows: for a one standard deviation increase in the explanatory variable, the response variable change in TMFR (%ΔTMFR) increases or decreases by β percentage points. Descriptive statistics of all the dependent and all explanatory variables are presented in Appendix A.3. To explain how to interpret the coefficient, the interpretation for the explanatory variable *infant mortality rate* with a parameter estimate of 0.32 in the linear model 1851 to 1881 (Table 4.3 – precondition model) is as follows: An increase in one standard deviation in the infant mortality rate in 1851 is associated with a positive 0.32 percentage point change in TMFR between 1851 and 1881 keeping all other factors constant. Accordingly, places with above-average infant mortality in 1851 exhibited an increase in marital fertility in the subsequent thirty years compared to below-average infant mortality areas, which was associated with a fertility decline.

The second set of models, here called change-models, takes the change in the explanatory variable (%ΔX) over every thirty years into account. These are presented on the right-hand side of Table 4.3 for the forerunner and Table 4.4 for the main decline years. As the variable *New Dissent* religions are only available for the year 1851 for the Registration District (RD) level, this variable is incorporated into all models. Model results for the smaller units of Registration Sub-Districts (RSD) are presented in Appendix A.11. Because explanatory variables of the change-models are measured in the same unit as the dependent variable (percentage change), the parameter estimates can be interpreted as elasticities (except for the *New Dissent* variable - this is because I do not have the data that allow to calculate a change in the *New Dissent* variable). Accordingly, a 1% increase in the explanatory variable is associated with a 100*β% change in the dependent variable. To have an example of such an interpretation, the interpretation of the parameter estimate for the variable *infant mortality rate* of -0.04 of the linear model (Table 4.3 – change model) is as follows: a 1% increase in the infant mortality rate between 1851 and 1881 is association with a 4% decrease in TMFR across the same period.

All linear and spatial lag models were estimated within R, whereas the *spatialreg* (version 1.2-1) package, developed by Roger Bivand and Gianfranco Piras, was used for the latter. The same package has been used to estimate the direct, indirect, and total effect of explanatory variables created through the spatial spillover effects.

The descriptive maps already suggested the existence of a spatial spillover effect and positive spatial lag coefficient ρ. All spatial autocorrelation coefficients in all four models are highly statistically significant and range between 0.66 and 0.77. A one-unit increase (here percentage point) in average TMFR in neighbouring areas *j* is associated with an increase in TMFR in location *i* by 0.66 to 0.77. Accordingly, a decrease in the average TMFR of the neighbouring district *j* is similarly associated with a decrease in TMFR in location *i*. The results strongly suggest that the change in fertility in one region might be related to the change in the fertility of a neighbouring region. This finding might be interpreted cautiously as spatial diffusion mechanisms associated with changing fertility.

The central hypothesis H 4.1 in this chapter is that regions strongly influenced by *New Dissent* religions show a more considerable decline in marital fertility than other areas. *The Index of Sitting* measures *New Dissent* in places of worship in a RD compared to the overall population. Indeed, the precondition-model in Table 4.3 for the forerunner years estimating the change in TMFR between 1851 and 1881 reveals the hypothesised association. A one standard deviation increase in *New Dissent* Index of Sitting is associated with an adverse change in fertility of 0.47 of a percentage point. Including spill-over effects, an increase in one standard deviation of *New Dissent* Index of Sitting is even associated with a change -1.39 points (total marginal effect), with the indirect effect contributing two-thirds. These results are statistically significant at the 0.01 level. Additionally, the results percentage for the *New Dissent* hold in the change-model for the same period. These results suggest that the estimate from the precondition-model for the forerunner years is robust. Here, a 1 percentage point increase in *New Dissent* is associated with a 12-percentage point decrease in TMFR (Table 4.3 – change model). During the main decline years from 1881 to 1911, the association is still slightly negative for both the precondition and change-model (Table 4.4) but is not statistically significant anymore. Therefore, areas with a strong *New Dissent* seem to be forerunners in England and Wales's early years of declining marital fertility, after which their distinctiveness seemed to diminish.

Table 4.3. *Modelling Change in Total Marital Fertility Rates (%ΔTMFR) for Forerunner Years (1851-1881) and Registration Districts: Linear Model and Spatial Lag Model (Direct and Indirect Effects)*

	Precondition Model					Change Model				
	Linear Model	Spatial Lag Model				Linear Model	Spatial Lag Model			
			Marginal Effects					Marginal Effects		
	β	β	Direct	Indirect	Total	β	β	Direct	Indirect	Total
Intercept	1.62***	0.55***				5.78***	2.54***			
Professional and Managerial Occupations	0.47	0.30	0.34	0.55	0.88	0.00	0.00	-0.01	-0.01	-0.02
Married Women Working	1.37***	0.76***	0.86***	1.40***	2.26***	-0.03***	-0.02***	-0.02***	-0.04***	-0.07***
Mining and Agricultural Occupations	-0.24	-0.39	-0.44	-0.71	-1.15	0.01**	0.01**	0.01*	0.02*	0.03*
Sex Ratio	0.39	0.15	0.17	0.27	0.44	0.02	0.02	0.02	0.04	0.06
Mean age at marriage (women)	-1.81***	-1.09***	-1.23***	-2.00***	-3.23***	0.29***	0.24***	0.27***	0.47***	0.74***
Infant Mortality Rate	0.32	-0.10	-0.11	-0.18	-0.29	-0.04°	-0.006	-0.01	-0.01	-0.02
Early Childhood Mortality Rate	-1.61*	-0.65	-0.74	-1.19	-1.93	0.04**	0.01	0.015	0.03	0.04
Teacher per 100 Children	0.49°	0.17	0.19	0.31	0.51	-0.01*	-0.01*	-0.01*	-0.01*	-0.02*
Population Density	0.14	-0.10	-0.12	-0.19	-0.31	-0.01*	-0.002	-0.003	-0.004	-0.01
New Dissent Index of Sittings 1851	-1.33***	-0.47*	-0.53**	-0.86*	-1.39**	-0.12***	-0.04**	-0.04***	-0.08***	-0.12***
Spatially lagged %ΔTMFR 1851-1881 (ρ)		0.66***					0.68***			
Num. obs.	621	621				621	621			
Adjusted R^2	0.21					0.20				
Moran's I of Model Residuals	0.44***	0.00				0.46***	-0.02			
AIC	3770	3520				3776	3504			

****p < 0.001; ** p < 0.01; * p < 0.05; ° p < 0.10.*

Sources: own calculations; data: Day, 2016; Reid et al., 2018; Ell & Southall 2020.

Table 4.4. *Modelling Change in Total Marital Fertility Rates (%ΔTMFR) for Main Decline Years (1881-1911) and Registration Districts: Linear Model and Spatial Lag Model (Direct and Indirect Effects)*

	Precondition Model					Change Model				
	Linear Model β	Spatial Lag Model				Linear Model β	Spatial Lag Model			
		β	Marginal Effects				β	Marginal Effects		
			Direct	Indirect	Total			Direct	Indirect	Total
Intercept	-22.39***	-5.21***				-14.2***	-1.70*			
Professional and Managerial Occupations	0.45	-0.71**	-0.86**	-2.11**	-2.97**	-0.03***	-0.01*	-0.02*	-0.04*	-0.06*
Married Women Working	-1.29***	-0.67***	-0.82***	-2.01***	-2.82***	0.02	0.00	0.00	-0.01	-0.01
Mining and Agricultural Occupations	0.44	-0.12	-0.15	-0.36	-0.51	0.03***	0.01***	0.01***	0.04***	0.05***
Sex Ratio	0.45	-0.14	-0.17	-0.42	-0.60	-0.03	-0.03	-0.04	-0.09	-0.13
Mean age at marriage (women)	-0.53°	-0.48*	-0.58*	-1.43*	-2.01*	0.4***	0.17***	0.21***	0.53***	0.74***
Infant Mortality Rate	-0.68	-0.51	-0.62	-1.52	-2.14	0.08*	0.05*	0.06*	0.16*	0.23*
Early Childhood Mortality Rate	1.61°	1.09°	1.32°	3.23	4.55°	0.09**	0.02	0.02	0.05	0.07
Teacher per 100 Children	-1.29***	-0.31	-0.37	-0.92	-1.29	-0.03***	-0.02***	-0.02***	-0.06***	-0.08***
Population Density	2.68***	1.20***	1.46***	3.58***	5.04***	-0.01*	-0.01**	-0.01**	-0.03*	-0.04**
New Dissent Index of Sittings 1851	0.59*	-0.07	-0.08	-0.21	-0.29	0.02	-0.01	-0.01	-0.04	-0.05
Spatially lagged Δ TMFR 1881-1911 (ρ)		0.76***					0.77***			
Num. obs.	622	622				622	622			
Adjusted R^2	0.38					0.32				
Moran's I of Model Residuals	0.53***	0.01				0.48***	-0.03			
AIC	3850	3451				3904	3476			

****p < 0.001; ** p < 0.01; * p < 0.05; ° p < 0.10.*

Sources: own calculations; data: Day, 2016; Reid et al., 2018; Ell & Southall 2020.

A critical theory proposed that the expansion of education is associated with a decline in fertility; a lack of suitable data prohibited testing this association in England and Wales prior to the release of data from the Populations Past project (Reid et al. 2018). The sixty years of study witnessed a tremendous expansion of schooling, with compulsory education being implemented by law in 1880. The schooling condition measured through teacher per 100 children both at the beginning of the forerunner years in 1851 (Table 4.3 – precondition model) with a positive total marginal effect of 0.51 and main decline years in 1881 (Table 4.4 – precondition model) with even a negative total marginal effect of 1.29 is not statistically significant. These findings indicate that the condition of schooling in 1851 and 1881 does not seem important for the fertility decline in the subsequent 30 years. However, the increase in schooling over both thirty-year periods is significantly associated with decreasing marital fertility according to the forerunner years change models. Considering 1851 to 1881, the mechanism of educational expansion reducing fertility might act through both the mother and the child. Women might reduce her fertility because she experienced more education throughout her childhood which potentially increases their opportunity costs. Being obliged to send children to school, especially during times when education was not necessarily free of charge and came with other obligations such as taking good care of a child's hygiene and appearance, might have been another factor for couples to reduce their number of offspring. The way, the variable measures educational provision does unfortunately not allow to disentangle the mechanisms through which education might act as a determinant of declining fertility. Between 1851 and 1881, a 1% increase in *teachers per 100 children* was associated with a statistically significant decrease of 2% in marital fertility, considering the total marginal effect of -0.02 in the same period and keeping all other factors constant (Table 4.3 – change model). For the main decline years, a 1% increase in the explanatory variable *teachers per 100 children* was associated with a 2% decline (β) in TMFR or even an 8% decrease, considering the total marginal effect (of which the indirect effect contributes 6%) (Table 4.4 – change model). The latter results are again highly statistically significant. Therefore, the findings suggest that the expansion of education was an essential driver of the decline in marital fertility throughout the second half of the 19^{th} and early 20^{th} centuries: similar, the results of the change model highlight the importance of spill-over effects of the educational expansion. However, since the mechanisms through which the variable *teachers* *per 100 children* acts is rather unclear, the actual meaning is still ambiguous and the interpretation needs to be considered with caution.

Considering the existing literature that found the middle-class population to be forerunners of the Fertility Transition, one might expect a negative association between marital fertility and a high share of the middle-class population. Here, middle-class population is measured through the share of professional and managerial occupations in the male working-age population as described earlier (Sub-Chapter 2.1.2.1). Against the expectations, however, the prevalence of the middle-class in Registration Districts in 1851 was positively associated with ΔTMFR (Table 4.3 – precondition model). A one standard deviation increase in professional and managerial occupations was associated with a 0.30 percentage point increase even though not statistically significant. Furthermore, the change in professional and managerial occupations across the forerunner years indicates a negative but not significant association (Table 4.3 – precondition model). What stands out in Table 4.4 is the expected association between the middle-class population and marital fertility during the main decline years, with a significant negative association between 1881 and 1911: This association indicates that an increase in one standard deviation in the variable professional and managerial occupations was linked to a decline of 2.97 percentage points in TMFR between 1881 and 1911 – given the total marginal effects (Table 4.4 – precondition model). A 1% increase in the middle-class population across the main decline years was associated with a 6% decrease in TMFR across the same time as indicated by a total marginal effect of -0.06 (Table 4.4 – change model). Besides not acting as forerunners between 1851 and 1881, these findings highlight the exceptional importance of regional patterns of the middle-class population for the main decline in fertility between 1881 and 1911. Agricultural and coal mining areas were traditionally considered laggards of the fertility decline. Models for the forerunner years (Table 4.3) and main decline years (Table 4.4) are consistent with this assumption. Similarly, results for the sex ratio as a measure of migration only estimate comparatively small and insignificant results across all models.

Registration Districts with a high share of married women were also expected to be forerunners: Here, parameter estimates are even positive and highly statistically significant, with TMFR increasing by 0.76 percentage points or even 2.26 percentage points (total marginal effects) for each standard deviation increase in married women working (Table 4.3 – precondition model). The high prevalence of home-based labour in 1851 might explain this unexpected association. Further results for the change in married women working by RD indicate a statistically negative association with the change in TMFR between 1851 and 1881 in the change model. A 1% change in the share of married women working was associated with a 2% decrease in TMFR with the parameter estimate of -0.02 and even a 7% decrease considering the total marginal effect of -0.07 (Table 4.3 – change model). During the main decline years, a high share of married women working in 1881 was associated with a further significant and fast decline in TMFR between 1881 and 1911: the total marginal effect estimates a 2.82 percentage point decline in TMFR between 1881 and 1911 in line with a one standard deviation increase in married women working in 1881 (Table 4.4 – precondition model). Accordingly, this association is the most crucial driver of declining fertility between 1881 and 1911, next to the share of the middle-class population. However, the change in TMFR (1881- 1911) seems to be unaffected by the change in the share of married women working over the same period (Table 4.4 – change model).

The variable *mean age at marriage of women* is included to account for regional differences in nuptiality. In both models accounting for preconditions in 1851 (Table 4.3) and in 1881(Table 4.4), the association of mean age at marriage and marital fertility is negative and significant with -1.09 and -0.48 (parameter estimates β) or even -3.23 and -2.01 considering total marginal effects in line with one standard deviation in age at first marriage. Accordingly, districts with a high *mean age at marriage* in 1851 or 1881 experienced a comparatively rapid decrease in marital fertility in the following thirty years. However, the coefficients for the change-models point in the opposite direction (Table 4.3, Table 4.4). An increase of 1% in the *age at marriage* during the forerunner and main decline years is associated with an increase in TMFR in total by 74% each (total marginal effects of which 53%/47% indirect effect). Therefore, if the *mean age at marriage* of women decreased, the associated TMFR decreased as well. The inclusion of age at marriage partially removes the TMFR artefact of overestimated exposure to motherhood within a five-year period, which often leads to inflated estimates of fertility in such age-groups. This artefact exists due to high fertility at young ages while only relying on short intervals of marriage, especially towards the end of five-year-age periods (Hoem and Mureşan, 2011). The same association does not necessarily apply for TFR.

Indeed, when modelling TFR an increase in *age at marriage* and celibacy leads to lower fertility. This pattern is found even if fertility among married couples stays constant, as confirmed by the models in Appendix A.12.[18] Here, in the models estimating TMFR using first age at marriage, the increase might also capture a speeding up of childbearing among married couples where the age of marriage is high, even though for TFR, in general, might be the opposite. Increasing the mean age at marriage reduces the exposure to the risk of marital fertility, so maintaining similar TFRs will need higher TMFRs. In general, including the change in age at first measure rather controls for an artifact in the calculation of TMFR rather than providing a useful association.

Geographical patterns of infant and early childhood mortality were very diverse. During the forerunner years between 1851 and 1881, the precondition and change models did not yield significant results (Table 4.3 – precondition model). Areas with higher *infant mortality rates* did not adjust their fertility due to higher survival rates of offspring yet. Given that *infant mortality* did not decline until 1900, it does not seem surprising that its association with marital fertility is inconclusive for the forerunner years. During the main decline years from 1881 to 1911, however, the results for the change-model suggest that a 1% change in *infant mortality* was positively associated with a change in marital fertility by 5 % or even 23% considering total marginal effects, both in the negative and positive direction. Accordingly, areas, where infant mortality declined most rapidly saw marital fertility decline most rapidly. The results for early childhood mortality rates are largely inconclusive. However, in areas where childhood mortality was high in 1881, also TMFR stayed high in the subsequent thirty years (Table 4.4 – precondition model).

When considering population density as a measure of urbanisation, neither the precondition nor the change model seems to be particularly important in explaining the change in TMFR during the forerunner years from 1851 to 1881 (Table 4.3). Surprisingly, high

[18] Another alternatively specified model excluding this variable confirms that the previously discussed results for *married women working* and other variables are robust (see Appendix A.17).

levels of population density at the onset of the main decline years in 1881, as shown in the model, seem with a highly statistically significant coefficient of 1.20 and a total marginal effect of 5.04 to be strongly associated with increasing marital fertility or at least not a decline over the following three decades (Table 4.4 – precondition model). However, population density seems to be a variable that correlates with outcome Y (%ΔTMFR) and other explanatory variables. Because population density may be highly correlated with other variables, multicollinearity might cause problems. The correlation matrixes in Appendix A.5 do only reveal moderate correlations with the variable *Early Childhood Mortality* in the Precondition Models. Further explorations of the Variance Inflation Factor (VIF) shown in Appendix A.6 also confirms that population density does not cause multicollinearity problem. When leaving out the variable population density in the model, the following parameter estimates are larger than in the fully adjusted model as presented in Appendix A.18: married women working, mean age at marriage, professionals and managers, and early childhood mortality. The shift towards becoming smaller when incorporating population density suggests that it positively correlates with the mentioned explanatory variables and ΔTMFR. Coefficients for both the *New Dissent* and *teacher per 100 children* increase when including Population Density, suggesting these are negatively correlated instead. In some cases, significance changes as well.

Theory suggests the opposite association of population density and fertility: urban areas witnessed an earlier and faster fertility decline. Here, we see this assumption is confounded by variables such as married women working and the middle-class population. Given that the coalfields and East of London were among the areas with the highest population density in 1881 while also having the highest TMFR (Appendix A.1, Fig. A1 (9b)), these positive associations might seem less surprising, however (Table 4.4). As shown in the model, a 1% change in population density between 1881 and 1911 is linked to a drop in fertility by 1%, increasing even to 4% when including spill-over effects. These results are significant on the 0.01 level. Accordingly, areas that witnessed more rapid urbanisation during the main decline years also saw marital fertility decline most rapidly in the same period. These findings are consistent with assumptions of the *Demographic Transition Theory*.

From a theoretical perspective, the model for this analysis is a spatial lag model, as I assume that regions in proximity have similar fertility behaviour but also experience a similar fertility transition. Another choice of model would have been a spatial error model (sub-chapter 3.2.4), which assumes that unmeasured factors are spatially dependent and accordingly accounts for this in the error structure. Equivalent spatial error models to the previous spatial lag models have been estimated. They are presented in Appendix A.8. Like the linear regression models, those models measure an even stronger association between change in TMFR and *New Dissent,* both in magnitude and statistical significance. However, the Lagrange Multiplier Test (Appendix A.9) confirms that the spatial lag model is a significantly better fit than a linear model and a spatial error model. Accordingly, it accounts better for the spatial structure of the data and further support the assumption that spatial diffusion mechanisms contributed to the fertility transition in England and Wales.

An identical model was estimated with data for Registration Sub-Districts (see Appendix A.11), the smaller administrative units after Registration Districts. Because religion data is unavailable on this smaller level, a fully adjusted model to estimate the percentage change in TMFR was specified, excluding the *New Dissent* variable. The results of these analyses are widely comparable, considering both directions and the significance of the parameter estimates presented in Appendix A.11. Also, previous analyses using individual-level data largely measured similar associations for social class and occupation variables (Garrett *et al.*, 2001; Jaadla *et al.*, 2020). Therefore, it seems unlikely that the modifiable areal unit problem poses a problem to the robustness of the results of the above-presented analysis using Registration Districts.

4.6 Discussion

This analysis reveals new insights into processes shaping the fertility transition on the sub-national level in England and Wales. A set of spatial lag models estimate that during the forerunner years of the fertility decline, 1851 to 1881, areas with a strong *New Dissent* seemed to have led England and Wales into the fertility transition. The proposed influence of the *New Dissent* through norms, institutions and identity was so high that marital fertility decreased remarkably and most rapidly in those areas where these religious groups were firmly embedded into society.[19] This finding corresponds with H 4.1 that says that geographical patterns of prevalence of *New Dissenters* correspond with geographical patterns of fertility change. This hypothesis is, however, only valid during the early decline in fertility before 1881. During the main decline years after 1881, higher social classes, the employment of married women and declining infant mortality were essential to changing fertility. Another new finding of this analysis is that the expansion of education throughout the second half of the 19th century was strongly associated with declining fertility on the sub-national level.

Calculating and mapping the change in TMFR over time proved valuable for identifying Cornwall and Wales as forerunners of fertility change. Even though marital fertility appeared to be among the highest in those areas in pre-transitional times, the rapid decline in the subsequent decades seemed to spread across space starting from these areas. The descriptive maps strongly suggest that spatial diffusion mechanisms played an essential role in the fertility transition across England and Wales. Calculating change over time and looking at different stages of the fertility transition allowed uncovering otherwise hidden features of population processes like the remarkable fertility decline in Cornwall and Wales. All spatial lag models (*see* Table 4.3 & Table 4.4) confirmed what has been observed on the descriptive maps: Change in marital fertility in one region is associated with a change in marital fertility in a neighbouring region.[20] These findings suggest that spatial diffusion mechanisms might contribute to the observed spatial patterns of the English and Welsh fertility transition. They further support the idea of Szreter's *communication communities* (1996): individuals likely adjusting their fertility behaviour to what they observe in their local community can be an explanation of such findings even though such processes cannot be measured here directly.

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[19] A comparatively high age at marriage as a possible confounding factor often mentioned for this religious group (Field, 1994, 2012, 2013a) has already been accounted for in the analysis. In addition, most *New Dissenters* belonged to the upper working-class or lower middle class.
[20] Results are consistent for both Registration District and Registration Sub-District administrative levels.

Different Methodists groups strongly influenced both Cornwall and Wales. These Methodist groups can be considered part of a more significant religious movement of the 18th century, the *New Dissent*. There have been other simultaneous socio-economic shifts which occurred in these peripheral areas, and one might argue that the ND variable only acted as a proxy for periphery or any other aspect that might have been occurring in peripheral areas (including the rise of *New Dissent* religions). Such developments were i.e. the recession in the copper industry in combination with depopulation especially of men in working-age and an increase in female-headed household in parts of Cornwall (Brayshay, 1980). To some extent, the spatial lag models control for such effects such as though the inclusion of the variable sex ratio. To ensure that the index of sittings for new dissenters does not only act as a proxy for periphery, I explored this potential issue in more detail through a further sensitivity test (*Appendix A.19*). The same spatial lag model as in *Table 4.3* was estimated only for the RDs in the Counties of Dorset, Somerset, and Wiltshire. The districts within these three counties are less-peripheral areas with high variation in the index of sitting of new dissenters within a short distance (10.5 to 43.2). And indeed, the model results for this subset of RDs support the previous findings for England and Wales as a whole that RDs with a high share of new dissenters witnessing an early and accelerated fertility decline during the forerunner years. Due to small sample size, the parameter estimates are not statistically significant, though. However, these further results strengthen the argument of the importance of ND for an early fertility decline in England and Wales.

McQuillan's framework (2004) to connect religion with fertility behaviour proved helpful in elaborating a conceptual framework of how *New Dissent* religions and fertility behaviour might be connected. This fact seems noteworthy as the examples McQuillan proposed in his article are all directed in the opposite direction: how does religion relate to high fertility? The culture associated with *New Dissent* seems to have promoted an early fertility decline in England and Wales. The findings apply well to previous research in other Anglophone contexts, such as Canada, where Methodists and Baptists had significantly fewer offspring than Anglican women during the fertility transition (Gauvreau, 2006). Critical to this is the prominence of individualism in the *New Dissent* theology and culture, including self-discipline, gaining education and abstinence. Culturally and behaviourally, this translates into a duty to behave soberly and responsibly, trying to improve the self and the family. The strong identification among *New Dissent*ers likely produced closely connected community structures and networks, which again are more prone in times of cultural drifts to witness "a rapid, large, and rare pattern of cultural change" (Jung *et al.*, 2021, p. 96).

New Dissent might also capture an interaction of gender and education with changing norms. The religious movement emphasized the relevance of religious education for all children regardless of gender (Murphy-Geiss, 2002; Prisco, 2020). Especially mothers became the most important transmitter of education and social (and religious) norms within the *New Dissent*. Gauvreau (2006) also assumes that Methodists' principles of agency, self-consciousness and a new perception of gender roles within the family contributed to the early adaption of family limitation.[21] Perrin (2022) describes how universal education after the French Revolution enabled girls to pass on Republican values to the next generation, which might have shaped the earlier fertility decline in France. A similar process – an early and rapid increase in education among *New Dissenting* women – might have been a catalyst for rapidly decreasing fertility in the middle of the 19th century.

The evidence for the importance of the *New Dissent* during the main decline years is due to data limitations only vague. According to the results, the geographical patterns of prevalence of *New Dissent* in 1851 did not seem to have an influential role in the fertility change after 1881. It is impossible to draw a conclusion about religion and family size without analysing individual-level data, which are unavailable. Nevertheless, the results indicate religion's important role during the early fertility decline using a spatiotemporal perspective of the sub-national living context in which individuals operate.

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[21] A citation in Gauvreau (2006, p. 253) highlights the importance of women's rights regarding their reproductive decision making from a Canadian Methodist newspaper. The same paragraph emphasizes the advantages of having less children for mothering: "[...]in marriage no woman can be absolute mistress of herself. Neither should her husband be absolute master of her. There must be mutual concessions. But her right to limit the number of her own offspring should be unquestioned. Even those who value a woman solely for her parental functions must admit that she who has but four children can give them three times the amount of attention and of mothering than she who has twelve."

Another critical new finding is the role of education for declining fertility. A lack of suitable data can explain the prior absence of research. The data used in this analysis have only been released through the *Populations Past* project by Reid et al. (2018) recently and allows analysing the expansion of education in England and Wales for the first time. Even though the individual level of schooling and school attendance were likely to differ substantially, the expansion in education provision leading to mass education is associated with declining fertility. A vast amount of literature has discussed possible relationships between fertility and education (Caldwell, 1980, 1999; Axinn and Barber, 2001). The low importance of schooling in 1851 in the precondition model might be explained by education being very patchy before the start of mandatory schooling. No national education system existed before 1870, so whether a particular place had schools depended on charities and local initiatives. This fact is one reason that obtaining data is very difficult. Officially recognised teachers and schools were rare prior to the Education Act of 1870 which required that local areas provide educational facilities for all children. Compulsory schooling was mandated in 1881. So, interpreting the occupational title 'teacher' from the 1851 to 1871 census is difficult as it is not clear what a person described as a 'teacher' did in 1851. Especially in peripheral areas of England and Wales, Sunday schools most likely provided the only form of education. However, this setting would not have been recognised by the census in 1851. Bearing in mind that with the introduction of compulsory schooling, attending school was still not free of charge for the first decade (Pooley, 2013), some parents were possibly moved to reduce their family size for financial reasons depending on where they were living. Those school fees and reductions varied from region to region so the financial burden might have been more considerable in some areas than others. However, since the mechanisms through which the variable *teachers per 100 children* acts is rather unclear, the actual meaning is still ambiguous, and the interpretation needs to be considered with caution.

The findings that the married women working in 1851 are positively associated with the subsequent fertility change seems surprising at first. It needs to be pointed out that the pattern of employment opportunities for married women was still very diverse in 1851 (Tilly and Scott, 1978). Opportunities for married women to participate in paid employment largely disappeared after 1881, except for factory work in textile mills[22]. One typical work for married women prior to 1881 was in the cottage industry, such as lace making, straw plating or glove making; this work was conducted in groups of women from home. Accordingly, childcare, and full-time work were comparatively easy to combine. The situation for women working in factories was the opposite. Therefore, we can see the anticipated effect of textile areas showing low fertility at an early transition stage when considering the change-model. Textile work is the only type of work for women where employment opportunities increased between 1851 and 1881. Thus, the negative association of change in fertility and the precondition *mean age at marriage* in 1851 is likely driven by the areas with factory work, in which we know that the age at marriage was exceptionally high and family size small among female textile workers (Garrett and Reid, 1994).

Due to data availability, the analysis, including religion, can only be performed on the Registration District-level instead of the preferred smaller Registration Sub-District-level. Excluding the variable for both models provide comparable results (Appendix A.11). Another drawback of the analysis is that the choice of explanatory variables is limited to the availability given through the Populations Past project. However, these already cover most of the main determinants of the historical fertility decline. A source of error for the Registration District data is that it has been extrapolated from the smaller units of the Registration Sub-District and weighted by population size. Also, areal weighted interpolation introduces some error into the different interpolated measures. Further limitations of the analysis applying to the other empirical chapters will be discussed in the overall conclusion in Chapter 7.

4.7 Conclusion

This chapter aimed to explain the association of religion with regional change in fertility in England and Wales between 1851 and 1911. Descriptive findings revealed that areas in Cornwall and North Wales were forerunners of the fertility transition and experienced

[22] See also descriptive maps in Appendix A.1 of geographical pattern of *married women working*. All clusters of higher participation of married women fade. In 1881, only clusters around Lancashire remain to have very high levels.

a rapid decline in fertility before most other areas in England and Wales. On the other side of the spectrum, not just the coalmining districts but also the sub-districts in the East of London with a high share of the working-class population performing semi- or unskilled manual work were the laggards of the fertility transition. Results of the spatial lag models revealed that the fertility change during the forerunner years was strongly shaped by the presence of *New Dissent* religions, while more conventional explanations related to social class and married women's employment were influential during the main decline years.

The culture associated with *New Dissent* promoted early fertility decline. This culture was strong enough to foster an early fertility decline even in some areas, such as Cornwall – an area otherwise unfavourable for an early fertility decline due to high infant mortality and mining activities. They had adopted the cultural characteristics of modernity before the rest of the population and, in this, showing the way that social and cultural values would evolve. Critical to this is the prominence of individualism in the *New Dissent* theology and culture. Through the transformation of norms, institutions and social identity, *New Dissenters* initiated a process of cultural and social change in 19th-century England and Wales. Thereby, they played an influential role in shaping the fertility transition in its very early stage. Given that the context of the 19th century's contemporaries was more local than national, the study highlights how critical a sub-national perspective is to disentangling processes related to the fertility transition. After 1881, the distinctiveness of the *New Dissent* disappeared because, by that time, massive secular forces were driving fertility down in most parts of England and Wales.

Another new finding is the substantial role of expanding schooling provisions between 1851 and 1911. These results possibly relate to mass education, as compulsory primary education was introduced in 1880. Like other contexts, the mere presence of schooling provision might have been influential within local settings regardless of individual school attendance.

Both descriptive results and the spatial models suggest a strong association between fertility change in neighbouring regions. This finding might indicate the presence of spatial diffusion mechanisms over time. Even though the latter interpretation needs to be treated with caution due to data and modelling limitations, these findings contribute another piece to the puzzle in spatial demography, trying to solve underlying processes of spatial variations in fertility behaviour over time. Looking back in time beyond the 'tipping point' in fertility change allows for tracing the spatial origins of chances in fertility behaviour and how determinants might change throughout a transition. The different results for both forerunner years (1851-1881) and main decline years (1881-1911) suggest that the reasons for entering the fertility transition are not uniform across England and Wales; the fertility decline before 1881 was geographically patchy and muted at the national level, even though essential developments for the future course of the transition occurred during this period. The major decline happened between 1881 and 1911.

Using individual-level data, research might investigate how diffusion processes have shaped the fertility transition in more detail. New research enquiries become possible with the relatively new availability of complete individual-level census data between 1851 to 1911 and the prospect of 1921 census data being released soon. Unfortunately, these do not entail information on the religious affiliation of individuals. Further enquiries into how communication and networks relate to the spread of new fertility behaviour need to be considered further.

Chapter 5 Illuminating the Past: Examining Forerunner Areas of Innovative Demographic Behaviour in England and Wales, 1851-2011

Abstract

The chapter aims to explore spatial continuities in demographic behaviour in England and Wales between 1851 and 2011. The analysis finds evidence for continuities in the geographical distribution of forerunner areas of low fertility in 1851 and high non-marital childbearing in 1951 using geographically weighted correlation. Whereas spatial patterns in low fertility seem to remain constant throughout the 19th and 20th century, spatial patterns in non-marital childbearing change considerably between 1951 and 2011. Due to data constraints, this study cannot provide a statistical analysis of possible determinants of such (dis)continuities. A comprehensive overview of the theoretical literature discusses possible correlates of both the historical fertility decline as well as the increase in non-marital childbearing. This overview proposes that spatial patterns of labour force participation among mothers, in combination with male employment opportunities, could be a likely determinant of both historical continuities and more recent discontinuities. Whereas female employment, especially in the early phases of change, contributed not only to changes in attitudes but also operates at the intersection of disadvantage in combination with unstable employment opportunities for men. Due to data limitations, many social and cultural aspects and its association with forerunner areas cannot be examined in this empirical chapter and remain unanswered.

5.1 Introduction

In 2020, approximately half of all births occurred outside marriage or civil partnership in England and Wales, ranging from 21.4 % to 75.8 % on the Local Authority level (ONS, 2022). Spatial patterns of family formation behaviour seem to diverge dramatically within this context. How did past spatial trends of demographic behaviour evolve in relation to these contemporary patterns?

Reflecting on the past, prior to the major surge in non-marital childbirth in England and Wales, the 1950s saw a remarkably low proportion of these births, with a mere one in twenty births (4.8%) taking place out of wedlock. These children were primarily born to unmarried women (ONS, 2022). Were the disparities exhibited in historical spatial patterns as marked as they are today? If this was the case, which regions were the forerunners of this new demographic trend? Given that England and Wales experienced a first-time substantial decrease in fertility rates in the prior century (approx. 1850 to 1950), the continuity of further family changes seems even more remarkable especially when one considers major events such as World War I and World War II and the Great Recession in between altering Europe throughout the first half of the 20th century. Accordingly, this chapter will ask if and how spatial patterns of forerunner areas might be linked throughout these two transitions.

Whereas initial theories viewed these two demographic changes as part of two distinct demographic transitions, the First and Second Demographic Transition, other scholars argue that the second might only be a continuation of the first (Lesthaeghe and Van de Kaa, 1986; Lesthaeghe, 1998; Coleman, 2004). An increasing body of literature highlights the significance of historical demographic spatial patterns in understanding present and future trends in spatial demographic patterns (Reher, 1998; Lesthaeghe and Neels, 2002; Lesthaeghe and Lopez-Gay, 2013; Klüsener, 2015; Vitali, Aassve and Lappegård, 2015; Doignon, Eggerickx and Rizzi, 2020).

Lesthaeghe and Neels (2002) found continuities in spatial patterns of both transitions in the context of Belgium. They argue that distinct spatial sub-cultures defined through structural but mainly cultural conditions facilitate these continuities. Thereby, correlates of these two transitions already emerged during the First Demographic Transition. Comparable discoveries are not exclusive to demographic investigations but have been demonstrated in numerous social science studies (Sears, 1983; Martin and Sunley, 2006; Becker, Mergele and Woessmann, 2020; Gruneau, 2021; Voth, 2021). However, historical demographic patterns in England and Wales are often overlooked in the discourse regarding present-day demographic behaviour.

Accordingly, this chapter follows the development of forerunner areas through two periods of population shifts in England and Wales, and critically explores if and how these two sets of transitions might be connected. Whereas low fertility could be considered an innovative demographic behaviour in the middle of the 19th century, it was widely established around the mid-1900s. By then, non-marital fertility was a new form of innovative demographic behaviour altering families. As levels of non-marital childbearing have changed dramatically since the 1950s, I will additionally investigate spatial patterns of non-marital fertility and their continuities until 2011.

Expanding on the findings of the preceding empirical chapter, in combination with a semi-systematic literature review of determinants of the historical fertility decline, I compare determinants of historically low fertility to proposed correlates of increasing non-marital childbearing. I have developed a set of explanatory factors, such as female labour force participation and male unemployment, focusing on an intersectional perspective that might connect the decline in fertility and the increase in non-marital childbearing at different times. Intersectionality in this context means that (spatial) determinants do not operate in isolation (McCall, 2005; Green et al., 2017) but might interact with each other or through other forms of disadvantage. Geographical patterns of TFR (1851, 1881, 1911) and NMR (1951, 1981, 2011) will be visualised, described, and compared through maps to investigate forerunner areas and spatial continuities. Unfortunately, a lack of data does not allow to analyse spatial patterns between 1911 und 1951 even though it would be extremely interesting to understand how both World Wars altered English and Welsh families. The limited availability of social and cultural variables over such a long period is in addition another obstacle to fully understand forerunner areas and its associations. Due to substantial changes in administrative units, areal weighted interpolation is used to create comparable data across all years for time-constant geographical units (here: 2011 Local Authority Districts). Second, by employing normal and geographically weighted Spearman's correlation, I attempt to empirically illuminate statistical associations of forerunner areas in both sets of transitions.

This chapter provides new insights into spatial (dis)continuities of demographic behaviour affecting the size, composition, and definition of families in England and Wales from 1851 to 2011. Therefore, the study contributes to the growing area of social science and demographic research on historical persistence by analysing the emergence of 'new' demographic behaviour across two waves of demographic innovations. Exploring if and how demographic developments in the past altered recent demographic behaviour does not only enhance our understanding of recent demographic patterns but might similarly inform forecasting of demographic processes and patterns in the future. The conceptual framework also highlights how an intersectional perspective can enhance spatial analysis by discussing associated background factors being related to both forms of demographic behaviour.

This chapter begins by explaining the concept of spatial continuities in social science and demographic research, including critical scientific contributions within these research fields. It will then discuss essential concepts explaining historically low fertility and how these link to theories around high non-marital fertility. Sub-chapter 5.3.2 lays out the theoretical dimensions of labour force participation among mothers and how this factor is a likely determinant explaining both continuities in forerunners and discontinuities in spatial patterns of non-marital fertility. The following chapters are concerned with the data and indicators used in this study. Chapter 5.6 illustrates the outcomes of the descriptive investigation of maps along with general and geographically weighted correlations. The seventh chapter discusses the research findings, focussing on the additional explanation of continuities and discontinuities considering other historical developments. The last chapter summarises the key findings and offers some final reflections.

5.2 The Idea of Spatial Continuities in Social Science and Demographic Research

> "[...] what has happened at an earlier point in time will affect possible outcomes of a sequence of events occurring at a later point in time."
> **(Sewel 1996, p. 263)**

Arguing that the early historical fertility decline and the subsequent increase in non-marital births a century later are related is not easily done. The reasons individuals limit fertility and choose to have a child outside of marriage vary greatly at the individual level. Additionally, considering all the technological, structural, political, and cultural transformations that occurred between 1851 and 1951, the continuation of these seemingly different demographic shifts appears nearly paradoxical. To name just a few, some of these shifts and events are secularisation, technologization, improvements in infrastructure, medicine and hygiene but also the first and second World War with major economic crisis and the end of colonisation in between. Yet, the decisions surrounding fertility and childbirth will be shaped by the societal context within which potential parents live. From the standpoint of a couple or sometimes even just a single mother, decisions regarding the addition of another child or marriage before childbirth are assessed in relation to their desirability, acceptability, and feasibility (Klüsener, 2015).

5.2.1 Spatial Persistence in Social Science Research

Research on persistence and continuities has piqued interest in demography and the (historical) social sciences in general. The variety of topics studied in these terms seems endless, ranging from gender attitudes over GDP per capita to institutional quality (Voth, 2021). The concept of path dependence, often used in social science disciplines including sociology, politics, and geography, serves as a common explanation for historical persistence (Mahoney, 2000; Martin and Sunley, 2006; David, 2007). The processes which define path dependency are a much-debated issue. However, there is general agreement among theorists that the excessive usage of the term 'path dependency' to say 'history matters' does not adequately describe this concept (Mahoney, 2000; Tilly, 2006). In addition, Voth emphasizes that persistence research should not only investigate persistence between different variables but focus on mechanisms explaining these continuities (Voth, 2021). Accordingly, on a theoretical basis I will elaborate on potential mechanisms leading to spatial persistence in the subsequent chapters.

To mention only a few examples of spatial continuities in social science research, I will point to recent research about various socio-economic and cultural factors from the late 19th century until the present day in Germany (Becker, Mergele and Woessmann, 2020). Although differences between East and West is often linked to the post-WWII era, many conditions such as female labour force participation, religious affiliation or voting patterns have already displayed similar geographical distributions from the 19th century onwards. The divide of Germany was likely just another factor reinforcing pre-existing disparities, already noted by Klüsener and Goldstein about non-marital childbearing in Germany (2016).

Nevertheless, strong evidence for long-term patterns exists not only in Germany but also in England and Wales. Spatial patterns of 20th-century voting for Labour reveal a remarkable resemblance to geographical distributions of *New Dissent* religions in the 19th century (Gay, 1971). There is a famous quotation by Morgan Phillips, General Secretary of the Labour party in the 1950s, that describes this relation: 'The Labour party owes more to Methodism than to Marxism' (cited after: Callaghan, 1987)[23]. In the prior empirical chapter, I delineated the link between this cultural variable and the historical fertility shift in this setting. An enduring argument has centred around the so-called North-South divide, a division in human geography, highlighting disparities in the North and South of England mapped through various indicators such as deprivation, health, wealth, employment or even voting (Green, 1988; Baker and Billinge, 2004; Dorling, 2010; Bambra, Barr and Milne, 2014). The North-South divide runs approximately along the line from the mouth of

[23] The quote was included in a speech at the Socialist International Conference 1953 in Denmark and written by Phillips' speechwriter Denis Healey.

the Severn to the river Humber (Baker and Billinge, 2004). Research investigating the North-South divide already finds evidence for its existence decades, if not centuries ago (Baker and Billinge, 2004; Boyer, 2016; Boberg-Fazlić and Sharp, 2018; Schürer and Day, 2019). Accordingly, it also seems reasonable to expect spatial continuities for demographic behaviour in England and Wales.

5.2.2 Spatial Persistence in Demographic Studies

A significant amount of research has shown that contemporary geographical patterns of demographic behaviour in different European countries depend not only on current socio-economic and cultural conditions.

Previous studies found that some demographic behaviours exhibit spatial continuity in particular countries over decades or even centuries. Historical forms of family ties in Europe reveal durability over decades and influence current social and welfare regimes (Reher, 1998, 2021; Lee and Reher, 2011). In the case of Germany, spatial clusters of high non-marital childbearing exist for more than a century dividing Germany into East and West regardless of and before the communist past (Klüsener and Goldstein, 2016). In other contexts, research confirms the existence of long-term spatial patterns of non-marital childbearing as in Belgium or fertility in Egypt (Doignon, Eggerickx and Rizzi, 2020; Doignon, Ambrosetti and Miccoli, 2021). Considering the historical context of England and Wales in the past two centuries compared to Germany's or Belgium's past, the regional cultural and political developments were likely more homogeneous over time. England and Wales were united under one government during the whole period under investigation, whereas Germany, as we know it today, was only founded after World War II and still divided until 1990. Accordingly, spatial patterns might not be as pronounced in England and Wales as in Germany or in Flemish and French-speaking Belgium.

Lesthaeghe and Neels (2002) attribute the spatial continuities in demographic behaviour primarily to persisting cultural values suggesting that some regional populations might be more susceptible to new demographic behaviour. Further research on France, Switzerland and Spain confirms the existence of long-term spatial clusters of innovative demographic behaviour (Lesthaeghe and Neels, 2002; Lesthaeghe and Lopez-Gay, 2013). Regions where the fertility decline started early during the FDT around 1900 in Belgium, were more likely to be the forerunners of rising cohabitation and non-marital childbearing starting in the 1970s. Lesthaeghe and Neels (2002) explain this persistence of spatial patterns by long-standing regional sub-cultures, resembled through language, secularisation or voting patterns. Especially norms are the determining factor in this setting influencing fertility and family formation behaviour. They argue that regional sub-cultures influence the 'willingness' to adopt a new behaviour through norms and other socio-economic factors. In their analysis, factors such as voting, secularisation/religion are comparatively stable over decades or centuries.

However, the interpretation of the existence of forerunner areas needs to be done with caution. Analysing spatial patterns of change may not reveal the underlying factors driving demographic shifts, as populations often respond with a time lag to changing socio-economic conditions. Thus, fertility changes may reflect adaptation processes at the population level, often linked to communication, rather than the structural changes that prompt these behaviours. Additionally, early adopters' adaptations can create further incentives for late adopters to change. Also, non-marital fertility was present before the 1950s and experienced a decline in the century leading up to that time. Therefore, the levels observed around 1950 may be more reflective of past trends than indicators of future changes. A similar perspective applies to 1851, where low fertility rates may not signify an early decline associated with the demographic transition but rather variations that existed prior to this transition, such as differences in marriage ages.

Indeed, as discussed in the previous chapter, such regional sub-cultures might have also existed in England and Wales. Areas of a strong *New Dissent* – leading areas of declining fertility in the second half of the 19th century – were liberal areas in terms of voting throughout the 20th century. Furthermore, findings in mortality studies indicate that other forms of demographic behaviour have exhibited spatial continuities in England and

Wales since 1900 (Gregory, Dorling and Southall, 2001; Dorling, 2006; Gregory, 2009; Buchan et al., 2017). The proposed mechanism here is that past events influence present events (A > B). Accordingly, the first hypothesis is:

H 5.1: England and Wales exhibit spatial continuities in forerunner areas of innovative demographic behaviour.

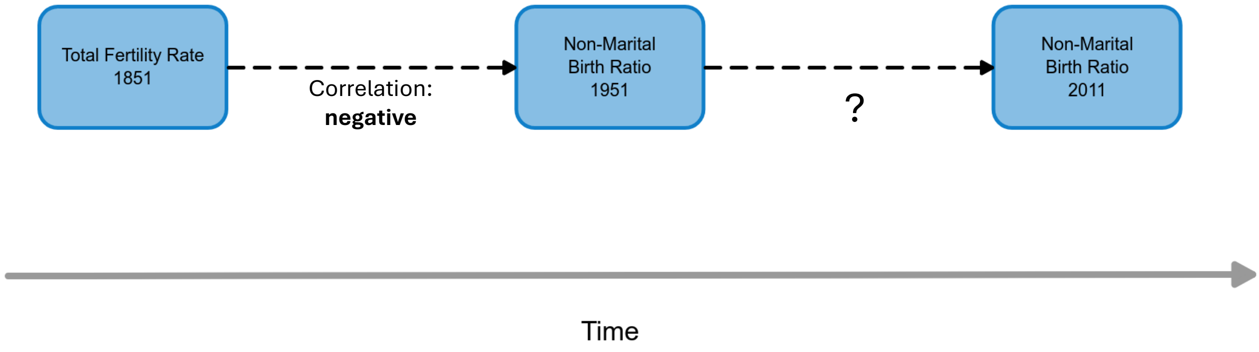


Figure 5.1. *Assumed Correlation of Demographic Behaviour over Time in England and Wales*

This hypothesis implies that in areas where fertility was low during the Fertility Transition, non-marital childbearing was high a century later. Transferring this assumption into statistical indicators, I expect a negative correlation when comparing both spatial patterns of demographic behaviour (Figure 5.1).

5.3 Possible Determinants of Spatial Persistence of Forerunner Areas. A Conceptual Framework

Given English and Welsh historical developments, the First and Second Demographic Transition has various possible determinants. However, not all will be reasonable explanatory factors for continuities in spatial patterns of both transitions. Accordingly, I will explain in the first step in this sub-chapter which factors might be useful explanatory factors for continuities of forerunner areas. Second, I will elaborate on possible underlying mechanisms likely contributing to these continuities within space.

5.3.1 A Semi-Systematic Analysis of Possible Determinants of Two Different Demographic Behaviours

In this chapter, I conduct a semi-systematic analysis of literature investigating the English and Welsh fertility decline. Thereby, I identify factors commonly associated with the historical fertility decline. These factors are then clustered into different broad types of regions by fertility levels in combination with other demographic, socio-economic and cultural determinants. Thereby, I will also be able to discuss contextual factors and identify compositional factors explaining different regional characteristics to a certain extent by population composition.

This extensive list of fertility indicators will be used in three ways:

1) Finding the common denominator for all low fertility regions/areas.

2) Comparing principal determinants of the historical fertility decline with frequent explanatory indicators of the rise in non-marital childbearing to determine a possible overlap.

3) Discussing regional patterns and their possible (dis)continuities of the historical fertility decline and increase in non-marital childbearing in the light of mutual explanatory indicators.

Considering a lack of data, this structured procedure seems to ensure the most transparent way to disentangle processes and mechanisms relating to both sets of demographic behaviours across and simultaneously at different times. Previous research with similar enquiries found, however, that socio-economic and cultural factors are most likely determinants of persistent spatial patterns (Lesthaeghe and Neels, 2002; Lesthaeghe and Lopez-Gay, 2013; Klüsener and Goldstein, 2016).

Table 5.1. *Cluster of Fertility Regions by Different Demographic, Socio-economic and Cultural Indicators in England & Wales, 1851-1911.*

No.	**Indicator**	**London 1 (Centre and West)**	**London 2 (East)**	**Urban 1**	**Urban 2**	**Rural**
	Fertility Level	**Low Fertility**	**High Fertility**	**Low Fertility**	**High Fertility**	**High Fertility**
1	Urban Type 1881 (Smith, Bennett and Radicic, 2018)	• profession and service • transport	• transport	• cotton, silk & clothing manufacturing • farming, building, transport, dealing, profession and service • wool & other textile	• coal mining • gas, coke, chemical manufacturing • metal & waterproof manufacturing • medium & heavy industry	-
2	Sex ratio (high = more men, low = more women) (Smith, Bennett and Radicic, 2018)	high in centre to balanced with increasing distance to centre (1881 – in 1851: low sex ratio)	balanced	low	high	balanced
3	Celibacy levels (never married at age 45 to 54) (Woods, 2000)	high for women and men	low for women and men	• high for women • low for men	• low for women • high for men	high for women and men
4	Average age at marriage (women) (Woods, 2000; Garrett *et al.*, 2001; Jaadla *et al.*, 2020)	high	low	average to high	low	• high (Wales, south of Scotland, Cornwall) • low (East Anglia, Southeast) • average (remaining)
5	Average age (Smith, Bennett and Radicic, 2018)	high	low	average	low	average to high

Table 5.1. *Cluster of Fertility Regions by Different Demographic, Socio-economic and Cultural Indicators in England & Wales, 1851-1911.*

No.	Indicator	London 1 (Centre and West)	London 2 (East)	Urban 1	Urban 2	Rural
	Fertility Level	**Low Fertility**	**High Fertility**	**Low Fertility**	**High Fertility**	**High Fertility**
6	Age at leaving home (Day, 2018)	high	high	high	high	low (North) / high (South)
7	Female labour force participation (Garrett *et al.*, 2001; Atkinson, 2012; Smith, Bennett and Radicic, 2018)	high	medium to low	high	low	high
8	**Labour force participation among married women/mothers** (Tilly and Scott, 1978; Garrett and Reid, 1994; Garrett, 1998; Garrett *et al.*, 2001)	**high**	**low**	**high**	**low**	**low**
9	Migration (internal and international) (Garrett *et al.*, 2001; Schürer and Day, 2019; Jaadla *et al.*, 2020)	high (also high share of people born over-seas)	low	high	high	low
10	Households including kin or boarders (Reher, 1998; Smith, Bennett and Radicic, 2018)	low	low	high	high	low (kin), high (board-ers in Southeast)
11	Households including live-in-serv-ants (Reher, 1998; Smith, Bennett and Radicic, 2018)	high	low	low	low	• high (Wales, south of Scotland, Corn-wall) • low (remaining)
12	Infant Mortality (Garrett and Reid, 1994; Garrett, Reid and Szreter, 2010; Jaadla and Reid, 2017)	high	high	high	high	low

Table 5.1 identifies five broad clusters of fertility regions – one rural, two different urban and two for London as s particular type of urban. Of course, this classification implies some simplification, and there is still much heterogeneity within each of these five regions. This classification was inspired by an article by Smith et al. (2018), developing a new classification of Victorian towns analysing main economic activity in relation to demographic and socio-economic characteristics. Among these classifications, they identified low and high fertility types of towns. Turning their matrix of indicators around and focussing on fertility instead of main economic activity allows viewing these towns from a different angle. Adding rural areas and other features of these regions to the existing literature provides a detailed picture of these five clusters of regions.

The colour scheme of Table 5.1 can be read as follows: light orange constitutes low fertility, and light blue indicates high fertility, considering the existing literature. Within Table 5.1, various factors can be classified as compositional factors on the spatial level. As such, a low sex ratio, indicating the presence of a higher proportion of women, may result in more women staying single: not all women of childbearing age can find a partner where monogamous relationships are the norm. Accordingly, fertility should be lower because these single women will be considered part of the female population at risk of childbearing without contributing to fertility. A high sex ratio indicating a higher prevalence of men likely implicates high fertility. Here, the population composition influences the components for calculating TFR and can therefore be classified as compositional. Even though this proposed association is present in four out of five broad fertility regions (Table 5.1, No. 2), London (West) has a higher share of men in 1881 but, at the same time, low fertility levels. It is an outlier, though, because sex ratios vary considerably over time. In 1851, the sex ratios were still low. Accordingly, it might be a common factor all regions have in common.

Observing the extensive array of factors that likely impact fertility, a single region typically does not conform to the overall scenario. Another example is female labour force participation. Although the common notion is that in areas with high female labour force participation, fertility is low, rural regions do not follow this expectation. Here, female labour force participation is high, but fertility is also high. If female labour force participation is limited only to married women working, I find the only indicator within this matrix of fertility areas where all regions follow the proposed line of reasoning. Accordingly, the second hypothesis of this chapter is as follows:

H 5.2: Spatial continuities of innovative demographic behaviour are associated with employment patterns among mothers throughout time.

Here, the mechanism is not that a past event influences a present or future even as described in section 5.2.2 (A > B). On the contrary, the mechanism can be conceptualised as follows: there is some background factor X which is long-lasting and influences both A (in the past) and B (in the present) (i.e., X > A and B). In this scenario, A and B are correlated only because they both depend on X.

In all regions with low fertility, labour force participation among mothers is high and vice versa. One might expect this association to be found for female labour force participation in general. However, rural areas witness high female labour force participation and medium to high fertility. Different types of female-dominated work patterns and compatibility with caring for small children could influence the number of children (including birth intervals) depending on household or factory-based work. And indeed, a similar mechanism has been found exploring the First and Second Demographic Transition in Spain, where indicators for both transitions were dependent on female labour force participation (Lesthaeghe and Lopez-Gay, 2013). If the spatial pattern of this determinant changes over time, one might still observe continuities.

Previous research in the context of England and Wales did not investigate the role of religion yet. Accordingly, this factor could not be incorporated into the previous table. Because the previous Chapter 4 found that religion was an important factor in shaping of forerunner areas in England and Wales during the early years of the Fertility Transition (1851), the role of religion for forerunner areas during the Second Demographic Transition will be explored as well. Unfortunately, a more detailed analysis cannot pre performed due to data limitations.

5.3.2 Employment of Mothers: Between Continuity and Change

There are definite continuities in the spatial pattern of female employment behaviour between the mid-nineteenth century and the twentieth century at least until 1980. Besides these shifts in the type of work from service and factory to white-collar occupations and share of women working (Gales and Marks, 1974; Hatton and Bailey, 1988; Lewis, 1992), spatial patterns of female labour force participation in the 1970s did not reveal much change since the 19th century (Fonda and Moss, 1976). London or Manchester, with high economic activity among women in the 19th century, remained centres of female labour force participation in the 20th century compared to areas such as Glamorgan, with low female economic activity. Similarly, until the 1970s, the male breadwinner model was still much more prevalent in regions dominated by mining or heavy industry since the 19th century.

Such continuities in spatial patterns in female and male employment are not unique to England and Wales but have been found in other contexts such as Germany or the United States (Fogli and Veldkamp, 2011; Becker, Mergele and Woessmann, 2020). Wyrwich (2019) demonstrated that spatial patterns of female labour force participation in the past and present had been associated with industrialisation and the acceptance of female employment is higher in such regions as well (Fogli and Veldkamp, 2011; Farré and Vella, 2013; Wyrwich, 2019). Unfortunately, data on suitable indicators for England and Wales are not readily available for the mid-20th century and other studies need to be consulted to get an understanding of female labour force participation in mid-20th century England and Wales. Joshi and Hinde (1993) illustrated that the uptake of employment after births in regions of England and Wales such as the North West were in the 1950s similar to pre-war employment patterns – a region with a strong tradition of paid employment of married women in the textile factories. In the 1960s, spatial variations of employment practices among married women were still depending on employment patterns of 1931 (Gales and Marks, 1974).

The overall literature review (Chapter 2) discussed possible associations between female labour force participation and low fertility as well as female labour force participation in combination with non-marital childbearing already. Diverse demand and opportunities for mothers to participate in the paid labour force altered sub-national patterns of the fertility decline. In those areas, where mothers participated in the paid labour force, fertility tended to be lower. In later times, assortative mating became more common while a higher share of women became more educated (Oppenheimer, 1988; Oppenheimer, Kalmijn and Lim, 1997). Women now opt more often for cohabitation than marriage including childbearing. This finding also aligns with the pattern of disadvantage hypothesis. In the following, these factors will be viewed at the intersection of other factors and across time.

5.3.2.1 Beginning: Labour Force Participation among Mothers and Low Fertility

Industrialisation in England and Wales brought significant changes to the everyday life of individuals but especially families (Tilly and Scott, 1978). The centre of production changed from households to factories and with it its organisation and scale of production (Landes, 1976). Before industrialisation, both production and consumption were carried out in the household the so-called family economy. One form of permanent female employment also performed by mothers was in the cottage industry (Gleadle, 2001). This type of work was primarily home-based and allowed women to combine work with childcare and other forms of domestic work. However, with industrialisation, the cottage industry diminished slowly before widely disappearing after the 1880s.

Afterwards, a new era, the family-wage-economy, emerged as the reality for most working-class individuals and households who were now largely propertyless and dependent on wages. During this period, it was common for young, single women to work for a wage but less for married women, especially mothers (Gleadle, 2001). Married women were more likely to participate in the labour force if the family required an additional income (Tilly and Scott, 1978; Gleadle, 2001). This need for an extra income – even if only in times of economic hardship – was often found in the context where men only found casual and low-income work with simultaneous demand for low-skilled female work, such as in textile areas (Gleadle, 2001; Atkinson, 2012). However, even if women's wages constituted the main source of a stable income, wages were low and did not allow to support a family on its own.

In these areas, fertility was usually low (Woods, 1987; Garrett and Reid, 1994; Garrett et al., 2001). Already contemporaries observed that women who engaged in paid employment tended to have lower fertility (Atkinson, 2010, 2012). Studies of individual-level data affirmed that a comparatively late age at first marriage resulting in the postponement of childbearing and lengthening of birth intervals were means of reducing fertility (Garrett et al., 2001). By having fewer children, women now found the opportunity for active labour market involvement. However, financial distress and the need to work may also have been a factor that compelled women to limit their childbirth – possibly in the light of economic necessity.

Next to economic necessity, the type of physically demanding work combined with long hours might have been another argument for lower fertility among women working in factories. This line of reasoning has not been explored in depth, yet. In 1838, a member of parliament commented on women in cotton mills working from 5 am to 7 pm and their unhealthy working environment (Tilly and Scott, 1978, pp. 63–64). Not being physically present at home, and limiting human interaction, including procreation, might be an apparent reason for lower fertility. Studies about recent female fertility considering stress also assume that both are negatively associated (Negro-Villar, 1993; Sharma et al., 2013; Palomba et al., 2018). The same line of research stresses the impact of environmental factors associated with infertility. Here, the harsh working conditions in the textile industry might have limited women's health and fertility besides stressful working conditions and hours. Various arguments link stress with infertility: Sexual desire and activity are negatively associated with stress (Bodenmann et al., 2010; Hamilton & Meston, 2013).

Transferring this knowledge to the historical context of the work, living conditions and fertility levels, low fertility in some areas might instead highlight social inequalities rather than high status.

Taking another view of female employment in mills and factories also reveals a cultural component possibly producing a distinct regional sub-culture persisting over time. Women often spent most of their time together, both during work and leisure activities, leading to a high degree of sociability and female comradeship (Gleadle, 2001). Even though single women were more active in leisure activities than mothers, this close network likely persisted throughout marriage and motherhood. A clear indication of a denser communication network and the stronger ties of such women is the founding of unions among female factory workers (Gleadle, 2001). Such line of reasoning also aligns with findings of long-term spatial patterns of acceptability of working mothers in specific areas (Fogli and Veldkamp, 2011; Farré and Vella, 2013; Wyrwich, 2019).

Such a synopsis indicates how difficult it is to view mothers' employment in terms of fertility on the spatial level from just one angle. On the individual level, there might be various possible explanations of how employment among mothers shaped low fertility on the local or regional level, namely socioeconomic and normative explanations. Female employment in the 19th century reflects one component of a complex family economy, including the employment of the male counterpart. In some contexts, low fertility on the aggregate level was connected to disadvantages and a lack of resources. Such a view aligns well with more recent findings on female-breadwinner families; these families are more prevalent in contexts with high male unemployment rates (Vitali and Arpino, 2016) and have been found to be economically more vulnerable (Kowaleska and Vitali, 2021).

Having set the scene, it seems reasonable to assume that the historical spatial patterns of labour force participation among mothers are associated with low fertility.

5.3.2.2 Continuity: Labour Force Participation among Mothers and Non-Marital Fertility

With the disappearance of the textile industry in the first half of the 20th century, new employment opportunities for women in the service sector and through the welfare state emerged in post-war Britain (Lewis, 1992). Unfortunately, the war- and interwar period cannot be explored in this analysis and the availability of other spatial analysis is rare due to data limitations in this period. This type of work allowed women to take up part-time work reconcilable with childcare responsibilities. By this time, most women of childbearing age had at least a minimum of school education compared to their counterparts a century earlier. Accordingly, they were now qualified to take these white-collar jobs previously only carried out by men. This new form of work also allowed them to earn higher wages. By the middle of the century, paid employment was considered acceptable for single women, married women, and mothers, as revealed by contemporary attitude surveys (Dex, 1988).

Prior to the outbreak of World War II, for which demographic indicators are unfortunately not available on a smaller geographical scale, women often had to surrender their illegitimate offspring owing to societal prejudice and economic necessity (Lewis, 1992). Often research depicts the increase in non-marital fertility after the 1960s as if it was a new phenomenon. On the contrary, non-marital fertility was only particularly low during this period, the Golden Age of Marriage, and higher in the previous decades and centuries as already discussed the literature review (Chapter 2.2).

However, shifts in wage structures, societal views towards working mothers, and the introduction of welfare state privileges allowed single mothers to retain their out-of-wedlock children and maintain economic stability. Approving views on mothers' occupation and engagement in work were more prevalent in regions with traditionally high rates of female employment – and low fertility (Wyrwich, 2019). Accordingly, it seems likely that in these areas, non-marital childbearing was more prevalent at an earlier time when considering birth to single mothers.

However, the main increase in non-marital childbearing in the second half of the 20th century was driven by childbearing to cohabiting couples. Different research has found that regional patterns of non-marital fertility in the past are associated with non-marital fertility in the present (Klüsener, 2015; Kok and Leinarte, 2015). Especially in historical times, reasons for clusters of high shares of non-marital fertility differed. Usually, women had one child out of wedlock and having an 'illegitimate' child was often stigmatised in historical times. Reasons for having a child outside marriage was casual sex which was stigmatised as well but also that premarital intercourse was part of marriage arranging. This marriage arranging in most cases ended in marriage but not in all. These courtship-led marriage customs in combination with the disappearance of social control and increasing poverty were likely explanations for increasing non-marital childbearing throughout the 19th-century before declining towards the mid-20th-century (Muir, 2018). The difference during the Second Demographic Transition is that couples formed families outside marriage without the intention to marry at a later stage and that this behaviour was increasingly accepted within society. Children were not solely born to single mothers anymore but eventually, childbearing within cohabitation was the prevalent form of childbearing outside marriage.

Especially lone mothers took up employment out of economic necessity. Here, labour force participation was as high as 85% in the 1980s (Lewis, 1992). Was economic necessity still a reason for other mothers to work in the middle of the 20th century as it was for working-class mothers of the 19thth century? Across the 20th century, female labour force participation increased among all groups of women but was primarily driven by married women joining the labour force. One out of three (36 %) women aged 20 to 64 participated in employment in 1951. This number almost doubled to two out of three (61 %) in 1981.[24] For men, however, the labour force participation rate declined from 97 % to 90 %

[24] Women made up 40 % of the total labour force by this time. This increase was even sharper among married women aged 15 to 59. Their participation increased from just 10 % in 1931 to 26 % in 1951 to 62 % in 1981 (statistics cited after: Lewis, 1992).

at the same time. This fact might already point towards the increasing importance of female breadwinner families or dual-earner couples (Vitali and Arpino, 2016; Kowalewska and Vitali, 2021) to compensate for lost income among men and secure a certain standard of living.

While changes in occupational structure in the post-war decades improved employment opportunities for mothers, a large part of women – often working part-time – still seemed to participate in the labour force out of economic necessity. In the 1980s, 60 % of mothers reported that they had to give up a lot without work, while 14 % even stated they would not be able to manage at all (survey results cited after: Dex, 1988; Lewis, 1992). It becomes apparent again that female employment cannot be separated from a family's income but that it intersects with a partner's wage or unemployment.

Similar to mothers' employment in the 19th century, mothers' employment a century later cannot be viewed from only one angle. Most women simultaneously reported that a job's most crucial aspect was enjoyment. Here again, employment had not only economic but also cultural/attitudinal dimensions and can be seen as a form of female empowerment, self-fulfilment or, to some extent, (economic) independence. These factors might also differ by educational background. Elizabeth Roberts (1985) argued that in the early twentieth century, middle-class women treasured their liberation as it opened doors for them to engage in work – societal notions were previously averse to this idea, while working-class women sought greater independence with the intent of potentially ceasing work and returning home to manage domestic responsibilities.

Continuities between forerunner areas of historically low fertility and forerunner areas of high non-marital fertility around a century later seem in the light of these facts mainly be driven by the association to long-term spatial employment patterns among mothers.

Having set the scene, the previous elaborations highlight that mothers' employment on the individual level might have operated through various mechanisms to shape spatial patterns of non-marital childbearing. Again, I found an economic as well as cultural/normative perspective. This aspect highlights the importance of a more nuanced view of possible determinants of the spatial distribution of non-marital childbearing. Of course, this proposed link with female employment cannot be tested empirically here and only describes one possible explanation of how forerunner areas of historically low fertility and non-marital childbearing might be associated as mentioned in hypothesis H 5.2.

5.3.2.3 Discontinuity: Mothers' Work and the Increase in Non-Marital Fertility

While most non-marital births until the 1950s still occurred to single women (Kiernan, 1971), the main increase between 1951 and 2011 can be attributed to childbearing within cohabitation. How could female labour force participation among women be associated with births to single mothers and births to cohabiting couples on the spatial level? The literature review (Chapter 2.2.3) has highlighted the findings of a negative educational gradient of childbearing within cohabitation for both men and women (Perelli-Harris et al., 2010). The prior sub-chapters mainly focussed on synthesising research covering the period between 1851 and 1951 with an outlook on some aspects of the following decades. In the last step, I want to discuss further developments of mothers' labour force participation until 2011 in the light of de-industrialisation, further shifts in labour market opportunities or losses, male (un)employment and how these might be associated with a further rise in non-marital fertility.

From the 1950s onwards, England and Wales witnessed a tremendous decline in all forms of industrial employment and structural changes often referred to as de-industrialisation (Rowthorn, 1986). Within a few decades, former economically prosperous areas characterised by manufacturing, mining or construction became areas with sparse labour market opportunities and high unemployment rates, often followed by a high degree of deprivation in the long run. Whereas in 1955, every second employee (48 %) in Britain worked in the industry sector – a predominantly male sector of the economy – only every third person had employment in industry (34 %) in 1984 (Rowthorn, 1986; Tomlinson, 2016) later declining further to every fifth person in 2011 (Labour Force Survey, 2022).

Only between 1981 and 1987, full-time male employment decreased universally in England and Wales by 711.00 in absolute numbers, with the most pronounced declines in all Northern regions of England as well as in Wales with changes of more than -10% (Frost and Spence, 1991). At the same time, part-time work among men increased but not to the same extent as full-time employment fell.

As already covered in the previous sub-chapter, female employment – both full- but especially part-time rose in times of an increasing service sector instead, although less pronounced in regions suffering the most from male unemployment (Rowthorn, 1986; Tomlinson, 2016). Due to the welfare system, the so called 'discouraged worker' effect might have led to women with an unemployed partner also staying out of the workforce (Molho, 1983). The 'added worker' effect was more important for women with partners with a partial loss in income (Greenhalgh, 1977). Unemployment and insecure employment did not only have a strong spatial dimension but were also highly gendered: Between 1975 and the middle of the 1990s, low pay doubled among economically active men (Steward, 1999). Female labour force participation rose in contrast.

Quantitative research suggests that men in unstable or part-time employment were less likely to marry their partners in the 1990s in Britain (Francesconi and Golsch, 2005). The male-breadwinner model had strongly dominated English and Welsh families and social norms. Unable to provide for a family as a man diminished the chances of marriage (Kalmijn, 2011). Even though parenthood (and marriage) seems to be delayed by unemployment in general, this is not the case for lower-educated men and women (Miettinen and Jalovaara, 2000). Here, chances are higher to enter parenthood early but without entering marriage at all. All of these observations are in line with the pattern of disadvantage hypothesis proposing a negative gradient of childbearing within cohabitation and education on the individual level (Perelli-Harris *et al.*, 2010). Other findings of unemployment on the aggregate level confirm that high shares of unemployment seem to operate as a general force of economic uncertainty, altering family formation behaviour regardless of an individual's employment situation (Lange et al., 2014): Even though individuals are less likely to form a union or get married, they do not postpone having a first child.

From a household perspective, there is a significant amount of research suggesting that with declining real wages for men, the need for supplementary earnings for women increases to provide for a family in England and Wales (Dex and Joshi, 1999; Dex, 2003; Lewis, 2003; OECD, 2004). Considering that especially the former industrial centres witnessed an increase in job insecurity among men, female employment was a common form of risk reduction and lowering vulnerability for family finances. These obstacles did not only burden families in industrial urban areas but similarly rural areas with declining employment opportunities in agriculture (Mathner et al., 2001).

Overall, economic uncertainties and insecurities have increased since the middle of the 20th century. These labour market changes could potentially imply obstacles to family formation for both men and women: reduced male employment security leads to an unwillingness among both men and women to commit to marriage, and hence a higher proportion of children being born to consensual or casual unions. This is associated with a greater tendency for women to work, both because a higher proportion of women are not in unions and hence need to be able to support themselves, and because the male partners of those who are in union are struggling to find work. Accordingly, these shifts could lead to further shifts from childbearing within marriage to childbearing within cohabitation. Considering the positive association of male unemployment and non-marital childbearing on the aggregate level combined with the positive link between female breadwinning/dual earner couples and male unemployment, one could assume that explanations for non-marital childbearing lie at the intersection of both factors.

Considering all the evidence, the third hypothesis is the following:

H 5.3: Spatial patterns of non-marital childbearing will present discontinuities between 1951 and 2011.

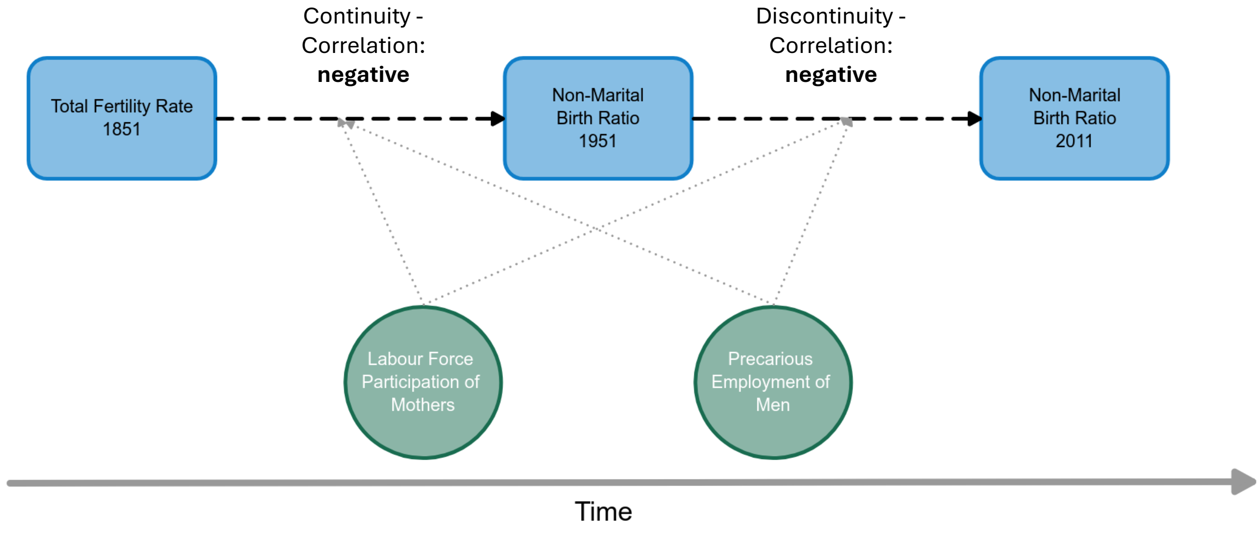


Figure 5.2. *Association of Demographic Behaviour over time and possible Mediating Factors in England and Wales over Time.*

Shifts in occupational structure alter geographical patterns of female employment, and male unemployment between 1951 and 2011 which contributes to discontinuities in spatial patterns of non-marital childbearing across the same time (Figure 5.2).[25]

Associations of such spatiotemporal mechanisms are highly complex. This chapter does not provide a complete picture of such mechanisms but aims to explore conceptually one likely and important mechanism. Given all previous elaborations, both forerunners and laggards of the First and Second Demographic Transition seem now likely to converge in demographic behaviour and follow the same trajectories of increases in non-marital childbearing. All these former industrialised areas, textile areas with historically high shares of female employment and mining areas with low female employment suffered from de-industrialisation and economic uncertainty in recent decades. Other economically more prosperous areas of England and Wales should diverge from this pattern of

[25] A common effect here might be that reduced employment opportunities for men lead to a reduction in marital fertility. The mechanism, though, was probably different in the nineteenth century than in the twentieth: in the nineteenth century, it reduced marital fertility by raising the opportunity costs; in the twentieth century it reduced marital fertility by substituting non-marital fertility.

increasing non-marital fertility if following the same reasoning. To illustrate this with one prominent example, London, an economically prosperous area, is expected to witness low shares of non-marital births.

5.4 Data

Geographical data on the Registration Sub-District (RSD) level for TFR are provided through the same sources discussed for TMFR in chapter 4.3. TFR and underlying ASFR were calculated by the Populations Past project (Reid et al., 2018) using data provided through the individual level enumerators books for each census year initially published by the I-CeM project team and advanced by the Atlas of Fertility project team. Corresponding boundary data was created and kindly shared by Joseph Day (2016).

To create a data set which allows to compare both TFR over time as well as with recent trends in non-marital fertility across 160 years, intensive areal weighted interpolation (as described in Chapter 3.1.2) was employed to interpolate historical RSD data (1851: 2,190 units; 1881: 2,175 units; 1911: 2,009 units) to the 2011 Local Authority Districts (LAD) of England and Wales consisting of 348 units. This form of AWI is suitable for rates and ratios. Extensive AWI instead is suitable for count data. The standard assumption of for both forms of areal weighted interpolation is that the variable of interest in evenly distributed across the source zone (here RSD). After intersecting polygons of source and target zone (here LAD), the new TFR would be calculated using the area as a weight. However, because population density varies considerably in historical England, population size is used as a weight instead of area size, which can be done with intensive AWI. Accordingly, population size is assumed to be evenly distributed within each RSD, providing a more accurate regional picture of TFR than area size for the target zone.

Interpolating spatial data from a source to a target region always introduces some unquantifiable bias to the estimates. The interpolation of rates using weights provides another source of bias. Even though population size is a more appropriate weight than area size, in this case, it needs to be kept in mind that the age and sex composition of each differed by RSD. This reminder is essential in the case of fertility because only women of a certain age can give birth. A more accurate weight could be the size of the female population aged 20 to 49 years, even though this measure would not prevent an inevitable introduction of bias in the final estimates. In the absence of such data, population size still provides a reasonable weight allowing a comparison of data otherwise impossible.

For non-marital childbearing, data on all births and non-marital births are used to calculate the Non-Marital (Birth) Ratio (NMR). Because these data are based on count data instead, extensive areal weighted interpolation is performed to interpolate 1951 Local Government District (LGD; 1,472 units) data as well as 1980 Local Authority District (LAD; 403 units) data to the 2011 LAD (348 Units). This form of AWI again assumes that all births are distributed equally across space. Because source regions (here 1951 LGD and 1971 LAD) are mostly smaller than target regions (2011 LAD), the bias introduced by this method is expected to be comparatively small for (non-marital) birth data. It is not possible to analyse data over the long run and incorporate analysis considering the years from World War I to World War II.

For data on non-marital and all births, different data sources were consulted. Both data on births as well as boundaries in 1951 have been provided through the Great Britain Historical GIS Project (Great Britain Historical GIS Project, 2011). Birth data for 1980 have been retrieved and transcribed from printed Local Authority Vital Statistics (OPCS, 1981). Afterwards, these data were matched to 1981 LAD boundaries (Walford, 2006). For the year 2011, the ONS publication *Live births by Area of Usual Residence* (ONS, 2011) provides data on live births. The ONS also published associated boundary data (ONS, 2020).

5.5 Indicators

The former chapter delivered an in-depth exploration of forerunners of the historical fertility decline and its determinants, focusing on changes in fertility levels over time. To focus on another dimension, this chapter will only consider fertility levels as another dimension of fertility transition. Unfortunately, it is impossible to examine possible determinants in this analysis context due to data limitations of indicators over such a long period.

The Total Fertility Rate (TFR) is the estimated number of births a hypothetical woman experiences between the ages of 20 and 49, given the age-specific fertility rates. Age-specific fertility rates estimate the number of births per woman in a specific. Here, 5-year-age groups are used. These measures are calculated as follows:

$$TFR = 5 * \sum_{i=20-24}^{45-49} \frac{ASFR_i}{1{,}000}, \text{ where}$$

$$ASFR_i = \frac{births_i}{female\ population_i} * 1{,}000$$

Within societies where childbearing within marriage is the norm, nuptiality can influence TFR. Where age at marriage is high, TFR is often lower in these contexts. Here young women are included within the group of females of childbearing ages but are less likely to contribute to the number of births. Similarly, where celibacy levels are high, women are included within the female population of childbearing ages without having children. Different age compositions of female populations on the regional or local level might also influence the measure of TFR. Regions with many young women employed in service, such as London and textile factories in the North, migrate to work but do not necessarily form families there. They do, however, still contribute to the number of women in the denominator $female\ population_i$.

The Non-Marital (Birth) Ratio (NMR) measures the percentage of all children born outside marriage compared to all live births:

$$NMR = \frac{all\ non\ marital\ \text{live}\ births}{all\ live\ births} * 100$$

Non-marital births include births to single mothers as well as to cohabiting couples. The indicator has its drawbacks, however. It does not account for the age structure of mothers, although the prevalence of non-marital childbearing possibly differs by age. Different age structures in a female population might be the reason for different NMRs. The variable cannot adjust for birth order, although first births are often more likely to occur outside marriage than higher-order births.

The variable married women working has already been described and used in the previous chapter (4.4). It gives information about all married women 15 or older with a recorded occupation as a percentage of all married women aged 15 or older, derived by Reid et al. (2018). Those women who have 'housewife' or 'house duties' recorded as an occupation have not been considered in this measurement as it is not considered paid employment. Women were identified through the individual-level census data using the combination of information on age and sex, marital status, and occupation. Between 1851 and 1911, female employment declined considerably. Partially, this might be attributed to changes in how questions were asked and how employment was classified. Nevertheless, home-based work, such as the cottage industry, decreased during the same decades in favour of factories.

In addition, the *New Dissent Index of Sitting* as described in the previous empirical chapter in Chapter 4.4 was interpolated to 2011 LAD. There are two reasons why the spatial patterns of New Dissent religions could be of interest: a) The previous chapter found that *New Dissent* religions were a major driver of declining fertility during the forerunner years of the Historical Fertility Transition/First Demographic Transition. b) Other scholars found spatial continuities of *New Dissent* religions/Methodist and voting patterns for the labour party in the 20th century (Gay, 1971). The associations here will be assumed as follos: High shares of New Dissenters in an area is associated with low fertility in 1851. The previous chapters already elaborated that low fertility is presumably associated with high shares of non-marital fertility. The consequence from these two statements is that the assumed association between New Dissent in 1851 and non-marital childbearing in 1951 is positive. Areas with a high share of New Dissenters are forerunner areas of childbearing outside marriage. Including the analysis of religion as well, also allows to gain a deeper understanding of ideational factors contributing to spatial persistence of demographic behaviour in England and Wales.

5.6 Results

5.6.1 (Dis)Continuities in Demographic Patterns 1851 to 2011

5.6.1.1 Descriptive Findings

First, national time series data on demographic behaviour are examined to determine when a country undergoes a secular change in such behaviour. At the sub-national level, forerunners are most likely to be identified prior to the tipping point where a sustained change in demographic behaviour occurs nationally. These years leading up to the tipping point may be termed the forerunner period.

For the Total Fertility Rate (TFR) between 1851 and 1922, a sustained decline can be observed after the 1880s (Figure 5.3). Therefore, the years preceding 1881 are considered the forerunner years, during which I anticipate discovering fore-runners at the regional level. As a result of the scarcity of data in 1871 and 1861, I have selected 1851 as the forerunner year of choice. Regarding the Non-Marital (Birth) Ratio (NMR), a continued decrease was evident after approximately 1980.

Here again, forerunner years can be defined as the decades prior to 1980. Because a slight increase in NMR already appears in the 1960s, 1951 is chosen as the year to analyse data for forerunner years. When comparing both spatial patterns, a negative association should be expected when continuities between forerunner (and laggard) areas exist, because we expect an increase in NMR where TFR declined early and vice versa.

How did spatial patterns of fertility develop in England and Wales between 1851 and 1911? And how did patterns of non-marital fertility evolve a century later between 1951 and 2011 within the same context? To study both phenomena, a detailed description of geographical patterns will allow us to follow changes in demographic behaviour and assess continuities in forerunner areas through simple descriptive analysis.

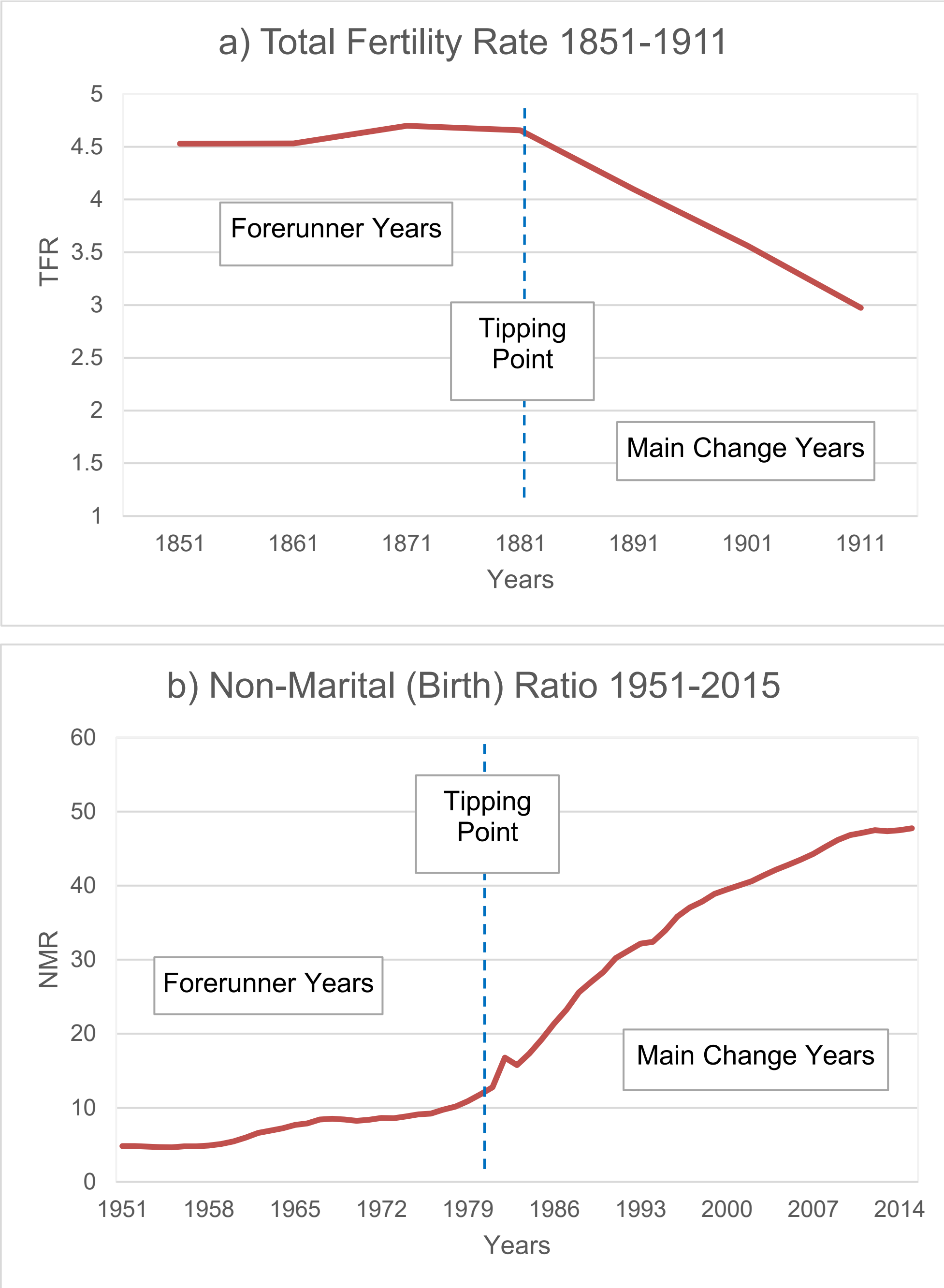


***Figure 5.3**. Detecting Forerunner Years: Changes in a) Total Fertility Rates 1851-1911 (mean of Registration Sub-District data) and b) Non-Marital (Birth) Ratio 1951-2011. (Sources: Reid et al. 2018; ONS, 2017).*

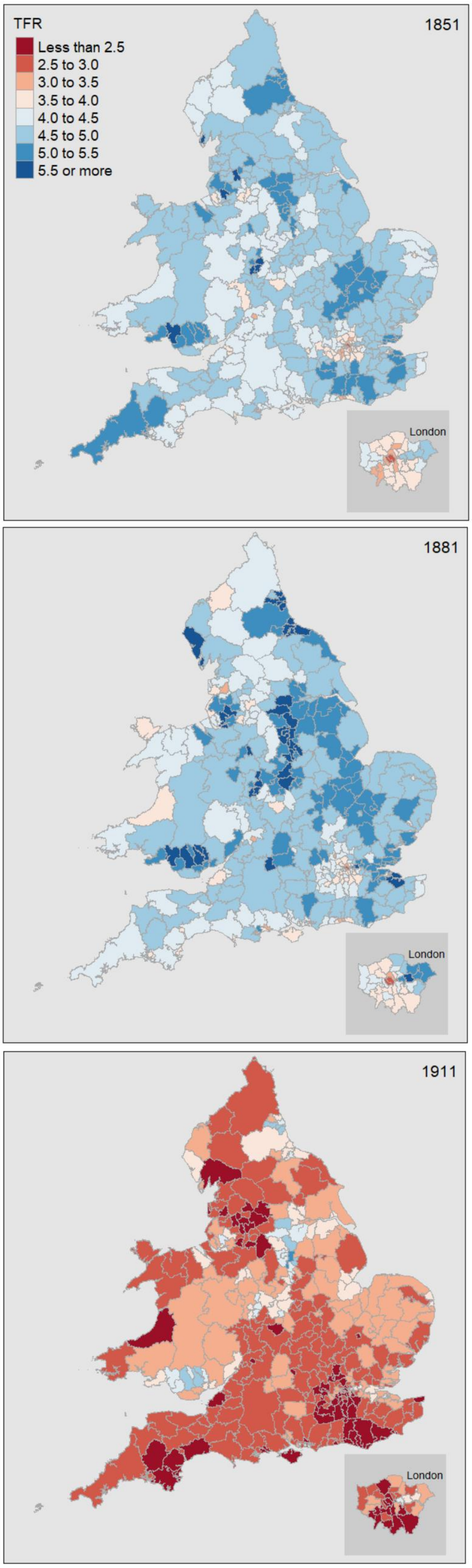


Figure 5.4. *Total Fertility Rates in 1851, 1881, and 1911 in England and Wales at the 2011 Local Authority District Level.*
(Source: own calculations; data - Reid et al. 2018; boundary - ONS , 2020, licensed under the Open Government Licence v.3.0)

Depending on where a woman in her fertile ages lived in 1851 in England and Wales, she experienced having an average of 2.82 children in areas of lowest fertility levels. In areas with the highest fertility, women gave birth to an average of 6.14 children, which is more than twice as many children. Fertility levels on average barely changed in the following three decades with TFR ranging between 2.52 to 6.60 and only a fraction of Local Authority Districts recording a TFR below 3 in 1881. Thirty years later, in 1911, the overall picture had changed considerably, and the Fertility Transition was way on its way. While in 1851 and 1881 low fertility areas were outliers, in 1911 only a small number of areas remained at levels considered standard levels in prior decades and centuries. By now, around 60% of LADs displayed TFR of below 3 with fertility levels in general falling between 1.41 and 5.28.

To allow a deeper understanding of spatial patterns of TFR over time, maps are a useful tool to explore continuities visually. Figure 5.4 shows TFR in 1851, 1881 and 1911 using 2011 at the Local Authority District units. Even though levels of fertility change over the course of these 60 years, spatial patterns seem comparatively stable. TFR at the lower side of the distribution could be found in London, especially the Western side. These districts featured a high share of professional and managerial occupations. Coastal middles-class towns like Bournemouth, Brighton but also the Isle of Wight follow a similar pattern of low fertility. The East of London ranged in the upper two quintiles of TFR values of over 4.68 instead. Similarly, in Northern LADs around the border regions of Greater Manchester, North and West Yorkshire, Derbyshire, and Lancashire fertility remained low throughout the period of study. All of them were centres of the British textile industry. On the other side of the range of TFR, Southern LADs in Wales – the Welsh mining centre – had among a few other areas the highest TFRs of above 5 both in 1851 and 1881 and still widely experienced a TFR over 4.5 in 1911. By this time, TFR had on average already dropped to 3.0 compared to 4.6 in 1851 and 4.7 in 1881. English coalfields and centres of the steel industry, such as a belt of LADs from the West Midlands through Leicestershire to Nottinghamshire but also Tyne and Wear and LADs around Hartlepool at the at the Northeast coast range on the upper side of the TFR values. Similarly, East Anglia as an agricultural area mainly exhibited high fertility, too.

All the above-mentioned areas can accordingly be considered core areas of demographic continuities during the fertility decline. A positive correlation of TFR values in 1851 and 1911 of 0.5 further underlines the prior observation of spatial continuities in patterns of fertility. Therefore, fertility levels almost persist over a period of 60 years across space. At the same time, forerunners areas of innovative fertility behaviour found in 1851 were still the same in 1911. It cannot be neglected that not all areas encountered the same degree of continuity. Cornwall and Devon being among the top 20% of TFR areas in 1851, were among the LADs at the lower 40% or even 20% range both in 1881 and 1911. Unfortunately, geographical distributions of fertility or non-martial childbearing cannot be explored throughout the following forty years due to data limitations.

When considering non-marital childbearing a century later, geographical differences in 1951 are not as pronounced on a first glance. Non-marital fertility was comparatively uncommon in the *Golden Age of Marriage*. In 1951, in more than four out of five LADs, less than 6% of children were born outside marriage with values ranging overall between 2.04

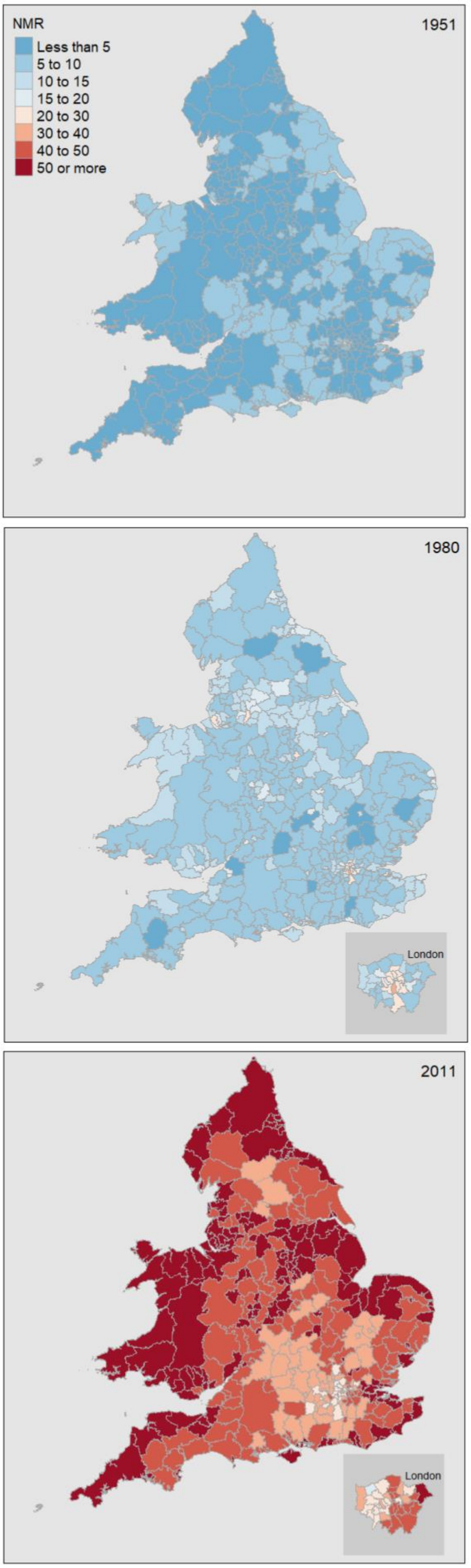


Figure 5.5. *Non-Marital (Birth) Ratios in 1951, 1980, and 2011 in England and Wales at the 2011 Local Authority District Level. (Source: own calculations; boundary – ONS, 2020, licensed under the Open Government Licence v.3.0).*

in Milton Keynes and 11.27 in Westminster. Accordingly, non-marital childbearing was far from being the norm in the middle of the 20th century and LADs were comparatively homogeneous in their family formation behaviour.

Thirty years later, a first slight increase in the Non-Marital (Birth) Ratio (NMR) had already occurred. Now, approximately every 10th child was born outside marriage with NMR ranging between 3.33 and 32.39. Not only London Boroughs but most larger cities and towns such as Nottingham with 26.54 and Manchester with 26.44 were among the LADs with the highest shares of non-marital births in 1980.

How do spatial patterns of forerunners compare across both transitions of demographic behaviour? As described earlier, I expect areas which displayed low TFR in 1851 to present high NMR in 1951. Within statistical terms, a negative correlation should appear.

The most striking pattern here is the high NMR in north-western England and parts of London in 1980. This pattern does seem to echo the areas of low marital fertility in the 1850s and 1880s. Both in 1951 and 1980, non-marital fertility levels were the highest in Central London and Northern areas around the former textile areas. These areas can be considered forerunners of changes in family formation behaviour in England and Wales. These areas were already forerunners of low fertility a century earlier during the Fertility Transition. This suggests indeed those spatial continuities of forerunner areas in England and Wales exist over a whole century.

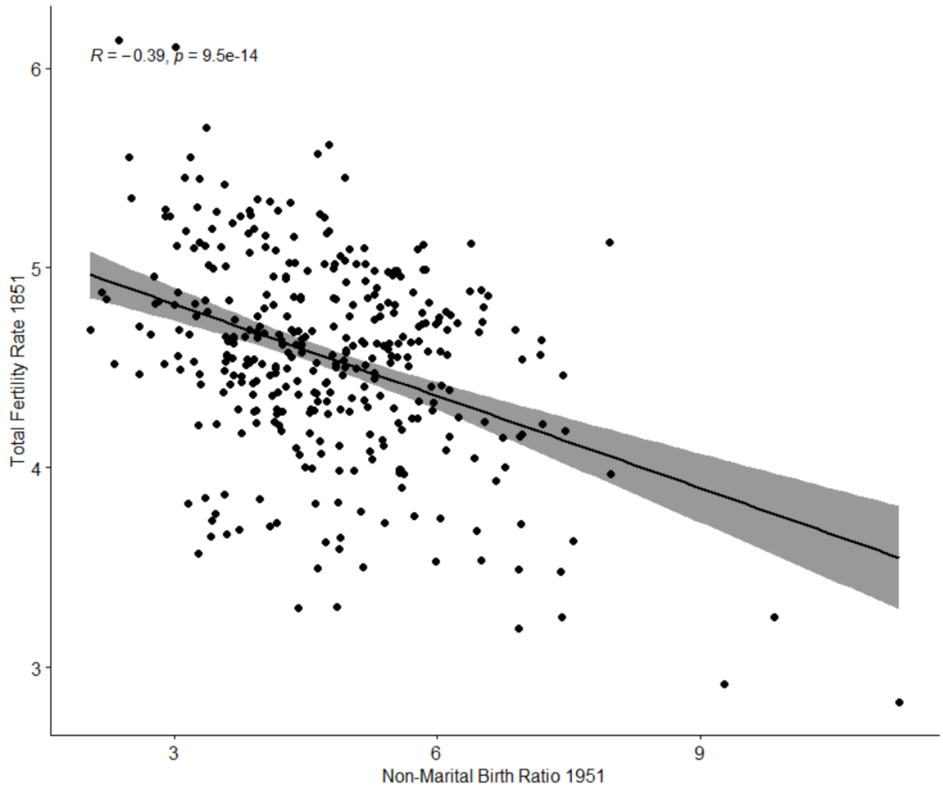


Figure 5.6. *Correlation Plot of Total Fertility Rates in 1851 and Non-Marital (Birth) Ratio in 1951 Based on 2011 Local Authority Districts (Sources: own calculations; data – GBHGIS 2011; Reid et al. 2018).*

A significant negative Pearson correlation of -0.39 and a Spearman's rank order correlation of -0.27 between both TFR in 1851 and NMR in 1951 further underlines the assumption of persisting spatial patterns. A negative correlation indicates that areas with low fertility in 1851 experience high shares of non-marital births in 1951 and vice versa. The same applies three decades later when both transitions are on the edge from the forerunner to main change years. Here, the overall correlation between TFR in 1881 and NMR in 1980 is still negative with -0.18. Accordingly, England and Wales reveal large similarities in spatial patterns of forerunners during the Fertility Transition as well as increase in non-marital childbearing.

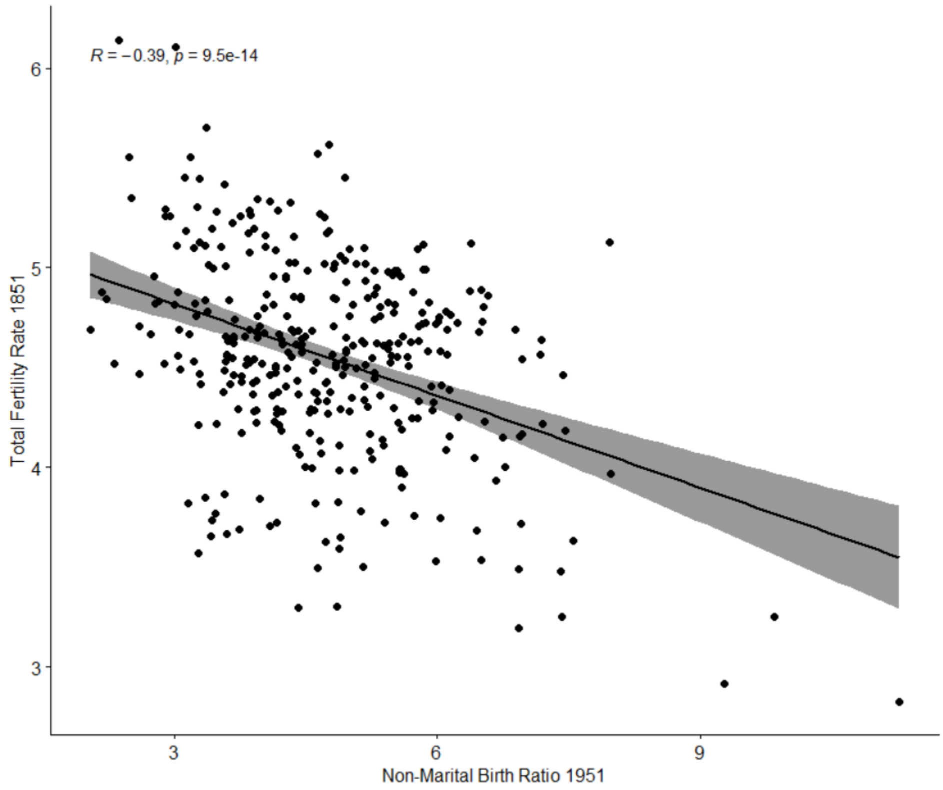


Figure 5.7. *Correlation Plot of Total Fertility Rates in 1851 and Non-Marital (Birth) Ratio in 1951 Based on 2011 Local Authority Districts (Sources: own calculations; data – GBHGIS 2011; Reid et al. 2018).*

What stands out after 1951, however, is the subsequent increase in non-marital childbearing in the following three decades. In around half of all LADs in England and Wales more than 50% of birth occurred outside in 2011. The top five LADs Knowsley, Blackpool, Hartlepool, Blaenau Gwent and Merthyr Tydfil experienced NMRs of 72.1 to 69.9. Clearly, by 2011 non-marital childbearing including both births to cohabiting parents as well as single mothers was widely established.

On the lower side of the spectrum, in Harrow only every fifth child was born out of marriage and in Westminster among other LADs only one out of four births (25.1 %) occurred outside marriage in 2011. Keeping in mind that Westminster among other London

Boroughs had the highest NMR in all of England and Wales in 1951 and with 30.54 % an even higher share of non-marital births in 1991 compared to 2011, this emerging reversal in family formation behaviour within London is striking. At the same time, it shows that the majority of England and Wales is converging towards very high non-marital fertility levels while London is converging from this new norm towards lower non-marital childbearing. Instead of continuities in spatial pattern of NMR, I do not find continuities anymore or in some cases, such as London, I even find discontinuities in family formation behaviour between 1951 and 2011.

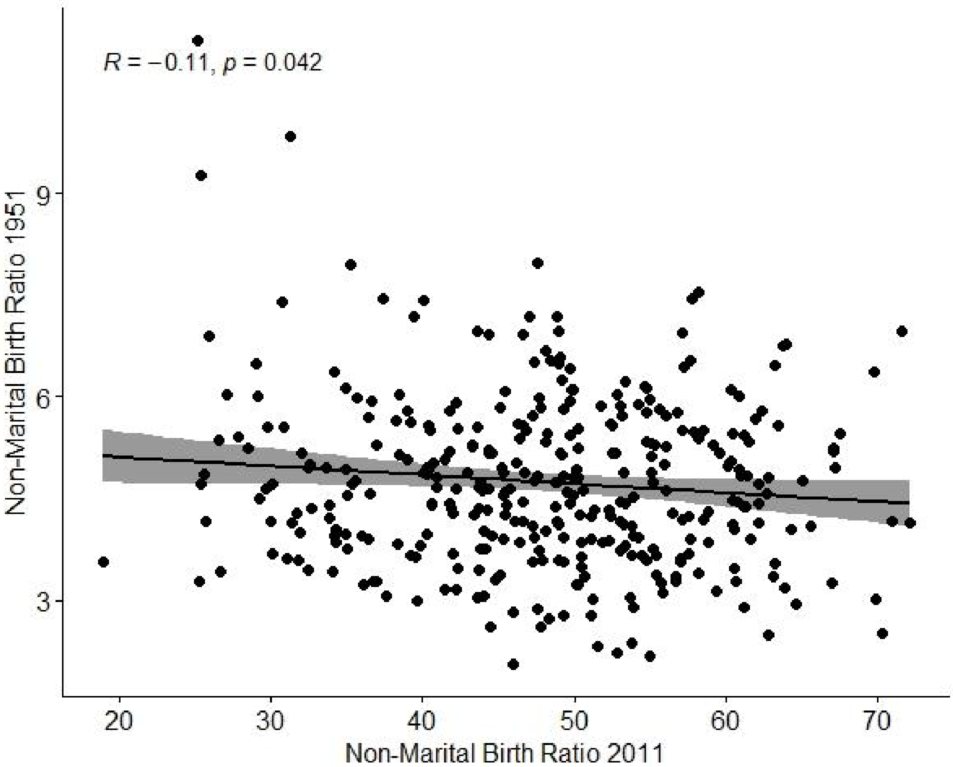


Figure 5.8. *Correlation Plot of Non-Marital (Birth) Ratio in 1951 and Non-Marital (Birth) Ratio in 2011 Based on 2011 Local Authority Districts (Sources: own calculations; data – GBHGIS, 2011; ONS, 2022).*

A negative correlation of -0.11, significant at the 5% level, between NMR in 1951 and 2011 further might illustrate the divergence in spatial patterns over these sixty years. However, the correlation is very small and seems to be driven by two outliers in NMR in 1951 (Figure 5.7) – both being situated in London. Further sensitivity analysis excluding these two outliers reveal that the significant correlation of -0.11 is only driven by these two outliers but does not hold hen excluding them from the analysis. The Spearman's rank correlation is only -0.06. In general, there does not seem to be a significant correlation when visualising because NMR values were so homogeneous in 1951 but then diverge dramatically in 2011. Accordingly, both transitions in fertility and family formation behaviour seem to follow different trajectories over the course of time.

5.6.1.2 Geographically Weighted Correlation

To assess if the spatial continuities described in the previous sub-chapter prevailed to a similar extend across all LADs of England and Wales, a geographically weighted Spearman's rank order correlation is performed (Fotheringham, Brunsdon and Charlton, 2003). This form of correlation estimates a correlation for each Local Authority District (LAD) based on a certain number of neighbouring LADs determined by cross-validation (CV) and Akaike information criterion (AIC) of the correlation performance as described in the methodology sub-chapter 3.2.3. Therefore, this local form of correlation allows to determine locally varying associations. In this context a bandwidth (bw) of 17 was determined through both AIC and CV with an adaptive kernel with a gaussian distribution.

The simple Pearson correlation highlighted those spatial continuities of forerunners existed between 1851 and 1951. Areas with low fertility during the forerunner years were the same to experience comparatively high shares of non-marital births during changes in family formation in 1951.

Figure 5.9 stresses how correlations are largely negative but still differ across England and Wales. Here, negative correlations indicate continuity in forerunner areas and positive correlation coefficients discontinuity. To some extend there seems to be a North-South divide appearing on the cartographic representation of Spearman's local correlation with the North exhibiting more continuities and the South, except of London, some continuity or no (dis)continuity. High degrees of spatial continuity with correlations ranging between -0.8 and -0.4 are present in Cornwall and Devon as well as large parts of Wales.

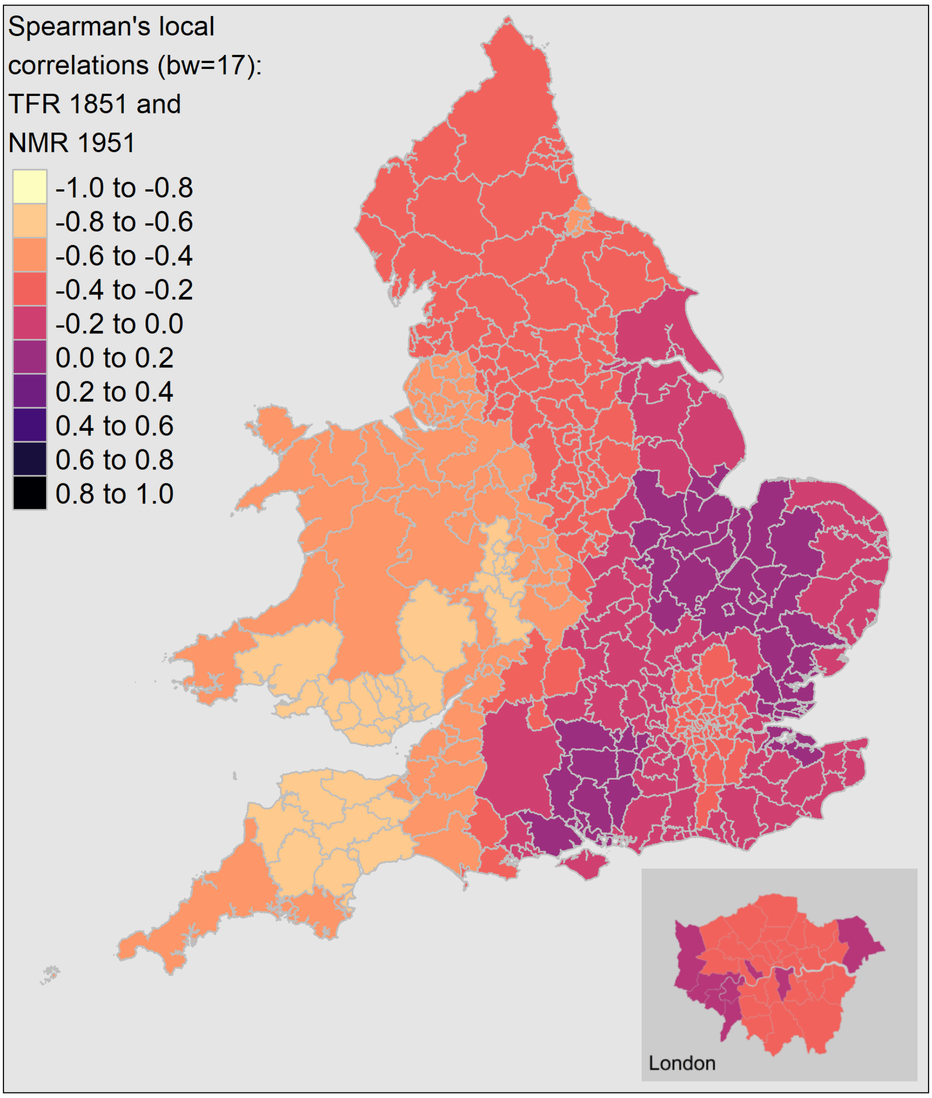


Figure 5.9. *Geographically Weighted Spearman's Rank Order Correlation Coefficients (Bandwidth=17) between Total Fertility Rates in 1851 and Non-Marital (Birth) Ratios Based on 2011 Local Authority Districts (Sources: own calculations; data – GBHGIS, 2011; Reid et al., 2018; boundary: Day, 2016, ONS, 2020).*

Notes: Meaning of colour scheme is yellow/orange– continuity, purple– discontinuity.

London as forerunner of both low fertility and high non-marital fertility already stuck out in the description of geographical patterns through maps. Many remaining LADs exhibit correlations of -0.5 and -0.25 still indicating a comparatively high degree of spatial continuities. Correlations of larger than -0.25 and close to 0 only show up in parts of East Anglia and a few LADs in the South suggesting that spatial continuities are lower or even inexistent here. The geographically weighted correlation for TFR 1881 and for NMR 1980 though

(Appendix B.3) suggests that continuities already disappear around the tipping point of both demographic changes.

Moving on in time, I now compare spatial patterns of non-marital childbearing in 1951 and 2011 (*Figure 5.10*). In general, evidence in the context of Europe suggests that spatial patterns of non-marital childbearing reveal continuity over decades or even centuries (Klüsener, Perelli-Harris and Sánchez Gassen, 2013; Klüsener, 2015; Klüsener and Goldstein, 2016). In contrast to the previous map negative correlations (purple) now indicate discontinuity and positive correlation coefficients continuity (yellow/orange). Following simple Pearson or Spearman's rank order correlation, these did not seem to be related. However, a different picture appears on the local level in Figure 5.10 displaying the local correlation when compared to previous map in Figure 5.9. Spatial patterns appear rather similar than in the previous map even though with Spearman's correlations being around 0.2 higher on this map. Continuity in NMR within the map appears as purple, whereas discontinuities appear in shades of yellow to orange. Again, to some extent, one can observe a North-South divide appearing on the map with the South exhibiting either no (dis)continuity or some degrees of continuity in non-marital childbearing with correlation coefficients of 0.0 to 0.4. Here, LADs with high NMR in 1951 tend to have high NMR in 2011 and vice versa. London and especially its boroughs in the centre and East, again, are an exception within the South revealing discontinuities with correlation coefficients of -0.4 to 0.0. This finding supports the visual observation that forerunner boroughs of high non-marital childbearing with high NMR in 1951 now have low NMR and vice versa. Especially Wales along with Cornwall and Devon display the highest degree of discontinuity with correlation coefficients between -0.2 and -0.6.

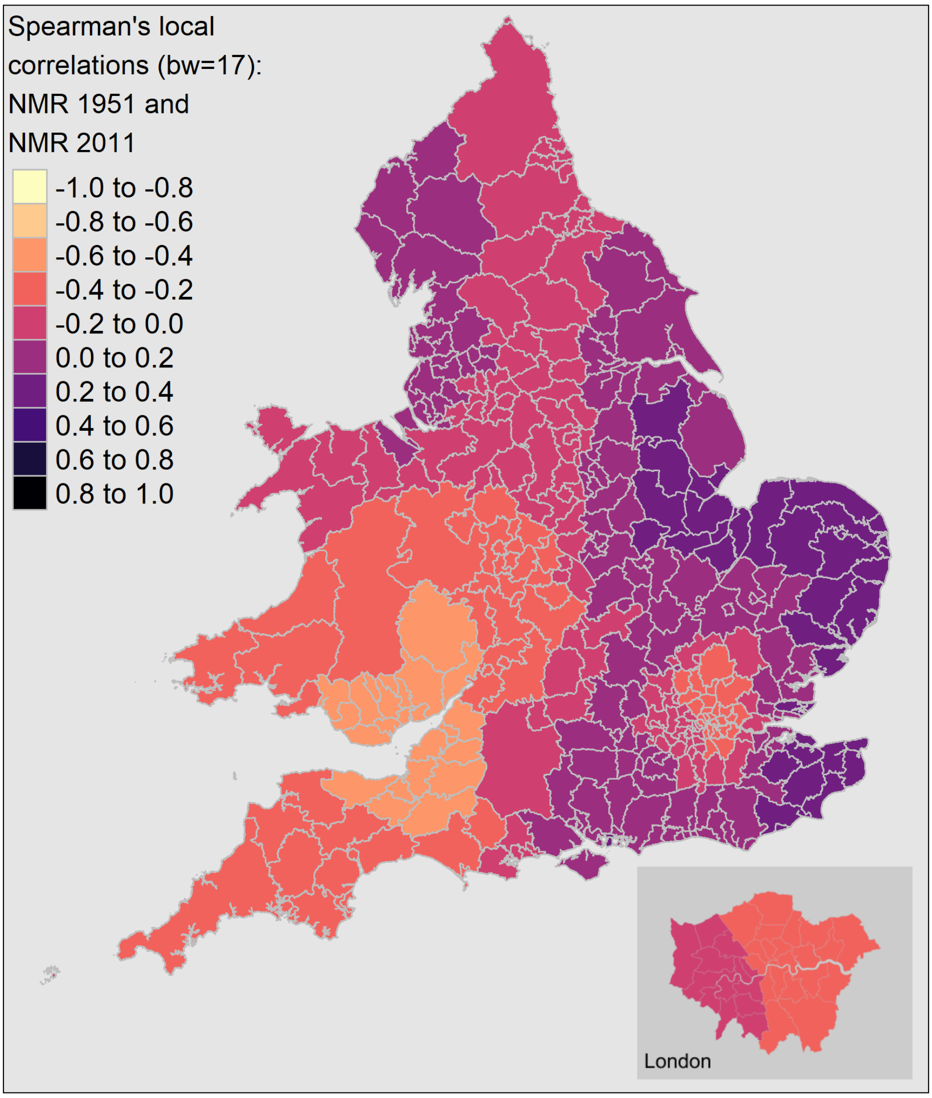


Figure 5.10. *Geographically Weighted Spearman's Rank Order Correlation Coefficients (bandwidth=17) between Non-Marital (Birth) Ratios in 1951 and Non-Marital (Birth) Ratios Based on 2011 Local Authority Districts (Sources: own calculations; data – GBHGIS, 2011; ONS, 2022; boundary – Day, 2016; ONS, 2020).*

Notes: Meaning of colour scheme is yellow/orange – discontinuity, purple– continuity.

5.6.2 Spatial Patterns of Forerunner and Employment among Mothers

After continuities in forerunner areas and discontinuities in demographic patterns from the second half of the 20th century have been discussed in detail, possible mechanisms will be explored through which historical fertility and non-marital childbearing patterns might be connected through the indicator employment among mothers. Unfortunately, data for the middle of the 20th century are not available and the analysis will be limited to data available for 1851. Accordingly, I can only apply simple bivariate analysis and cannot explore associations of forerunner areas and possible indicators more detailed or through more sophisticated models.

5.6.2.1 Descriptive Findings

If patterns of employment among mothers remained constant between the 1850s to the 1980s and that this is the connecting factor between forerunner areas during the Fertility Decline and forerunner areas of high non-marital fertility, one might expect an association between the share of married women working in 1851 and the NMR in 1951 as well. Given the lack in other suitable data sources for the mid-20th century, testing this association is the only possible analysis.

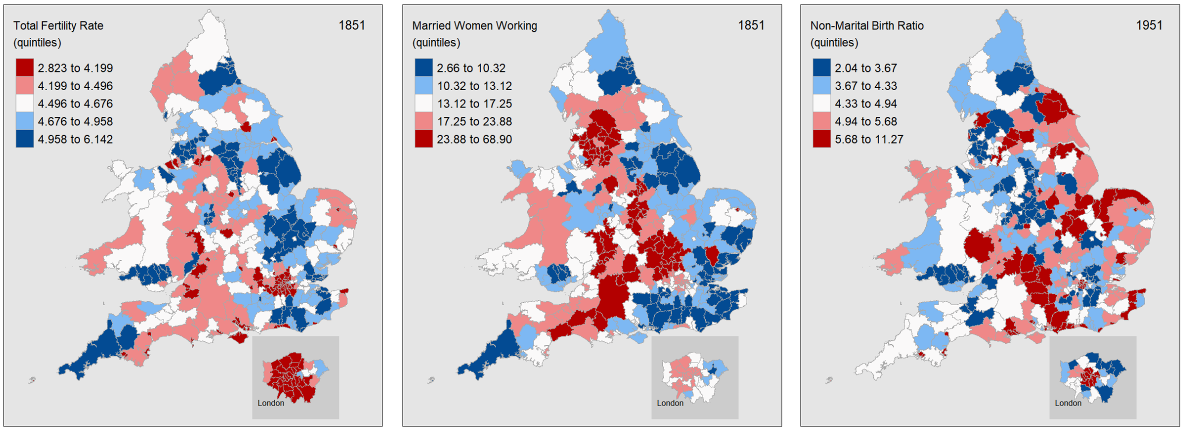


Figure 5.11. *Maps Depicting Quintiles of Total Fertility Rate 1851, Married Women Working 1851 and Non-Marital (Birth) Ratio 1951 (Sources: own calculations; data – GBHGIS, 2011; Reid et al., 2018; boundary – Day 2016; ONS, 2020).*

Descriptive maps in Figure 5.11 depict quintiles of the TFR in 1851, share of married women working in the same year and the NMR in 1951. Similar colours constitute values that are expected to be positively correlated such as red for low TFR, high share married women working and high NMR. Especially 1851 variables reveal similarities in spatial patterns. These exhibit a significant negative Pearson correlation of -0.12 (p: 0.02). London

Boroughs with the lowest TFR where in the quintiles but also Southwest England, West Midlands, Wales and southern parts of the Northwest had both low TFR and high shares of married women working. Large parts of the Southeast, East, Yorkshire and the Humber and the Northeast had high fertility and lower shares of married women working in 1851. There were some exceptions, however. Not all districts belonging to the textile areas in the North such as Manchester had low fertility despite a high level of mothers' employment. Hertfordshire and Bedford in the North of London – centres of the cottage industry with home-based employment for women – experienced vice versa high fertility while having high levels of married women working.

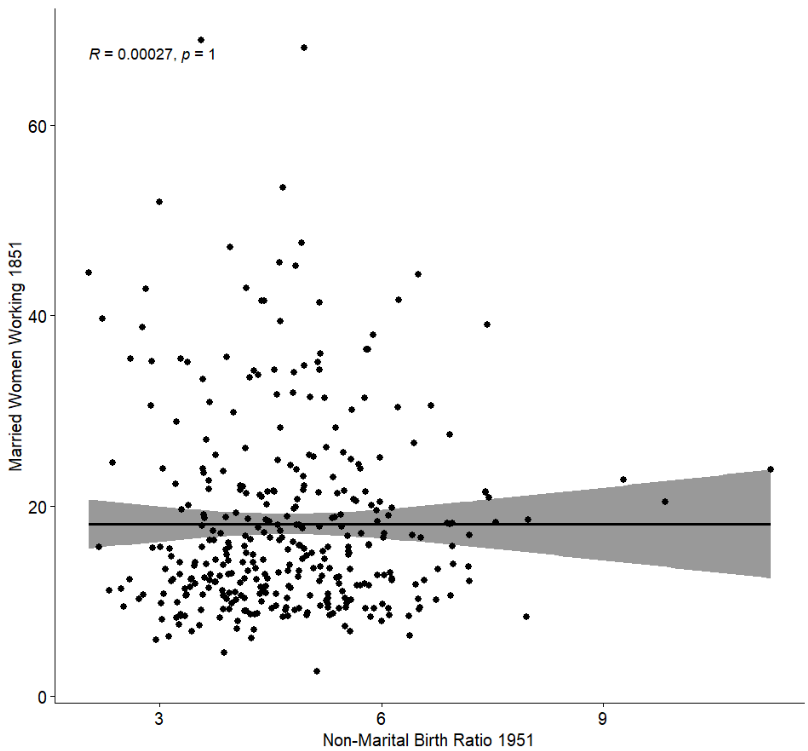


Figure 5.12. *Correlation Plot of Married Women Working in 1851 and Non-Marital (Birth) Ratio 1951 (Sources: own calculations; data – GBHGIS, 2011; Reid et al., 2018).*

The comparison of spatial patterns of married women working in 1851 and NMR in 1951 is not as straightforward anymore. Given the small range of NMR values from the first into the fifth quintile as also depicted in Figure 5.5 it is difficult to determine real spatial variation. Here, the centre of London, Manchester, Liverpool and other larger to mediumsized town exhibit the highest levels of non-marital fertility. In the same areas, the share of married women working was often larger a century earlier.

Since the assumption is that areas with a high share of mothers working in 1851 are like areas with high non-marital fertility in 1951, one would expect a positive correlation between both variables. Data on mothers' employment does not exist directly but it is known that marriage is a decent proxy for childbearing soon during that era. A correlation plot of the two variables married women working in 1851 and non-marital childbearing in 1951 does not reveal any obvious pattern Figure 5.12, however. And indeed, both Pearson (0.00) and Spearman Rank Order Correlation (0.06) do not reveal a significant correlation.

5.6.2.2 Geographically Weighted Correlation

A simple correlation between married women working in 1851 and non-marital childbearing in 1951 did not reveal an association of both factors. The diverse employment opportunities in the middle of the 19th century consisting of both factory and home-based work might have obscured this picture on the national level, however. Again, a geographically weighted correlation is a useful tool to detect spatially heterogeneous associations.

Indeed, the national picture seems to mask local variations in associations. Figure 5.13 reveals that the correlation between both factors varies spatially between being non-existent (-0.2 to 0.2) around Lincolnshire to being positive and significant (up to 0.8) in London. In the latter case, a high share of married women working in 1851 is correlated with a high share of non-marital fertility in 1951 and vice versa. These results point towards employment among mothers being a mediating factor between forerunner areas of low fertility in 1851 and forerunner areas of high non-martial fertility in 1951.

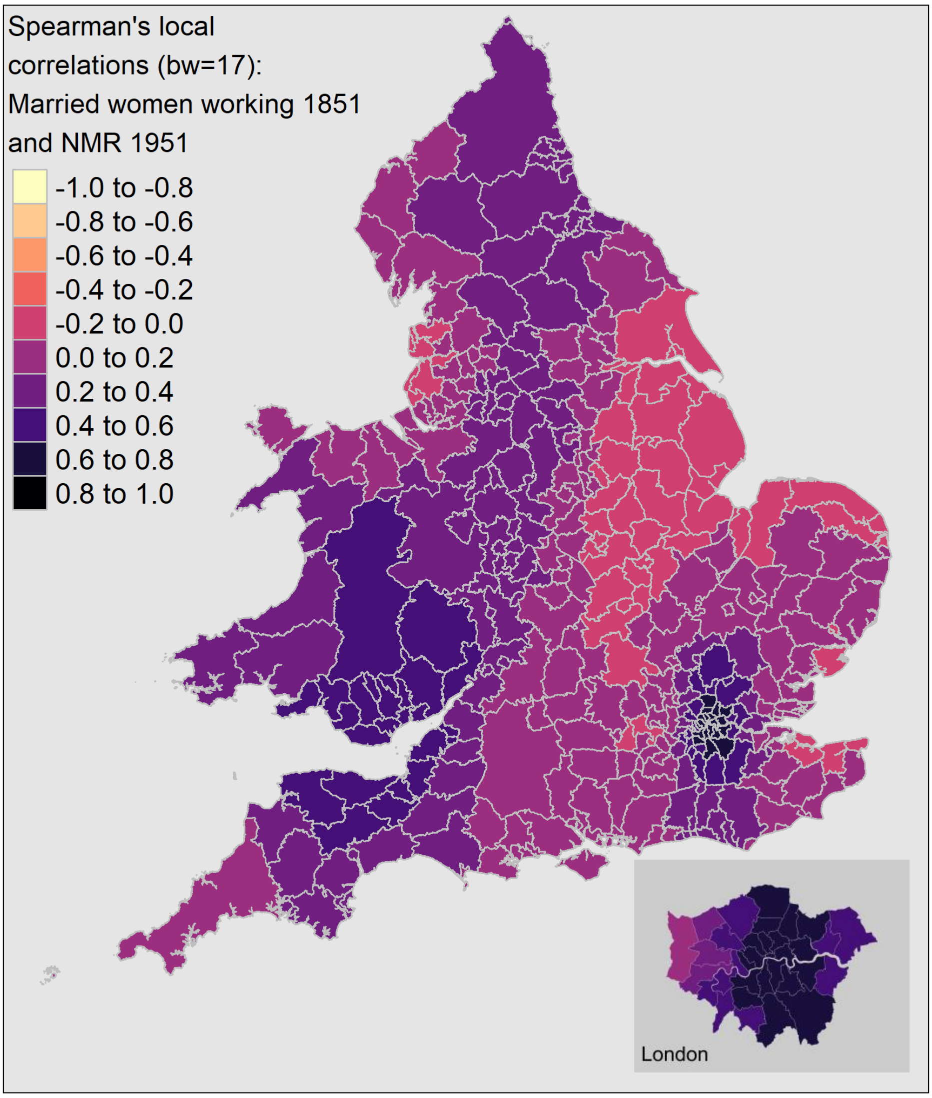


Figure 5.13. *Geographically Weighted Spearman's Rank Order Correlation Coefficients (bandwidth=17) between Married Women Working in 1851 and Non-Marital (Birth) Ratios in 1951 Based on 2011 Local Authority Districts (Source: own calculations; data – GBHGIS, 2011; Reid et al., 2018; boundary – Day 2016; ONS, 2020).*

Notes: Meaning of colour scheme is purple – continuity, yellow/orange – discontinuity.

5.6.3 Spatial Patterns of Forerunners and *New Dissent* Religions

As discussed before, I assume that the association of high shares of New Dissenters in 1851 measured through the Index of Sittings in 1851 is positively associated with forerunner areas of non-marital childbearing.

The correlation plot (Figure 5.14), however, reveals the opposite association. The Pearson correlation is -0.11 and statistically significant on the 0.5-level. This means that in areas with high shares of New Dissenters, non-marital childbearing is low in 1951 or vice versa where the Index of Sittings is low, non-marital childbearing is high.

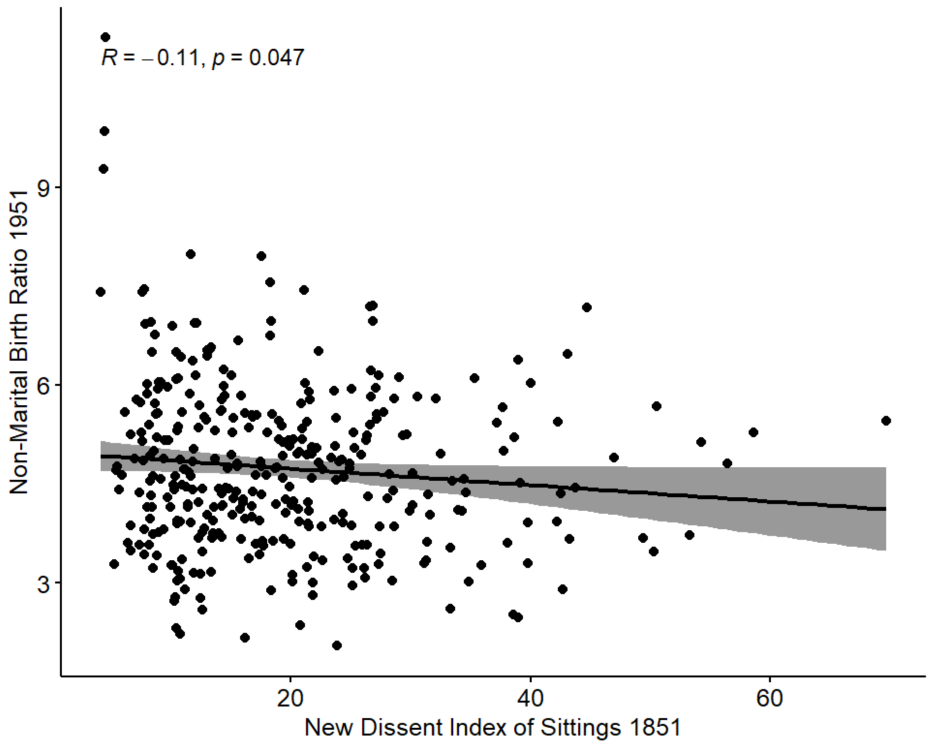


Figure 5.14. *Correlation Plot of New Dissent Index of Sittings in 1851 and Non-Marital (Birth) Ratio 1951 (Sources: own calculations; data – GBHGIS, 2011; Reid et al., 2018).*

The geographically weighted correlation depicted in Figure 5.15 reveals that in large areas of England in Wales, the association is around zero and hence not existent. In London, the Southwest (Cornwall, Devon, Dorset, Sommerset), the West Midlands and large parts of Wales, especially the South, the association is negative. In Somerset as well as Glamorganshire, the correlation is as low as -0.8 to -0.6. Given that the New Dissenters were very religious with a strong focus in piety, it might not seem surprising that these areas in the Southwest and Wales do not come up as forerunner areas of non-marital childbearing.

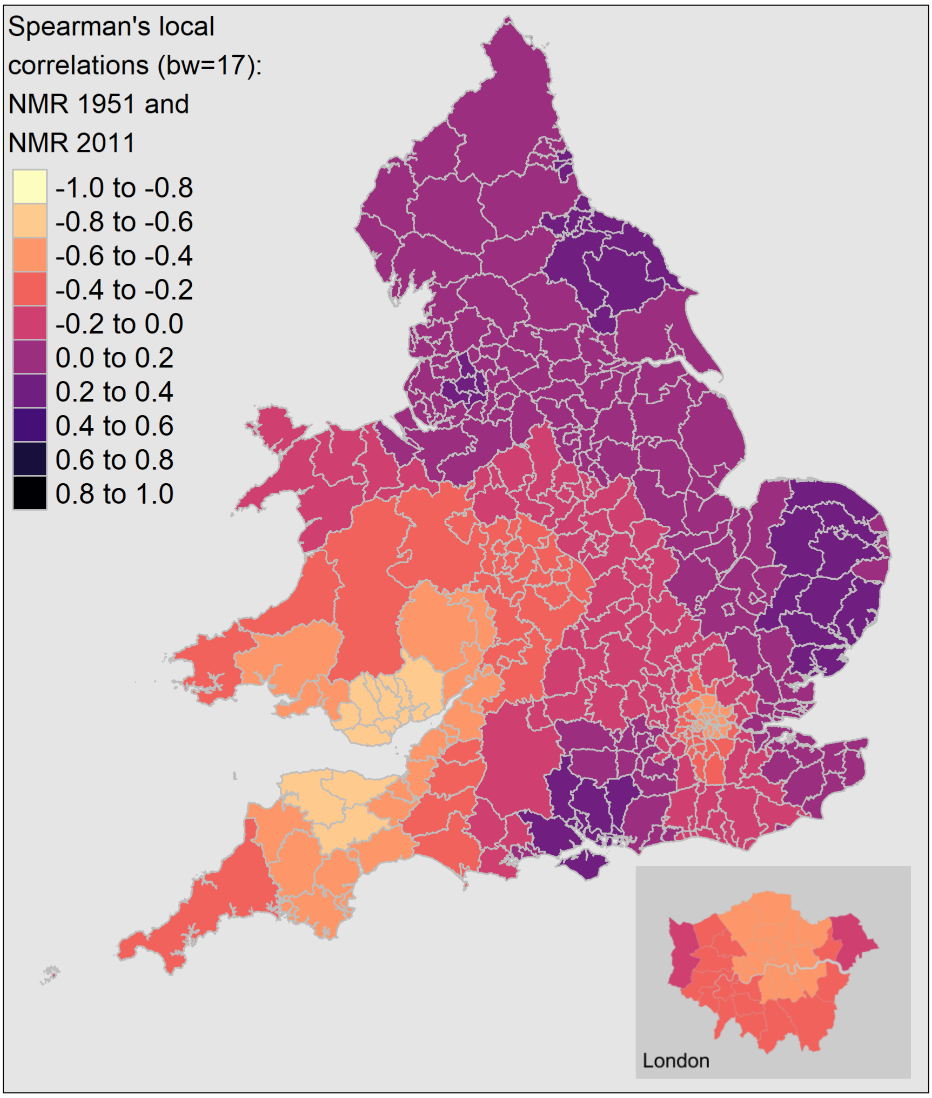


Figure 5.15. *Geographically Weighted Spearman's Rank Order Correlation Coefficients (bandwidth=17) between New Dissent Index of Sitting in 1851 and Non-Marital (Birth) Ratios in 1951 Based on 2011 Local Authority Districts (Source: own calculations; data – GBHGIS, 2011;Ell and Southall, 2020; boundary – Day 2016; ONS, 2020).*

Notes: Meaning of colour scheme is purple – continuity, yellow/orange – discontinuity.

Together, these results provide important insights into more than one and a half centuries of spatial patterns of English and Welsh family demography. Even though forerunner areas of new demographic behaviour demonstrate a high degree of spatial persistence this is not the case for forerunner areas of non-marital childbearing and the same demographic behaviour six decades later after having children outside marriage has become a more common behaviour. The most surprising aspect is, however, that spatial patterns of local correlation coefficients are similar with a North-South divide appearing for both previous comparisons through local correlations. Clusters of New Dissenters do not proof to be forerunner areas of non-marital childbearing. Especially districts with highest degrees of continuity of forerunner areas display the highest degree of discontinuity in non-marital fertility between 1951 and 2011.

5.7 Discussion

The objective of this chapter is to detect forerunner areas of new demographic behaviour at the onset of the historical fertility decline in association with changes in family formation behaviour a century later. An additional goal was to find out if these forerunner areas maintain spatial continuities over time. In almost all Local Authority Districts of England and Wales, I find strong evidence for spatial continuities in forerunner areas in 1851 and 1951, even with slightly different strengths. These results back up hypothesis H 5.1, indicating continuities in spatial patterns of forerunner areas. Like other European contexts, such as Belgian (Lesthaeghe and Neels, 2002), some areas seem more perceptive to adopt new demographic behaviour than others.

One mechanism I proposed is that spatial labour force participation patterns among mothers might have been associated with an early uptake of new demographic behaviour during both demographic changes altering Europe's families in certain areas earlier than in others. As another analysis the correlation of the indicator New Dissent Index of Sitting in 1851 was correlated with non-marital childbearing in 1951 because it was found to be an important factor being associated with forerunner areas of fertility decline during the First Demographic Transition. Of course, correlation does not imply causation and the analysis does not control for any other determinants. While at first sight this determinant may appear to be economic in nature, the importance of norms pertaining to working mothers in specific areas cannot be dismissed. On one side, mother's employment might denote personal self-fulfilment and financial autonomy, while also signifying economic precariousness and uncertainty at the same time.

Here, a spatial analysis helps again to point out the importance of context in terms of location and time to understand the (changing) meaning of indicators. These economic, social and cultural explanations might even amplify each other. It seems like cultural indicators seem more important during forerunner years. They pave the attitudinal road to make changes in demographic behaviour such as fertility and family formation acceptable. However, once accepted and practised by a particular share of the population, we observe a tipping point in demographic behaviour on the aggregate level. Now, socio-economic interpretations of indicators are of higher relevance. Research in other contexts has revealed that areas with a long history of female employment are more open to mothers' employment (Wyrwich, 2019). These local norms diverging from the conservative male-breadwinner model in the 19th century may also be associated with a broader acceptance of new forms of family formation in the 1950s.

Such developments are similarly embedded in the context of general spatial continuities of other demographic behaviour. Not only mortality presented persistent spatial patterns in England and Wales across the 20th century (Gregory, Dorling and Southall, 2001; Gregory, 2009), but also the geographical distribution of fertility patterns remained relatively constant between 1851 and 1911, as discussed in the results section 5.6. Even though norms regarding family size changed over this period, prevailing social and cultural norms of what constitutes a family probably remained comparatively stable. The Fertility Transition took place during a period of many societal changes, including socio-economic conditions such as changing forms of labour or rapid urbanisation, or other demographic changes, e.g., increasing life expectancy and decreasing mortality, increasing awareness of hygiene and improving health conditions accordingly or cultural changes such as secularisation. What seems striking, however, is that all areas head towards the same direction of falling fertility, even with different onsets and tempos, in the long run in England and Wales despite all geographical differences.

What stands out is the finding of a North-South divide when examining locally varying correlation coefficients through geographically weighted Spearman's correlation. These results reflect those of other studies that found that spatial inequalities in England and Wales manifest in a North-South divide (Green, 1988; Dorling, 2010; Buchan *et al.*, 2017; Schürer and Day, 2019). Whereas the North of England, alongside Wales, exhibited a high degree of continuity of demographic forerunner (and laggard) areas, these continuities are not as pronounced in the South. Only London stands out in the South of England by showing higher degrees of continuities in demographic behaviour. Accordingly, this chapter supports the evidence from previous research (Gregory, Dorling and Southall, 2001; Schürer and Day, 2019) that the North-South divide likely existed as early as the 19th century.

Surprisingly and in contrast to mainland Europe (Klüsener, 2015), England and Wales seem to be among the only examples in this context that do not exhibit continuities in non-marital childbearing after the *Golden Age of Marriage*. In England and Wales, I found that this is not the case, and spatial patterns do not exhibit continuities or even discontinuities, such as in the case of London. These findings support hypothesis H 5.3 that there are discontinuities in spatial patterns of non-marital childbearing.

Correlations between 1951 and 2011 differ across space, though: Local Spearman's rank order correlation coefficients reveal spatially varying associations. Once the epicentre of England's Industrial Revolution, the North discloses a great extent of discontinuities. During this period, England and Wales, but particularly the North of the country, suffered from deindustrialisation leading to significant shifts in economic structure. With the decline in industry, especially heavy industries such as coal mining, steelmaking, shipbuilding and heavy engineering, unemployment rose. Depending on the type of dominant industry, centres of the Industrial Revolution witnessed distinct fertility patterns of particularly low (textile areas) or high fertility (mining areas). However, all areas were hit by deindustrialisation in the second half of the 20th century, leading to high rates of unemployment. Accordingly, it is possible that both fertility forerunners and laggards in 1851 ended up having high levels of non-marital childbearing in the long run when following the pattern of disadvantage hypothesis (Perelli-Harris et al., 2010)

Female-breadwinner- or dual-earner-families and their economic vulnerability seem likely of importance across more than a century to explain demographic changes. At least since the mid-19th century, women took up employment to contribute financially to family income. The conceptual framework underscores how conditions influencing families, such as employment prospects for men and women, and labour force participation, intersect not only at the individual level but also at the collective spatial level. Accordingly, female labour force participation, driven by the uptake of mothers' employment, rose in areas of deindustrialisation in the second half of the 20th century. It seems likely that spatial inequalities in families' income manifest in both labour force participation of mothers (H 5.2) and employment and earning potentials of fathers. Both again are the driver of spatial continuities in demographic forerunners on the regional level. Similarly, the same factors are associated with the divergence of spatial patterns of non-marital fertility in the second half of the 20th century.

On the contrary, religion which was found to be an important factor in association with forerunner areas of low fertility during the First Demographic Transition. This finding is possibly not surprising on the second glance. During the Fertility Transition, areas with a high share of New Dissenters/Methodist were found to reduce their fertility early and faster than other areas. The main explanation was, that a strong set of norms, institutions and social identity among New Dissenters were possible explanations related to lower fertility (Chapter 4.2.3). Factors such as the early education among Methodist women, individualisation, but also the downplaying of values of present consumption in favour of consumption in the future were arguments why Methodists were likely to be sympathetic to restraining current childbearing and having fewer, ‘higher-quality’ children. Prudence was a high value among New Dissenters and most likely reducing fertility happened through abstinence. In environments were marriage, virtue and prudence was highly valued within the population, it does not seem surprising that non-marital fertility was particularly low in such areas.

However, the chapter cannot disregard other major changes on the regional level happening after the 1950s. These might have altered local levels of non-marital childbearing regardless of previous levels of TFR or labour force participation among mothers. From the 1960s, England witnessed large immigration waves from countries with more conservative norms. Immigration in the early decades came predominantly from New Commonwealth (NCW) countries such as India, Pakistan and Bangladesh (Smith, 1981; Peach, 2006). In recent decades, EU migrants came, mainly from Romania and Poland (Rampazzo *et al.*, 2021), countries also holding more conservative family values. These waves of immigration altered local population structure which again potentially changed local values and norms. Even though the overall share of the population of NCW ethnicities with 6.2% compared to 84.6% of white ethnicity according to the 2016 ONS Annual Population Survey, comparatively small, often local clusters with high shares of these ethnic groups developed (Overtoil, 1980). Results on ethnicity from the 2011 Census further illustrate this phenomenon. Particularly in urban areas such as London, the proportion of non-white ethnicities is concentrated in certain local authority districts (LADs) (ONS, 2024). In Newham, 43.5% of the total population were of Asian/Asian British ethnicity and 19.6% were of Black/African/Caribbean/Black British ethnicity. However, although high proportions of Asian/Asian British Indian were found in London, for example, the comparatively small LAD of Oadby and Wigston, just outside Leicester, also had 17.7%of its population of Indian ethnicity. The highest proportion of the population with a Pakistani ethnicity was found in Bradford with 20.4%.

Presumably, these areas witness lower levels of non-marital childbearing regardless of historical spatial patterns. Koops (2020) showed that even in recent years, the chance of having a first birth outside marriage is much lower for South Asian minorities compared to natives in the UK. For Caribbean minorities, non-marital birth ratios are higher than for natives, though. For fertility, research found that fertility of women in England who grew up in areas of low residential segregation, fertility was closer to Native English women (Wilson and Kuha, 2018). Instead, women who grew up in areas of high segregation had higher fertility illustrating the importance of early childhood socialisation. The context in which people grow up and live matters for their future family formation patterns regardless of ethnicity. Unfortunately, data on the LAD level providing some kind of immigration only exists in 1981. It provides information on persons of whom both parents were born outside the UK (including both in the New Commonwealth). This data does not help to understand non-marital childbearing. Since the patterns on New Commonwealth immigrants and their descendants might vary depending on the actual country (South Asian or Caribbean) only information on New Commonwealth does not seem to be a helpful information as well.

Another finding that came up repeatedly is that London usually seems to be an outlier of demographic behaviour. Is London in general the forerunner of new demographic behaviour? London was not the forerunner of both changes in demographic behaviour but seemed to be on a different demographic trajectory than the rest of England, especially after the 1980s. Most parts of England and Wales converge towards higher levels of non-marital childbearing. London instead seems to have a high propensity to revert patterns and changes to marital childbearing. London now has comparatively low levels of non-marital fertility compared to the rest of the country. London was always an outlier in terms of population composition (Hamnett and Williams, 1980; Hamnett, 2015; Johnston, Poulsen and Forrest, 2015; Schürer and Day, 2019). In addition, London witnessed rapid changes in the population composition in recent decades due to a high degree of inhabitants with a university degree or professional and managerial occupational classes, immigration from other countries and gentrification.

There are other possible explanations for why London has been different from England and Wales's remaining areas for more than 1.5 centuries. Being the centre of the nation, it was early the largest city in Europe, rapidly urbanising from the 18th century. London has always been home to many highly educated people, occupying professional and managerial occupations. Also, highly educated women, increasing over time, reside in London, which might point to London holding more liberal gender norms. What cannot be disregarded is the gentrification of London since the 1960s, leading to a changing social structure of Inner and later Greater London, subsequently surrounding LADs. Gentrification refers to “the colonization of the working-class inner areas of certain cities by the middle classes” (Glass, 1973, in: Donnison & Eversley). Inner London was, until around 1900, mostly middle-class before it was left to the working class. Gentrification, starting in1960s, changed the local population structure again towards a higher share of the middle-class population. London seems to be a centre of constant change but also innovation.

The study still has its limitations, and some results must be interpreted cautiously. Areal weighted interpolation always introduces some unknown error when interpolating areal data to other units. However, the error should be small because only smaller units are interpolated to larger units. Comparing data over such a long period was otherwise impossible, the advantage outweighs the possible limitations here. Unfortunately, the lack of available data for the mid-20th century has important implications for the conceptual framework. These circumstances did not allow me to statistically test hypothesis H 5.2, that spatial continuities of forerunner areas were emphasized through patterns of labour force participation among mothers. Further releases of census data for 1931 to 1961 are currently under investigation by ONS and UK Data Archive. Accordingly, the proposed associations might be tested if these data were made available in the future. Here, panel data covering multiple decades might allow investigating spatiotemporal mechanisms to gain a deeper understanding of spatial continuities in demographic behaviour.

5.8 Conclusion

This analysis provided new insights into spatial (dis)continuities of demographic behaviour affecting the size, composition, and definition of families in England and Wales from 1851 to 2011. Therefore, the study makes an essential contribution to the growing area of social science and demographic research on historical persistence by analysing the emergence of ‘new’ demographic behaviour across two waves of demographic innovations. Exploring if and how long-term demographic developments altered recent demographic behaviour does not only enhance our understanding of recent demographic patterns but might similarly inform forecasting of demographic processes and patterns in the future. The chapter finds clear evidence for continuities in the geographical distribution of forerunner areas of low fertility in 1851 and high non-marital childbearing in 1951. Whereas spatial patterns in low fertility seem to continue throughout the historical fertility transition, spatial patterns of non-marital childbearing are altered substantively between 1951 and 2011.

Due to data constraints, this study cannot provide a statistical analysis of possible determinants of such (dis)continuities. Whilst the study did not statistically confirm associations of low fertility and non-marital childbearing a century later, it did partially substantiate possible mechanisms such as spatial patterns of labour force participation among mothers and male employment opportunities. These could likely be determinants of both historical continuities and more recent discontinuities. However, associations of such spatiotemporal mechanisms are highly complex. This chapter does not provide a complete picture of such mechanisms but aims to explore conceptually one likely mechanism of employment among mothers in the light of the family's income.

Thereby, the analysis highlights the need to take an intersectional view of explanatory factors in spatial demography and not just on the individual level. Also, in space, inequalities interact with each other and might lead to different demographic outcomes depending on the interaction. Demographic innovations changing how families were defined in the previous 150 years seem to be driven to some extend through the intersection of multiple disadvantages. The assumptions of mechanisms proposed here align well with research findings about female-breadwinner families in recent years (Vitali and Arpino, 2016; Kowalewska and Vitali, 2021). Women are more likely to be a family's 'breadwinner' in a couple of constellations where the husband is unemployed or has an unstable employment situation. Female breadwinner families have, on average, a lower income then male-breadwinner-families or dual-earner-families and are accordingly economically more disadvantaged.

How will these processes of demographic continuities or discontinuities develop in the future? There has been a continuing trend over recent decades fostering regional wealth disparities and similarly inequalities: Brexit as well as Covid-19-pandemic possibly even accelerated the increase in inequalities: In England, groups with lower socio-economic status were more likely to have unstable work conditions and incomes, conditions exacerbated by the responses to COVID-19 and its aftermath (Patel *et al.*, 2020). Even in countries with a more supporting welfare system, such as Sweden, monthly earnings inequality increased during the pandemic. The critical driver of inequalities was income loss among low-paid individuals. Middle- and high-income earners were economically almost unaffected by the pandemic (Angelov and Waldenström, 2021). It seems reasonable to assume that such socio-economic developments will increase differences in demographic behaviour and ultimately manifest across space in the future. Non-marital childbearing patterns nowadays in England and Wales can be interpreted as the manifestation of 'diverging destinies' across space as described by Sarah McLanahan (2004) on the individual level. These findings seem to support the idea that it is unlikely that spatial patterns of family formation behaviour will converge soon and possibly diverge even further.

Chapter 6 Left-Wing Voting and Non-Marital Childbearing in Germany: Examining Trends and Spatial Variations over Time, 1994-2014

Abstract

There have been considerable changes in family formation patterns and an uptake of non-marital childbearing in Europe since the 1970s. Germany is probably the most extreme case with large spatial variations in births out of wedlock in Europe. Different theoretical frameworks have been developed to understand this phenomenon: Ideational or value change to more liberal values is advocated to be the reason on the one hand and economic uncertainty is seen to be the driver on the other hand. Theories as well as research in politics and political psychology propose that voting behaviour is closely linked to personal values. How does liberal voting behaviour help to understand fertility behaviour will be explored here as proposed by the SDT framework. Other important correlates are economic uncertainty, female labour force participation as well as education. The objective of this paper is to study the spatial associations of non-marital childbearing and especially which correlate contributes the most to it in different points of time (1994, 2004 and 2014). A geographically weighted regression using standardised variables is applied to determine the variable with the highest explanatory power and adding the most to childbearing out of wedlock. When comparing the variables with most explanatory power the usual East-West-divide completely disappears. Liberal and egalitarian family values measured through voting for the Left and voting seem to matter in explaining an increase in non-marital childbearing. Voting for the Green party instead seems to be insignificant. As non-marital childbearing becomes more prevalent, male unemployment becomes more important in understanding this behaviour in times of higher economic uncertainty. The analysis suggests as well that when childbearing within cohabitation becomes more prevalent, different variables (values and economic uncertainty) have higher explanatory power than when births to single mothers are more widespread.

6.1 Introduction

Non-marital fertility is on the rise in most European countries including Germany. A notable feature of non-marital fertility in Germany is that its spatial distribution varies considerably across German districts, manifesting itself in a clear East-West divide (Goldstein *et al.*, 2010; Klüsener and Goldstein, 2016). Whereas the share of non-marital births was 30.4% in West Germany in 2016, it was 57.1% in East Germany (*destatis*, 2018).

Different theories exist to account for the increase in non-marital fertility (Sobotka, 2008; Billari and Liefbroer, 2010; Perelli-Harris *et al.*, 2010). Lesthaeghe and Van de Kaa (1986) attribute the rise to ideational change from conservative to more liberal values and attitudes starting among the highly educated. Most often these changes are referred to as the Second Demographic Transition (Lesthaeghe, 2010b, 2020). Other scholars highlight that those with lower levels of education have faced increasing economic uncertainty making them less willing or able to enter into long-term commitments, such as marriage (Oppenheimer, 1988, 2003; Perelli-Harris *et al.*, 2010). Such aspects have been discussed in more detail in sub-chapter 2.2.3.

In this chapter, I introduce left-wing voting behaviour as a measure of liberal values at the aggregated regional level. Thereby, the thesis examines how the rise in non-marital fertility is linked to macro-level voting behaviour. Demographers have historically shown interest in the voting patterns in relation to population (processes) (Lesthaeghe, 1977; Coale and Watkins, 1986), and this interest has resurged in recent times (Hudde, 2023). Using left-wing voting such as Socialist parties as a proxy for secularisation and liberal values and attitudes has a long tradition in the field of demography (Lesthaeghe, 1977; Coale and Watkins, 1986; Lesthaeghe and Neels, 2002; Valkonen *et al.*, 2008; Lesthaeghe and Lopez-Gay, 2013). Although its importance is often discussed as an indicator for ideational change in line with the Second Demographic Transition, current empirical findings are scarce (Lesthaeghe and Neidert, 2006; Lesthaeghe and Lopez-Gay, 2013). Despite the existence of a wide range of literature on values and voting in political research (Schwartz, 1996; Thorisdottir *et al.*, 2007; Piurko, Schwartz and Davidov, 2011; Aspelund, Lindeman and Verkasalo, 2013), an elaborated theoretical framework of how liberal norms and values measured through left-wing voting behaviour relates to demographic change, especially to different forms of family formation behaviour such as non-marital childbearing, is still missing. This chapter aims to fill this gap in the literature.

To understand the interplay of left-wing voting behaviour with family formation outcomes at the macro-level and the role of local norms for an increase in non-marital childbearing, a spatial perspective is most appropriate. Examining fertility behaviour from a spatial perspective has found that across Europe, the Second Demographic Transition theory is more important in explaining between-country differences, whereas the pattern of disadvantage is relevant in understanding subnational regional and individual level variations (Lappegård, Klüsener and Vignoli, 2018). In this chapter, I ask additionally if associations between non-marital childbearing and related factors vary across space and over time in Germany. Germany is a highly interesting case to analyse differences in the association of non-marital fertility and voting behaviour because it has been subject to different political regimes between World War II and Reunification in 1990. For this purpose, I analyse German district level data for the years 1994, 2004 and 2014 using geographically weighted regression models – which explicitly incorporate space into statistical analysis. Although there is extreme spatial heterogeneity of non-marital childbearing in Germany over centuries and regions (Klüsener and Goldstein, 2016) research has not yet questioned whether its determinants vary spatially.

This chapter is divided into four main parts. The first section about theoretical explanations will focus on how non-marital childbearing is linked to voting behaviour and values together with providing evidence for how left-wing parties link to values and norms in Germany. The next chapter will describe the data sources including different indicators for the analysis. Next, the results will be presented, starting with the descriptive findings and evidence of spatial clustering, followed by the general geographically weighted regression results; I afterwards discuss especially the covariates with the highest explanatory power. Finally, the results will be discussed in the light of the theoretical background and other empirical findings.

6.2 Voting, Values and Demographic Change

A detailed descriptions of historical developments of non-marital childbearing was already provided in the overall literature review in chapter 2.2.2. Accordingly, I will move to the conceptual framework directly.

Research in politics has a long tradition of discussing the link between voting and values (Inglehart, 1977; Flanagan, 1987; Schwartz, 1996; Barnea and Schwartz, 1998; Piurko, Schwartz and Davidov, 2011).[26] There are values which have been found to be consistent among different cultural contexts (Schwartz, 1996). Liberal values such as universalism and benevolence are closely linked to a left-wing orientation in politics whereas conservative values (for instance. security, conformity, and tradition) relate to right-wing voting (Piurko, Schwartz and Davidov, 2011; Aspelund, Lindeman and Verkasalo, 2013). Political studies often operationalise the so-called left-right orientation to analyse this phenomenon. Most recent research confirms that values are a better predictor of voting than belonging to a certain social group (Piurko, Schwartz and Davidov, 2011). A left-wing self-placement correlates with promoting the welfare state, social and economic equality and the protection of the environment (Thorisdottir *et al.*, 2007; Piurko, Schwartz and Davidov, 2011; Aspelund, Lindeman and Verkasalo, 2013). Based on this literature, I assume that liberal values strongly correlate with voting for left-wing and liberal parties.

Hence, I will introduce political voting behaviour for those parties as a measure of liberal values and attitudes.

Aspelund et al. (2013) point out, though, that this left-right relationship with a specific set of values only holds in Western societies but not necessarily in post-communist countries which tend to be culturally and politically different. Here, the connection between conservatism as well as liberalism with left-right orientation might be shaped differently (Aspelund, Lindeman and Verkasalo, 2013). This observation might be of particular

[26] Other influential variables on voting behaviour: group membership, special individual interest and popularity or character of candidate (Sears, 1987).

interest for Germany where the Eastern regions have a communist history. Therefore, it seems likely that the meaning of voting and values differs in East and West Germany. Nevertheless, some attitudes in the East e.g. attitudes towards state intervention, converges towards the West, which has been found to be stable over time (Svallfors, 2010).

Table 6.1. *Value Dimensions Related to Second Demographic Transition by Surkyn and Lesthaeghe (2004)*

Value dimension	***Description***
I. Secularisation	"the reduction in religious practice, the abandonment of traditional religious beliefs (heaven, sin, etc.) and a decline in individual sentiments of religiosity (prayer, meditation, etc.)"
II. The "new political left"	"indicators pertaining to Inglehart's 'postmaterialism', voting for Green parties or left-wing liberals, the propensity to protest, distrust in institutions, and anti-authoritarianism more generally"
III. Egalitarianism	"an emphasis on gender equality, tolerance for minorities, rejection of social class distinctions, and a pre-occupation with North-South equity associated with 'world citizenship'"
IV. Accentuation of expressive values	"showing an enhanced preoccupation with individuality and self-fulfilment. Typical indicators are the ranking of the traits of "imagination" and "independence" above all other qualities in the education of children, or the preference for a job's intrinsic qualities (challenging, interesting, permitting social contact and initiative) rather than its material advantages (pay, vacations, promotion)"
V. Companionship and unconventional marital ethics	"stressing the quality of a relationship (communication, tolerance and understanding, happy sexual relationship) over the conventional and institutional foundations of marriage and parenthood, and the toleration of deviations from strict marital morality (adultery, casual sex, etc.)"

Investigating the role of voting as a measure of certain attitudes and values has a long tradition in the field of demography. Lesthaeghe analysed the role of voting for the fertility decline in early 20th century Belgium as part of the Princeton Fertility Project (Lesthaeghe, 1977). This research conducted in the 1970s found that the developments of the First Demographic Transition were closely linked to a set of cultural indicators such as secularisation measured by voting for socialist parties, not just in Belgium but also Switzerland (Lesthaeghe and Neels, 2002). In addition, Lesthaeghe and Neels (2002) found spatial continuities of cultural indicators between the First and Second Demographic Transition. A study analysing the Second Demographic Transition in Finland found a positive (yet modest) effect of secularisation and voting for the Socialist and *Green* party in explaining its spatial patterns (Valkonen *et al.*, 2008). There, regional socioeconomic characteristics moderated through cultural characteristics seem to be of higher importance. Similarly, voting for conservative parties in the Nordic countries is positively associated with fertility using spatial modelling techniques (Campisi *et al.*, 2020a). These findings support the expectation of finding a link between voting and demographic behaviour which is not independent of space.
For the United States, similar research by Lesthaeghe and Neidert (2006, 2009, 2017) concludes that voting and demographic behaviour are linked through social values promoted by certain parties (Lesthaeghe and Neidert, 2009). Residents of areas with a multitude of living arrangements including more unconventional family formation patterns were more likely to vote for the Democratic party. This party represents liberal as well as progressive values and can be described as left-wing. Areas with a prevalence of married couples, instead, were found to be more likely to vote for the right-wing Republican party. These observations are robust for the 2004, 2008, and 2016 (Lesthaeghe and Neidert, 2017). Therefore, I expect to find that voting for parties supporting liberal values is linked to a rise in non-marital childbearing. Nevertheless, the United States could be considered a special case due to their two-party system (Lesthaeghe and Neidert, 2009). Implementing a similar simple research design in a European country seems more difficult since a wide range of parties exist.

A helpful framework to identify parties supporting liberal values is a set of value dimensions (Table 6.1) developed by Surkyn and Lesthaeghe (2004). These value dimensions are developed using data from Northern, Western and Southern Europe to investigate how value orientation and the Second Demographic Transition are related. The proposed set of values consists of five core value dimensions namely 'secularisation', 'the 'new political left', 'egalitarianism', 'accentuation', and 'companionship and unconventional marital ethics'. Based on this set of values, I argue that values can be directly linked to voting behaviour and even specific parties which resemble the described liberal values the most. Nevertheless, it is important to point out that voting behaviour always captures a variety of values and attitudes depending on the context. These values are unique and do not necessarily represent the Second Demographic Transition even though some parties seem to represent Surkyn's and Lesthaeghe's value dimensions better than others. Such an interpretation would seem too simplistic, glossing over the variety of factors that voting behaviour might resemble.

6.2.1 Voting Behaviour in Germany

The outcome of elections was traditionally assumed to be determined by social class and identity (Elff and Roßteutscher, 2009). In West Germany, the classical political cleavages with its origins in the 19th century related to a very distinct voting pattern until the 1950s and 1960s (Ohr 2009). Labourers mainly used to vote for the 'Sozialdemokratische Partei Deutschland' (*Social Democrats*) or 'Kommunistische Partei Deutschlands' (*Communists*). Catholics instead voted for the 'Christlich Demokratische/Soziale Union' (*Christian Conservatives*). Since the 1970s, a variety of new parties emerged altering the political landscape in Germany. The most prominent theories in political science discussing the emergence of new parties ascribe these changes to a conflict between materialist and postmaterialist conceptions and values (Inglehart, 1977). The rise in individualisation and secularisation are believed to be of major importance in understanding these trends in Western societies (Elff and Roßteutscher, 2009; Piurko, Schwartz and Davidov, 2011). Larger parties and their classical electorates gradually decoupled in the more recent decades in Europe including Germany (Kaspar and Falter, 2009; Ohr, 2009; Ohr and Quandt, 2011). In addition, structural changes and secularisation largely diminished the share of both Catholics and labourers in the population.

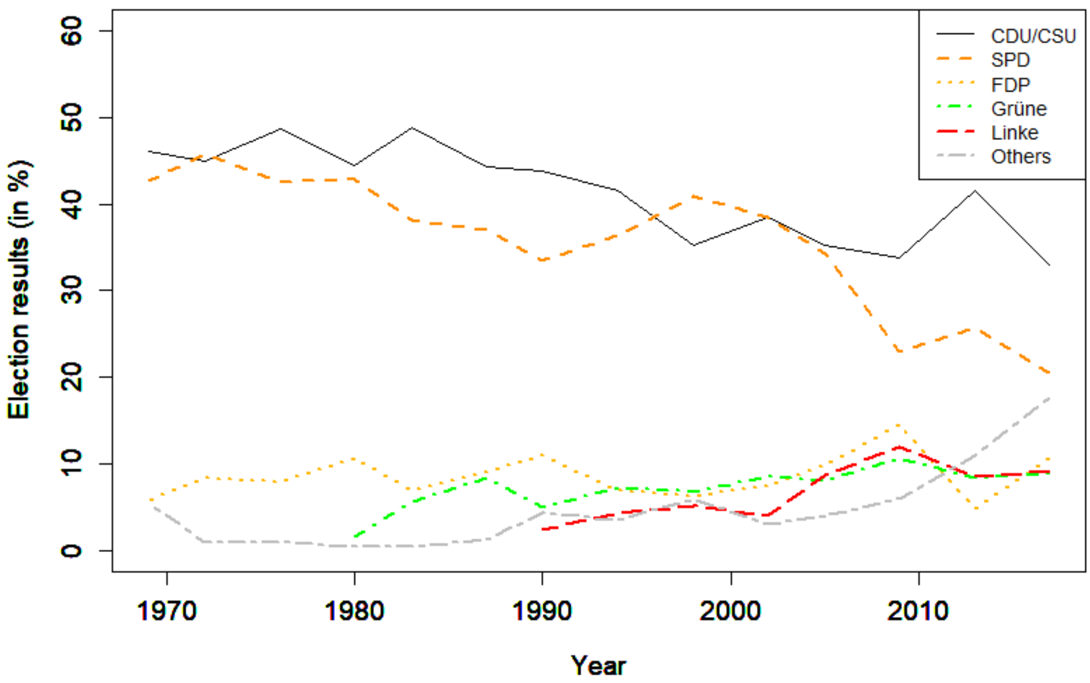


Figure 6.1. *Results of Federal Elections from 1969 to 2017 (CDU/CSU – Christian Democratic/Social Union/Conservatives; SPD – Social Democratic Party of Germany/Labour; FDP – Free Democratic Party/Liberals; Grüne – Greens; Linke – Left; Sources: German Bundestag, 2018 [data until 1987 only for West-Germany])*

The Second Demographic Transition theory focusses on explanations related to individualisation and secularisation in a similar manner (Lesthaeghe, 2020). Whereas 80% of West Germans considered themselves to be affiliated with certain parties due to their social class and identity in 1980, the percentage dropped to 60% in 1998 (Ohr, 2009). Although the classical cleavages still exist (for instance preference of Catholics for *Christian-conservative* party), they do not determine the outcome of an election anymore (Figure 6.1). It needs to be mentioned that these explanations are more relevant for the context of West Germany.

In general, a permanent party affiliation was much lower in the East due to its different political history (Kaspar and Falter, 2009). Higher votes for the Communist party could already be found in the East prior to World War II (Becker, Mergele and Woessmann, 2020). In the GDR only one party, the *SED* (Sozialistische Einheitspartei Deutschlands – Socialist Unity Party of Germany) existed, which presented itself as the voice of the working-class and was succeeded by 'Die Linke' (*Left party*)[27] after reunification. To diminish the influence of the church on the population, the socialist regime fostered secularisation. The society in the East was more secularised in pre-communist times already (Klüsener and Goldstein, 2016; Becker, Mergele and Woessmann, 2020). Still, the *Christian Conservatives* won a high share of votes in the East during the first two Federal elections after reunification even though the population belonged mainly to the working-class. Therefore, classical cleavages are not related to these election results, but a positive image of the party related to reunification most likely generated this outcome (Kaspar and Falter, 2009). This image disappeared in subsequent elections again. The lack of consistent party affiliation as well as the communist history of the East might suggest that the link between voting and liberal values could be more difficult to attach to specific parties in the East compared to the West.

6.2.2 Ideational Change and its Link with German Parties

The increase in childbearing within cohabitation in Germany can be considered to be a new and innovative behaviour according to diffusion theory (Rogers, 1995; Casterline, 2001a). I expect to find a positive association between prevalence of non-marital childbearing and voting for parties which support diverse family forms, gender equality, as well as progressive and liberal family policies. Influential research in politics by Flanagan finds that left-wing parties best reflect liberal values such as equality, tolerance for minorities and dissidents, as well as openness for new ideas and lifestyles, environmentalism, quality of life, compliance and self-actualisation (Flanagan, 1987).

In both East and West Germany, egalitarian gender norms and diverse family forms find high support among those who consider themselves close to the political left as empirical findings analysing the 2008 European Value Survey revealed (Janotta, 2012). More

[27] The *Left* party was found in 2007 by merging the *Party of Democratic Socialism* (PDS) and *Labour and Social Justice - The Electoral Alternative* (WASG). For simplicity, I will only refer to this party as the *Left* party throughout the chapter, regardless *of* the time I am discussing.

conservative family norms are correlated with a right-wing orientation instead. Voting for *Greens* and *Left* is significantly associated with support for the welfare state including gender equality and progressive family policies in the West as well as East of Germany (Janotta, 2012). However, voters for *Social Democrats* and *Liberals* although their profile could be considered liberal seem to promote a more politically centred view rather than left-wing. Furthermore, voting for *Greens* but especially *Left* party is associated with being secularised as well in the East and West of Germany (Janotta, 2012). These findings make a strong case for analysing how voting behaviour of both the *Green* and *Left* party as a measure of liberal values is linked to non-marital childbearing. Accordingly, if more people in a district tend to have more radical liberal rather than moderate values and attitudes, the whole population is on average also more likely to hold more liberal values.

Table 6.2. *Support of Green Party and Left Party for Value Dimensions Related to Second Demographic Transition* (Surkyn and Lesthaeghe, 2004) *according to their Election Manifestoes 1994, 2002 and 2013.*

Value Dimension according to Surkyn and Lesthaeghe (2004)	***Greens***	***Left***	***Social Democrat***	***Christian Conservatives***	***Liberals***
I. Secularisation	completely	completely	neutral	not at all	completely
II. The 'new political left'	completely	completely	partially	not at all	partially
III. Egalitarianism	completely	completely	completely	partially	completely
IV. Accentuation of expressive values	completely	not at all	partially/ completely	neutral	completely
V. Companionship and unconventional marital ethics	completely	completely	partially/ completely	not at all	partially/ completely

In order to investigate how well these two left-wing parties as well as the other three largest German parties (*Social Democrats*, *Christian Conservatives*, and *Liberals*) support liberal values and if there is a change between the 1990s and 2010s, their election manifestoes are analysed qualitatively in terms of the value dimensions related to the SDT elaborated by Surkyn and Lesthaeghe (2004).[28] An overview of the results is displayed in Table 6.2. The first value dimension is 'secularisation'. This dimension is clearly fulfilled by the *Greens* and *Left but also the Liberals*. All three parties call for institutional separation of state and church (Bündnis 90/Die Grünen, 1994; FDP, 1994; Die Linke, 2013). This separation includes the elimination of church taxes[29] and an end of special treatment of the Christian churches by the state and government as argued by the *Greens* and *Liberals*. The *Left* also demands that "[...] the constitution must not include religious references." (Die Linke, 2013, p. 85) and school education needs to be independent of ecclesiastic and religio-political influences. The *Social Democrats,* however, do not refer in any term to secularisation or separating state and church (SPD, 1994, 2002). However, they do advocate 'religious freedom' especially in their 2013 election manifesto (SPD, 2013), probably placing them a neutral position compared to the *Christian Conservatives* who clearly view Germany in a Christian tradition (CDU/CSU, 1994, 2002).

Value dimension II, the emergence of a 'new political left' is already inherent in voting for a green or left-wing liberal party. In addition, the *Left* especially protests against the government by criticising oversea deployments and urging to stop armament and arms exports (PDS [Partei des Demokratischen Sozialismus], 1994; Die Linke, 2013). The main objective of the *Greens* are ecological policies for a 'greener' future especially the replacement of nuclear power plants and industrialised agriculture (Bündnis 90/Die Grünen, 1994, 2002, 2013). Especially the *Left* but also in partially the *Green* party show anti-authoritarianism tendencies in their election manifestoes. The *Social Democrats* also advocate 'greener' policies; however, they might not be perceived as radical by the population in comparison to the *Green* party. Being one of the two leading German parties from the 1960s to 2000s, it does not seem surprising that they do not reveal distrust in institutions or anti-authoritarian values in their election manifestoes.

[28] Here the most recent federal elections to the years under study were chosen: 1994, 2002 and 2013.
[29] By being affiliated to a religion, church taxes will be directly deducted from the income and transferred to the according church.

Value dimension III 'egalitarianism' is in this study probably one of the two most important dimensions because it is directly linked to alternative attitudes towards different forms of family formation such as non-marital childbearing. Again, both the *Left* and *Green* parties appear to strongly support this dimension. The *Left* calls to 'empower diversity' (Die Linke, 2013, p. 40) and the *Greens* to 'enhance rights of discriminated minorities' (Bündnis 90/Die Grünen, 1994, p. 2). The *Green party*, *Left*, *Social Democrats* and *Liberals* all strongly, but even the *Christian Democrats* partially emphasize the importance of a gender equal society (Bündnis 90/Die Grünen, 2013; CDU/CSU, 2013; Die Linke, 2013; FDP, 2013; SPD, 2013). This includes the support of equal labour market opportunities for men and women and equal division of household tasks as well. Accordingly, a more gender equal society seems to be a pressing topic for all parties. The *Left* already claimed in 1994 to "break the patriarchal division of labour within the society" (PDS [Partei des Demokratischen Sozialismus], 1994, p. 6). The *Left* and *Green* party campaign for the rejection of social class distinctions and, most importantly, both as well as the *Liberals* stress the equality of all forms of living arrangements (Bündnis 90/Die Grünen, 1994, 2013; PDS [Partei des Demokratischen Sozialismus], 2002; Die Linke, 2013).

The support for value dimension IV 'accentuation of expressive values' differs among the two parties. Whereas the *Greens* are advocates of individuality and self-fulfilment, articulating this especially for education ("School is supposed to support creativity and individual character", Bündnis 90/Die Grünen, 1994, p. 54), this issue is lacking in all the *Left*'s manifestoes. Also *Liberals* and *Social Democrats* campaign for free development of the individual, especially for children and the youth (FDP, 1994, 2013; SPD, 2002). When considering the *Left* as the successor of the communist *SED* party in the GDR this does not seem surprising: the *SED* regime was always suspicious of a public articulation of individual interests and opinions. Hence, the relationship between the individual and the state has always been ambiguous (Gensicke, 1996). Further research concluding that the population in the East is more supportive of state interventions, seems to underline this argument (Alesina and Fuchs-Schündeln, 2007). Although the *Left* does not directly oppose the accentuation of individual freedoms, they are more interested in supporting the working class rather than concerned with the individual itself (PDS [Partei des Demokratischen Sozialismus], 2002; Bündnis 90/Die Grünen, 2013, 2013; Die Linke, 2013).

The last value dimension V ‘companionship and unconventional marital ethics’ is directly connected to non-marital childbearing. *Greens*, *Left* and *Liberals* support all forms of families, ways of life and living arrangements in all their election manifestoes. The *Social Democrats*, however, only explicitly acknowledge them in 2013, while being comparatively vague in 1994 and 2002. In contrast, the *Christian Conservatives*’ family model still consists of a marriage between man and woman (CDU/CSU, 1994). In 2013, however, also *Christian Conservatives* clearly articulate that all other forms of families and living arrangement, including same-sex couples should not be discriminated. The *Green*, *Left* and *Social Democrats* all strongly advocate legalisation of abortion (PDS [Partei des Demokratischen Sozialismus], 1994, 2002; Bündnis 90/Die Grünen, 2002, 2013, 2013; Die Linke, 2013), whereas the *Liberals* even though not opposing abortion take a more moderate line. In 1994, the *Greens* endorse a nonviolent relationship of men and women and the dissolution of the patriarchal family model in favour of quality of the relationship of couples (Bündnis 90/Die Grünen, 1994). In addition, *Left*, *Green* and *Liberal* parties advocate same-sex marriage or legal equality of same-sex couples. “So far, marriage and civil unions are treated equally when considering legal obligations but in a lot of areas (taxes, adoption, social security) they are discriminated. [...] For the *Left* we hold the principle of acknowledging all living arrangements: single-parent families, singles, friends living together, relatives, patchwork families, elective affinity as well as couples deciding against marriage and civil unions.” (Die Linke, 2013, p. 40). This includes shifting legal privileges from married couples to couples with children regardless of a marriage certificate (Bündnis 90/Die Grünen, 1994, 2013; PDS [Partei des Demokratischen Sozialismus], 2002; Die Linke, 2013).

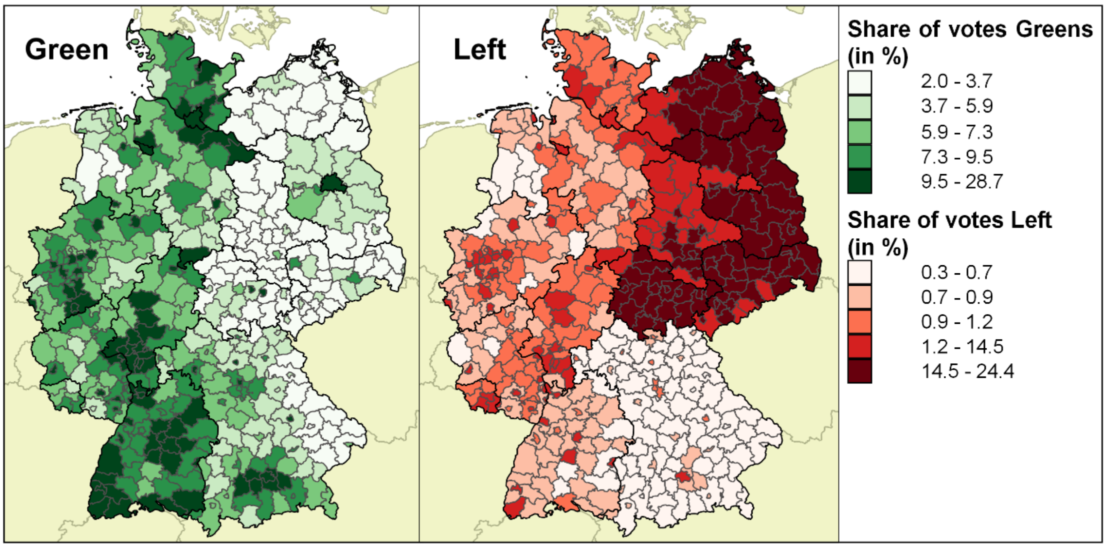


Figure 6.2. *Quintiles of Share of Votes in Federal Election of 2002 for Green Party (left) and Left Party (right) (Source: destatis, 2016b).*

What seems most important is that both left-wing parties, the *Greens* and *Left*, fulfil the majority of the five value dimensions of the SDT already in the 1990s and can accordingly be considered as political forerunners of such values. They campaign especially for defining families based on children and not on marriage certificates. They advocate to change laws (e.g., tax benefits) accordingly. This position reveals liberal values towards family formation and is crucial for the matter of non-marital childbearing. The ideas of the *Greens* seem to be more closely aligned with the ideas motivating the Second Demographic Transition. Drawing on these results, the next hypothesis is as follows:

H 6.1: A high share of votes for left-wing parties in an area, such as the *Greens* and the *Left,* is positively associated with the rise in non-marital childbearing.

Still, due to very different spatial voting patterns, different positions towards individualisation as well as historical context it might not be surprising as well if both parties show different spatial associations with non-marital childbearing in different areas.

Accordingly, the last hypothesis is:

H 6.2: Associations with non-marital childbearing and its correlates, especially voting behaviour, are heterogeneous across space.

It is important to point out the large spatial variations of voting for both parties within Germany. The differences in voting patterns are clearly visible in maps of election results for both parties (Figure 6.2). The *Greens* are a strong advocate of environmental topics and other values, such as emancipation for women and gender equality. They have a higher share of support in the West compared to the East. In West Germany, most of the population does not favour voting for the *Left*. Apparently, just a very distinctive group of people in West Germany votes for the *Left* who can probably be considered holding very strong left-wing or even socialist views. In the East, the *Left* in contrast can be considered a 'working class' party. As mentioned before, the *Left* was the successor of the communist party *SED* which ruled the GDR regime during the communist era and portrayed itself as a supporter of labourers. However, the 1924 Reichstag election results already reveal similar patterns for share of votes for the *Communist* as for voting for the *Left* in recent years (Becker, Mergele and Woessmann, 2020). In areas as the Ruhr-Area in West Germany – historically characterised by mining, coal and steel industry – support for the *Left* party is comparatively high for this context due to a high share of labourers within the population.

One main assumption of the thesis is that associations of demographic behaviour and its determinants might vary spatially. Given that the pattern of disadvantage hypothesis proposes that economic uncertainty is positively associated with childbearing in cohabitation (section 2.2.3.2), I will in the following section explain changes in unemployment in Germany.

6.3 Contextual Indicators (Control Variables)

In the following section the choice of control variables is presented and discussed.

Germany had compared to other European countries (EU-15) and the United States the highest unemployment rates between the 1970s and 1990 (Ebbinghaus and Eichhorst, 2006; Rinne and Zimmermann, 2013). This trend was exacerbated after reunification in 1990 with unemployment rates rising constantly in the East of Germany for almost two decades (Figure 6.3). Like other early post-communist countries, the population experienced sudden changes from a socialist to a market-driven economy. These changes included the privatisation of widely overstaffed state firms resulting in an uncompensated loss of employment opportunities (Ebbinghaus and Eichhorst, 2006). Unemployment among women increased even more rapidly in the East, only converging with unemployment of men after a decade again. In the West, registered unemployment was comparatively similar among men and women (Ebbinghaus and Eichhorst, 2006).

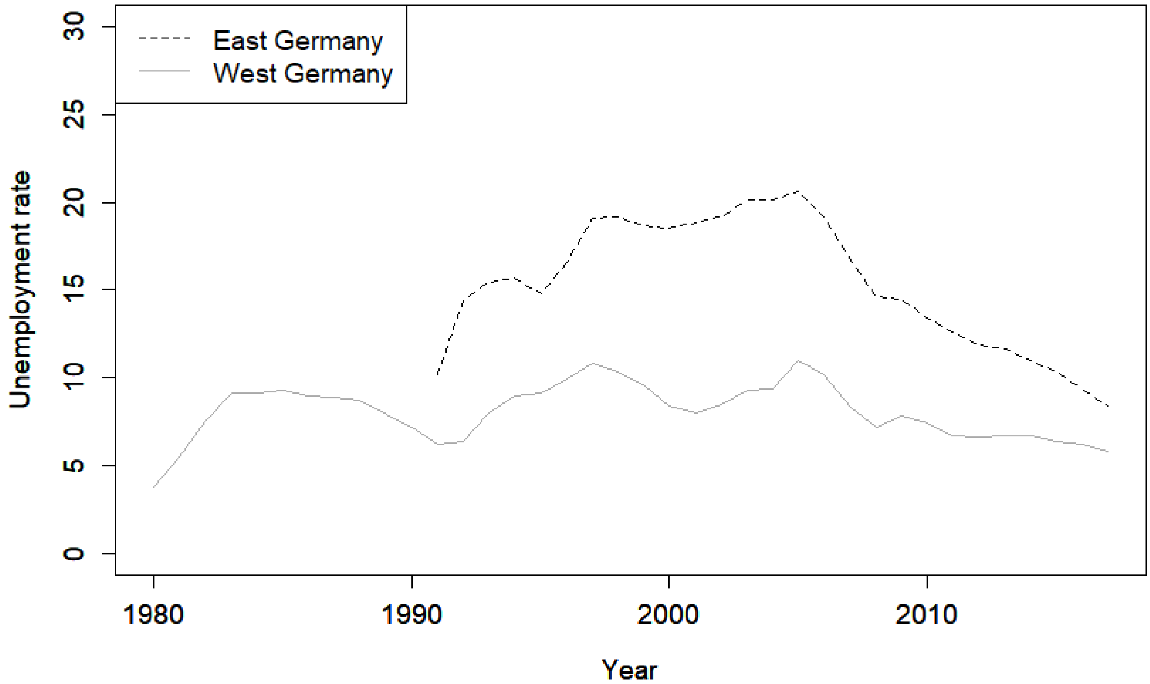


Figure 6.3. *Unemployment Rates in East (1991-2017) and West Germany (1980-2017) (Notes: West Germany – old federal states excluding Berlin, East Germany – new federal states including Berlin; source: StatBA, 2018).*

More structural labour market problems are hidden in the overall numbers: In 2004, the labour force participation rate among young workers (15-24 years) dropped simultaneously with those of the low-skilled workers (Ebbinghaus and Eichhorst, 2006; Rinne and Zimmermann, 2013). This development most likely fostered economic uncertainty among the young and more precarious groups as described before. In order to also persuade the high number of long-term unemployed into work the benefit system was changed between 2003 and 2005 from an earning-related long-term assistance to a means-tested flat rate benefit – the so called *Hartz reforms* (Jacobi and Kluve, 2007; Rinne and Zimmermann, 2013). After reaching a peak of unemployment in the years 2004 and 2005 of 11% in the West and 20.6% in the East (SBA, 2018) the reforms seemed successful in raising employment thereafter.

The Great Recession (2007-2009) led to a rise in unemployment in the majority of European countries and the United States (Rinne and Zimmermann, 2013). The German labour market instead seemed resilient to these macroeconomic disturbances and was the exception in Europe where youth unemployment decreased in the aftermath of the economic crisis (Aassve, Cottini and Vitali, 2013; Rinne and Zimmermann, 2013). In both East and West Germany unemployment rates were unaffected and on the decline during the recession, although levels differed considerably in both parts (West-East comparison: 2007 – 8.3% and 16.7%; 2009 – 7.8% and 14.5%; SBA, 2018). Even though non-marital fertility levels might be higher in areas with higher unemployment rates according to the pattern of disadvantage, I do not expect a rise in Germany due to the economic recession. However, it does not seem impossible that only some districts were affected by economic recession even if this development is not represented on the national level.[30] Therefore, these districts could have witnessed a higher Non-Marital (Birth) Ratio in 2014. Research for the United States showed fertility responded differently to the Great recession in in different regions (Kim and Potter, 2020). In the years after 2009, unemployment rates fell constantly in West Germany to 5.8% in 2017. In 2016, unemployment rates crossed the 10% benchmark in East Germany for the first time since reunification. It seems that unemployment in Germany is converging in the most current years after more than two centuries of larger differences (Figure 6.3).

Female education and female labour force participation are important variables that have a complicated interpretation. The theoretical background of both is closely linked also there are opposing theories and depending on the context (time and space) and differing empirical evidence for the association of female education and nonmarital childbearing. Examining both from an ideational change perspective as proposed by

[30] As analysis uses cross-sectional framework and data cannot be compared over time, I can unfortunately not be answered determine if unemployment or the nonmarital increase.

Lesthaeghe, female education leading to female independence is one driver of the Second Demographic transition (Lesthaeghe, 1998, 2010b). Especially higher educated women tend to object strongly against institutions such as marriage. A rise in female education also fosters individual autonomy and an urge to self-fulfilment (Lesthaeghe, 1998). This causes not just an increase of childbearing within cohabitation among the higher educated women but also an increased willingness to divorce or separate in the case of marital or relationship dissatisfaction (Lesthaeghe, 1998, 2010b). Lesthaeghe (2010b) also argues that the SDT starts among the higher education and then diffuses through the population.

The economist Gary Becker argued female education is supporting a decline in marriages and rise in nonmarital childbearing through a new economic independence of women (Becker, 1981, 1986). Increasing opportunity costs when having children are the result of women spending more time in education and in the labour market. In addition, educated women participating in the labour force are economically more independent and the economic gains of marriage decrease. Although arguing from an economic point of view, Becker assumes the same outcome for family formation patterns due to female education and labour force participation Van de Kaa and Lesthaeghe support: A decline in marriage and a rise of childbearing to cohabiting unions.

One of the basic ideas in the first elaborations of the SDT was in addition the role of urbanisation (Lesthaeghe, 2010b) assuming that childbearing within cohabitation was more prevalent in urban than in rural areas (Vitali, Aassve and Lappegård, 2015). Here, it is not of main interest and treated as a control. In addition, the gross-domestic product (GDP) per capita is included as a control for economic performance of an area to make sure that the results of male unemployment and female unemployment are not influenced by it being missing.

6.4 Data

To answer the research question, I analyse data for German district, administrative geographical units equivalent to the European Union classification NUTS-3 (*Nomenclature of Territorial Units for Statistic)*. The data are collected by the *Federal Statistical Office of*

Germany (*destatis*). All openly accessible data is provided through a specific online database for small scale geographical data (www.regionaldatenbank.de), other data was directly retrieved from Statistical Offices of the different Federal States. Due to a set of reorganisations of districts in line with various boundary changes since 1990, the number of districts differs across the study period. The analysis investigates three cross-sections: 1994, 2004, and 2014. Germany consists of 16 Federal states and comprised 402 units in the year 2014, of which 295 are classified as rural districts and 107 as urban districts (*destatis,* 2016b) depending on its population size and density. In 1994, a total of 444 and in 2004 a total of 439 districts existed.

The Federal Agency for Cartography and Geodesy (BKG, 2016) provides geo-referenced boundary data for the most recent cross-section 2014 showing the course of district borders. For all previous years, shapefiles are provided by the *MPIDR Population History GIS Collection* (MPIDR & CGG, 2016) which is accessible through www.censusmosaic.org.
For all years, the response variable Non-Marital Births Ratio and its correlates are organised by the districts' identification numbers. An additional dataset for 1984 contains only information on non-marital births for descriptive purposes. All data are linked to boundary data for the corresponding year using a unique identifier. The actual model fitting process requires information about the distance between all districts even though the shapefile only includes data on borders. Hence, I compute the centroid of each district to calculate the distance between points.

6.5 Indicators

Dependent variable. The response variable in this analysis is the **Non-Marital (Birth) Ratio** (NMR) for each district (see Table 6.3). This variable measures the percentage of all children born outside marriage compared to all live births. The indicator has its drawbacks. It does not account for the age structure of mothers, although the prevalence of non-marital childbearing possibly differs by age. Different age structures in a female population might be the reason for different NMRs. The variable cannot adjust for birth order although there is empirical evidence for Germany that first births are more likely to occur outside marriage than higher order births (Kreyenfeld & Konietzka 2010; Perelli-Harris et al. 2012). In West Germany, couples often decide to have two children or stay childless, whereas couples in East Germany are more likely to have at least one child but not necessarily have a second afterwards (Hornung 2010).

Explanatory variables. The different indicators are calculated using the formulas in Tab. 2. Appendix C.1 shows a table of descriptive statistics for all variables and Appendix C.7 shows the correlation matrices for all explanatory variables and years under study.

The main two explanatory variables are **voting for *Greens*** and **voting for the *Left*** as two indicators for liberal values. These parties are chosen because their ideas are most closely aligned with the ideas motivating the Second Demographic Transition (as discussed above). The total numbers of votes for each party are calculated as percentage of all votes.

The analysis also incorporates the following control variables: Economic uncertainty is measured by the **male unemployment** rates for each district. Male unemployment is calculated by taking the male unemployed mid-year population (age 15 to 64 years) over the whole male working-age population times 100.

Another variable of interest is the **female labour force participation** rate. It is calculated by taking all women in the female labour force who are subject to social security over all women aged 15 to 64 times 100. It needs to be mentioned that this indicator excludes most self-employed women. Another drawback is that the variable does not account for full- and part-time employment.

Additionally, **female education** is included in the model as well. The measure is calculated by dividing all female school leavers with a university entrance degree by all female school leavers times 100.

Table 6.3. *Indicators Used in the Statistical Analysis: Description, Type of Variable, Calculation and Further Explanations.*

Indicator	Variable	Type of variable	Formula	Explanations
Non-marital fertility	Non-marital birth ratio (NMR)	Dependent	$\frac{all\ non-marital\ births}{all\ live\ births} * 100$	Non-marital births include births to single mothers as well as to cohabiting couples
Liberal Values	• Percentage voting for the *Left* party • Percentage voting for *Greens*	Explanatory	• $\frac{\boldsymbol{votes\ for\ the\ Left\ party}}{\boldsymbol{all\ valid\ second\ votes}}$ • $\frac{\boldsymbol{votes\ for\ the\ Greens}}{\boldsymbol{all\ valid\ second\ votes}}$	Political voting behaviour is measured by the outcome of the most recent federal elections (1994, 2002, 2013).
Economic Uncertainty	Male unemployment rate	Explanatory	$\frac{male\ unemployed\ population}{male\ working\ age\ population\ (15\ to\ 64)} * 100$	
Female Employment	Female labour force participation rate (FLFP rate)	Explanatory	$\frac{female\ labour\ force}{female\ working\ age\ population\ (15\ to\ 64)} * 100$	Female labour force is defined as all women being subject to social security contributions. Social security is compulsory for all employees. Women who are self-employed or civil servants are just partially captured in the figure since they can apply for exemption from the insurance.
Female Education	Percentage of female school leavers finishing school with higher education entrance certificate	Explanatory	$\frac{female\ school\ leavers\ with\ higher\ education\ entrance\ certificate}{all\ female\ school\ leavers} * 100$	Measure of % attaining at least secondary education?
Urbanisation	Population density	Explanatory	$\frac{population}{area}$	Area is measured in square kilometres (km^2)
Economic performance	Gross-domestic product per capita	Explanatory	$\frac{market\ value\ of\ all\ goods\ and\ services}{population}$	

Another basic idea proposed by the initial SDT theory is the role of **urbanisation** (Lesthaeghe, 2010b). Empirical evidence points towards a higher prevalence of childbearing within cohabitation in urban than in rural areas (Vitali, Aassve and Lappegård, 2015). To control for the degree of urbanisation population density is included, where population size is divided by the area size in km^2. In this analysis, this factor is not of main interest and treated as a control. In addition, the **gross-domestic product** (*GDP*) per capita is included as another control for economic performance of an area to not exclude other economic influences in the results of male unemployment and female employment. Therefore, to take the economic performance of each district into account I also control for the gross-domestic product per capita (GDP) measured in Euros.

Other variables indicating religiosity or share of foreigners were considered as well but have not been included due to data limitations. Religiosity could not be included due to a lack of openly available data at the district level. Similarly, the share of foreigners or immigrants who were born in more conservative countries could not be included due to a lack in data for comparable geographic units. The only available data is the share of foreigners within each district. It does not allow however to distinguish by origin and only includes people without a German passport. Accordingly, this measure does not include 1st or 2nd generation immigrants (BBSR Bonn, 2017). Given that most descendants of Turkish immigrants from the 1960s and 1970s have been born in Germany and are more conservative in terms of non-marital fertility, this data can unfortunately not measure the spatial variation of this group. Most importantly, the variable cannot be included because it is not available for the whole of Germany for all points of time. Childcare availability was considered as a potential explanatory variable but only data for 2013 is available. Childcare availability for 3- to 6-year-olds is almost universal across the whole of Germany but varies considerably for under 3-year-olds. However, the correlation between childcare for children below age 3 and voting for the *Left* party has a correlation of 0.88. Including both variables into a geographically weighted regression caused severe local multicollinearity problems with the local variance inflation factor being as large as 14.74 in some areas. Accordingly, this variable could not be included for further robustness checks. To test the robustness of the final model for 2014, an additional model including share of immigrants is estimated and displayed in Appendix C.16.

The spatial distributions of all standardised explanatory variables are displayed in maps in Appendix C.2. Because the standardised variables cannot give a picture of the possible developments of the different indicators over time, quintile ranges of the unstandardised variables are given in addition as well. In most maps, we can observe an East-West divide in all periods under study: for voting and male unemployment, shares are higher in East Germany, but for GDP and population density it is the other way around. Still, North-South differences exist as well as shown by female employment.

6.6 Results

6.6.1 Descriptive Findings

The spatial distribution of non-marital childbearing in Germany for the four years 1984 to 2014 using ten-year intervals is displayed in Figure 6.4. A clear East-West divide is already apparent in 1984 as expected from the literature review and the aggregated data for East and West Germany. Whereas in the East the NMRs were between 30% and 39%, the majority of NMRs in the West are below 10%. A small number of districts across the Austrian border in Bavaria, along the Danish border in the North and in urban districts revealed slightly elevated levels of births outside marriage compared to the rest of West Germany. In 1994, a similar spatial pattern appeared across Germany. In the East, around 40% to 51% of births took place out of wedlock in 2014. By contrast, the majority of NMRs in Western districts still displayed ratios under 10%. Districts with previously elevated levels remain at the higher end of the spectrum with NMRs above 10%. Non-marital childbearing seemed to have spread to more districts in 1994 compared to 1984. In 2004, most children were born outside marriage in East Germany with a few districts showing values higher than 60%. In addition, all NMRs in the West were above 13% with a larger number also increasing to 20% and more. In the North, the share of non-marital births already reached above 40% in the states of Schleswig-Holstein, Bremen and Hamburg. In 2014, all values displayed at least an increase of 10-percentage-points compared to 2004 in the West. Now, NMRs of less than 20% rarely appear in West Germany. In the far North and West, NMRs rise to 30% and even 49%. Clusters of higher values emerge also in the South (Bavaria) next to the Austrian border and North Rhine Westphalia in the West with values between 30% and 39%. In the East most districts have a prevalence of non-marital births of more than 60% by 2014.

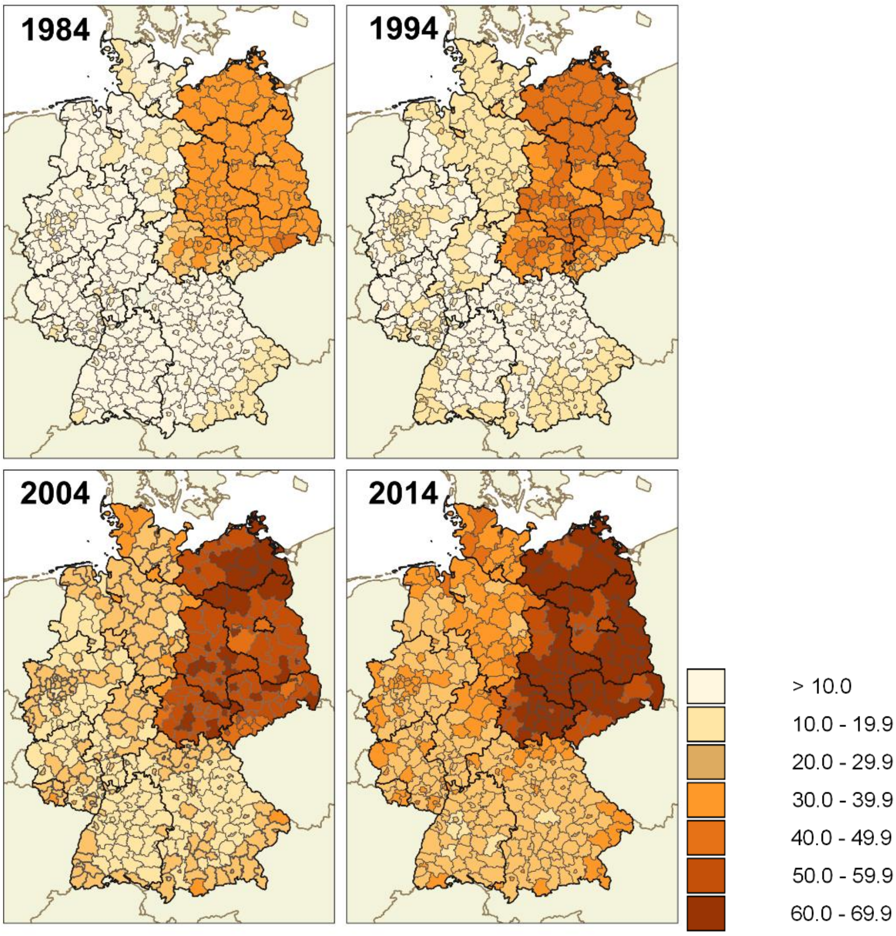


Figure 6.4. *Non-Marital (Birth) Ratio (NMR) in German Districts. 1984 to 2014 (Sources: own calculations; data - Statistisches Bundesamt, 1985, 1995, 2005, 2016; SSO Saxony, 2016; SSO Thuringia, 2016; SSO Mecklenburg-Western Pomerania, 2016; SZS 1986; MPIDR & CGG, 2016 [1984, 1994, 2004]; boundary - BKG, 2016 [2014])*

The maps of the NMRs for the years 1984 to 2014 (Figure 6.4) reveal that over time and across space having children out of marriage becomes more common. Whereas non-marital childbearing regarding cohabiting couples was considered an accepted behaviour at the start of the observation period in the East, we can observe the onset of the rise and diffusion of non-marital fertility in West Germany. Particularly, the increase between 1994 and 2004 with many values risings above 10% marks the uptake of childbearing within cohabitation. Previous findings based on individual level survey data concluded that the onset of childbearing of cohabiting couples is in the 1990s in West Germany

(Konietzka & Kreyenfeld 2002; Kreyenfeld & Konietzka 2010). The aggregated time series of NMRs separated for East and West (Fig. 1) shows a similar pattern.

While most research studying fertility behaviour focusses on the East-West divide (Konietzka and Kreyenfeld, 2002; Kreyenfeld, 2004; Bernardi, Keim and von der Lippe, 2007; Goldstein *et al.*, 2010; Klüsener and Goldstein, 2016), this district data (Figure 6.4) reveals that spatial heterogeneity is prevalent within West and East Germany as well: Between 1994 and 2014, although observing a rise in non-marital childbearing in both parts, they do not seem to converge so far. As already mentioned above, the regional clustering in 1984 points to spatial autocorrelation which then becomes stronger and wider in subsequent years. Again, these geographical patterns provide strong support for the idea that non-marital childbearing is not independent of space. This observation supports the assumption that spatial diffusion mechanisms contribute to a rise in this new demographic behaviour. The general rise over time supports the diffusion hypothesis furthermore. A new demographic behaviour diffuses through the population as already suggested by previous studies (Cleland, 2001; Vitali, Aassve and Lappegård, 2015; Vitali and Billari, 2017) and non-marital childbearing is not an exception.

There are two more observations that stand out. In 1994, the districts to the East and West of the former border have very different NMRs being more like those of either the former East or West. In 2004 then, the districts in the West of the former border show a rise in non-marital childbearing, appearing like a belt across the border. This development might as well be interpreted as the diffusion of non-marital childbearing from the East to the West. Similar trends can be observed alongside foreign borders, especially next to the Danish and Austrian border in 1984 and additionally next to the French and Dutch border in 1994. These countries already show a higher overall prevalence of non-marital childbearing in the same period of time (Klüsener, Perelli-Harris and Sánchez Gassen, 2013). These findings suggest that fertility behaviour is not entirely determined and bound to states but might diffuse across foreign borders as well.

6.6.2 Spatial Autocorrelation: Global and Local Moran's I

To report spatial autocorrelation Global Moran's I is calculated for 1994, 2004 and 2014. Moran's can take values between 0 and 1, whereas 0 resembles complete randomness and 1 perfect clustering. All three values show positive spatial autocorrelation and are extremely high with ringing between 0.884 and 0.900 (Table 6.4) which is very close to perfect clustering.

Table 6.4. *Global Moran's I of NMR for 1994, 2004, and 2014*

Year	Global Moran's I
1994	0.896***
2004	0.900***
2014	0.884***

$^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Sources: own calculations; data: Statistisches Bundesamt, 1995, 2005, 2016.

To explore spatial autocorrelation on the local rather than global level Local Moran's I is calculated and depicted in Figure 6.5. As expected from the descriptive maps and Global Moran's I statistics, East Germany forms a large continuum of 'high-high' units whereas most of West Germany forms a cluster of 'low-low' units in 1994. The border regions in West Germany consist accordingly of high-low units. Especially larger cities in the West come up as outliers of 'high-low' units since they already experienced higher rates of non-marital childbearing at this earlier point in time. The map for 2004 appears with a similar distribution of values. In 2014, the pattern of units becomes more diverse in West-Germany with not just 'low-low' but also 'high-high', 'high-low' and 'low-high' units. Similar to the Local Moran's I, the maps reveal almost perfect clustering of non-marital childbearing indicating that this family formation behaviour does not manifest randomly across space. Similar to the descriptive maps, this emerging new pattern might point to a spatial diffusion of non-marital childbearing within the North. Denmark being the direct neighbour in the North and presenting high shares of non-marital fertility earlier than

West-Germany additionally supports the idea of spatial diffusion across foreign borders.[31]

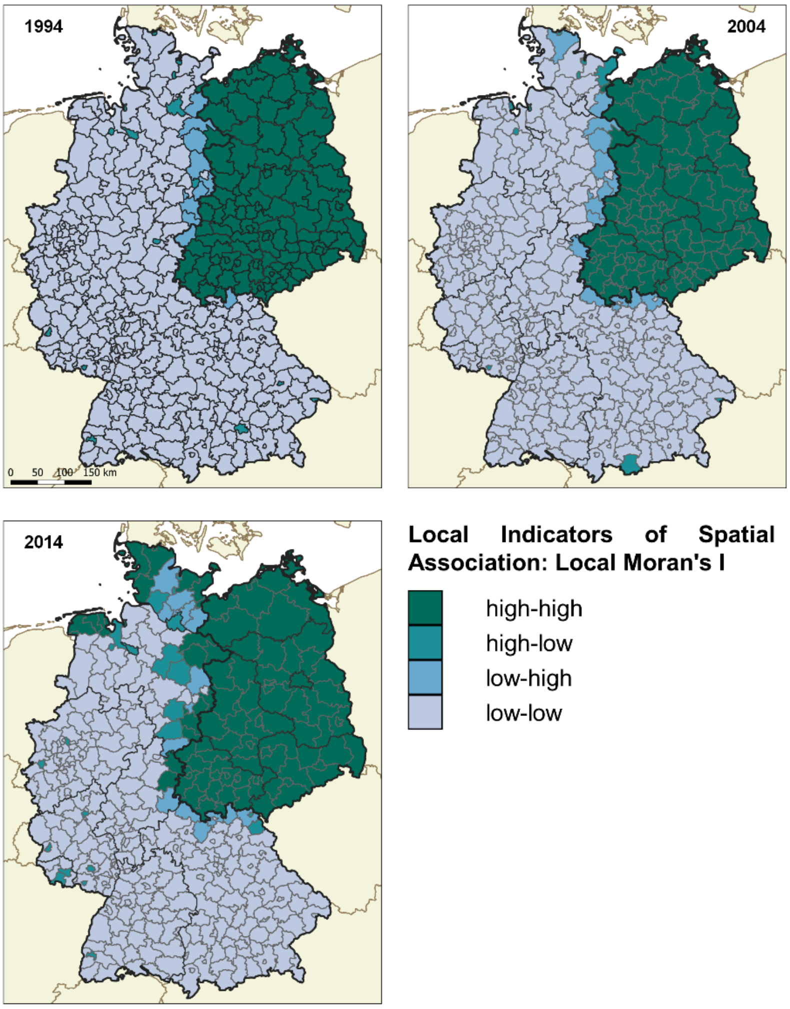


Figure 6.5. *Local Moran's I for Non-Marital (Birth) Ratios (NMR) in German Districts. 1994 to 2014 (Sources: own calculations; data - Statistisches Bundesamt, 1995, 2005, 2016; MPIDR & CGG, 2016 [1994, 2004]; boundary - BKG, 2016 [2014])*

6.6.3 Geographically Weighted Regression Model Results I: General Findings

In this section, the first set of results drawn from the geographically weighted regression (GWR) model are discussed: To analyse if the cross-district associations change over

[31] Additionally, the number of districts was reduced between the years 2004 and 2014 which might also cause more districts coming up as "high-high" units.

time, I run separate fully adjusted models for the years 1994, 2004 and 2014 including all explanatory variables presented before (section 6.5). All the explanatory variables are standardised according to their mean and standard deviation. The models all use an adaptive kernel with a Gaussian distribution. Due to changes in number of administrative units over time, the statistically best bandwidth ranges between 17 and 21 according to cross-validation and Akaike Information Criterion. The average bandwidth of 18 was accordingly used to estimate results for all models. Further bandwidth specifications (10 and 30) are presented in Appendices C.13 (1994), C.14 (2004), and C.15 (2014). Here, the GWR model results are first displayed as a table. Second, explanatory variables of interest in this analysis (voting) and that came up as very important (male unemployment) will additionally be displayed through maps for each period separately. To compare time periods, parameter estimates are displayed through the same scales. The standardisation of explanatory variables allows to interpret the parameter estimates the following way: for a one standard deviation increase in the explanatory variable the response variable NMR increases by one percentage point. The standardisation of variables allows to compare the strength of all parameters estimates directly. Strength of parameter estimates, however, cannot be compared across different years.

What can be clearly seen in Table 6.5 is the variability in quantiles of parameter estimates of the different variables ranging from negative to positive in most cases. This finding indicates that associations of variables might differ across space.

Voting for the *Left* seems to be of highest explanatory power considering both median (1994: 8.74; 2004: 10.40; 2014: 7.40) as well as minimum and maximum of the coefficients. Male unemployment follows in importance.

Table 6.5. *Results of Geographically Weighted Regression Estimating Non-Marital (Birth) Ratio for 1994, 2004, and 2014: Quantiles (Qu.) of Coefficients.*

Variable	**Model Year**	**Coefficients**				
		Min	1st Qu.	Median	3rd Qu.	Max
Intercept	1994	-4.14	17.05	18.88	21.23	38.95
	2004	7.12	29.24	31.45	32.92	36.65
	2014	24.76	28.84	34.41	37.74	39.53
Voting Left	1994	-25.77	6.55	8.74	11.46	44.52
	2004	-24.75	6.79	10.40	11.87	21.86
	2014	-10.31	1.78	7.40	8.74	10.85
Voting Green	1994	-3.11	-0.16	0.45	1.05	3.55
	2004	-4.86	-0.55	0.31	1.24	2.72
	2014	-2.09	-0.37	0.49	1.12	3.29
Male Unemployment	1994	-1.28	1.73	2.82	3.64	7.36
	2004	-0.72	4.18	5.69	6.89	9.55
	2014	-0.01	3.16	4.74	5.42	7.13
Education	1994	-1.52	0.15	0.66	0.95	2.78
	2004	-2.60	-0.29	0.17	0.64	2.80
	2014	-1.17	0.02	0.41	0.69	1.37
Female Labour Force Participation	1994	-1.19	-0.06	0.40	0.71	1.88
	2004	-3.42	-1.09	0.17	1.32	3.04
	2014	-2.73	-1.27	-0.30	1.49	3.69
Population Density	1994	-4.91	-1.01	0.02	0.60	2.05
	2004	-2.87	-1.18	-0.23	0.69	2.44
	2014	-5.76	-1.63	-0.85	-0.44	0.57
Gross Domestic Product per Capita	1994	-5.04	-1.00	0.20	0.83	2.29
	2004	-1.95	-0.43	0.02	0.42	2.99
	2014	-1.42	-0.67	-0.35	0.00	1.39
Number of Data Points	1994	444				
	2004	439				
	2014	402				

Sources: own calculations; data: StatBA, 1994, 2004, 2005; Statistisches Bundesamt, 1995, 2005, 2016; AK VGL, 2011; destatis, 2016b, 2016c, 2016d, 2016e, 2016f, 2016g, 2017; German Bundestag, 2018; boundary - MPIDR & CGG, 2016 [1994, 2004]; BKG, 2016 [2014].

Both female labour force participation as well as population density seem to witness a shift in sign over time. Precisely, the association of female labour force participation and non-marital childbearing becomes more negative over time. And indeed, the maps (Appendix C.3) reveal that a high share of female employment in the East is associated with childbearing within marriage in all times whereas in the West female labour force participation is associated with childbearing within cohabitation at first but also changes to childbearing within marriage over time. While in the West, women who participate in the labour force are the forerunners of non-marital childbearing, as the behaviour becomes more prevalent, economically active women tend to opt for childbearing within marriage as in East Germany. In the East, however, I cannot investigate forerunner behaviour because the shift happened much earlier when suitable spatial data does not exist. These findings are supportive of the assumption that associations of demographic behaviour and its correlates differ across space.

The GWR model results for key independent variables of interest in this analysis – voting for Left and voting for *Greens* - will be depicted and described through maps in the following. The colouring scheme of the maps run from yellow for negative association over green to dark blue (positive association). Maps for model results of all other control variables are in Appendix C.3. Maps depicting quintile ranges for coefficients of all explanatory variables of the same models and for all years are displayed in Appendix C.4.

The GWR model results for the variable voting for the *Left* party varies considerably across space in all three years under study, although the wide range of parameter estimates decreases over time (Figure 6.6). In 1994, the local parameter estimates vary between -25.8 to 44.5. In 2004, a one standard deviation increase in voting for the *Left* is associated with a decrease of non-marital childbearing of -24.7 up to an increase of 21.9. These very large values are probably due to the large standard deviation of voting across Germany. In 2014, the association's range is between -10.3 and 10.8. Interestingly, there is just a small fraction of very negative values within the first quintile of parameter estimates whereas the rest of the country has positive values. The negative values only appear in the light cluster in the far West – the so-called Ruhr-Area – and in a small patch in the South of Bavaria. In the East, parameter estimates are positive yet moderate together with being stable across all years.

Parameter estimates in the rest of Germany are mainly positive but comparatively higher. In 2014, there appears an even clearer South-North divide with South Germany showing a negative association between voting for the *Left* party and non-marital childbearing. This could point towards a shift in fertility behaviour where people with more liberal values and with possibly higher education are more likely to have children within marriage.

Results for the *Green* party differ considerably from those for the *Left* party already visible through the lighter colour scheme (Figure 6.7). The parameter estimates of the GWR model results including its range is much lower for voting for the *Green* party compared to voting for the *Left* party[32]. Again, the strength and sign of association change across space. In general, we find many regions in all years where the association is close to zero, suggesting there is no association between both variables. In 1994, the parameter estimates vary between -3.11 and 3.55. In the North of East Germany, parameter estimates are negative. The association hence might be reversed from the initial expectations. Voting for the *Green* party seems to be linked to childbearing within marriage rather than cohabitation in these areas. Alongside the border in the West and in larger areas of Southeast Germany, parameter estimates are positive. Here, liberal values seem to be related to having children outside marriage. In 2004, spatial patterns appear like 1994 with parameter estimates ranging between -4.86 and 2.72. In 2014, the association appears to diminish further with coefficients being between -1 and 1. The results suggest that the relationship between voting for *Greens* and non-marital childbearing support the Second Demographic Transition theory. Pursuing this line of argument, it might indicate that higher educated people holding liberal values tend to vote for the *Green* party. The interpretation is, however, highly speculative and not consistent across all areas.

[32] As shown in Figure 6.2 fewer people vote for the *Green* party compared to the *Left*. However, support for the *Left* is only very high in the East and comparatively low in the West. Regardless of this. their importance still comes up as high for non-marital fertility in the West.

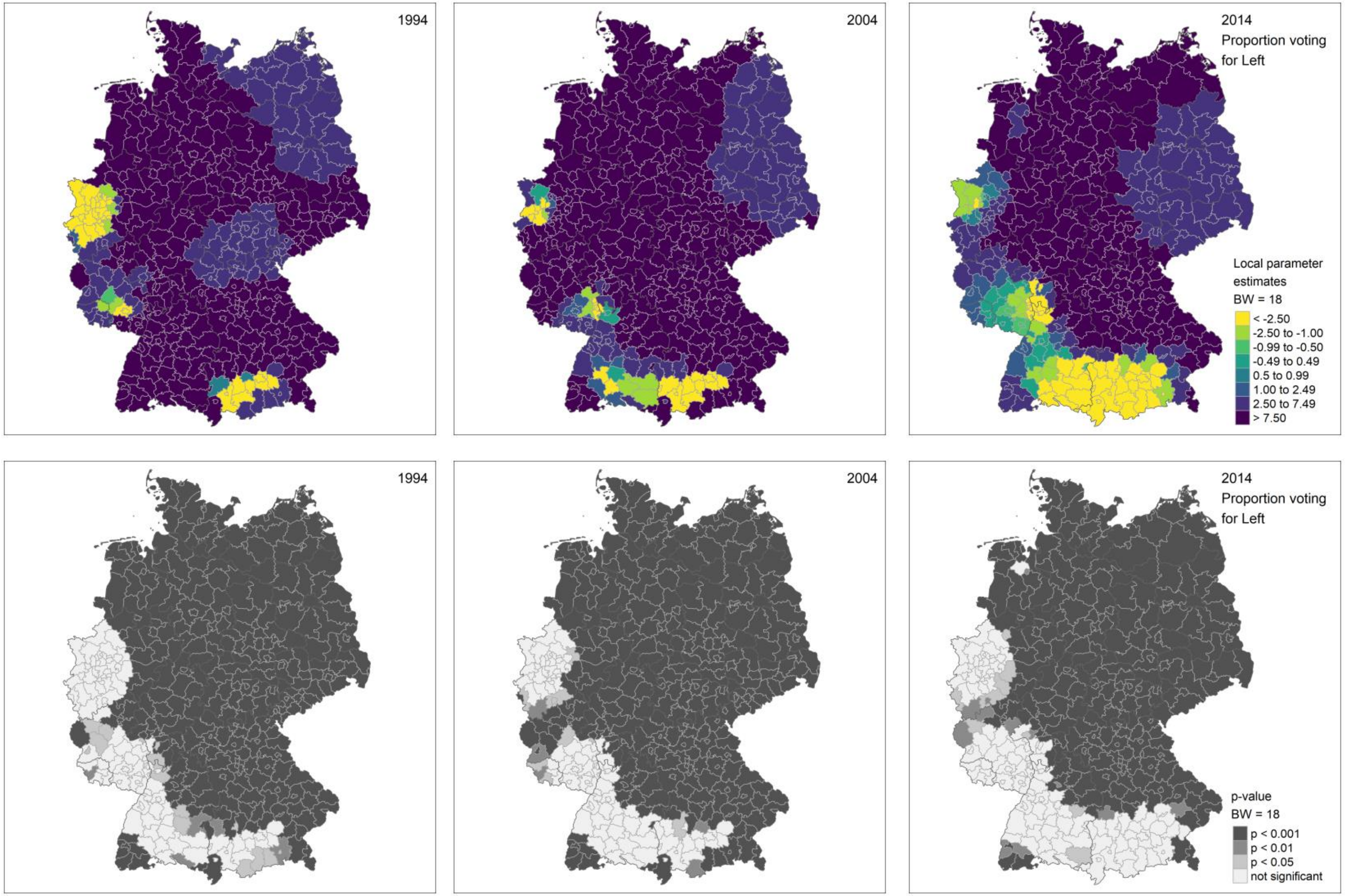


Figure 6.6. *GWR Model Results for Non-Marital Childbearing: Parameter Estimates with Standardised Categories over Time for Voting for the Left Party Variable and p-values Based on t-Test (Sources: own calculations; data - Statistisches Bundesamt, 1995, 2005, 2016; destatis, 2016b; MPIDR & CGG, 2016 [1994, 2004]; boundary - BKG, 2016 [2014]).*

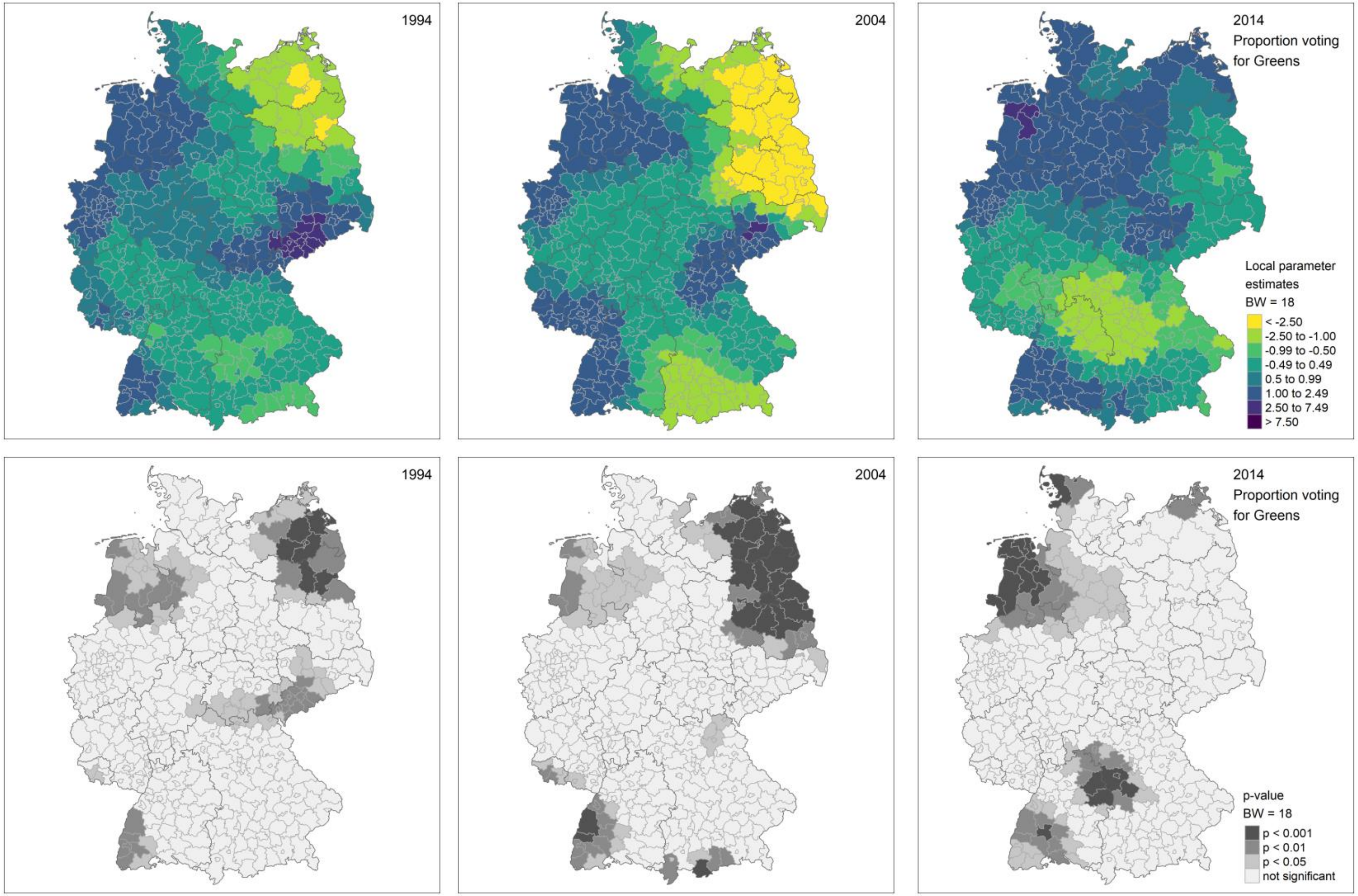


Figure 6.7. *GWR Model Results for Non-Marital Childbearing: Parameter Estimates with Standardised Categories over Time Voting for the Green Party and p-Values Based on t-Test (Source: own calculations; data - Statistisches Bundesamt, 1995, 2005, 2016; destatis, 2016b; MPIDR & CGG, 2016 [1994, 2004]; boundary - BKG, 2016 [2014]).*

Overall, we find as expected that associations of non-marital childbearing vary across space in strength. In some cases, the parameter estimates reveal that the associations even differ in the direction, being negative in some areas but positive in others. Over time, we can observe a change in sign pointing towards a diffusion of new ideas related to non-marital childbearing together with female employment across space.

6.6.4 Geographically Weighted Regression Model Results II: Most Important Variable

The explanatory variable contributing the most to non-marital childbearing is determined for each district for each year in another step.
Table 6.5 already revealed the importance of male unemployment. The results of the geographically weighted regression for male unemployment and non-marital childbearing reveal a positive gradient. The mapped GWR model results (Appendix C.3) for the variable male unemployment as an indicator for economic uncertainty appears widely positive in 1994, 2004 and 2014 as expected from the theoretical elaborations. Again, level of associations differs considerably across space. In 1994, around 20% of the parameter estimates (-1.3 to 1.5) either present very low or no associations between non-marital childbearing and male unemployment. The remaining associations fluctuate strongly over space. An increase in one standard deviation on male unemployment is linked to a change in non-marital childbearing by 1.5% to 7.4%.

In 2004, a one standard deviation increase is related to a shift of non-marital births by -0.7% to 9.0%. Hence, just the minority of districts – again in the South – do not present an association. In 2014, an increase of one standard deviation is associated with a gain in non-marital childbearing of 0.0% to 7.1%. Now, all districts exhibit a positive association although associations vary considerably in strength across all districts. In all years, coefficients in the districts with either low or no associations are statistically not significant.

These results further demonstrate just mild evidence of the usual East-West divide in 1994 and 2004 as expected from the descriptive statistics. The divide disappears in 2014. In general, one cluster with the highest association is found in the far North in all three cross-sections and another area in Mid-Germany in 1994 moving South-East over the time under study. The lowest associations appear in the South of Bavaria and Baden-Wuerttemberg in 1994 and 2004 and in addition also in the West, in the so-called Ruhr-Area across all years. In 2014, both in the South of Bavaria and Baden-Württemberg associations become positive and comparatively strong. Overall, these results indicate that male unemployment is a key factor in understanding non-marital childbearing at the local level throughout the whole country.

The variable with the highest explanatory power can be identified by using the previously discussed GWR model results for the fully adjusted model. For this step the standardisation of variables is necessary to directly compare all parameter estimates. The standardisation allows to filter the variable with highest coefficient for each district. This variable is considered to contribute the most to a rise in non-marital childbearing. These results are displayed in maps accordingly (Figure 6.8).

In all years under study voting for the *Left* is the variable with the highest explanatory power in most districts. This is a notable feature since it does not represent the geographical distribution of voting. Male unemployment is more important in explaining non-marital childbearing in small clusters like the Ruhr-Area in the West where parameter estimates for voting for the *Left* party were negative. In 2004, most districts in the East reveal male unemployment as becoming most important. In South Germany, male unemployment appears to become a more important factor in explaining in 2004 as well as 2014. These results might suggest that male unemployment becomes more important as non-marital childbearing is increasing.

When comparing the variables with highest explanatory power, the East-West divide completely disappears in 1994 and 2014 (Figure 6.8). Certain values linked to specific parties – here the *Left* party – seem to matter in explaining an increase in non-marital childbearing consistently across time and space. This is apparent as well in the West of Germany in 1994 where non-marital childbearing was on the rise. But it is also the case in the East, where this childbearing behaviour was already widespread at the same time. However, male unemployment becomes more important in explaining non-marital childbearing in times of high economic uncertainty in the East as shown in 2004 (Figure 6.8).

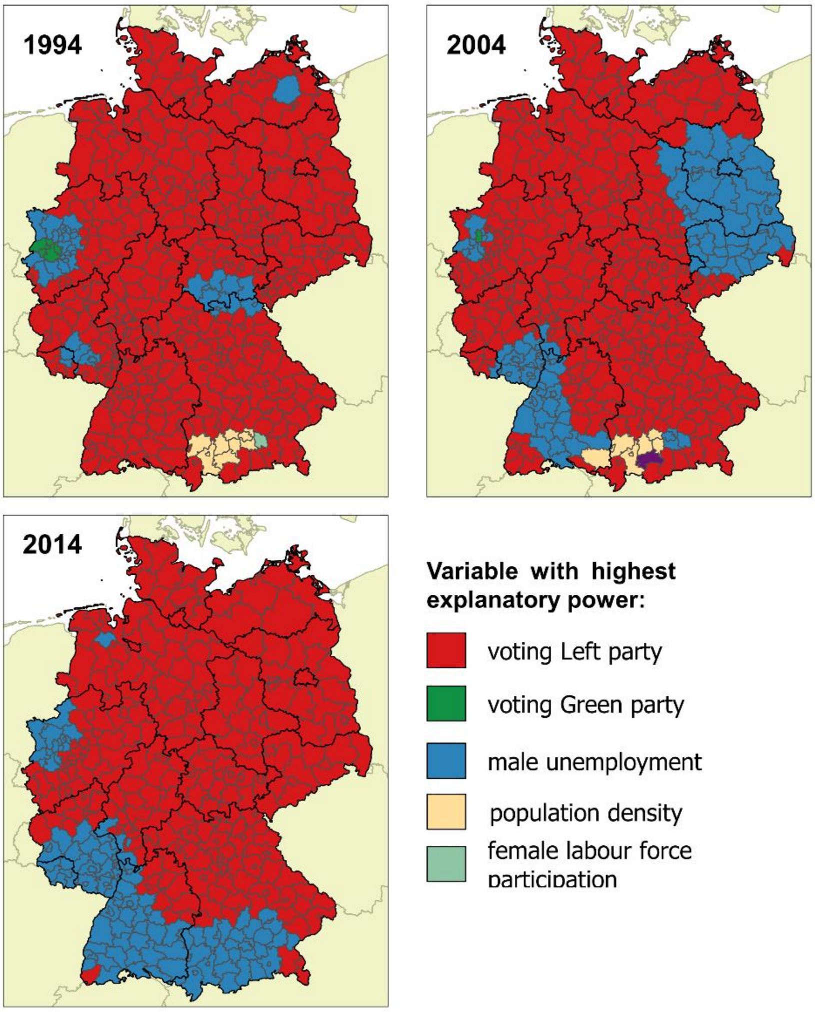


Figure 6.8. *GWR Model Results. Determining Variable with Most Explanatory Power with Standardised Variable (Sources: own calculations; data - StatBA, 1994, 2004, 2005; Statistisches Bundesamt, 1995, 2005, 2016; AK VGL, 2011; destatis, 2016b, 2016c, 2016d, 2016e, 2016f, 2016g, 2017; MPIDR & CGG, 2016 [1994, 2004]; BKG, 2016 [2014]; German Bundestag, 2018; boundary - BKG, 2016 [2014]).*

Because one variable comes up in most places as most important in explaining non-marital fertility, I determine the second most important variable the same way as the variable with the highest explanatory power (Appendix C.10). Additionally, I calculate the difference between the variable with the highest and second highest explanatory power (Appendix C.11). In case the parameter estimates are very close, it seems difficult to decide which variable is more important. The results reveal that male unemployment is in most cases the variable with the second highest explanatory power. In the West, the difference between the first and second variable is high overall in 1994. The difference in parameter estimates decreases considerably over the years until 2014. In the East, the difference in parameter estimates of voting for the *Left* and male unemployment is very low in all years under study. The results display that an increase in male unemployment or voting for the *Left* by one standard deviation is related to an almost equivalent increase in non-marital childbearing. A clear distinction of the most important variable cannot be made any more. These findings might suggest that when childbearing within cohabitation is already widespread as in the East in all years or becomes more prevalent as in the West in 2014 the importance of male unemployment increases accordingly.

From the descriptive maps (Appendix C.2) it appears that the variables for male unemployment and voting for the *Left* could be correlated since we find clusters of high values for both variables in the East and lower values in general in the West. Considering the correlation matrices (Appendix C.7) for all three years reveals that both variables are indeed positively correlated. This might suggest that both variables could be measuring the same phenomenon: people who are unemployed might be more likely to vote for the *Left*. Since the clear East-West divide appears the correlations are determined for both areas separately to investigate if the correlations still exist within each area. The correlations (Appendix C.8) demonstrate that the correlation of voting for the *Left* and unemployment only persists in West Germany in 2004. Since one known drawback of GWR is local multicollinearity (Fotheringham, Brunsdon and Charlton, 2003; Gollini *et al.*, 2015) local correlations (Appendix 6) and local Variance Inflation Factors (VIF) are calculated (Appendix C.9) for each variable and each location in a last step. The results of the local correlations and local VIF suggest that the estimated models are robust under the chosen model specifications.

Table 6.6. *Model Diagnostics: Akaike Information Criterion (AICc) and Global Moran's I of Residuals for Linear Regression Compared to Geographically Weighted Regression of Fully Adjusted Model.*

	Linear regression		**Geographically weighted regression**	
	AICc	**Moran's I residuals**	**AICc**	**Moran's I residuals**
1994	2501.6	0.34***	2250.4	0.15***
2004	2439.5	0.43***	2271.2	0.19***
2014	2272.3	0.45***	2079.5	0.15***

**p < 0.05, **p <0.01, ***p < 0.001.*

Sources: own calculations; data: StatBA, 1994, 2004, 2005; Statistisches Bundesamt, 1995, 2005, 2016; AK VGL, 2011; destatis, 2016b, 2016c, 2016d, 2016e, 2016f, 2016g, 2017; German Bundestag, 2018; boundary - MPIDR & CGG, 2016 [1994, 2004]; BKG, 2016 [2014].

The model diagnostics in Table 6.6 reveal that changing the model from a global to local model improves the model fit. The Akaike Information Criterion for geographically weighted regressions (AICc)[33] allows to compare models which are not nested and simultaneously takes different degrees of freedom into account. To assess the goodness-of-fit the expectation is to minimise the AICc when advancing the model to a GWR. In this case, the AICc decreases for all years suggesting that the GWR model is a better fit than the linear model. Another feature suggesting the improvement of the GWR model is the Global Moran's I of the regression residuals. For the linear regression models the Moran's I illustrates large and statistically highly significant spatial autocorrelation of the residuals. Therefore, assumptions of a linear regression are clearly violated. For the GWR, spatial autocorrelation decreases to half or even a third of the one for the linear regression. From these results, I conclude that a GWR model is more appropriate to estimate

[33] The Akaike Information Criterion for GWR is calculated following Fotheringham, Brunsdon and Charlton (2002) as follows: $AIC_c = 2n\log(\hat{\sigma}) + n\left\{\frac{n+tr(S)}{n-2-tr(S)}\right\}$, where the sample size is denotated by n, the standard deviation of the error term is $\hat{\sigma}$ and the denotation for the hat matrix as a function of the bandwidth is $tr(S)$.

regional NMR compared to a linear model since it decreases spatial autocorrelation of the residuals and improves the model fit.

6.7 Discussion

The findings of the analysis highlight the importance of voting as a correlate of demographic behaviour. The variable voting for the *Left* reveals the highest explanatory power during the rise of childbearing within cohabitation in the 1990s in Germany. In 2004, male unemployment gains explanatory power in the East, but then becomes more inconsequential. This may reflect the high economic uncertainty of the mid-2000s when non-marital childbearing was more likely to be practiced by those facing economic difficulties. Overall, the importance of liberal values and economic uncertainty seems to converge over time. The results additionally confirm that the associations between childbearing outside marriage and its correlates differ substantially across space not just in strength but sometimes even direction. Furthermore, the associations change over time in magnitude and sign: the parameter estimates of female labour force participation shift from being mostly positive in 1994 to widely negative in 2014. This is supportive of a diffusionist perspective.

The understanding of the various meanings of voting across space is crucial to gain insights into differing association of voting behaviour and childbearing outside marriage. Germany as a historically divided country seems to be a particularly interesting but also challenging case to study this issue. According to their election manifestoes, two left-wing parties in Germany – the *Left* and *Green* party – seem to resemble the dimension of five core values related to the Second Demographic Transition by Surkyn and Lesthaeghe (2004) most closely. The *Green* party's profile bears a resemblance to the Second Demographic Transition (SDT) theory more closely, however, being a strong advocate of individualisation compared to the *Left*. Even though the Left holds strong liberal values regarding family or labour policies, its profile is rather illiberal/authoritarian or in terms of the role of the state/government. Accordingly, the Left is only liberal in some respects which needs to be taken into consideration when interpreting the results.

The East-West divide of Germany is noticeable when considering descriptive maps of voting. Hence, it is a very notable feature that voting for the *Left* party comes up as equally important across the whole country. The associations between voting for the *Left* party and non-marital childbearing is positive but comparatively modest and stable in the East in all years. The spatial difference in parameter estimates in the West are noteworthy. In the so-called Ruhr-Area the parameter estimates are highly negative in 1994 and 2004 whereas in most other areas they are highly positive. The industrial Ruhr-Area has a very large population of labourers, the main group of traditional voters for the *Left*. Here, the *Left* has a comparatively high share of votes in West Germany. At the same time, a relatively large part of the population within this area has a migration background as well. The origins of migration are mostly countries with more traditional family values like Turkey, Italy, or Eastern Europe (Koops, 2020). Those groups seem more likely to vote for the *Left* party because of their support of the working-class not for their support of liberal family policies. The small, but presumably very distinct group of people voting for the *Left* in other parts of the West might hold more extreme liberal and socialist values. In this context, the mechanism of social pressure might prevent non-marital childbearing in such contexts. Nevertheless, since this is an aggregated measure resembling liberal values, I assume that these values are more widespread within the overall population in these areas in the West even though just a small group holds more extreme values. These distinct voting behaviours seem to be a plausible explanation for the severe spatial differences in parameter estimates of voting for the *Left* party within Germany as a whole and within West Germany in particular.

Even though previous research by Lesthaeghe and Neidert (2006, 2009) demonstrated for the United States that voting patterns are closely related to indicators for the Second Demographic Transition the results here do not necessarily confirm this link. The United States, where elections are decided between two parties, seems to be a particular example and those results cannot be directly transferred to Europe. Most European countries including Germany have a multiparty system. A variety of parties support liberal family values but having quite distinct profiles in other areas of politics. These circumstances complicate drawing conclusions on the link of demographic behaviour and voting. Different understandings and meanings of liberal but also left-wing values and attitudes are deeply embedded in Germany's political history due to Germany's diverging history after

World War II and the communist past of the East. One can expect that the association of fertility behaviour and voting patterns might be highly complex in most other European countries. Furthermore, the findings highlight that voting behaviour as a measure of demographic behaviour needs to be treated with caution when only used as a global measure. Especially, geographically varying reasons for voting for certain parties leading to spatial heterogeneity in statistical analysis needs to be considered when incorporating voting behaviour into demographic analysis.

Further results are supportive of the pattern of disadvantage hypothesis. The importance of male unemployment is prominent in several clusters, especially in 2004 in East Germany. Given the very high unemployment rates in Germany in 2004 and 2005 particularly among the young and lower educated (Ebbinghaus and Eichhorst, 2006; Rinne and Zimmermann, 2013) the relevance of male unemployment as a general measure of economic uncertainty does not seem surprising. Additionally, this variable has the second highest explanatory power in the majority of Germany in all years under study. Hence, not just values but also economic uncertainty is a relevant indicator in illustrating non-marital childbearing patterns on the regional level. The convergence of the parameter estimates of voting for the *Left* and male unemployment over time might also be a sign for both variables becoming equally important if childbearing outside marriage is already more prevalent.[34]

Female labour force participation seems a suitable indicator to support the argument that the association of this factor and non-martial fertility might differ across space. There is a variety of research discussing East-West difference in female labour force participation in Germany (Besenthal *et al.*, 2005; Wengler, Trappe and Schmitt, 2008). Diverging developments are in general attributed to Germany's division after World War II (Rosenfeld, Trappe and Gornick, 2004; Matysiak and Steinmetz, 2008). Recent research points out that female labour force participation was already higher in the East than in the

[34] The closeness of parameter estimates of both variables in East Germany in all three year supports this assumption further.

West in 1925 (Wyrwich, 2019; Becker, Mergele and Woessmann, 2020). Further regional heterogeneity within East and West is often ignored at the expense of understanding differing demographic behaviour, regional culture and varying attitudes (Bertram, Nauck and Klein, 2000).

Results of the GWR for female labour force participation also came up as heterogeneous and changing in sign over time (Appendix C.3). This fact may not be surprising when considering pre-1990s research in this area. A notable feature of pre-1990 research is that it focusses on a German North-South divide within the old Federal Republic instead of East-West (Bender and Hirschenauer, 1993; Sackmann and Häussermann, 1994; Sackmann, 1997). This fact reveals that other geographical variations are neglected in favour of an obvious East-West divide in post-1990 research. In 1991, participation in the paid labour force was common in the South, whereas in the North and West women were less likely to participate in the labour market (Sackmann and Häussermann, 1994; Sackmann, 1997). These long-standing patterns can be traced back until 1900. In the South, female labour force participation was associated with a low level of qualifications (Bender and Hirschenauer, 1993). Female employment in the North is characterised by low participation but high levels of qualification. A third example with different patterns of female employment are urban areas. They display high female labour force participation at a simultaneously high level of qualification leading to a strong attachment to the labour market. In the North, West and South, urban centres were also centres of high shares of non-marital childbearing comparatively early. Like East Germany, childcare availability was also better in cities than in urban areas. Women in these areas were financially more independent. Accordingly, it is very likely that the meaning of female employment varies spatially and that it ‘takes different forms and means different things in different regions’ (Sackmann and Häussermann, 1994, p. 1381). In the context of this analysis, the role of mothers in the labour market in relation to family might play a crucial role in how spatially differing patterns emerge. Social imitation and contagion as forms of indirect communication might play a role for social transmission of non-marital childbearing.

The analysis of non-marital childbearing in Germany between 1994 and 2014 is highly indicative of diffusion mechanisms shaping spatial patterns of non-marital fertility in this context. To conclude, possible mechanisms of diffusion need to be discussed. Social imitation and contagion have been mentioned as a form of local communication. Even though connectivity of distant places increases constantly through the availability of the internet and social media (usage), personal contacts such as family, friends and colleagues on average still live in geographical proximity.

Especially in the 1990s a lot of migration occurred from East to West Germany. Migration was relatively selective: younger cohorts and also more educated cohorts as well as more women left the East and moved to the West. Unemployment among women in the East after reunification was much higher than for men, in addition the share of highly educated women in East at that point in time much higher than in West. (Heiland, 2004). The evidence for diffusion through migration is mixed, though. According to Vatterrott, women who migrated from East to West, though, adapt their fertility behaviour (non-marital or marital) to West-German women or are between East and West German women, although it also depends on the origin of their partner (Vatterrott, 2011). However, also in the East highly educated women were less likely to have children outside marriage and this selective group was more likely to move to the West (Konietzka and Kreyenfeld, 2017). Boelmann et al. (2020) however possibly find evidence for diffusion mechanism of childbearing and the subsequent return to work of mothers. The uptake of employment after giving birth is earlier among East German women than West German women. However, in areas of cross-border local labour markets the close contact to East German female colleagues seems to accelerate the uptake of work after having a child for West German women. The districts in West Germany right next to districts in the East analysed in this paper (Boelmann, Raute and Schönberg, 2020) also show a faster increase in non-marital childbearing in 2004 than other districts in the West. Here, communication links as a form of social learning, contagion and imitation through commuting and similar social environment are likely explanations of diffusion mechanisms. Similar mechanism (as well as historical continuities) might also be an explanation of similar family formation behaviour across national borders to neighbouring countries such as Austria, Denmark as well as France.

This analysis is not without its limitations. First, data availability poses some problems. Although we are mainly interested in childbearing within cohabitation, only data on non-marital childbearing is accessible on the district level for Germany. This measure not only includes fertility to cohabiting couples but to single mothers. These problems and further drawbacks of the variable have been discussed in detail in subchapter 3.5. Voting as a measure of liberal values also needs to be treated with caution since the composition of the variable differs considerably by region when using votes by *Greens* and *Left*. Disentangling voting seems difficult and it might capture various other factors than norms and attitudes. The explanatory variable female labour force participation does not account for full- and part-time employment. The prevalence of both varies much across space. Another issue of the analysis is the cross-sectional framework. It is also due to data problems: Unfortunately, a variety of district re-orderings during the period under investigation make it impossible to use consistent regional units over time.

The GWR model is not without its drawbacks. Although we are interested in investigating a certain behaviour, we were only able to do this analysis using aggregated data which generates the possibility of ecological fallacy. By introducing a weight function which takes the values of the determinants of the neighbouring localities into account the method basically imposes the idea of diffusion into the model. This is one reason why clear clusters appear. Another issue is that the local parameter estimates can differ depending on the type of spatial kernel and bandwidth chosen by the researcher. Local multicollinearity might cause spatial patterns in the maps of the GWR model results. Test on global and local multicollinearity do not seem to find severe multicollinearity problems in the models in this analysis, though. Also, the modelling does not allow to account for non-marital across national borders.

6.8 Conclusion

The findings highlight the usefulness of considering voting behaviour in the analysis of demographic, and especially family formation, behaviour. The results demonstrate that during the upswing of childbearing within cohabitation in the 1990s in West Germany, as well as during the following years, values measured through voting were a key factor associated with non-marital childbearing. Following previous research findings, I assumed that liberal voting behaviour could be closely linked to the Second Demographic Transition. The analysis shows, however, that the interplay of voting behaviour, values, and demographic patterns is far more complex in a multi-party system than indicated by the Second Demographic Transition theory. Individualisation seems to be of minor importance and might even be more relevant in explaining marital childbearing.

On the contrary, liberal values towards family formation measured by voting for the *Left* suggest being a key explanatory factor for patterns of non-marital childbearing in both East and West. Therefore, the actual manifestation of spatial patterns of non-marital childbearing might in large parts be due to differences in liberal values towards family formation in East and West. The results also reveal that even though voting behaviour appears to be an adequate measure of liberal values in some parts of Germany, its meaning might differ in other parts. As a result, notwithstanding its high importance, voting behaviour should be treated with caution when being incorporated into a global analysis not accounting for possible spatial heterogeneity.

Beyond the relevance of voting behaviour, the analysis identified the high explanatory power of male unemployment as a measure of economic uncertainty for understanding non-marital fertility in the context of Germany. This observation supports the pattern of disadvantage hypothesis. Particularly in years of high economic uncertainty, such as the mid-2000s in Germany, the relevance of male unemployment increased. Over time, both voting for the *Left* and male unemployment seem to converge in their explanatory power. Hence, it appears that the liberal values measured by voting and the pattern of disadvantage hypothesis are not necessarily mutually exclusive in explaining the spatial patterns of non-marital childbearing in Germany.

Even though the modelling approach has its limits to draw conclusions about diffusion over time the application here proves its usefulness to gain a better understanding of the role of space for family formation behaviour. Ideally, diffusion mechanisms should be explained following individuals over time in combination with individual-level network data

Chapter 7 Conclusion

The introduction in Chapter 1 already set out to explore changes in demographic behaviours altering family life in Europe across two demographic transitions between 1851 and 2011 through a spatial perspective. In doing so, the thesis combines geographical data sources and cultural indicators which have previously not been studied in combination. Thereby, it offers new insights into spatial demographic patterns. Chapter 4 examines the historical fertility decline in England and Wales between 1851 and 1911 and how it relates to religion. Chapter 5 analyses how both the historical change in fertility and more recent increase in non-marital childbearing are linked through spatial patterns of labour force participation among mothers. Chapter 6 describes how non-marital childbearing and patterns of voting are associated in Germany between 1994 and 2014.

In this concluding chapter, I summarise the key conclusion of each of the three empirical chapters and the novel insights each paper offers. Afterwards, the thesis contribution is discussed in line with main limitations and future research.

7.1 Summary of Findings

Overall, the thesis set out to assess three assumptions:

- Accordingly, I assume that cultural indicators are crucial in explaining changes in demographic behaviour across space.
- demographic behaviour around fertility and family formation in one area is dependent on the same behaviour in nearby areas.
- associations of demographic behaviour and its correlates may be heterogeneous across space.

Chapter 4 examines the spatial distribution of changing fertility during the initial phases of the fertility transition in England and Wales from 1851 to 1911. The results of spatial lag models suggest that districts with a high prevalence of *New Dissenters* witnessed an earlier and faster decline in fertility than other districts between 1851 and 1881 even after controlling for several other known explanatory factors. Analysing the change in the Total Marital Fertility Rate (TMFR) over time helped identify Cornwall and Wales as leading regions in fertility change prior to 1881. *New Dissent*, emphasizing religious education for all children, possibly contributed to the rapid decrease in fertility in the mid-19th century. After that time, the TMFR began to decrease rapidly from 1881 across most districts, marking the tipping point of the transition. The study also confirmed findings of previous research that regions with a significant middle-class population and high urbanization levels showed a marked fertility decline between 1881 and 1911. However, other factors outside religion and occupational structure such as expansion of education also played a crucial role in the fertility decline in England and Wales as well. As suggested, this investigations show that fertility behaviour in on area is dependent on fertility behaviour in neighbouring areas even after controlling for most important explanatory variables. Overall, using geographical data to analyse long-term trends in marital fertility helps identify early adopters of 'new' behaviour and provides valuable insights into the fertility transition in England and Wales. Data limitation makes it challenging to study the influence of *New Dissent* post-1881.

Chapter 5 explores how the historical fertility decline in the 19th century and subsequent increase in non-marital births in the 20th century are associated through socioeconomic factors in England and Wales. By examining new demographic behaviours from 1851 to 2011, the study highlights areas with early demographic changes during both transitions. Spatial continuities were detected in the majority of Local Authority Districts, suggesting adoptive behaviour. These finding also confirm the existence of statistical spatial dependence of demographic behaviour again. Spatial patterns of labour force participation patterns among mothers may have triggered early adoption of these new behaviours. Although this factor is often interpreted as economic, norms related to working mothers should not be overlooked. The chapter also considered the impact of changes after the 1950s, including large immigration waves altering local values and norms. Furthermore, it points out that London consistently exhibited unique demographic behaviour. Overall, the chapter underscores the need for intersectional perspectives in spatial demography due to its complexity and identifies possible future trends in demographic continuities or discontinuities.

Chapter 6 identifies how non-marital childbearing has increased in Germany between 1994 and 2014 and how it is associated to values and norms as proposed by the Second Demographic Transition theory. Here, the link with left-wing voting which often represents liberal attitudes is conceptualised and explored in detail in addition to common explanatory factors such as unemployment, female employment or population density. Local indicators of spatial associations and geographical weighted regression models are used to examine district data for 1994, 2004 and 2014. The results suggest that associations of non-marital childbearing and its determinants are heterogeneous across space. Non-marital childbearing in Germany can be linked to liberal values, represented by voting for the *Left* party. Counter to previous research, individualisation, symbolised by voting for the *Green* party, is seen as less important. The study highlights that voting tendencies relating to demographic behaviour can explain patterns of non-marital childbearing, especially in Germany during the 1990s. Male unemployment started to gain explanatory power by 2004, reflecting the economic instability during the mid-2000s and the subsequent rise in non-marital childbearing. These indicators tend to converge over time as they become of equal importance. In addition, this investigations sheds light on another dimension of space in demographic research: associations of demographic behaviour and its correlates differ across space. However, these patterns are complicated in a multi-party system, rendering conclusions about demographic behaviour and values uncertain. Especially recent shifts in voting for right-wing populist parties in former left-wing voting areas highlights the difficulties of linking certain attitudes and norms with demographic behaviour through certain parties.

7.2 Thesis Contribution and Implications

The thesis illustrates empirically how the understanding of demographic processes benefits from a spatial or spatiotemporal perspective to gain new insights around family and historical demography. Exploring if and how long-term demographic developments in the past altered recent demographic behaviour does not only enhance our understanding of recent demographic patterns but might similarly inform forecasting of demographic processes and patterns in the future. Therefore, the thesis demonstrates how important it is to consider norms and values particularly in the context of spatial demography.

Conceptually, the thesis contributes to the understanding of space that can be interpreted as a meso-level from the individual-level processes to national outcomes. To do so, I elaborate the idea of the role forerunners and tipping point in changing behaviour from the viewpoint of spatial analysis.

Previous research about the historical fertility transition already found that neighbouring areas are important in shaping an areas demographic behaviour such as fertility behaviour. Goldstein and Klüsener (2014) already found support for the idea that social diffusion mechanism play an important role in the transmission of new fertility behaviour in Prussia. This finds new evidence for diffusion mechanisms in the context of England and Wales which was long said to be geographically comparatively homogeneous compared to mainland Europe.

The idea of analysing cultural indicators and fertility change was originally based on the ideas of the *Princeton European Fertility Project*. They suggested that cultural factors such as secularisation or voting patterns would alter the geographical patterns of fertility change in Europe (Knodel, 1974; Lesthaeghe, 1977; Coale and Watkins, 1986). *The Cambridge Group for the History of Population* and Social Structure also found evidence for the importance of context in influencing individual fertility behaviour (Garrett *et al.*, 2001). This thesis confirms previous findings, but also adds to existing knowledge. Indeed, cultural factors are of great importance in understanding changes in historical families. The analysis of the historical fertility decline in England and Wales provides evidence of the importance of religion in the early years of the fertility transition. Interestingly, these findings show that religion can be an indicator not only of high fertility, but also of low fertility, because of a particular set of norms that motivate individuals to favour a lower number of children. The analysis also provides a more nuanced picture of the fertility transition at the small geographical level by mapping much smaller spatial units than previously done.

The different empirical chapters suggest that forerunners are areas of early adoption of new demographic behaviours. They play a crucial role in the early adoption of an 'innovative' or 'new' demographic behaviour and contribute to spatial diffusion mechanisms. In theory, trends of a new demographic may not be immediately visible at a national level until a tipping point is reached, in which innovations have been adopted by a sufficient number of areas. Moreover, cultural norms also have a significant impact on spatial demography, particularly during the forerunner years. They help in creating a conducive environment for changes in demographic behaviours such as fertility and family formation. Thereby, all three chapters confirm, that cultural factors are crucial in explaining changes in demographic behaviour across space. However, once these behaviours have been widely accepted, we only then witness a tipping point in behaviour on an aggregate level where socio-economic indicators become of higher significance. All these observations are supportive of a diffusionist perspective. Demographic behaviour in one location such as fertility is not just dependent on its own characteristics but also on the demographic behaviour in neighbouring locations.

In addition to the contribution in knowledge, this thesis produced a novel data set to explore changes in demographic behaviour in England and Wales across more than a century. To compare data from both the First as well as Second Demographic Transition, I apply areal weighted interpolation to create harmonised data from different geographical data sources. Hereby, I can overcome the common problem in spatial analyses of administrative boundary changes. Often, such changes do not allow to compare geographical data sources even over very short periods of time. This thesis thereby advocates to look over the boundary of academic disciplines such as history, demography and statistics.

From a methodological perspective, spatial statistical models should be the models of choice for demographers when analysing geographical data. Both fertility and family formation behaviour are highly clustered within space and spatial models deal better with violation of independence imposed through spatial data compared to regular linear regression models and therefore produce more reliable estimates. However, the choice of model always needs to be driven by the conceptual framework of an analysis. Still, to make claims about spatial processes, it is not always necessary to apply complicated statistical modelling techniques. The thesis highlights how simple maps of change in demographic behaviour allow to identify forerunner areas of new demographic behaviour and provide more detailed insights into spatial diffusion mechanisms than previously shown.

7.3 Limitations

The limitations of each of the three papers are discussed in greater detail in their individual chapters' conclusion. Here, I will provide a generalised and condensed overview of the key limitations of this thesis.

The results presented in this analysis refer to some form of geographically aggregated data. The choice of spatial scale is always important for the results since aggregation at different spatial scales might yield different outcomes because spatial autocorrelation (Chapter 3.1.1) may vary by geographical scale. Accordingly, all results might be subject to the modifiable areal unit problem discussed in more detail in Chapter 3.1.3. To test the robustness of results, similar analyses were carried out using different units of geographical aggregation to ensure signs of coefficients are of similar direction. The choice of units was in most cases driven by using the smallest units possible where data were available. In the first empirical Chapter 4, the choice of units was Registration Districts instead of the smaller Registration Sub-Districts because information on Religion only exists on that level. In addition, when using aggregated data, it is always possible to encounter ecological fallacy problems. Hence, I cannot draw conclusions on individual level behaviour.

This problem links to a common limitation in social science and demographic research: the lack of data. In some cases, such as for the mid-20th century, published geographical data of interest is not available at all and were hence left out of the analysis. In other cases, preferred indicators are not available either at the spatial aggregation of choice or time of interest. In the case of Germany in Chapter 6, data on religion e.g., is only available for the 2011 census and prior only for 1987 and had to be excluded from the analysis.

Another issue is that in most cases, administrative boundary changes do not allow to relate data over time. Areal weighted interpolation was applied to allow to compare previously incomparable data sources with different sets of administrative boundaries over time. But using any kind of interpolation or kriging techniques introduces other forms of unknown errors.

The thesis tried to use different techniques to explore spatial diffusion mechanisms, such as through calculating change in the Total Marital Fertility Rate over time or spatial lag models as in Chapter 4. However, to gain a deeper understanding of the role of space for long-run demographic processes and possible mechanisms of spatial diffusion, the application of a real panel framework including corresponding modelling techniques need to be considered over a cross-sectional perspective (Vitali, Aassve and Lappegård, 2015; Vitali and Billari, 2017). Again, the lack of data is a limitation. All observations about diffusion mechanisms here are since of a more speculative nature. Additionally, I am aware that behaviour does not solely spread geographically but that there might be other channels of diffusion, e.g. broadband internet as has been shown for Germany by Billari et al (2019). Since diffusion mechanisms are of interest here, individual level data containing information on networks would be preferable. The lack of network data is, however, a major problem in most settings and only a limited number of studies was able to carry out enquiries using individual level data to explore the diffusion of demographic behaviour (Balbo and Barban, 2014).

To conclude, also the spatial modelling techniques have some limitations. Multicollinearity does not only impact regular model fitting but might also influence spatial patterns that appear for geographically weighted regression (GWR) results (Wheeler and Tiefelsdorf, 2005). Both GWR and GW correlation results are in addition dependent on the spatial kernel and bandwidth (Farber and Páez, 2007)as demonstrated in both Appendices B.4 and C.13 to C.15. The models also do not allow to take values of neighbouring countries into account.

7.4 Future Research

Future research will have to study diffusion mechanisms and spatial continuity in more detail. Other case studies in different contexts using similar research design but also considering these phenomena from different angles will enhance our knowledge in historical and recent studies of families and ultimately allow to make inference on future families and how these are embedded in social, economic but especially cultural context. To explore cultural components of demographic behaviour and diffusion mechanisms it will be critical in spatial demography to conceptually develop indicators that allow to compare attitudes and norms in a comparable way across space.

Research in the future will also need to link the recent developments in Europe to voting to more populist parties to population (processes). First attempts have already been published for Germany investigating gender differences in voting in Germany (Hudde, 2023). Again, especially changes from far left-wing voting to far right-wing voting highlights the importance to further investigate how voting for certain parties can mean different things in different regions. In general, the meaning of cultural indicators and how these intersect with other variables across space and time will be of interest in the near future. Thereby, I want to point out the need to also employ an intersectional view (McCall, 2005; Green, Evans and Subramanian, 2017) in spatial analysis.

Although the thesis is interested in identifying the existence of diffusion mechanisms, it is not possible to go beyond answering this question and define ways of diffusion. Besides the diffusion of norms in proximity, other ways of disseminating of new attitudes might be through migration other means of communication channels (Klüsener, Dribe and Scalone, 2019). As in the case of Germany, norms might not only diffuse through space but additionally through migration: There was a lot of migration, especially in the 1990s from East to West. Migration was relatively selective with younger more educated cohorts as well as more women being more prone to leave the East (Heiland, 2004). However, women who migrated from East tended to adopt to West-German women (Vatterrott, 2011). Boelmann et al. (2020) however possibly find evidence for diffusion mechanism of childbearing and the subsequent return to work of mothers. The uptake of employment after giving birth is earlier among East German women than West German women. However, in areas of cross-border local labour markets the close contact to East German female colleagues seems to accelerate the uptake of work after having a child for West German women. These districts analysed by Boelmann et al. also depict a faster increase in NMR as depicted in Figure 6.4.

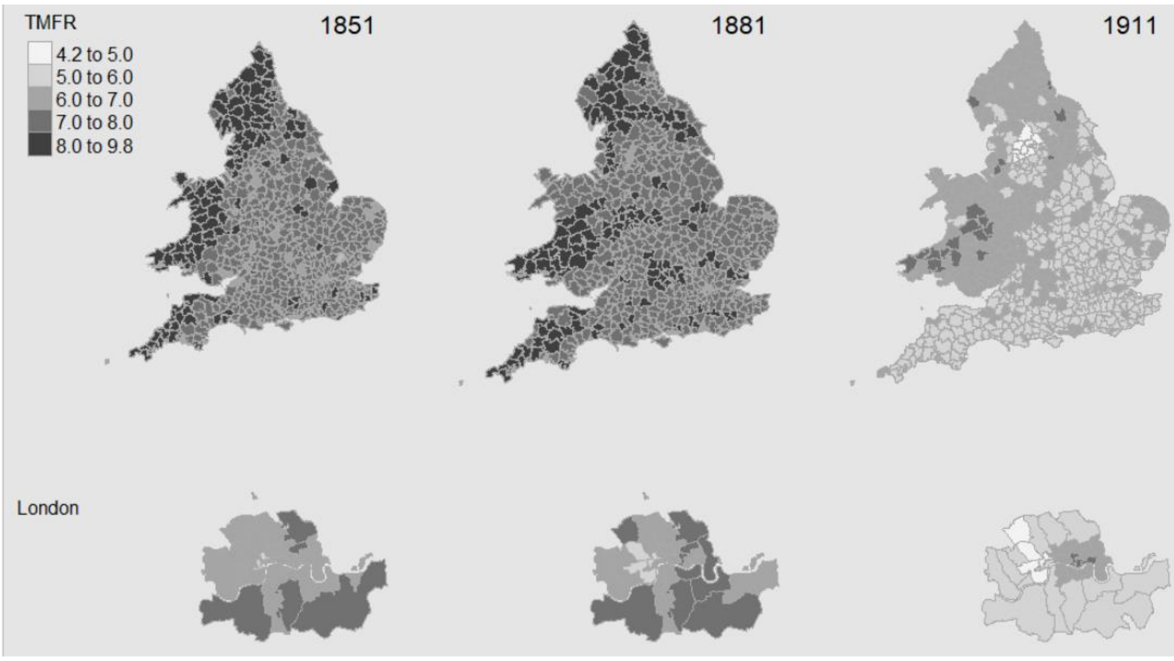
New forms of data and data sources – both individual and spatial - will facilitate new enquiries into (spatial) diffusion mechanisms. This assumption is likely for both recent data (Yildiz *et al.*, 2017; Alburez-Gutierrez *et al.*, 2019; Kashyap, 2021; Alexander, Polimis and Zagheni, 2022) but also historical data, e.g. through genealogy platforms (Blanc and Wacziarg, 2020). Also, more historical data sources such as historical but more recent census data from 1921 will become available for research purposes soon. All census data remains under custody of the Office for National Statistics (ONS) for 100 years. Other geographical data sources, which have only been published in paper format throughout the 20th century may become available through digitalisation initiatives. Also advances in (spatial) modelling techniques and further computing power will allow to make more profound enquiries into the area of diffusion mechanisms.

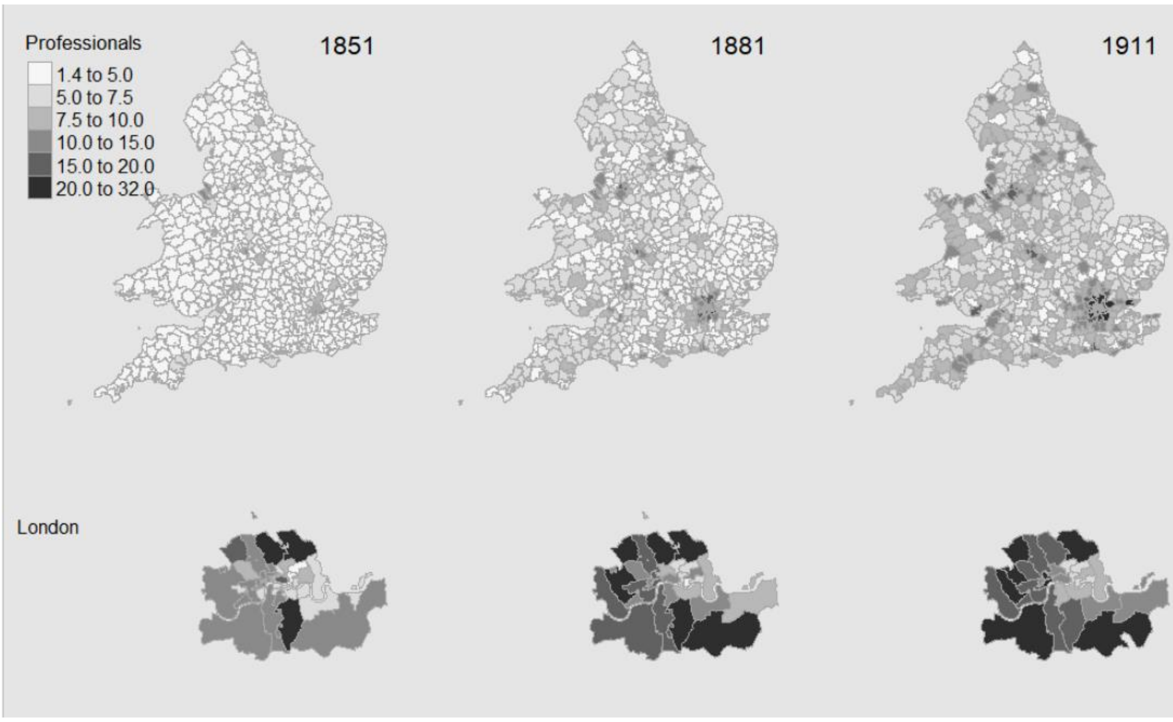
7.5 Concluding Remarks

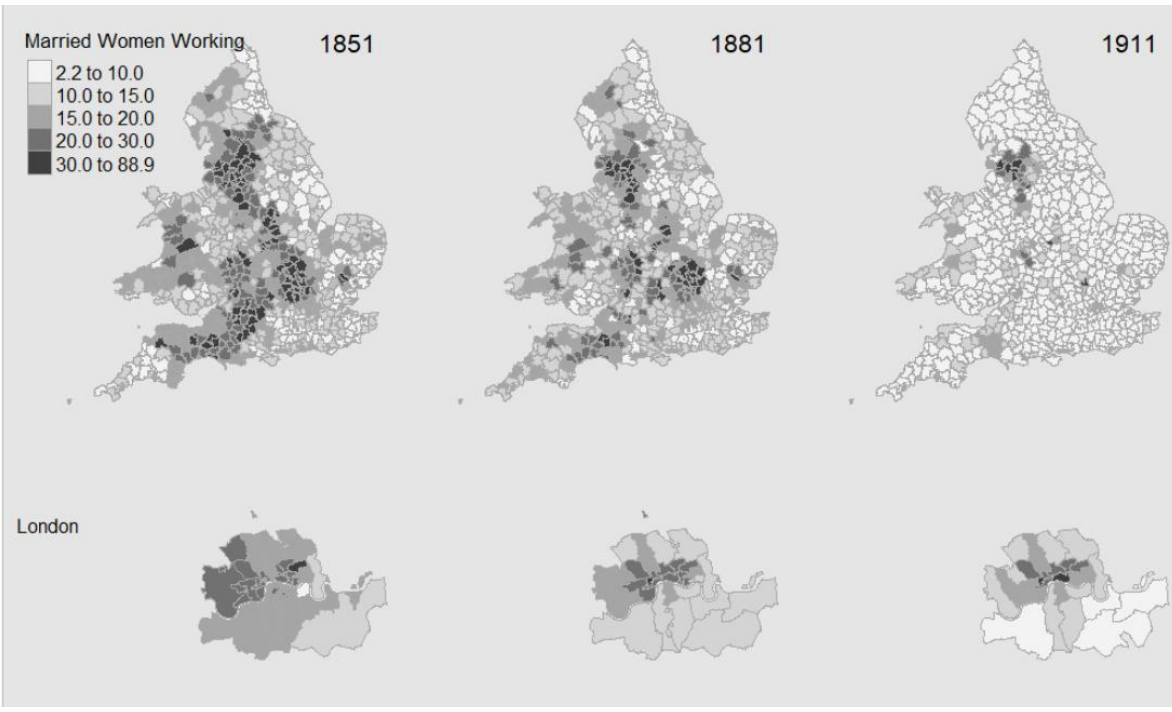
This thesis aimed to explore the role of space conceptually and empirically in relation to demographic behaviour such as fertility and non-marital childbearing. To accomplish this aim, I studied long-term spatial continuities in demographic behaviour and the role of spatial diffusion mechanisms in the context of England and Wales as well as Germany. This research revealed that even after controlling for explanatory factors, demographic behaviour in one area is associated with demographic behaviour in neighbouring areas. In addition, the analysis revealed that associations with explanatory factors might differ across space and change over time.

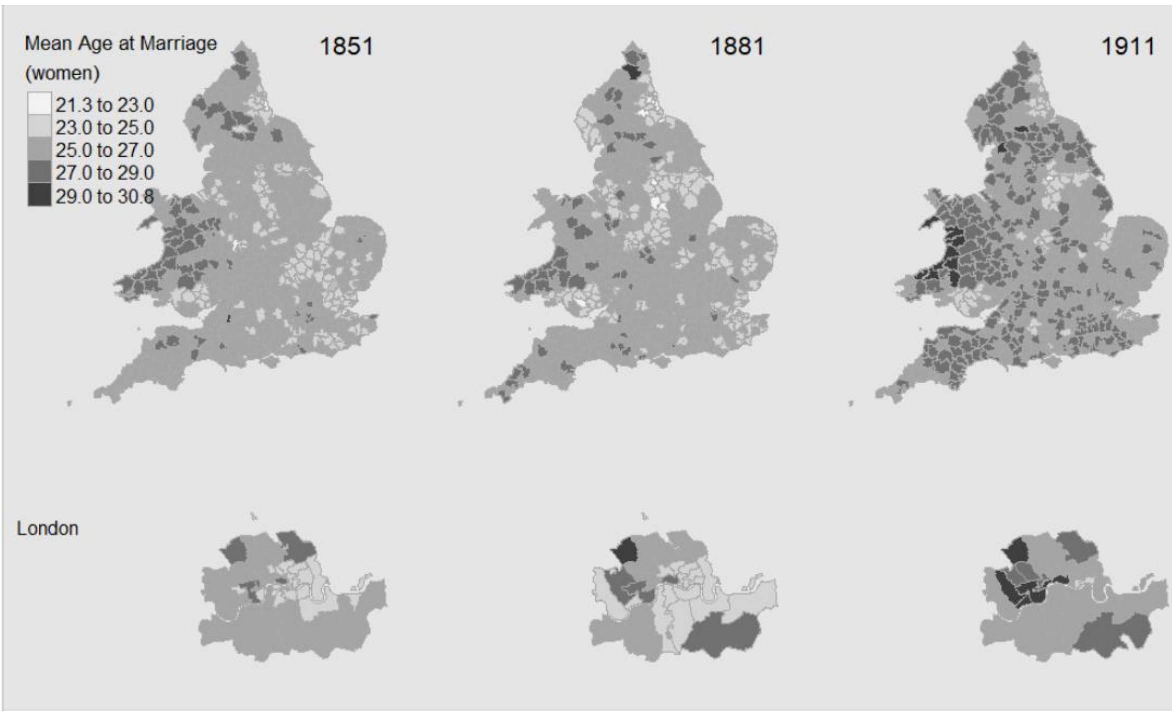
Appendix A The Role of Religion and Forerunners during the Fertility Transition in England and Wales, 1851-1911

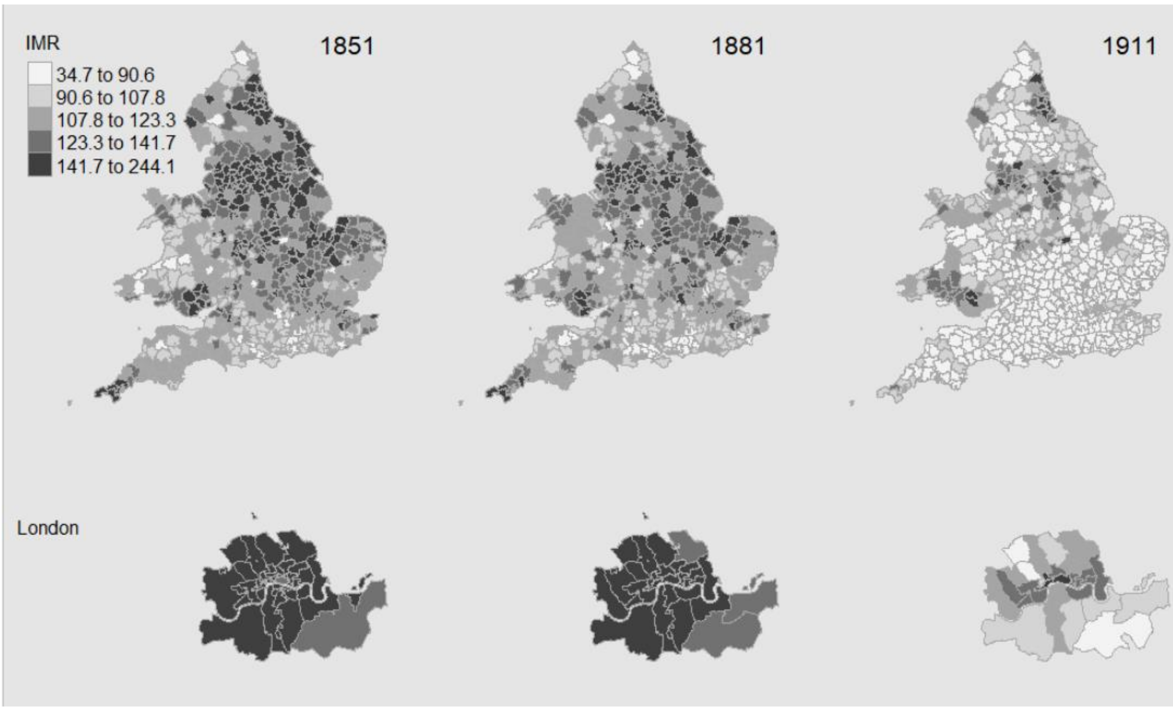
A.1 Figure: Descriptive Maps of Variables (Registration Districts)




Professionals
1.4 to 5.0
5.0 to 7.5
7.5 to 10.0
10.0 to 15.0
15.0 to 20.0
20.0 to 32.0
1851
1881
1911
London

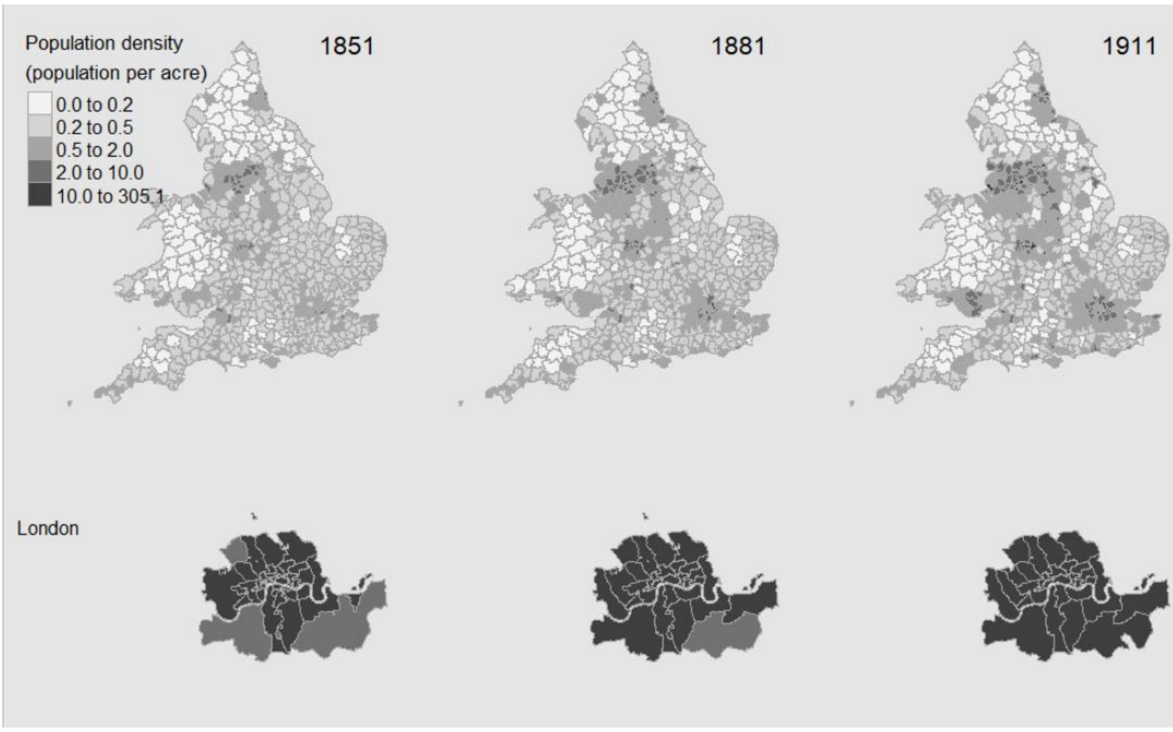

Married Women Working
2.2 to 10.0
10.0 to 15.0
15.0 to 20.0
20.0 to 30.0
30.0 to 88.9
1851
1881
1911
London


Mean Age at Marriage (women)
21.3 to 23.0
23.0 to 25.0
25.0 to 27.0
27.0 to 29.0
29.0 to 30.8
1851
1881
1911
London

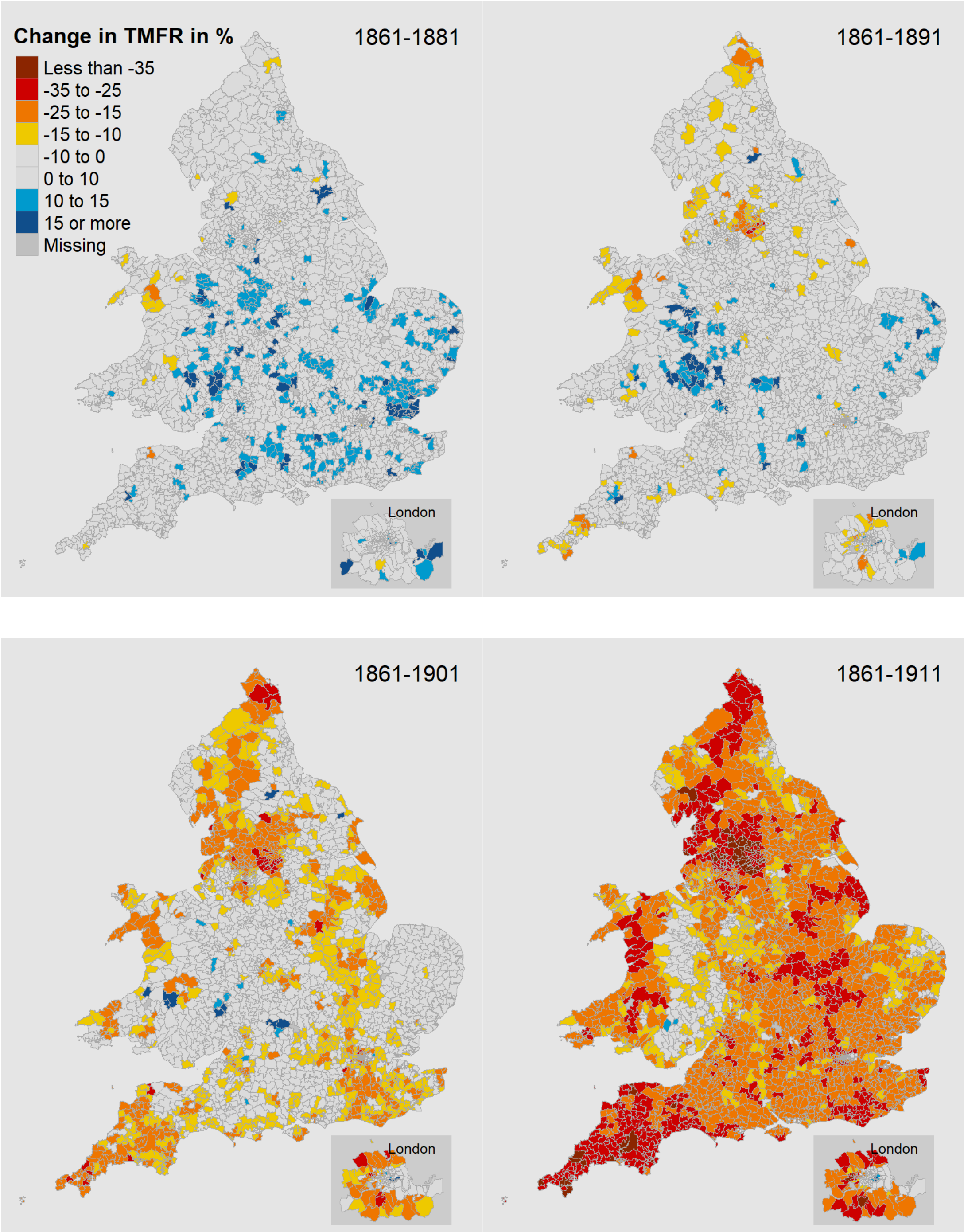

IMR
34.7 to 90.6
90.6 to 107.8
107.8 to 123.3
123.3 to 141.7
141.7 to 244.1
1851
1881
1911
London


ECMR
14.1 to 40.0
40.0 to 70.0
70.0 to 100.0
100.0 to 150.0
150.0 to 289.4
1851
1881
1911
London


Miners and Agricultural Workers
0.0 to 10.0
10.0 to 25.0
25.0 to 35.0
35.0 to 45.0
45.0 to 71.2
1851
1881
1911
London


Population density
(population per acre)
0.0 to 0.2
0.2 to 0.5
0.5 to 2.0
2.0 to 10.0
10.0 to 305.1
1851
1881
1911
London

A.2 Figure: Change in TMFR Using 1861 as Baseline Year



A.3 Table: Descriptive Statistics of Variables in Regression Analysis (Precondition)

Variable (Precondition)	Time	Min	Median	Max	Mean	Standard Deviation
Total Marital Fertility Rate (Change)	1851 - 1881	-14.87	1.94	17.53	1.62	5.60
	1881 - 1911	-37.92	-23.41	16.40	-22.38	6.71
Professional and Managerial Occupations	1851	2.23	5.23	29.67	6.26	3.36
	1881	3.21	7.07	32.70	8.18	4.06
Married Women Working	1851	3.92	13.98	59.56	16.29	8.46
	1881	2.21	7.54	46.82	9.42	5.65
Mining and Agricultural Occupations	1851	0.08	22.77	63.94	22.92	14.15
	1881	0.11	17.75	69.20	19.12	13.80
Sex Ratio	1851	53.51	97.13	156.70	97.06	11.43
	1881	56.59	96.17	196.98	96.68	13.46
Mean Age at Marriage (Women)	1851	22.38	25.71	29.38	25.63	1.17
	1881	23.18	26.77	30.74	26.67	1.16
Teacher per 100 Children	1851	0.54	2.20	6.34	2.23	0.57
	1881	0.22	3.52	8.13	3.47	0.94
Population Density	1851	6.12	92.21	53550.69	2154.07	7520.64
	1881	5.76	107.97	48410.41	2022.61	6504.66
Infant Mortality Rate	1851	70.18	121.97	209.02	124.87	23.26
	1881	34.79	90.56	244.01	95.88	25.21
Early Childhood Mortality Rate	1851	39.05	77.00	193.20	86.17	27.95
	1881	14.19	38.32	182.01	44.95	22.15
New Dissent Index of Sitting	1851	0.01	18.46	78.30	21.41	13.70

N = 623 (1851); 622 (1881)

A.4 Table: Descriptive Statistics of Variables in Regression Analysis (Change)

Variable (Percentage Change)	Time	Min	Median	Max	Mean	Standard Deviation
Total Marital Fertility Rate	1851 - 1881	-14.87	1.94	17.53	1.62	5.60
	1881 - 1911	-37.92	-23.41	16.40	-22.38	6.71
Professional and Managerial Occupations	1851 - 1881	-32.81	55.19	294.55	60.86	40.68
	1881 - 1911	-25.90	30.80	342.41	34.53	30.84
Married Women Working	1851 - 1881	-91.82	-9.82	448.50	-3.71	37.05
	1881 - 1911	-85.65	-40.79	23.17	-39.73	19.25
Mining and Agricultural Occupations	1851 - 1881	-89.62	-30.18	590.38	-26.97	39.72
	1881 - 1911	-83.72	-21.94	546.68	-13.22	51.80
Sex Ratio	1851 - 1881	-25.56	-1.44	92.96	0.17	10.20
	1881 - 1911	-30.70	-0.99	88.82	-0.22	9.31
Mean Age at Marriage (Women)	1851 - 1881	-12.09	-0.36	14.42	-0.38	3.71
	1881 - 1911	-11.91	4.24	18.38	4.16	3.49
Teacher per 100 Children	1851 - 1881	-60.92	45.54	373.91	54.91	53.65
	1881 - 1911	-73.74	55.87	226.39	57.62	38.89
Population Density	1851 - 1881	-99.15	8.81	482.62	31.96	63.85
	1881 - 1911	-93.39	9.10	349.85	25.60	53.73
Infant Mortality Rate	1851 - 1881	-40.01	-5.32	48.71	-4.37	10.14
	1881 - 1911	-67.53	-24.09	44.99	-23.21	13.07
Early Childhood Mortality Rate	1851 - 1881	-52.24	-12.15	57.76	-10.83	15.82
	1881 - 1911	-79.11	-49.32	25.06	-48.62	12.93
New Dissent Index of Sitting (Condition)	1851	0.01	18.46	78.30	21.41	13.70

N = 622

A.5 Table: Correlation Matrix for All Variables

Table A.5.1. Correlation of Variables in Precondition Model for Forerunner Year (1851-1881).

	TMFR Change	Teacher per 100 Children	Professionals	Married Women Working	Mean Age at Marriage	Sex Ratio	Miners & Agricultural Labourers	Infant Mortality	Early Childhood Mortality	Population Density
TMFR Change		0.12	0.01	0.18	-0.27	0.09	0.04	0.03	0.01	0.00
Teacher per 100 Children	0.12		0.50	-0.05	0.19	-0.35	-0.20	-0.05	-0.03	-0.02
Professionals	0.01	0.50		-0.01	0.14	-0.59	-0.64	0.32	0.53	0.44
Married Women Working	0.18	-0.05	-0.01		0.11	-0.25	-0.20	0.18	0.17	0.07
Mean Age at Marriage	-0.27	0.19	0.14	0.11		-0.37	-0.06	-0.34	-0.29	-0.11
Sex Ratio	0.09	-0.35	-0.59	-0.25	-0.37		0.54	-0.23	-0.33	-0.18
Miners & Agricultural Labourers	0.04	-0.20	-0.64	-0.20	-0.06	0.54		-0.59	-0.76	-0.45
Infant Mortality	0.03	-0.05	0.32	0.18	-0.34	-0.23	-0.59		0.83	0.39
Early Childhood Mortality	0.01	-0.03	0.53	0.17	-0.29	-0.33	-0.76	0.83		0.67
Population Density	0.00	-0.02	0.44	0.07	-0.11	-0.18	-0.45	0.39	0.67	

Table A.5.2. Correlation of Variables in Change-Model for Forerunner Year (1851-1881).

	TMFR Change	Teacher per 100 Children Change	Professionals Change	Married Women Working Change	Mean Age at Marriage Change	Sex Ratio Change	Miners & Agricultural Labourers Change	Infant Mortality Change	Early Childhood Mortality Change	Population Density Change
TMFR Change		-0.20	-0.09	-0.22	0.14	-0.02	0.12	-0.06	-0.01	-0.09
Teacher per 100 Children Change	-0.20		0.33	0.06	0.12	-0.17	0.00	0.20	0.14	-0.11
Professionals Change	-0.09	0.33		-0.04	0.11	-0.42	-0.15	0.13	0.14	0.21
Married Women Working Change	-0.22	0.06	-0.04		0.23	0.02	-0.05	-0.02	-0.04	-0.08
Mean Age at Marriage Change	0.14	0.12	0.11	0.23		-0.33	-0.03	0.06	-0.06	-0.29
Sex Ratio Change	-0.02	-0.17	-0.42	0.02	-0.33		0.08	-0.08	-0.15	0.12
Miners & Agricultural Labourers Change	0.12	0.00	-0.15	-0.05	-0.03	0.08		-0.14	-0.01	-0.18
Infant Mortality Change	-0.06	0.20	0.13	-0.02	0.06	-0.08	-0.14		0.50	-0.07
Early Childhood Mortality Change	-0.01	0.14	0.14	-0.04	-0.06	-0.15	-0.01	0.50		0.01
Population Density Change	-0.09	-0.11	0.21	-0.08	-0.29	0.12	-0.18	-0.07	0.01	

Table A.5.3. Correlation of Variables in Precondition Model for Main Decline Year (1881-1911).

	TMFR Change	Teacher per 100 Children	Professionals	Married Women Working	Mean Age at Marriage	Sex Ratio	Miners & Agricultural Labourers	Infant Mortality	Early Childhood Mortality	Population Density
TMFR Change		-0.40	0.11	-0.13	-0.33	0.21	-0.13	0.31	0.35	0.50
Teacher per 100 Children	-0.40		0.29	-0.04	0.36	-0.30	-0.06	-0.29	-0.29	-0.33
Professionals	0.11	0.29		0.06	0.12	-0.42	-0.65	0.30	0.40	0.37
Married Women Working	-0.13	-0.04	0.06		0.18	-0.38	-0.30	0.34	0.33	0.16
Mean Age at Marriage	-0.33	0.36	0.12	0.18		-0.50	-0.03	-0.40	-0.41	-0.19
Sex Ratio	0.21	-0.30	-0.42	-0.38	-0.50		0.32	-0.07	-0.09	-0.02
Miners & Agricultural Labourers	-0.13	-0.06	-0.65	-0.30	-0.03	0.32		-0.41	-0.51	-0.43
Infant Mortality	0.31	-0.29	0.30	0.34	-0.40	-0.07	-0.41		0.96	0.43
Early Childhood Mortality	0.35	-0.29	0.40	0.33	-0.41	-0.09	-0.51	0.96		0.50
Population Density	0.50	-0.33	0.37	0.16	-0.19	-0.02	-0.43	0.43	0.50	

Table A.5.4. Correlation of Variables in Change-Model for Main Decline Years (1881-1911).

	TMFR Change	Teacher per 100 Children Change	Professionals Change	Married Women Working Change	Mean Age at Marriage Change	Sex Ratio Change	Miners & Agricultural Labourers Change	Infant Mortality Change	Early Childhood Mortality Change	Population Density Change
TMFR Change		-0.20	-0.28	0.23	0.26	-0.05	0.30	0.35	0.38	-0.11
Teacher per 100 Children Change	-0.20		0.29	-0.09	0.06	-0.11	-0.06	0.06	-0.13	-0.22
Professionals Change	-0.28	0.29		-0.03	0.11	-0.32	-0.24	-0.13	-0.16	0.26
Married Women Working Change	0.23	-0.09	-0.03		0.32	-0.17	-0.03	0.25	0.32	-0.03
Mean Age at Marriage Change	0.26	0.06	0.11	0.32		-0.46	0.04	0.07	0.08	-0.06
Sex Ratio Change	-0.05	-0.11	-0.32	-0.17	-0.46		0.13	0.00	0.00	-0.07
Miners & Agricultural Labourers Change	0.30	-0.06	-0.24	-0.03	0.04	0.13		0.11	0.08	-0.15
Infant Mortality Change	0.35	0.06	-0.13	0.25	0.07	0.00	0.11		0.82	0.06
Early Childhood Mortality Change	0.38	-0.13	-0.16	0.32	0.08	0.00	0.08	0.82		0.08
Population Density Change	-0.11	-0.22	0.26	-0.03	-0.06	-0.07	-0.15	0.06	0.08	

A.6 Table: Variance Inflation for all Explanatory (Linear Regression)

Variable	Precondition Model 1851	Change Model 1851-1881	Precondition Model 1881	Change Model 1881-1911
Professional and Managerial Occupations	3.25	1.52	2.80	1.44
Married Women Working	1.23	1.09	1.66	1.27
Mining and Agricultural Occupations	3.83	1.09	2.40	1.11
Sex Ratio	2.17	1.43	1.92	1.42
Mean Age at Marriage (Women)	1.77	1.33	2.10	1.42
Infant Mortality Rate	4.24	1.43	17.38	3.55
Early Childhood Mortality Rate	10.75	1.45	21.21	3.63
Teacher per 100 Children	1.84	1.37	1.76	1.49
Population Density	2.32	1.31	1.79	1.26
New Dissent Index of Sitting	1.38	1.28	1.41	1.19

A.7 Table: Linear Model for Registration Districts

	(1)	(2)	(3)	(4)
Dependent Variable	$\Delta TMFR1851-1881$		$\Delta TMFR1881-1911$	
Explanatory Variables	Precondition 1851	Change 1851–1881	Precondition 1881	Change 1881–1911
Intercept	1.62***	3.21***	−22.39***	−13.86***
	(0.20)	(0.47)	(0.21)	(1.14)
New Dissent 1851 (level)	−1.33***	−1.64***	0.59*	0.22
	(0.24)	(0.23)	(0.25)	(0.24)
Teacher per 100 children	0.49	−0.01*	−1.29***	−0.03***
	(0.27)	(0.00)	(0.28)	(0.01)
Professionals & managers	0.47	−0.00	0.45	−0.03***
	(0.36)	(0.01)	(0.35)	(0.01)
Married women working	1.37***	−0.04***	−1.29***	0.02
	(0.22)	(0.01)	(0.27)	(0.01)
Mean age at marriage	−1.81***	0.29***	−0.53	0.40***
	(0.27)	(0.06)	(0.31)	(0.08)
Miners & agricultural labourers	−0.24	0.01**	0.44	0.03***
	(0.39)	(0.01)	(0.33)	(0.00)
Sex ratio	0.39	0.01	0.45	−0.03
	(0.30)	(0.02)	(0.29)	(0.03)
Infant Mortality Rate	0.32	−0.04	−0.68	0.08*
	(0.41)	(0.02)	(0.88)	(0.03)
Early Childhood Mortality Rate	−1.61*	0.04**	1.61	0.09**
	(0.66)	(0.02)	(0.98)	(0.03)
Population density	0.14	−0.01*	2.68***	−0.01*
	(0.30)	(0.00)	(0.28)	(0.00)
R^2	0.22	0.21	0.39	0.33
Adj. R^2	0.21	0.20	0.38	0.32
Num. obs.	621	622	622	622

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Notes: Results of Spatial Lag Model Estimating Percentage Change in Total Marital Fertility Rates for Forerunner Years (1851-1881) and Main Decline Years (1881-1911). Registration Sub-Districts.

A.8 Table: Spatial Error Model for Registration Districts

Dependent Variable	(1)	(2)	(3)	(4)
	$\Delta TMFR1851-1881$		$\Delta TMFR1881-1911$	
Explanatory Variables	Precondition 1851	Change 1851–1881	Precondition 1881	Change 1881–1911
Intercept	27.64***	2.86***	−13.88*	−18.57***
	(7.38)	(0.63)	(7.07)	(1.22)
New Dissent 1851 (level)	−1.05***	−1.07***	−0.58*	−0.66*
	(0.29)	(0.28)	(0.28)	(0.30)
Teacher per 100 children	0.03	−0.01	−0.61	−0.01*
	(0.47)	(0.00)	(0.38)	(0.01)
Professionals & managers	0.14	−0.01*	−0.20*	−0.01*
	(0.12)	(0.00)	(0.09)	(0.01)
Married women working	0.09***	−0.02***	−0.09**	0.00
	(0.02)	(0.00)	(0.03)	(0.01)
Mean age at marriage	−1.10***	0.24***	−0.25	0.13*
	(0.22)	(0.05)	(0.22)	(0.05)
Miners & agricultural labourers	−0.04	0.01*	−0.01	0.01**
	(0.02)	(0.00)	(0.02)	(0.00)
Sex ratio	0.03	0.01	−0.01	−0.04
	(0.03)	(0.02)	(0.02)	(0.02)
Infant Mortality Rate	−0.00	−0.00	−0.01	0.04
	(0.01)	(0.02)	(0.03)	(0.02)
Early Childhood Mortality Rate	−0.01	0.01	0.04	0.03
	(0.01)	(0.01)	(0.02)	(0.02)
Population density	−0.00	−0.00	0.00***	−0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
Num. obs.	621	621	622	622
Parameters	13	13	13	13
Log Likelihood	−1744.00	−1742.60	−1714.89	−1745.93
AIC (Linear model)	3769.81	3775.95	3849.75	3904.06
AIC (Spatial model)	3514.00	3511.19	3455.79	3517.86
LR test: statistic	257.81	266.75	395.96	388.20
LR test: p-value	0.00	0.00	0.00	0.00

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Model Robustness Check: SDM RD incl. New Dissent (Appendix)

A.9 Table: Lagrange Multiplier Test for Comparing Spatial Lag and Spatial Error Model

Model	Time	Test	Statistic	p-value
Precondition	1851	Linear - Spatial Error	285.50	2.00E-16
		Linear - Spatial Lag	299.29	2.00E-16
		Robust: Linear - Spatial Error	4.04	0.04
		Robust: Linear - Spatial Lag	17.83	2.24E-05
Change	1851-1881	Linear - Spatial Error	306.23	2.00E-16
		Linear - Spatial Lag	330.61	2.00E-16
		Robust: Linear - Spatial Error	1.80	0.18
		Robust: Linear - Spatial Lag	26.19	3.09E-07
Precondition	1881	Linear - Spatial Error	415.43	2.00E-16
		Linear - Spatial Lag	426.87	2.00E-16
		Robust: Linear - Spatial Error	16.73	4.31E-05
		Robust: Linear - Spatial Lag	28.17	1.11E-07
Change	1881-1911	Linear - Spatial Error	333.25	2.00E-16
		Linear - Spatial Lag	438.64	2.00E-16
		Robust: Linear - Spatial Error	0.11	0.74
		Robust: Linear - Spatial Lag	105.51	2.00E-16

A.10 Table: Spatial Durbin Model for Registration Districts

	(1)	(2)	(3)	(4)
Dependent Variable	$\Delta TMFR1851-1881$		$\Delta TMFR1881-1911$	
Explanatory Variables	Precondition	Change	Precondition	Change
	1851	1851–1881	1881	1881–1911
Intercept	11.44	0.70	13.98	−3.46**
	(11.88)	(0.60)	(9.49)	(1.32)
New Dissent 1851 (level)	−0.83**	−0.80*	−0.69*	−0.57
	(0.32)	(0.32)	(0.29)	(0.30)
Lag - New Dissent 1851 (level)	0.59	0.34	1.13**	0.63
	(0.40)	(0.40)	(0.37)	(0.37)
Teacher per 100 children	−0.25	−0.01*	−0.47	−0.01*
	(0.50)	(0.00)	(0.39)	(0.01)
Lag - Teacher per 100 children	1.41	−0.00	−0.49	−0.02*
	(0.78)	(0.01)	(0.60)	(0.01)
Professionals & managers	0.09	−0.01	−0.27**	−0.01*
	(0.13)	(0.00)	(0.10)	(0.01)
Lag - Professionals & managers	−0.18	0.02**	0.43**	−0.00
	(0.22)	(0.01)	(0.14)	(0.01)
Married women working	0.08***	−0.02***	−0.06*	−0.00
	(0.02)	(0.00)	(0.03)	(0.01)
Lag - Married women working	−0.04	0.00	0.03	−0.01
	(0.03)	(0.01)	(0.05)	(0.02)
Mean age at marriage	−1.03***	0.25***	−0.23	0.14**
	(0.22)	(0.05)	(0.22)	(0.05)
Lag - Mean age at marriage	0.45	−0.02	−0.48	0.20*
	(0.36)	(0.09)	(0.33)	(0.09)
Miners & agricultural labourers	−0.05*	0.01	−0.01	0.01**
	(0.02)	(0.00)	(0.02)	(0.00)
Lag - Miners & agricultural labourers	0.07*	0.00	0.04	0.00
	(0.03)	(0.01)	(0.03)	(0.01)
Sex ratio	0.03	0.03	−0.01	−0.03
	(0.03)	(0.02)	(0.02)	(0.02)
Lag - Sex ratio	−0.01	0.02	0.03	0.04
	(0.04)	(0.04)	(0.03)	(0.04)
Infant Mortality Ratio	−0.01	0.00	−0.01	0.04*
	(0.01)	(0.02)	(0.03)	(0.02)
Lag - Infant Mortality Ratio	0.00	−0.03	−0.03	0.06
	(0.02)	(0.03)	(0.04)	(0.04)
Early Childhood Mortality Ratio	−0.01	0.01	0.04	0.01
	(0.01)	(0.01)	(0.02)	(0.02)
Lag - Early Childhood Mortality Ratio	0.00	0.01	−0.01	−0.03
	(0.02)	(0.02)	(0.04)	(0.04)
Population density	−0.00	−0.00	0.00***	−0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
Lag - Population density	0.00*	−0.01	−0.00*	0.01
	(0.00)	(0.01)	(0.00)	(0.00)
ρ	0.69***	0.68***	0.76***	0.74***
	(0.03)	(0.03)	(0.03)	(0.03)
Num. obs.	621	621	622	622
Parameters	23	23	23	23
Log Likelihood	−1736.09	−1733.47	−1696.98	−1714.56
AIC (Linear model)	3758.64	3757.28	3797.95	3795.93
AIC (Spatial model)	3518.17	3512.94	3439.95	3475.12
LR test: statistic	242.47	246.34	360.00	322.81
31 LR test: p-value	0.00	0.00	0.00	0.00

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

A.11 Table: Spatial Lag Model for Registration Sub-Districts

	(1)	(2)	(3)	(4)
Dependent Variable	$\Delta TMFR1851-1881$		$\Delta TMFR1881-1911$	
Explanatory Variables	Precondition 1851	Change 1851–1881	Precondition 1881	Change 1881–1911
Intercept	0.42***	0.87***	−4.12***	−1.37***
	(0.10)	(0.16)	(0.30)	(0.37)
Teacher per 100 children	0.19	0.00	−0.15	−0.01***
	(0.13)	(0.00)	(0.11)	(0.00)
Professionals & managers	−0.07	−0.00*	−0.43***	−0.00
	(0.16)	(0.00)	(0.13)	(0.00)
Married women working	0.37***	−0.00**	−0.28**	0.00
	(0.11)	(0.00)	(0.10)	(0.00)
Mean age at marriage	−0.81***	0.09***	−0.41***	0.09***
	(0.11)	(0.02)	(0.11)	(0.02)
Miners & agricultural labourers	−0.65***	0.00	−0.11	0.00***
	(0.17)	(0.00)	(0.12)	(0.00)
Sex ratio	0.14	0.01	0.12	0.01
	(0.13)	(0.01)	(0.11)	(0.01)
Infant Mortality Rate	−0.21	0.02**	−0.53	0.02
	(0.17)	(0.01)	(0.29)	(0.01)
Early Childhood Mortality Rate	−0.80**	0.01*	0.60	0.03***
	(0.25)	(0.00)	(0.32)	(0.01)
Population density	0.27*	−0.00	1.01***	−0.00***
	(0.14)	(0.00)	(0.11)	(0.00)
ρ	0.74***	0.75***	0.82***	0.84***
	(0.02)	(0.02)	(0.01)	(0.01)
Num. obs.	2173	2173	2190	2190
Parameters	12	12	12	12
Log Likelihood	−6519.72	−6526.90	−6310.54	−6305.47
AIC (Linear model)	14251.05	14363.36	14551.91	14843.20
AIC (Spatial model)	13063.43	13077.80	12645.07	12634.93
LR test: statistic	1189.62	1287.56	1908.84	2210.27
LR test: p-value	0.00	0.00	0.00	0.00

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Notes: Results of spatial lag model estimating percentage change in Total Marital Fertility Rates for forerunner years (1851-1881) and main decline years (1881-1911). Registration Sub-Districts.

A.12 Table: Spatial Lag Model for TFR instead of TMFR

	(1)	(2)	(3)	(4)
Depedent Variable	*TFR 1851 – 1881*		*TFR 1881 – 1911*	
Explanatory Variable	Precondition	Change	Precondition	Change
	1851	1851–1881	1881	1881–1911
Intercept	1.20**	4.85***	−17.60***	−11.32***
	(0.37)	(0.84)	(1.55)	(1.97)
New Dissent 1851 (level)	−0.28	−0.04	0.47	0.04
	(0.41)	(0.02)	(0.36)	(0.02)
Teacher per 100 children	−0.13	−0.01*	−1.19**	−0.06***
	(0.48)	(0.01)	(0.40)	(0.01)
Professionals & managers	1.64**	−0.02	0.50	−0.03**
	(0.63)	(0.01)	(0.51)	(0.01)
Married women working	1.02**	−0.04***	0.15	−0.02
	(0.39)	(0.01)	(0.39)	(0.02)
Mean age at marriage	−0.67	−0.81***	−1.81***	−0.31**
	(0.47)	(0.09)	(0.45)	(0.10)
Sex ratio	0.70	0.23***	0.81	0.05
	(0.52)	(0.04)	(0.42)	(0.04)
Infant Mortality Ratio	1.39	−0.02	−0.35	0.07
	(0.72)	(0.03)	(1.27)	(0.04)
Early Childhood Mortality Ratio	−1.28	0.05*	0.50	0.04
	(1.15)	(0.02)	(1.40)	(0.04)
Population density	−0.89	0.00	1.21**	0.00
	(0.53)	(0.01)	(0.41)	(0.01)
ρ	0.58***	0.47***	0.53***	0.48***
	(0.04)	(0.04)	(0.04)	(0.04)
Num. obs.	621	621	622	622
Parameters	13	13	13	13
Log Likelihood	−2251.97	−2136.69	−2163.39	−2137.14
AIC (Linear model)	4692.10	4424.84	4484.12	4416.41
AIC (Spatial model)	4529.95	4299.38	4352.79	4300.28
LR test: statistic	164.15	127.47	133.33	118.13
LR test: p-value	0.00	0.00	0.00	0.00

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Notes: Results of spatial lag model estimating percentage change in Total Fertility Rates for forerunner years (1851-1881) and main decline years (1881-1911). Registration Districts.

A.13 Table: Alternative Spatial Lag Model 1: Including Index of Sittings for Roman Catholics in addition to *New Dissent*

Dependent Variable / *Explanatory Variables*	(1) $\Delta TMFR1851-1881$ Precondition 1851	(2) $\Delta TMFR1851-1881$ Change 1851–1881	(3) $\Delta TMFR1881-1911$ Precondition 1881	(4) $\Delta TMFR1881-1911$ Change 1881–1911
Intercept	0.54***	2.49***	−5.23***	−1.44
	(0.16)	(0.46)	(0.60)	(0.85)
New Dissent 1851 (level)	−0.45*	−0.04**	−0.06	−0.01
	(0.19)	(0.01)	(0.17)	(0.01)
Roman Catholics 1851 (level)	0.10	0.05	0.07	−0.12
	(0.16)	(0.12)	(0.15)	(0.11)
Teacher per 100 children	0.17	−0.01*	−0.30	−0.02***
	(0.21)	(0.00)	(0.19)	(0.00)
Professionals & managers	0.30	−0.01	−0.70**	−0.01*
3	(0.28)	(0.00)	(0.24)	(0.01)
Married women working	0.76***	−0.02***	−0.67***	−0.00
	(0.17)	(0.00)	(0.18)	(0.01)
Mean age at marriage	−1.11***	0.24***	−0.49*	0.16***
	(0.21)	(0.05)	(0.21)	(0.05)
Miners & agricultural labourers	−0.37	0.01**	−0.10	0.01***
	(0.30)	(0.00)	(0.22)	(0.00)
Sex ratio	0.13	0.02	−0.14	−0.03
	(0.23)	(0.02)	(0.20)	(0.02)
Infant Mortality Rate	−0.11	−0.01	−0.52	0.05*
	(0.32)	(0.02)	(0.59)	(0.02)
Early Childhood Mortality Rate	−0.67	0.01	1.06	0.02
	(0.50)	(0.01)	(0.65)	(0.02)
Population density	−0.09	−0.00	1.22***	−0.01**
	(0.23)	(0.00)	(0.20)	(0.00)
ρ	0.67***	0.68***	0.76***	0.77***
	(0.03)	(0.03)	(0.03)	(0.03)
Num. obs.	622	622	623	623
Parameters	14	14	14	14
Log Likelihood	−1749.60	−1741.70	−1715.14	−1726.64
AIC (Linear model)	3776.62	3781.37	3854.39	3911.74
AIC (Spatial model)	3527.20	3511.39	3458.28	3481.28
LR test: statistic	251.42	271.98	398.11	432.46
LR test: p-value	0.00	0.00	0.00	0.00

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

A.14 Table: Alternative Spatial Lag Model 2: Including Index of Sittings for Roman Catholics as Only Measure of Religion

	(1)	(2)	(3)	(4)
Dependent Variable	$\Delta TMFR1851-1881$		$\Delta TMFR1881-1911$	
Explanatory Variables	Precondition 1851	Change 1851–1881	Precondition 1881	Change 1881–1911
Intercept	0.51**	1.70***	−5.27***	−1.64
	(0.16)	(0.37)	(0.60)	(0.84)
Roman Catholics 1851 (level)	0.14	0.08	0.08	−0.11
	(0.16)	(0.12)	(0.15)	(0.11)
Teacher per 100 children	0.31	−0.01**	−0.29	−0.02***
	(0.20)	(0.00)	(0.18)	(0.00)
Professionals & managers	0.38	−0.01	−0.68**	−0.01*
	(0.27)	(0.00)	(0.23)	(0.01)
Married women working	0.81***	−0.02***	−0.66***	−0.00
	(0.17)	(0.00)	(0.18)	(0.01)
Mean age at marriage	−1.18***	0.25***	−0.51*	0.17***
	(0.21)	(0.05)	(0.20)	(0.05)
Miners & agricultural labourers	−0.30	0.01*	−0.09	0.01***
	(0.30)	(0.00)	(0.21)	(0.00)
Sex ratio	0.19	0.01	−0.13	−0.03
	(0.23)	(0.02)	(0.20)	(0.02)
Infant Mortality Rate	−0.27	−0.00	−0.58	0.05*
	(0.31)	(0.02)	(0.56)	(0.02)
Early Childhood Mortality Rate	−0.45	0.01	1.12	0.02
	(0.50)	(0.01)	(0.63)	(0.02)
Population density	−0.07	−0.00	1.24***	−0.01**
	(0.23)	(0.00)	(0.19)	(0.00)
ρ	0.68***	0.71***	0.76***	0.77***
	(0.03)	(0.03)	(0.03)	(0.03)
Num. obs.	622	622	623	623
Parameters	13	13	13	13
Log Likelihood	−1752.55	−1746.05	−1715.20	−1727.26
AIC (Linear model)	3807.28	3831.84	3859.13	3910.52
AIC (Spatial model)	3531.10	3518.09	3456.40	3480.52
LR test: statistic	278.18	315.75	404.73	432.00
LR test: p-value	0.00	0.00	0.00	0.00

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

A.15 Table: Alternative Spatial Lag Model 3. Index of Attendance

Dependent Variable / *Explanatory Variables*	(1) $\Delta TMFR 1851-1881$ Precondition 1851	(2) Change 1851–1881	(3) $\Delta TMFR 1881-1911$ Precondition 1881	(4) Change 1881–1911
Intercept	0.54***	2.38***	−5.18***	−1.71*
	(0.16)	(0.44)	(0.59)	(0.82)
New Dissent 1851 (level)	−0.48**	−0.03*	−0.20	−0.01
	(0.18)	(0.01)	(0.16)	(0.01)
Teacher per 100 children	0.14	−0.01*	−0.34	−0.02***
	(0.21)	(0.00)	(0.19)	(0.00)
Professionals & managers	0.29	−0.01	−0.75**	−0.01*
	(0.28)	(0.00)	(0.24)	(0.01)
Married women working	0.78***	−0.02***	−0.69***	−0.00
	(0.17)	(0.00)	(0.18)	(0.01)
Mean age at marriage	−1.14***	0.25***	−0.46*	0.17***
3	(0.20)	(0.05)	(0.20)	(0.05)
Miners & agricultural labourers	−0.33	0.01**	−0.15	0.01***
	(0.30)	(0.00)	(0.22)	(0.00)
Sex ratio	0.07	0.02	−0.17	−0.03
	(0.23)	(0.02)	(0.20)	(0.02)
Infant Mortality Rate	−0.16	−0.00	−0.38	0.05*
	(0.31)	(0.02)	(0.58)	(0.02)
Early Childhood Mortality Rate	−0.59	0.01	0.96	0.02
	(0.50)	(0.01)	(0.65)	(0.02)
Population density	−0.11	−0.00	1.17***	−0.01**
	(0.23)	(0.00)	(0.20)	(0.00)
ρ	0.67***	0.69***	0.76***	0.77***
	(0.03)	(0.03)	(0.03)	(0.03)
Num. obs.	621	621	622	622
Parameters	13	13	13	13
Log Likelihood	−1746.67	−1740.19	−1711.53	−1724.77
AIC (Linear model)	3776.30	3795.53	3854.86	3904.87
AIC (Spatial model)	3519.34	3506.39	3449.06	3475.54
LR test: statistic	258.96	291.14	407.80	431.33
LR test: p-value	0.00	0.00	0.00	0.00

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Notes: Alternative Model 1 including Index of Attendance (instead of Index of Sittings): Results of Spatial Lag Model Estimating Percentage Change in Total Marital Fertility Rates for Forerunner Years (1851-1881) and Main Decline Years (1881-1911). Registration Districts.

A.16 Table: Alternative Spatial Lag Model 4: All Dissenters

Dependent Variable	(1) $\Delta TMFR1851-1881$	(2)	(3) $\Delta TMFR1881-1911$	(4)
Explanatory Variables	Precondition	Change	Precondition	Change
	1851	1851–1881	1881	1881–1911
Intercept	0.54***	2.50***	−5.18***	−1.59
	(0.16)	(0.47)	(0.59)	(0.82)
Old and New Dissent 1851 (level)	−0.40*	−0.03*	−0.14	−0.02
	(0.19)	(0.01)	(0.17)	(0.01)
Teacher per 100 children	0.18	−0.01*	−0.33	−0.02***
	(0.21)	(0.00)	(0.19)	(0.00)
Professionals & managers	0.29	−0.01	−0.71**	−0.01*
	(0.28)	(0.00)	(0.24)	(0.01)
Married women working	0.78***	−0.02***	−0.66***	−0.00
	(0.17)	(0.00)	(0.18)	(0.01)
Mean age at marriage	−1.10***	0.24***	−0.48*	0.17***
	(0.21)	(0.05)	(0.20)	(0.05)
Miners & agricultural labourers	−0.34	0.01**	−0.13	0.01***
	(0.30)	(0.00)	(0.22)	(0.00)
Sex ratio	0.11	0.02	−0.14	−0.03
	(0.23)	(0.02)	(0.20)	(0.02)
Infant Mortality Rate	−0.14	−0.00	−0.44	0.05*
	(0.31)	(0.02)	(0.59)	(0.02)
Early Childhood Mortality Rate	−0.60	0.01	1.00	0.02
	(0.50)	(0.01)	(0.65)	(0.02)
Population density	−0.10	−0.00	1.18***	−0.01**
	(0.23)	(0.00)	(0.20)	(0.00)
ρ	0.67***	0.68***	0.76***	0.77***
	(0.03)	(0.03)	(0.03)	(0.03)
Num. obs.	623	623	624	624
Parameters	13	13	13	13
Log Likelihood	−1754.01	−1746.02	−1717.57	−1729.81
AIC (Linear model)	3791.30	3800.64	3864.39	3918.42
AIC (Spatial model)	3534.01	3518.03	3461.14	3485.62
LR test: statistic	259.29	284.61	405.25	434.80
LR test: p-value	0.00	0.00	0.00	0.00

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Notes: Alternative Model 2 Including All Dissenters (Presbyterian Church in England, United Presbyterian Church, Church of Scotland, Independents (or Congregationalists), Baptists, Quakers, Unitarians, Wesleyan Methodist Original Connexion, Wesleyan Methodist New Connexion, Primitive Methodists, Calvinistic Methodists, Lady Huntingdon's Connexion, Wesleyan Methodist Association, Wesleyan Reformers, Bible Christians, Independent Methodists, New Church): Results of Spatial Lag Model Estimating Percentage Change in Total Marital Fertility Rates for Forerunner Years (1851-1881) and Main Decline Years (1881-1911). Registration Districts.

A.17 Table: Alternative Spatial Lag Model 5. Excluding Age at Marriage

	(1)	(2)	(3)	(4)
Dependent Variable	$\Delta TMFR1851-1881$		$\Delta TMFR1881-1911$	
Explanatory Variables	Precondition	Change	Precondition	Change
	1851	1851–1881	1881	1881–1911
Intercept	0.51**	2.54***	−5.22***	−0.52
	(0.17)	(0.45)	(0.60)	(0.76)
New Dissent 1851 (level)	−0.61**	−0.05***	−0.15	−0.01
	(0.19)	(0.01)	(0.16)	(0.01)
Teacher per 100 children	0.19	−0.01	−0.35	−0.02***
	(0.21)	(0.00)	(0.19)	(0.00)
Professionals & managers	0.16	−0.00	−0.78***	−0.01*
	(0.28)	(0.00)	(0.24)	(0.01)
Married women working	0.63***	−0.02***	−0.78***	0.00
	(0.17)	(0.00)	(0.18)	(0.01)
Miners & agricultural labourers	0.01	0.01*	−0.11	0.01***
	(0.29)	(0.00)	(0.22)	(0.00)
Sex ratio	0.47*	−0.01	0.04	−0.06***
	(0.22)	(0.02)	(0.18)	(0.02)
Infant Martality Rate	0.07	0.00	−0.50	0.05**
	(0.32)	(0.02)	(0.59)	(0.02)
Early Childhood Martality Rate	0.13	0.01	1.35*	0.01
	(0.49)	(0.01)	(0.64)	(0.02)
Population density	−0.30	−0.01*	1.18***	−0.01**
	(0.23)	(0.00)	(0.20)	(0.00)
ρ	0.69***	0.68***	0.76***	0.78***
	(0.03)	(0.03)	(0.03)	(0.02)
Num. obs.	621	621	622	622
Parameters	12	12	12	12
Log Likelihood	−1760.63	−1751.60	−1714.97	−1730.69
AIC (Linear model)	3812.93	3795.69	3850.78	3930.18
AIC (Spatial model)	3545.26	3527.19	3453.93	3485.38
LR test: statistic	269.67	270.49	398.85	446.80
LR test: p-value	0.00	0.00	0.00	0.00

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Notes: Alternative Model 3 Excluding Mean Age at Marriage: Results of Spatial Lag Model Estimating Percentage Change in Total Marital Fertility Rates for Forerunner Years (1851-1881) and Main Decline Years (1881-1911). Registration Districts.

A.18 Table: Alternative Spatial Lag Model 6. Excluding Population Density

	(1)	(2)	(3)	(4)
Dependent Variable	$\Delta TMFR1851-1881$		$\Delta TMFR1881-1911$	
Explanatory Variables	Precondition	Change	Precondition	Change
	1851	1851–1881	1881	1881–1911
Intercept	0.55^{***}	2.50^{***}	-4.40^{***}	-2.08^{*}
	(0.16)	(0.44)	(0.54)	(0.82)
New Dissent 1851 (level)	-0.47^{*}	-0.04^{**}	-0.34^{*}	-0.01
	(0.19)	(0.01)	(0.17)	(0.01)
Teacher per 100 children	0.17	-0.01^{*}	-0.69^{***}	-0.01^{**}
	(0.21)	(0.00)	(0.18)	(0.00)
Professionals & managers	0.28	-0.01	-0.49^{*}	-0.02^{***}
	(0.27)	(0.00)	(0.24)	(0.01)
Married women working	0.76^{***}	-0.02^{***}	-0.63^{***}	-0.00
	(0.17)	(0.00)	(0.19)	(0.01)
Mean age at marriage	-1.10^{***}	0.25^{***}	-0.40	0.18^{***}
	(0.20)	(0.05)	(0.21)	(0.05)
Miners & agricultural labourers	-0.41	0.01^{**}	-0.34	0.01^{***}
	(0.29)	(0.00)	(0.22)	(0.00)
Sex ratio	0.14	0.02	-0.07	-0.03
	(0.22)	(0.02)	(0.20)	(0.02)
Infant Martality Rate	-0.05	-0.00	-0.61	0.05^{*}
	(0.30)	(0.02)	(0.60)	(0.02)
Early Childhood Martality Rate	-0.78	0.01	1.41^{*}	0.02
	(0.41)	(0.01)	(0.66)	(0.02)
ρ	0.66^{***}	0.68^{***}	0.80^{***}	0.77^{***}
	(0.03)	(0.03)	(0.02)	(0.03)
Num. obs.	621	621	622	622
Parameters	12	12	12	12
Log Likelihood	-1747.12	-1739.23	-1731.12	-1728.94
AIC (Linear model)	3768.02	3779.36	3932.91	3906.99
AIC (Spatial model)	3518.24	3502.47	3486.25	3481.88
LR test: statistic	251.78	278.89	448.67	427.11
LR test: p-value	0.00	0.00	0.00	0.00

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Notes: Alternative Model 4 Excluding Population Density: Results of Spatial Lag Model Estimating Percentage Change in Total Marital Fertility Rates for Forerunner Years (1851-1881) and Main Decline Years (1881-1911). Registration Districts.

A.19 Table: Modelling Change in Total Marital Fertility Rates (%ΔTMFR) for Forerunner Years (1851-1881) and Sub-set of Registration Districts (Dorset, Somerset, and Wiltshire): Linear Model and Spatial Lag Model (Direct and Indirect Effects)

	Precondition Model					Change Model				
		Spatial Lag Model					Spatial Lag Model			
	Linear Model	β	Marginal Effects			Linear Model	β	Marginal Effects		
	β		*Direct*	*Indirect*	*Total*	β		*Direct*	*Indirect*	*Total*
Intercept	2.32	0.97				1.29	1.85			
Professional and Managerial Occupations	0.73	1.33	1.45	1.52	2.97	0.03	0.02	0.02	0.02	0.04
Married Women Working	0.9°	0.75*	0.82*	0.86	1.68°	-0.04	-0.02	-0.02	-0.02	-0.04
Mining and Agricultural Occupations	1.58	0.36	0.39	0.41	0.80	0.00	0.00	0.00	0.00	0.00
Sex Ratio	0.26	-0.28	-0.30	-0.32	-0.62	0.01	0.05	0.06	0.06	0.12
Mean age at marriage (women)	-0.98	-1.54	-1.68	-1.76	-3.44	0.22	0.22	0.24	0.26	0.5
Infant Mortality Rate	0.77	0.79	0.87	0.90	1.77	0.01	0.04	0.04	0.05	0.09
Early Childhood Mortality Rate	0.85	-0.8	-0.87	-0.91	-1.78	0.04	0.04	0.05	0.05	0.10
Teacher per 100 Children	0.67	-0.02	-0.02	-0.02	-0.05	-0.01	-0.01	-0.01	-0.02	-0.03
Population Density	-1.13	-1.24	-1.36	-1.42	-2.78	0.00	-0.01	0.00	-0.01	-0.02
Nex Dissent Index of Sittings 1851	-0.52	-0.87	-0.96	-1.00	-1.95	0.01	-0.02	-0.02	-0.03	-0.05
Spatially lagged Δ TMFR 1851-1881 (ρ)		0.55***					0.56***			
Num. obs.	621	621				621	621			
Adjusted R^2	0.21					0.20				
Moran's I of Model Residuals	0.44***	0.00				0.46***	-0.02			
AIC	3770	3520				3776	3504			

***p < 0.001; ** p < 0.01; * p < 0.05; ° p < 0.10

Appendix B Reflecting on the Past: Long-term Spatial Persistence of Innovative Demographic Behaviour in England and Wales, 1851-2011

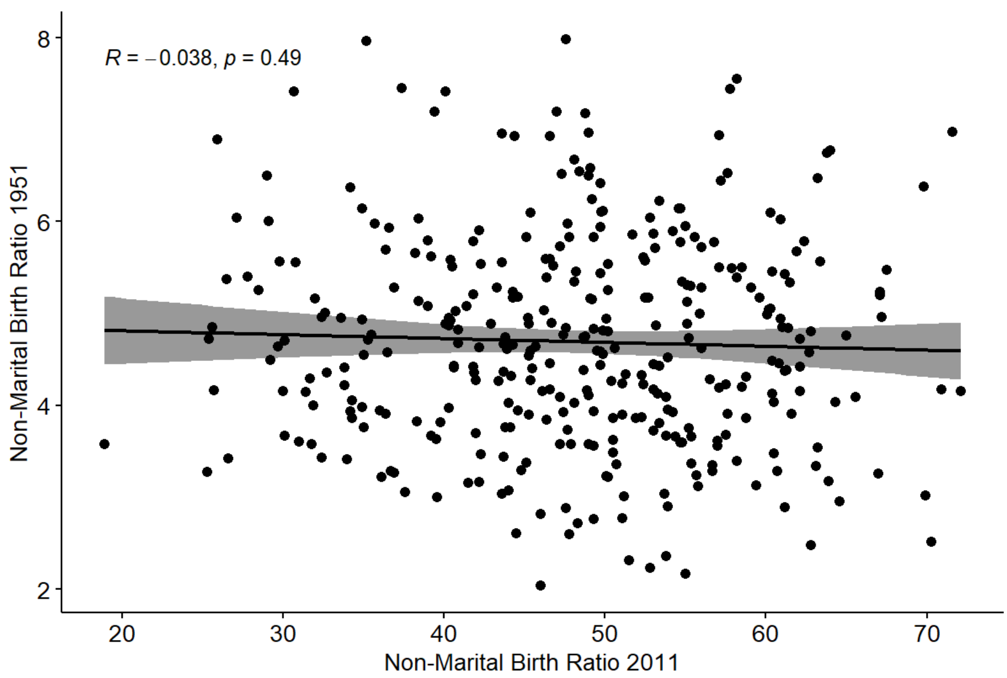
B.1 Table: Descriptive Statistics of All Variables

Variable	Year	Min	Median	Max	Mean	Standard Deviation
Total Fertility Rate	1851	2.82	4.58	6.14	4.55	0.5
	1861	2.83	4.56	6.1	4.53	0.53
	1881	2.52	4.7	6.6	4.72	0.64
	1891	2.23	4.12	5.84	4.15	0.64
	1901	1.79	3.52	5.82	3.6	0.65
	1911	1.41	2.86	5.28	2.97	0.62
Non-Marital Ratio	1951	2.04	4.64	11.27	4.74	1.25
	1971	3.25	6.87	19.47	7.54	3.01
	1980	3.33	9.2	32.39	10.29	4.6
	1991	0	27.42	52.58	28.08	7.24
	2001	14.3	38.7	63.78	39.18	9.44
	2011	18.9	48.85	72.1	48.05	10.39
Married Women Working	1851	2.66	15.34	68.9	18.12	10.19

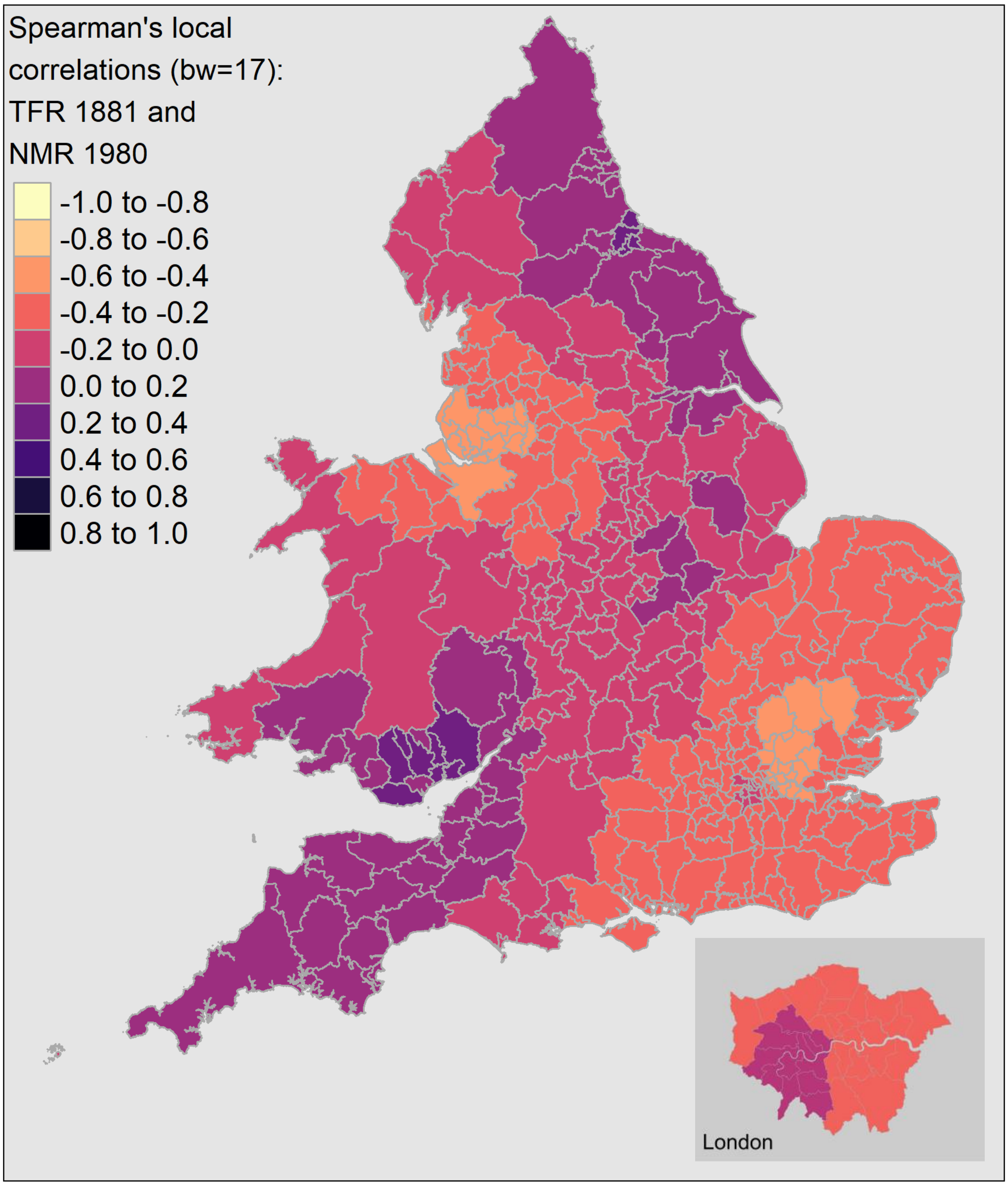
N = 348

B.2 Figure: Sensitivity Analysis: Correlation Plot of Non-Marital (Birth) Ratio in 1951 and Non-Marital (Birth) Ratio in 2011

Correlation plot of Non-Marital (Birth) Ratio in 1951 and Non-Marital (Birth) Ratio in 2011 based on 2011 Local Authority Districts Excluding Outliers (NMR 1951 > 9) (Sources: own calculations; data – GBHGIS 2011; ONS 2022).



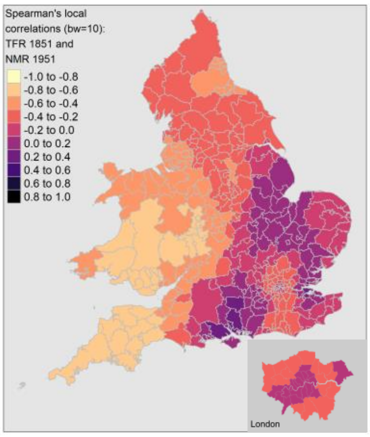
B.3 Figure: Geographically Weighted Spearman's Rank Order Correlation of Total Fertility Rate in 1881 and Non-Marital (Birth) Ratio in 1980

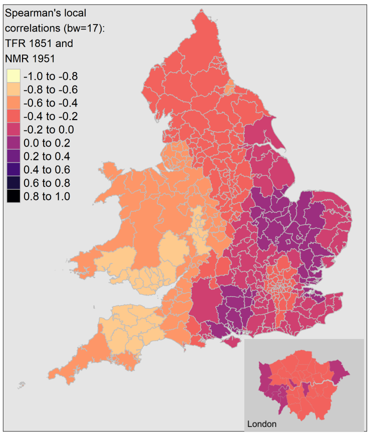


B.4 Figure: Alternative GWC with Smaller and Larger Bandwidth.

Figure B.4.1: Geographically Weighted Spearman's Rank Order Correlation of Total Fertility Rate in 1851 and Non-Marital (Birth) Ratio in 1951.

Bandwidth		
BW = 10	BW = 17	BW = 30





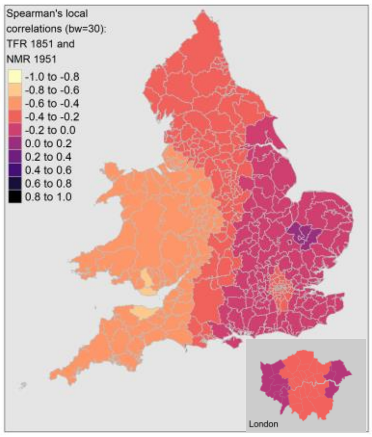
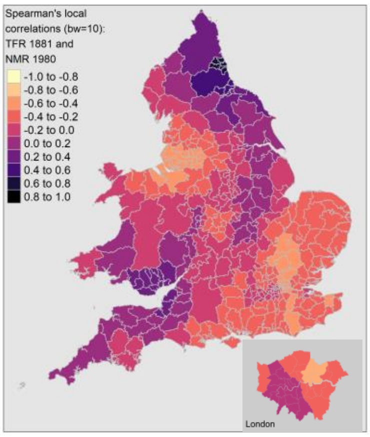
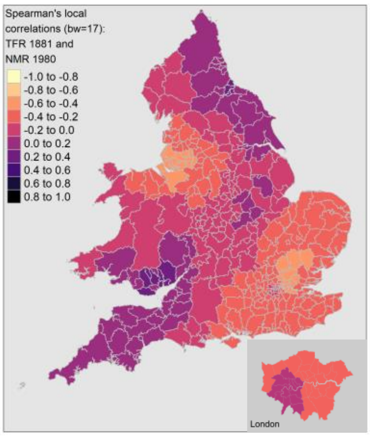


Figure B.4.2: Geographically Weighted Spearman's Rank Order Correlation of Total Fertility Rate in 1881 and Non-Marital (Birth) Ratio in 1980.

Bandwidth		
BW = 10	BW = 17	BW = 30





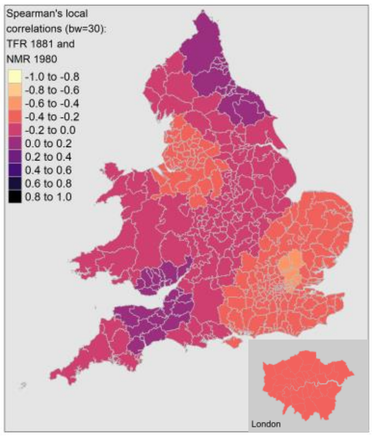


Figure B.4.3: Geographically Weighted Spearman's Rank Order Correlation of Non-Marital (Birth) Ratio in 1951and Non-Marital (Birth) Ratio in 2011.

Bandwidth		
BW = 10	BW = 17	BW = 30

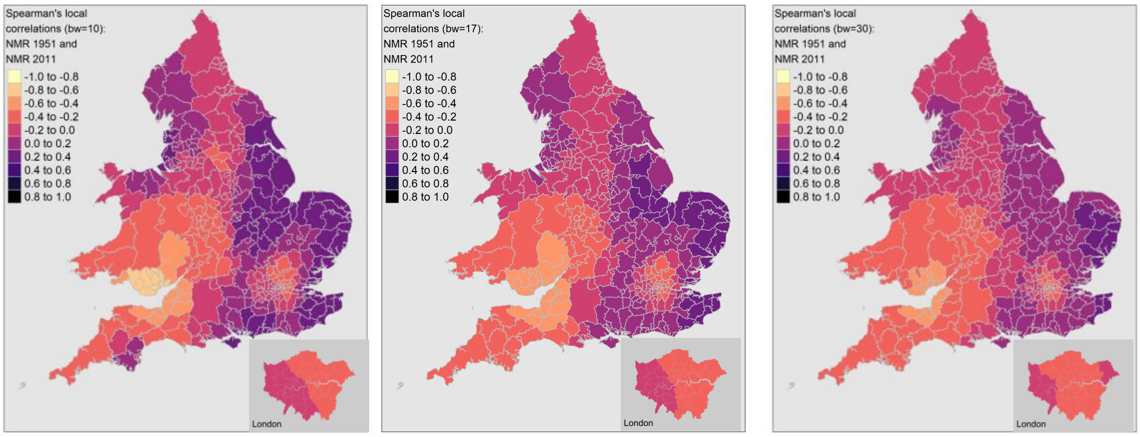
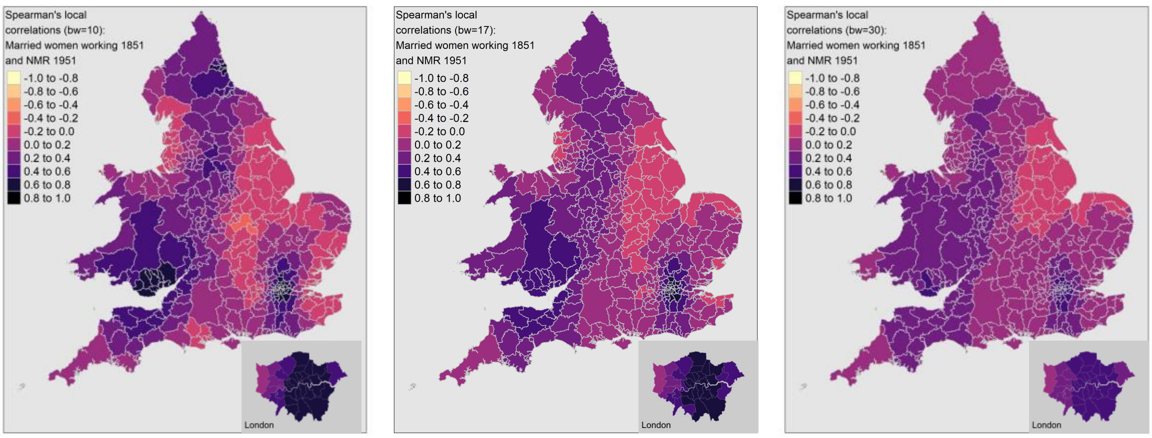


Figure B.4.4: Geographically Weighted Spearman's Rank Order Correlation of Share of Married Women Working in 1851and Non-Marital (Birth) Ratio in 1951.

Bandwidth		
BW = 10	BW = 17	BW = 30



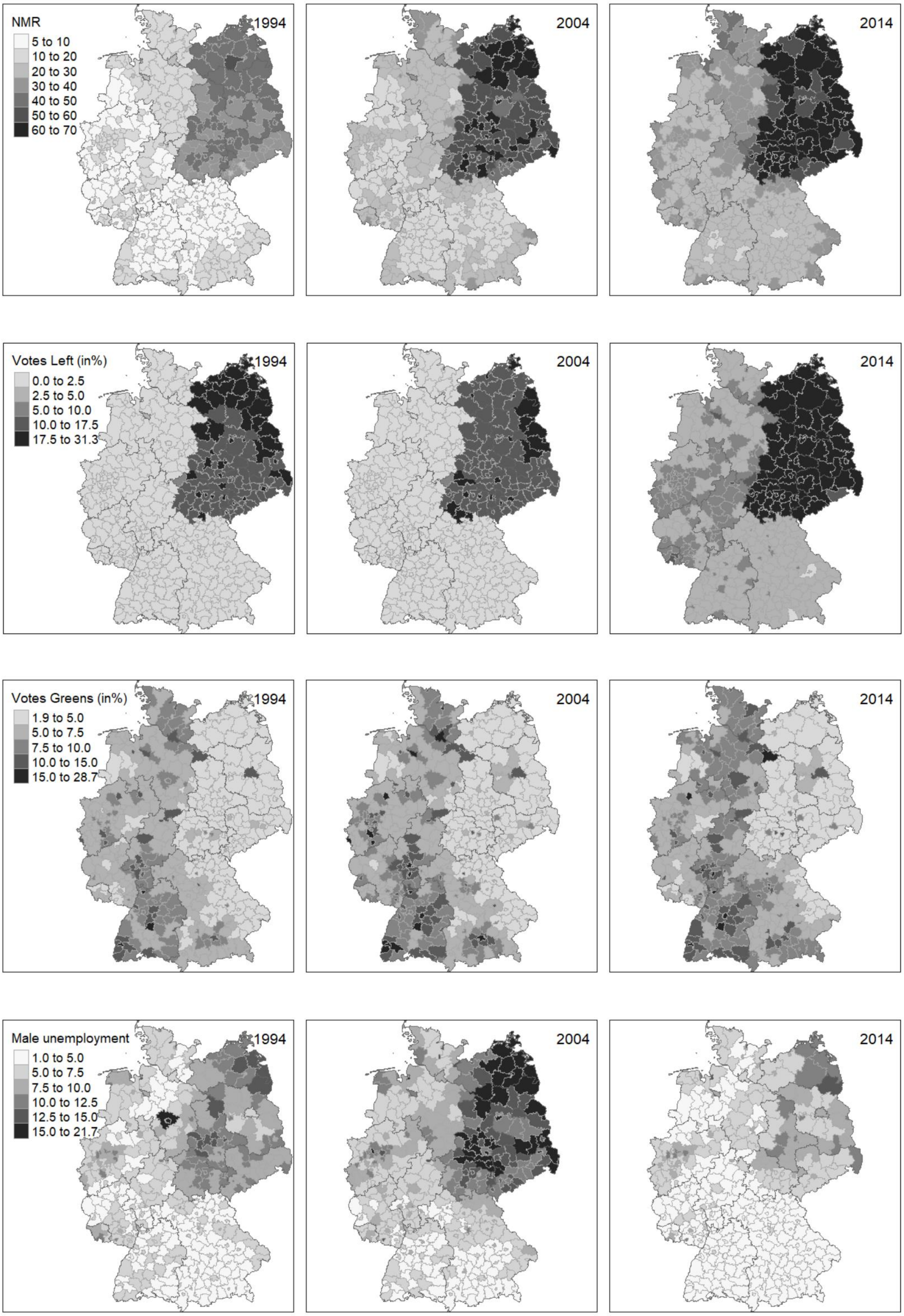
Appendix C Left-Wing Voting and Non-Marital Childbearing in Germany across Time and Space

C.1 Table: Descriptive Statistics of (Unstandardised) Variables

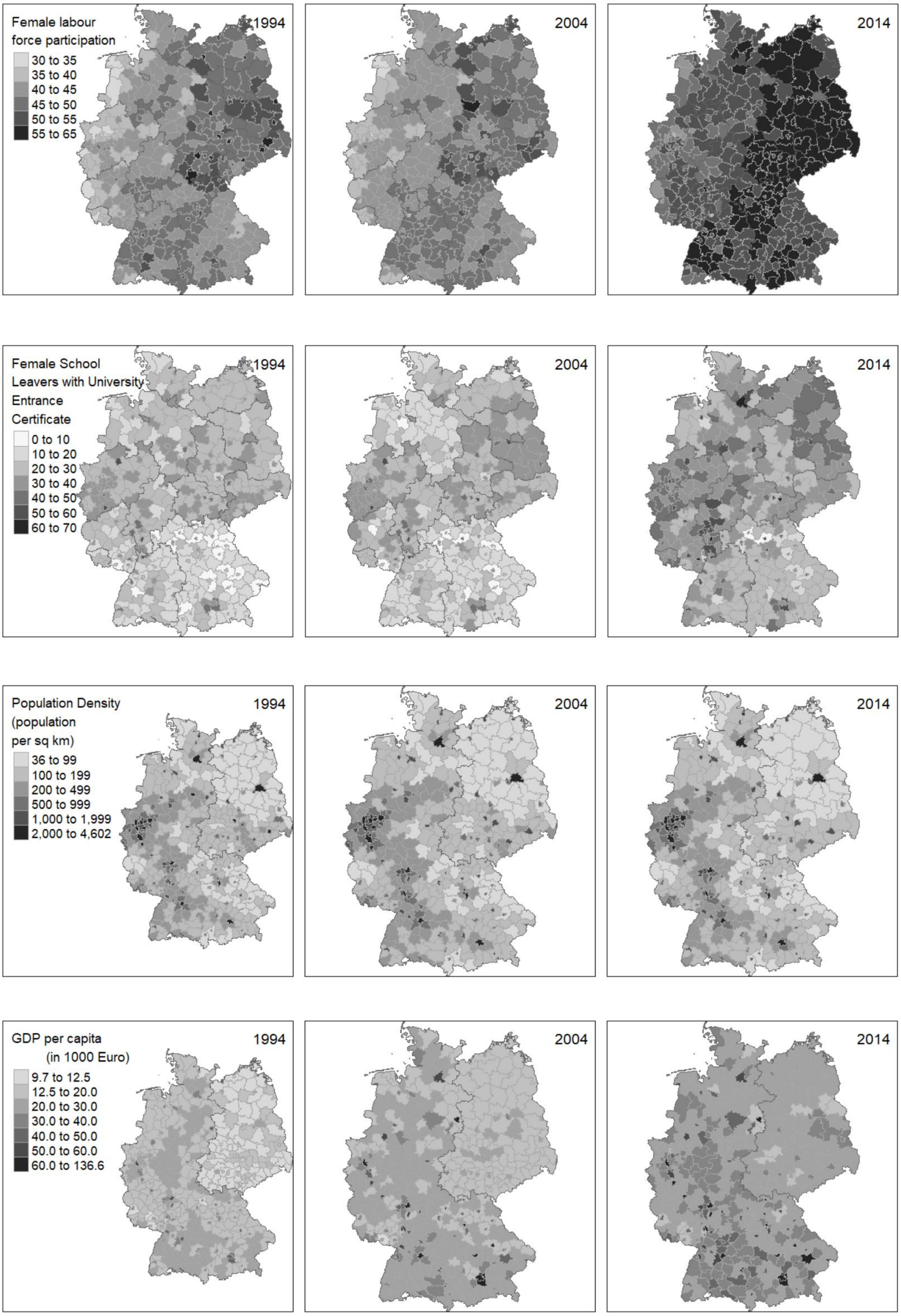
Variable	Year	Minimum	Median	Maximum	Mean	Standard Deviation
Non-Marital Ratio	1994	5.22	13.42	51.00	19.40	13.43
	2004	12.96	23.73	69.96	31.54	16.49
	2014	17.59	30.61	69.54	35.69	13.84
Voting *Left*	1994	0.19	0.83	31.26	5.22	7.82
	2004	0.29	1.06	24.4	4.85	6.72
	2014	2.42	5.22	30.32	8.45	7.17
Voting *Greens*	1994	2.13	5.88	21.94	6.21	2.62
	2004	1.99	6.76	28.68	7.1	3.56
	2014	2.55	7.34	22.14	7.62	3.09
Male Unemployment	1994	2.63	6.34	17.81	7.03	2.79
	2004	2.8	7.8	21.58	8.9	3.92
	2014	1.04	4.77	12.83	5.19	2.40
Female Labour Force Participation	1994	31.25	45.04	63.78	45.00	5.04
	2004	31.83	44.28	55.14	44.28	3.83
	2014	39.15	52.95	67.13	53.09	4.74
Female Education	1994	0.00	25.99	56.26	25.58	8.99
	2004	0	25.87	58.14	26.21	9.32
	2014	0.00	34.44	66.20	35.28	10.04
Population Density	1994	41.00	194.50	3,999.00	525.93	694.89
	2004	40.00	198.95	4,010.33	507.69	654.10
	2014	36.26	195.59	4,601.17	520.27	683.16
Gross Domestic Product per Capita	1994	9,788.00	18,185.00	57,867.00	19,913.72	8,101.83
	2004	11,478.00	21,955.00	85,274.00	25,088.31	11,141.68
	2014	14,945.00	29,201.00	136,531.00	33,553.21	14,686.63

N = 444 (1994); 439 (2004); 402 (2014)

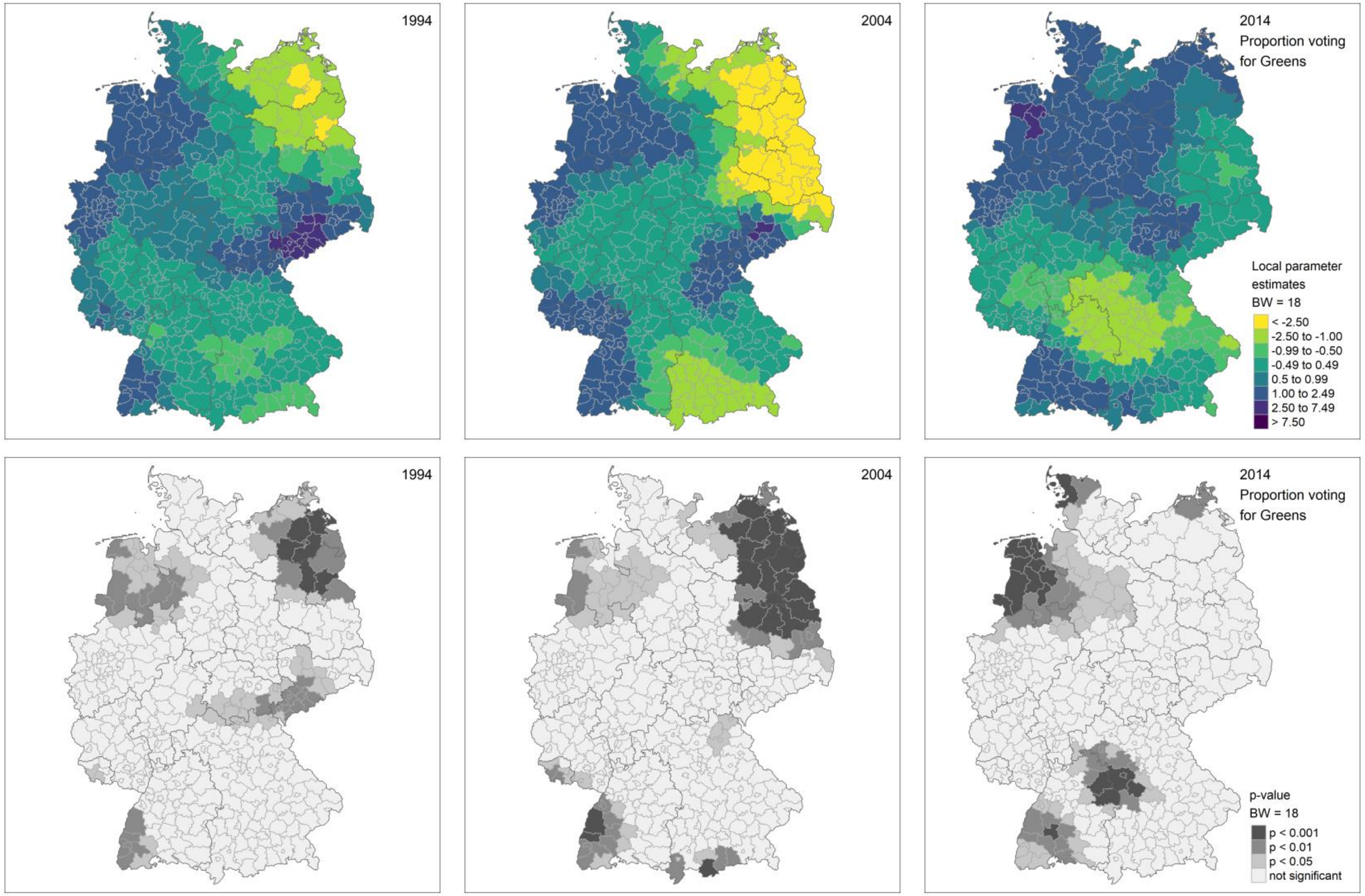
C.2 Figure: Descriptive Maps of (Unstandardised) Variables



Appendix C

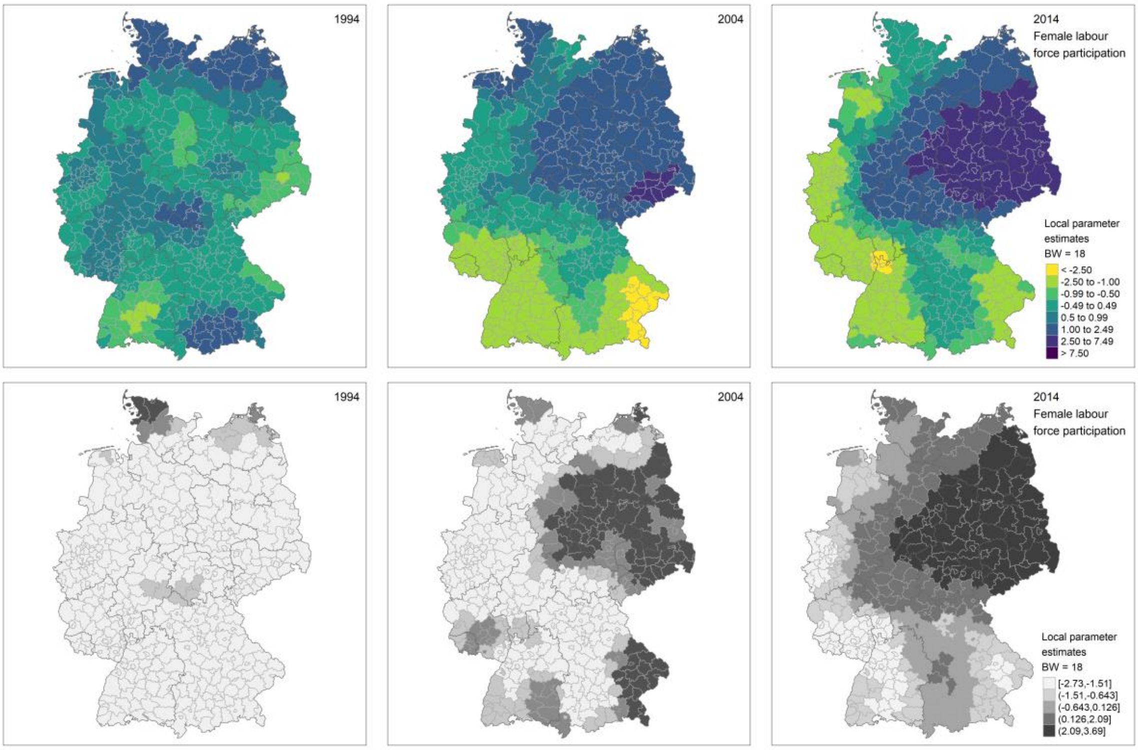

Female labour force participation
30 to 35
35 to 40
40 to 45
45 to 50
50 to 55
55 to 65
1994
2004
2014
Female School Leavers with University Entrance Certificate
0 to 10
10 to 20
20 to 30
30 to 40
40 to 50
50 to 60
60 to 70
1994
2004
2014
Population Density (population per sq km)
36 to 99
100 to 199
200 to 499
500 to 999
1,000 to 1,999
2,000 to 4,602
1994
2004
2014
GDP per capita (in 1000 Euro)
9.7 to 12.5
12.5 to 20.0
20.0 to 30.0
30.0 to 40.0
40.0 to 50.0
50.0 to 60.0
60.0 to 136.6
1994
2004
2014

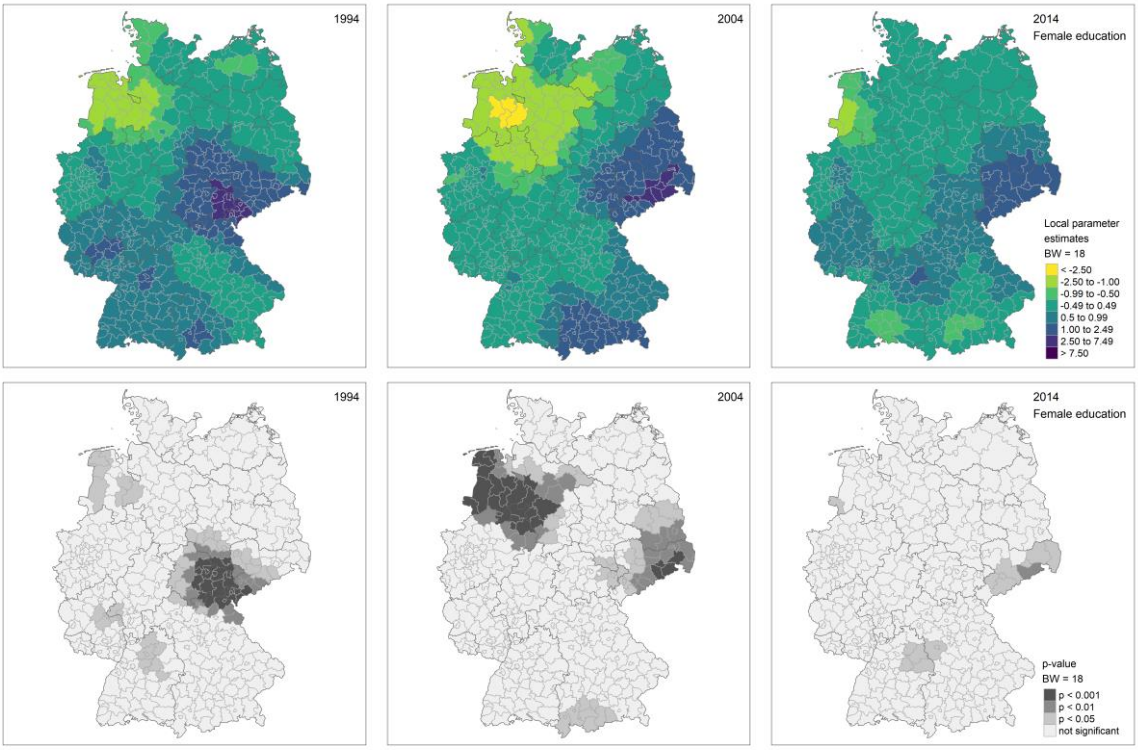
C.3 Figure: GWR Model Results of Control Variables. Standardised Coefficient Categories over Time



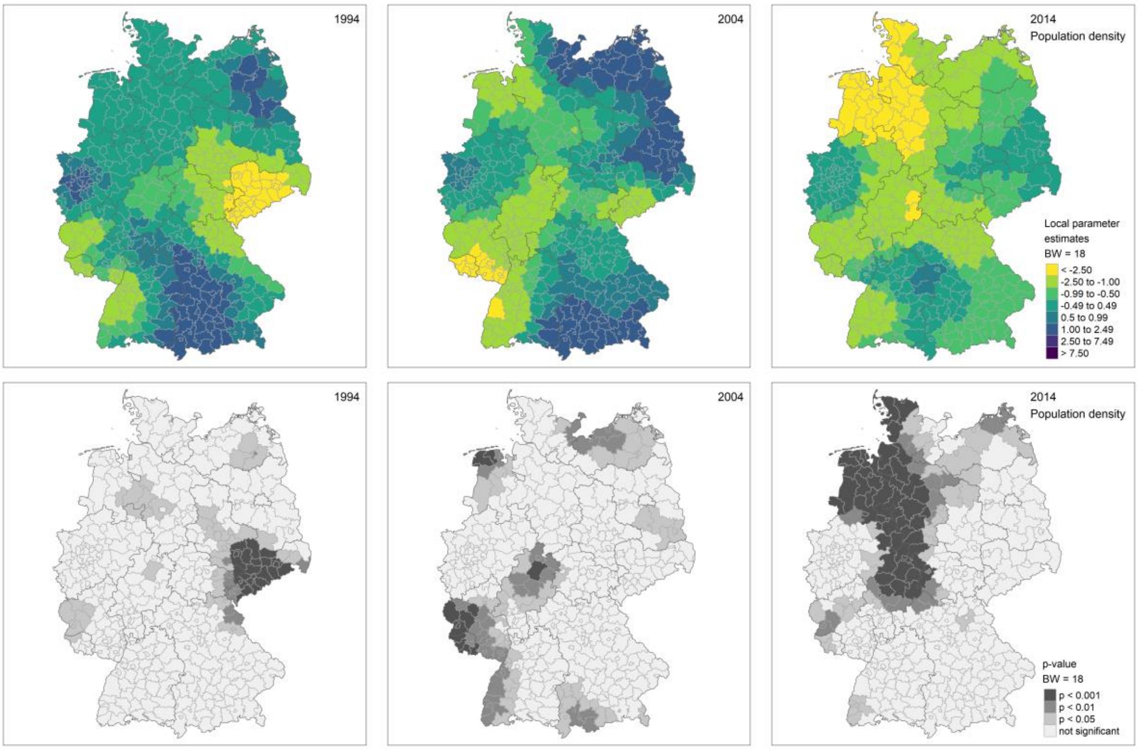
GWR Model Results for Non-Marital Childbearing: Parameter Estimates with Standardised Categories over Time Voting for the Green Party and p-Values Based on t-Test (Source: own calculations; data - Statistisches Bundesamt, 1995, 2005, 2016; destatis, 2016b; MPIDR & CGG, 2016 [1994, 2004]; boundary - BKG, 2016 [2014]).

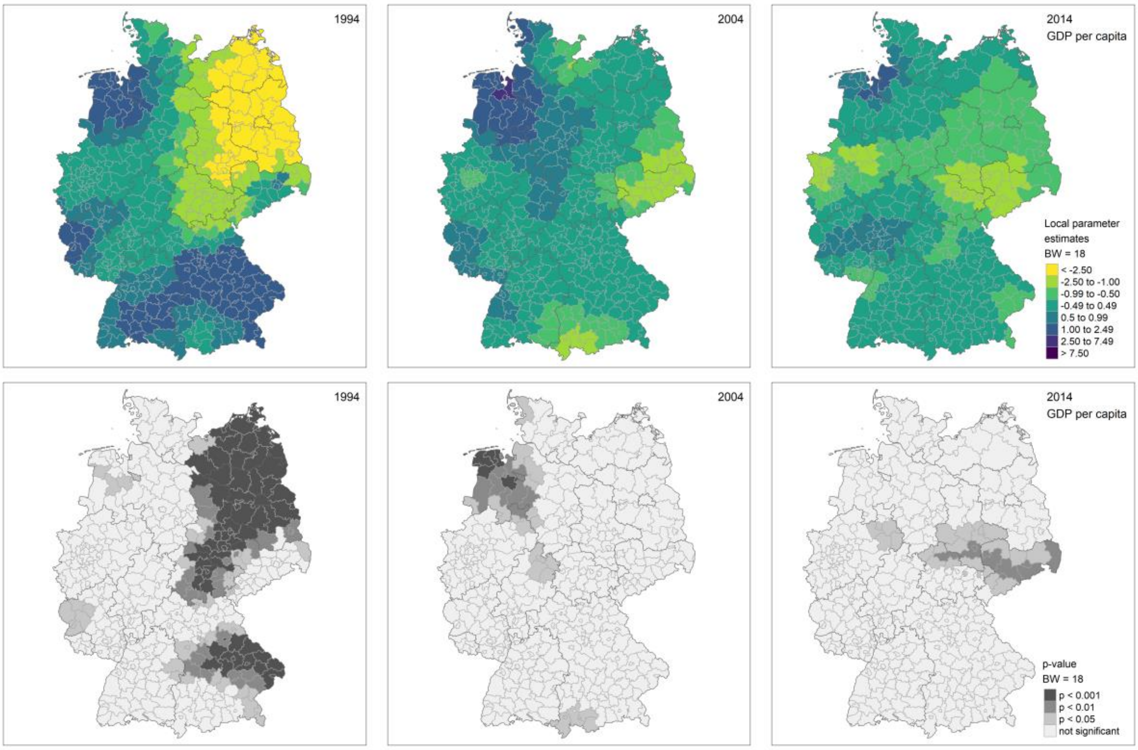
Year		
1994	2004	2014



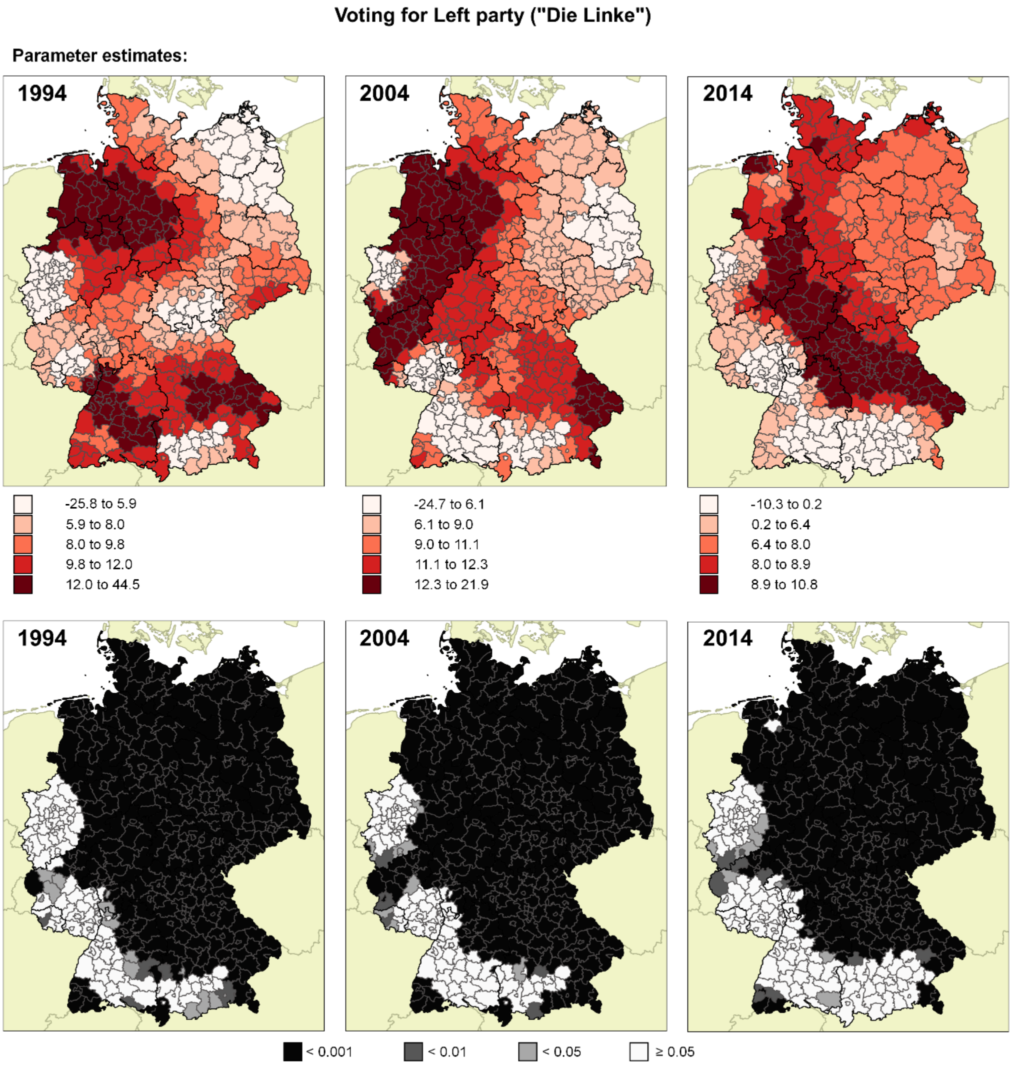


Year		
1994	2004	2014

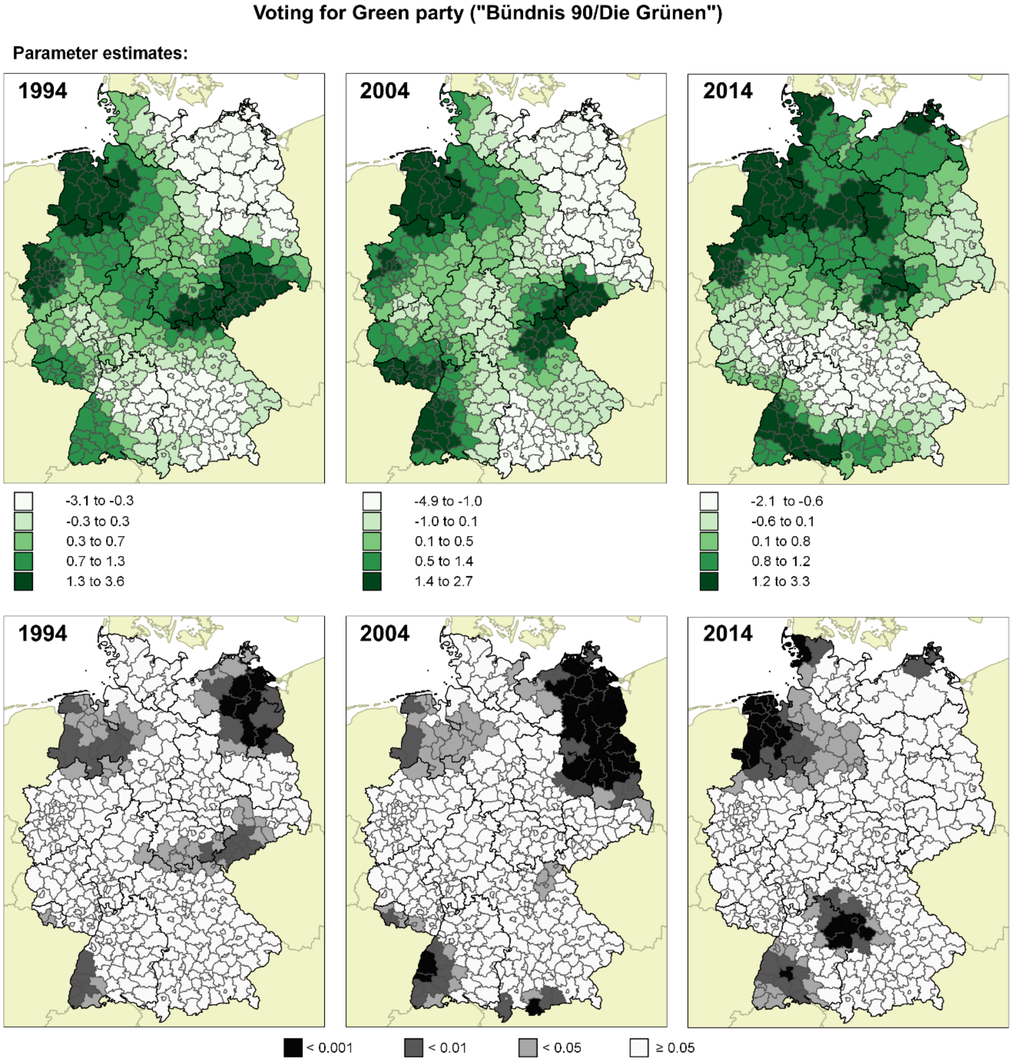




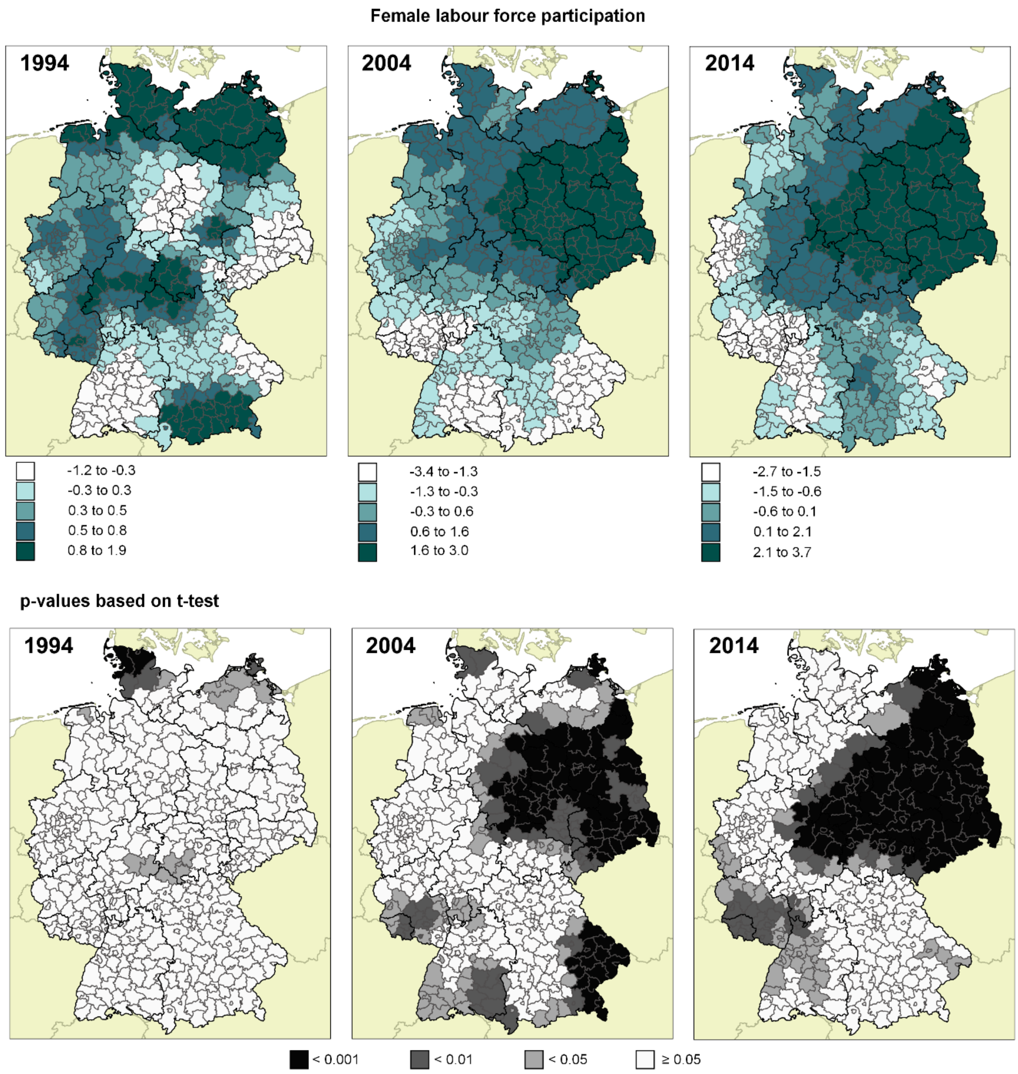
C.4 Figure: GWR Model Results of All Explanatory Variables. Quintile Ranges of Coefficients



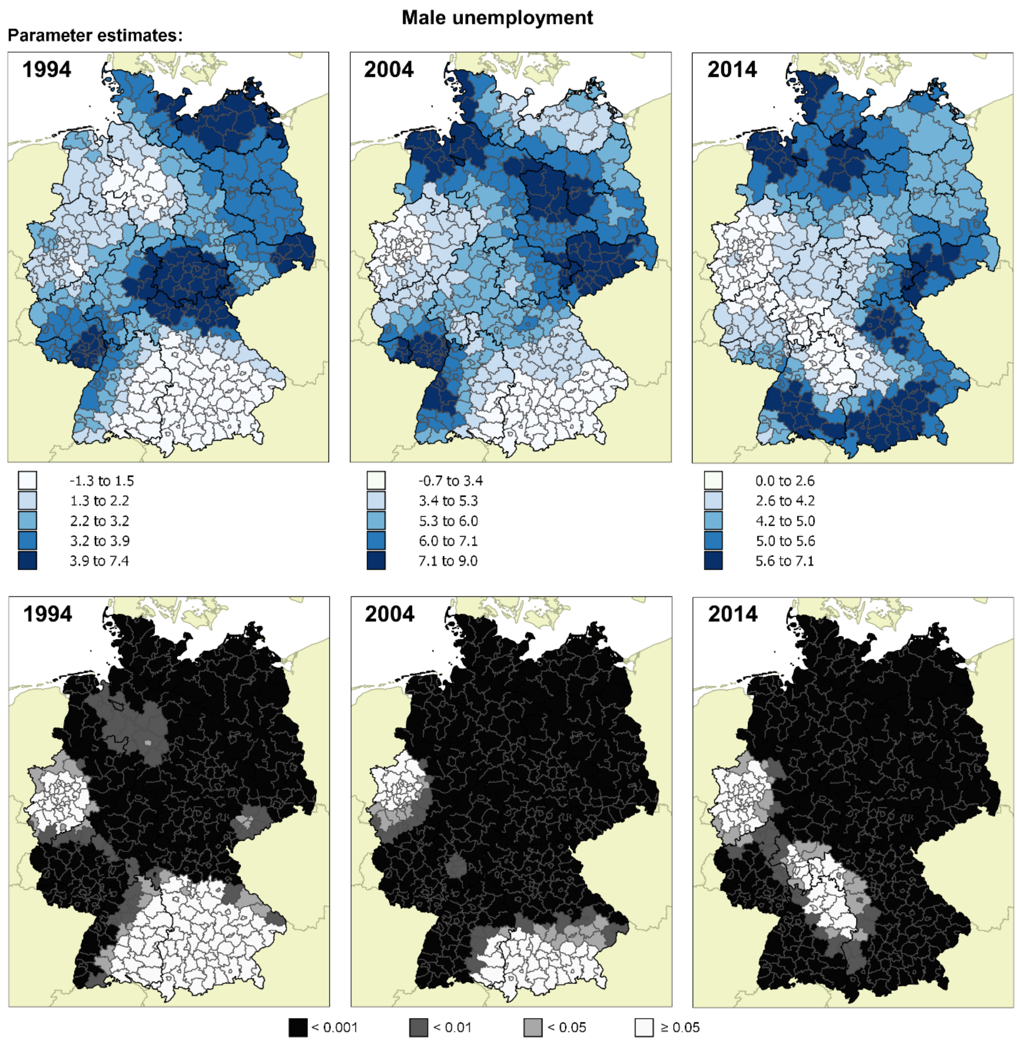
GWR model results on non-marital fertility: parameter estimates by quintile range for voting Left party variable and p-values based on t-test (Source: own calculations; data: Statistisches Bundesamt, 1995, 2005, 2016; destatis, 2016b; MPIDR & CGG, 2016 [1994, 2004]; BKG, 2016 [2014]).



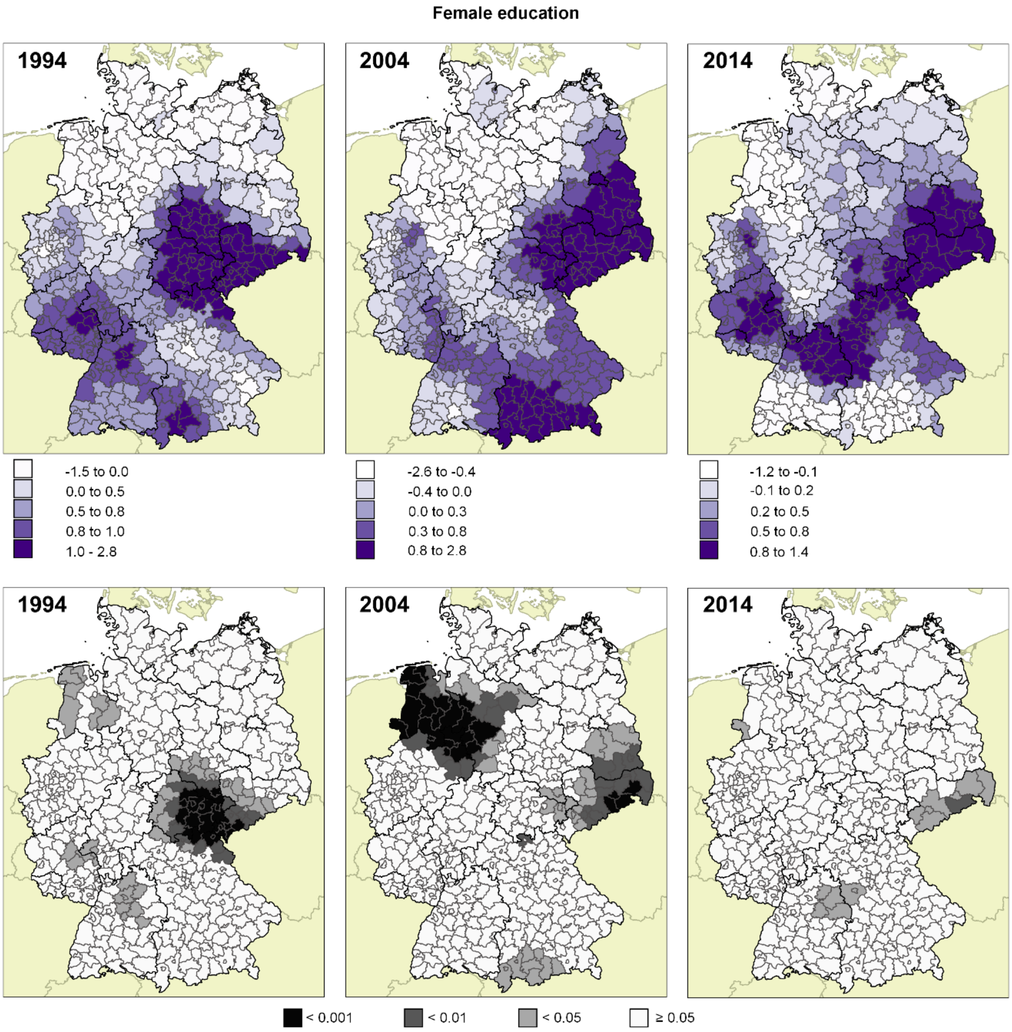
GWR model results on non-marital fertility: parameter estimates by quintile range for voting Green party variable and p-values based on t-test (source: own calculations; data: data: Statistisches Bundesamt, 1995, 2005, 2016; destatis, 2016b; MPIDR & CGG, 2016 [1994, 2004]; BKG, 2016 [2014]).



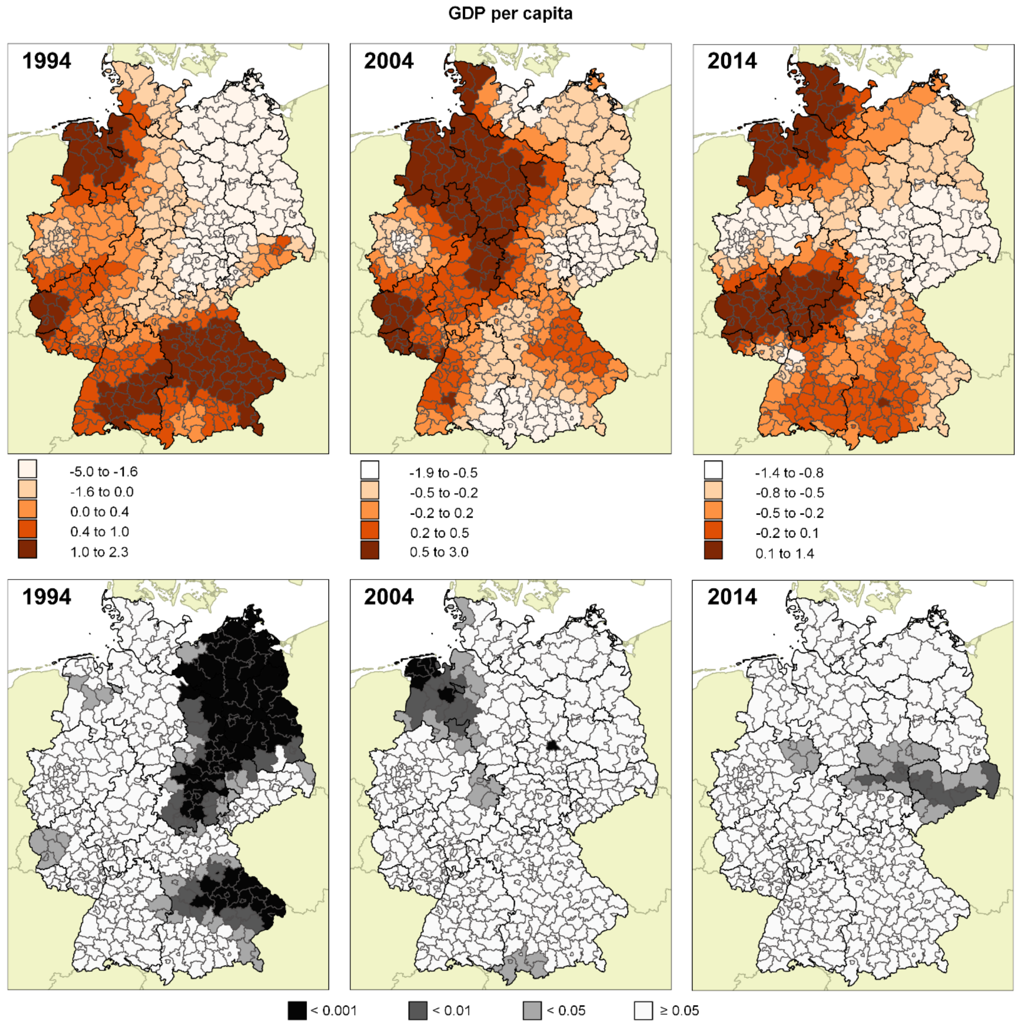
GWR model results on non-marital fertility: parameter estimates by quintile range for female labour force participation variable and p-values based on t-test (source: own calculations; data: Statistisches Bundesamt, 1995, 2005, 2016; SBA, 1994, 2004; destatis, 2016d; MPIDR & CGG, 2016 [1984, 1994, 2004]; BKG, 2016 [2014]).



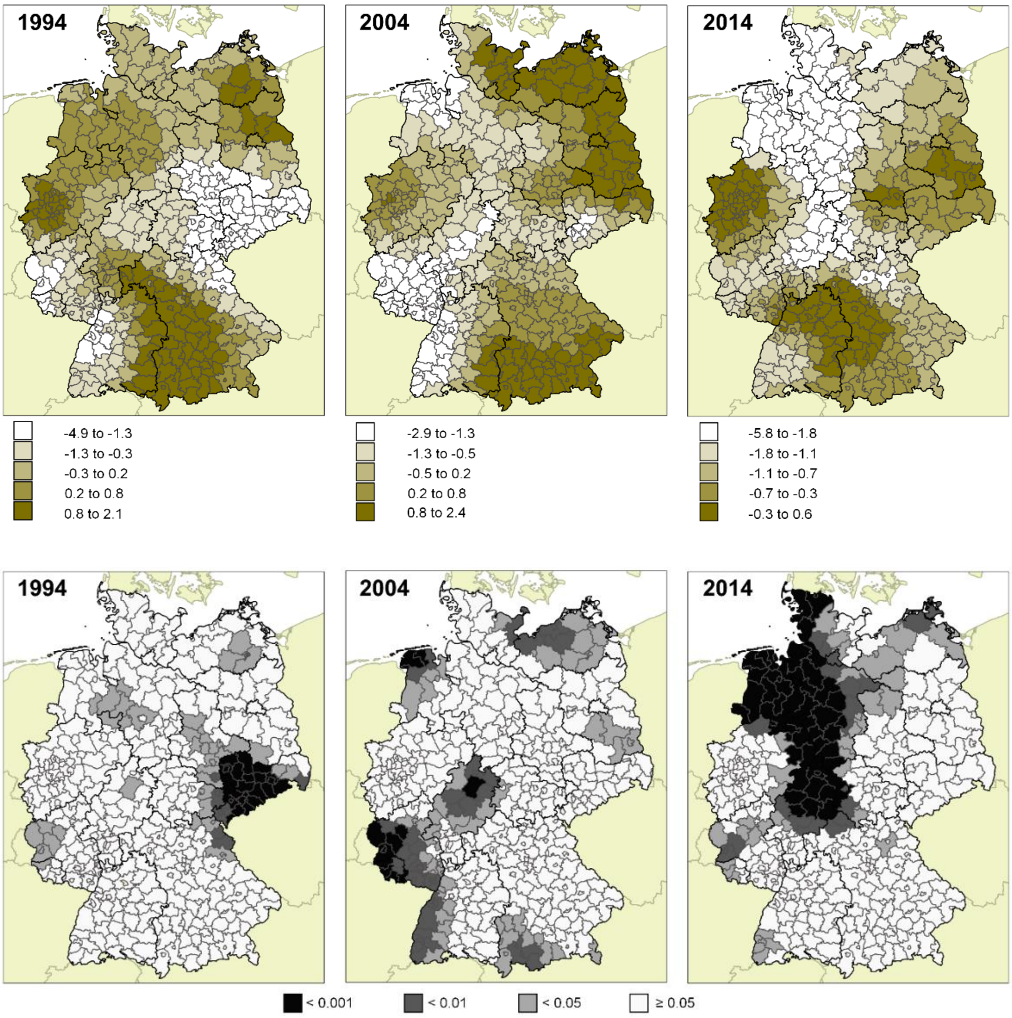
GWR model results on non-marital fertility: parameter estimates by quintile range for male unemployment variable and p-values based on t-test (source: own calculations; data: Statistisches Bundesamt, 1995, 2005, 2016; StatBA 2005; destatis, 2016c; MPIDR & CGG, 2016 [1994, 2004]; BKG, 2016 [2014]).



GWR model results on non-marital fertility: parameter estimates by quintile range for female education and p-values based on t-test (source: own calculations; data: Statistisches Bundesamt, 1995, 2005, 2016; destatis, 2016e; MPIDR & CGG, 2016 [1994, 2004]; BKG, 2016 [2014]).



GWR model results on non-marital fertility: parameter estimates by quintile range for GDP per capita and p-values based on t-test (source: own calculations; data: Statistisches Bundesamt, 1995, 2005, 2016; AK VGL 2011; destatis, 2016g; MPIDR & CGG, 2016 [1994, 2004]; BKG, 2016 [2014]).



GWR model results on non-marital fertility: parameter estimates by quintile range for population density and p-values based on t-test (source: own calculations; data: Statistisches Bundesamt, 1995, 2005, 2016; destatis, 2016f, 2017; MPIDR & CGG, 2016 [1994, 2004]; BKG, 2016 [2014]).

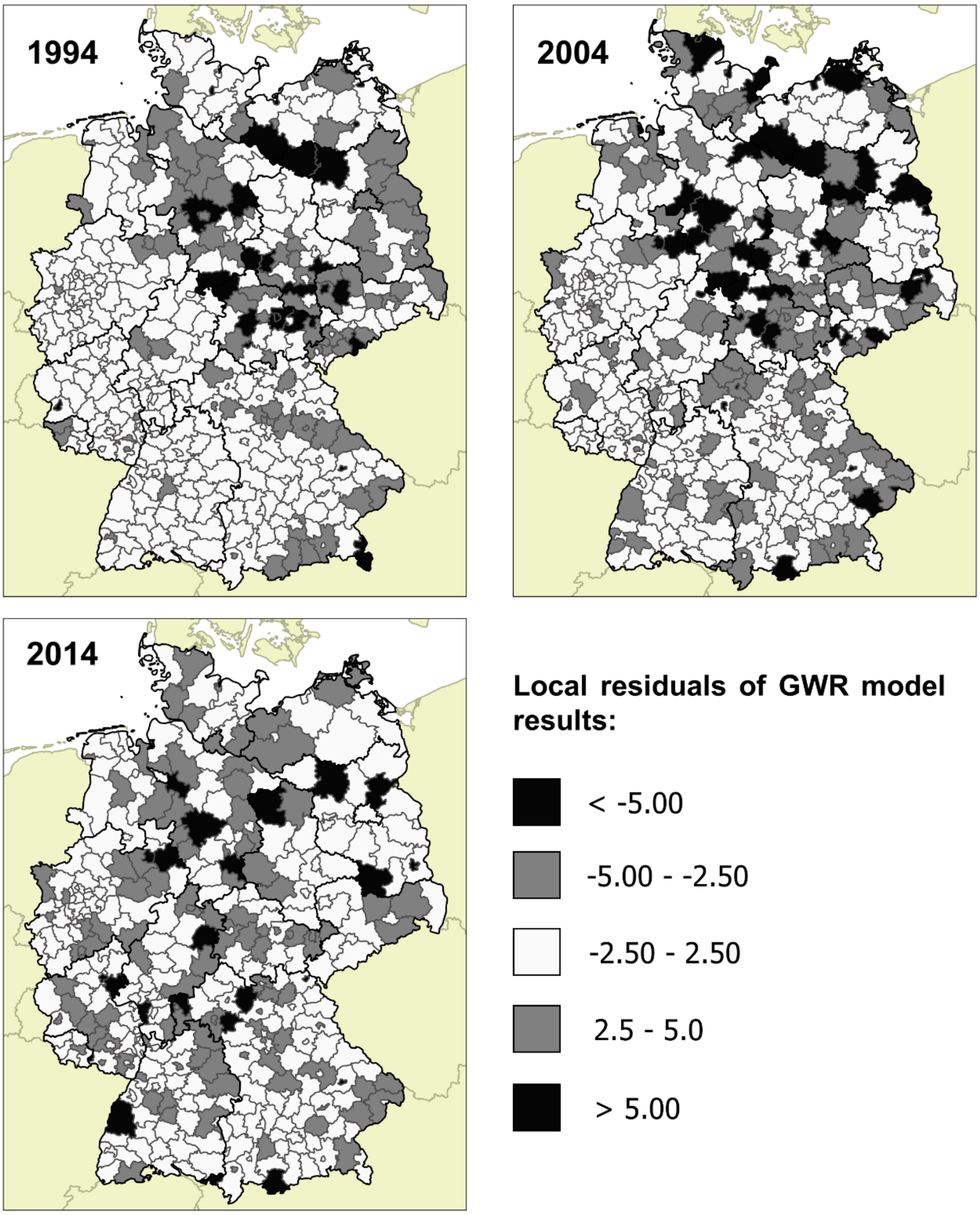
C.5 Table: Equivalent Global Model (Linear Regression) to GWR Models for 1994, 2004 and 2014

Fully adjusted linear regression model for the Non-Marital (Birth) Ratio.

	1994			2004			2014		
	Esti-mates	**SE**	**p-value**	**Esti-mates**	**SE**	**p-value**	**Esti-mates**	**SE**	**p-value**
Intercept	**19.40**	0.19	0.000	**31.54**	0.18	0.000	**35.69**	0.20	0.000
Voting Left	**10.04**	0.45	0.000	**11.12**	0.46	0.000	**9.44**	0.40	0.000
Voting Green	0.26	0.28	0.353	0.67	0.30	0.027	**0.66**	0.30	0.029
Male unemployment	**3.27**	0.32	0.000	**6.15**	0.40	0.000	**4.80**	0.37	0.000
Female labour force participation	**0.71**	0.28	0.012	0.48	0.25	0.541	**1.29**	0.31	0.000
Female education	0.28	0.28	0.315	-0.50	0.27	0.072	-0.24	0.27	0.370
Population density	**-0.45**	0.23	0.049	**-1.12**	0.28	0.000	**-1.94**	0.31	0.000
GDP per capita	0.16	0.28	0.573	0.40	0.26	0.124	-0.05	0.26	0.845
	OLS	**GWR**		**OLS**	**GWR**		**OLS**	**GWR**	
Residual sum of squares	6979.34	2638.41		6390.51	2860.47		6407.22	2586.44	
Adjusted R squared	0.911	0.956		0.946	0.968		0.915	0.955	
AICc	2501.60	2131.40		2439.92	2271.22		2272.31	2079.53	

Notes: Own calculations.

C.6 Figure: Spatial Distribution of Residuals of GWR Model



C.7 Table: Correlation Matrices of All Explanatory Variables for 1994, 2004 and 2014

Table C.7.1. Correlation Matrix of All Variables 1994

1994	NMR	Votes *Greens*	Votes *Left*	Male Unemployment	Female Labour Force Participation	Female Education	Population Density	GDP per Capita
NMR		-0.42	0.94	0.76	0.55	0.39	0.01	-0.36
Votes *Greens*	-0.42		-0.48	-0.33	-0.16	0.31	0.41	0.58
Votes *Left*	0.94	-0.48		0.69	0.60	0.34	-0.03	-0.44
Male Unemployment	0.76	-0.33	0.69		0.20	0.43	0.24	-0.22
Female Labour Force Participation	0.55	-0.16	0.60	0.20		0.19	0.06	-0.02
Female Education	0.39	0.31	0.34	0.43	0.19		0.49	0.29
Population Density	0.01	0.41	-0.03	0.24	0.06	0.49		0.56
GDP per Capita	-0.36	0.58	-0.44	-0.22	-0.02	0.29	0.56	

Table C.7.2. Correlation Matrix of All Variables 2004

2004	NMR	Votes *Greens*	Votes *Left*	Male Un-employ-ment	Female Labour Force Partici-pation	Female Educa-tion	Popula-tion Den-sity	GDP per Capita
NMR		-0.49	0.95	0.87	0.37	0.35	-0.09	-0.32
Votes *Greens*	-0.49		-0.49	-0.43	-0.22	0.30	0.53	0.57
Votes *Left*	0.95	-0.49		0.80	0.46	0.36	-0.12	-0.33
Male Unemploy-ment	0.87	-0.43	0.80		0.09	0.38	0.12	-0.24
Female Labour Force Participa-tion	0.37	-0.22	0.46	0.09		0.01	-0.19	-0.08
Female Educa-tion	0.35	0.30	0.36	0.38	0.01		0.47	0.33
Population Den-sity	-0.09	0.53	-0.12	0.12	-0.19	0.47		0.57
GDP per Capita	-0.32	0.57	-0.33	-0.24	-0.08	0.33	0.57	

Table C.7.3. Correlation Matrix of All Variables 2014

2014	NMR	Votes *Greens*	Votes *Left*	Male Unemployment	Female Labour Force Participation	Female Education	Population Density	GDP per Capita
NMR		-0.44	0.94	0.72	0.46	0.12	-0.07	-0.27
Votes *Greens*	-0.44		-0.42	-0.24	-0.38	0.42	0.49	0.46
Votes *Left*	0.94	-0.42		0.64	0.52	0.13	-0.03	-0.23
Male Unemployment	0.72	-0.24	0.64		-0.07	0.35	0.33	-0.11
Female Labour Force Participation	0.46	-0.38	0.52	-0.07		-0.26	-0.36	-0.18
Female Education	0.12	0.42	0.13	0.35	-0.26		0.48	0.35
Population Density	-0.07	0.49	-0.03	0.33	-0.36	0.48		0.52
GDP per Capita	-0.27	0.46	-0.23	-0.11	-0.18	0.35	0.52	

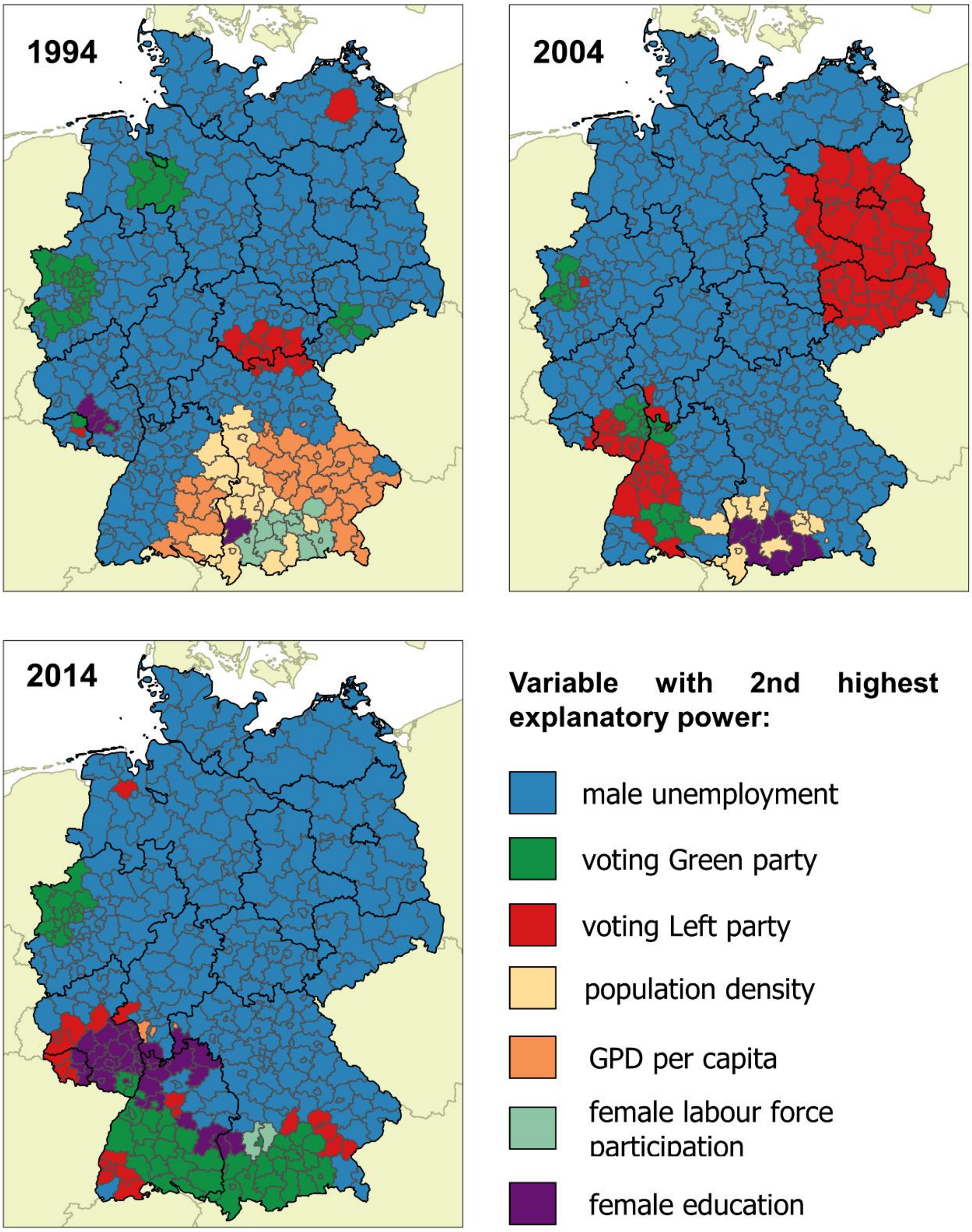
C.8 Table: Correlations for Male Unemployment and Voting in East and West Germany.

		Correlation of male unemployment with		
		Voting for Greens and Left	***Voting for Greens***	***Voting for Left***
All	*1994*	0.65	-0.33	0.69
	2004	0.65	-0.43	0.80
	2014	0.59	-0.24	0.64
West	*1994*	0.17	0.11	0.25
	2004	0.08	0.02	0.57
	2014	0.37	0.06	0.72
East	*1994*	0.05	-0.14	0.09
	2004	-0.07	-0.26	0.10
	2014	0.04	-0.16	0.17

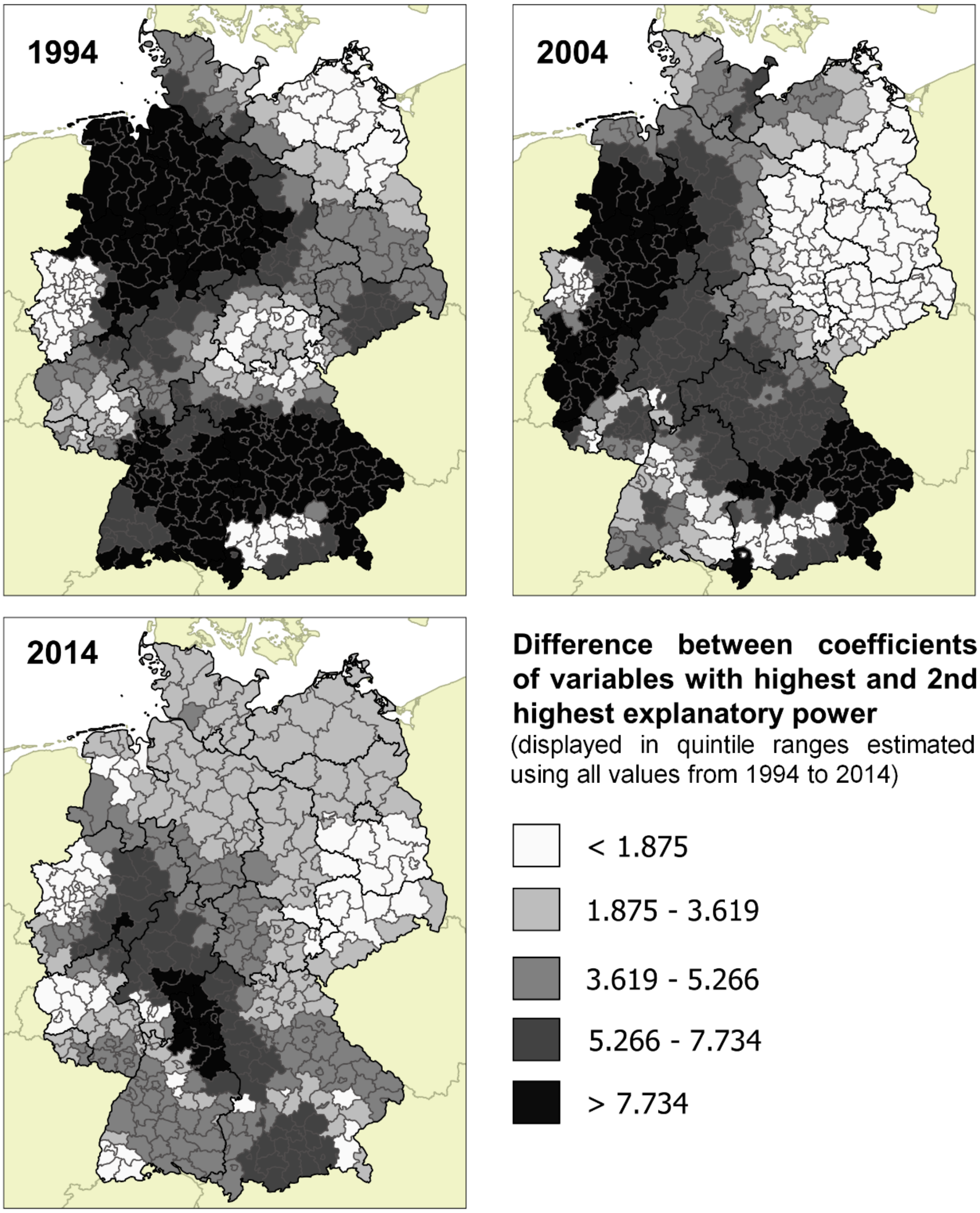
C.9 Table: Local Variance Inflation Factor for GWR Model

Variable	Year	Min	1st Qu.	Median	Mean	3rd Qu.	Max.
***Left* party**	1994	1.21	1.95	3.89	3.84	5.29	8.86
	2004	1.15	1.74	3.49	3.76	5.50	8.74
	2014	1.29	1.70	2.50	2.96	4.31	5.73
***Green* party**	1994	1.55	1.93	2.22	2.25	2.47	3.44
	2004	2.11	2.55	3.03	3.06	3.59	4.26
	2014	1.57	2.05	2.55	2.72	3.14	4.85
Male unemployment	1994	1.57	2.01	2.33	2.62	3.03	5.67
	2004	2.05	2.86	3.40	3.43	3.83	5.43
	2014	2.26	2.90	3.11	3.28	3.42	5.82
Female labour force participation	1994	1.29	1.67	1.94	2.03	2.32	3.42
	2004	1.18	1.40	1.74	1.71	1.97	2.64
	2014	1.22	1.59	2.11	2.24	2.83	3.89
Female education	1994	1.94	2.16	2.35	2.41	2.51	3.61
	2004	1.89	2.22	2.45	2.47	2.63	3.40
	2014	1.40	1.84	2.03	2.00	2.17	2.56
GDP per capita	1994	1.78	2.24	2.69	2.78	3.13	5.07
	2004	1.53	1.86	2.20	2.28	2.57	3.90
	2014	1.34	1.58	1.82	1.92	2.16	3.35
Population density	1994	1.22	1.62	2.29	2.30	2.81	4.09
	2004	2.17	2.52	3.00	3.00	3.38	4.40
	2014	1.93	2.57	3.01	3.17	3.67	5.83

C.10 Figure: Variable with the Second Highest Explanatory Power

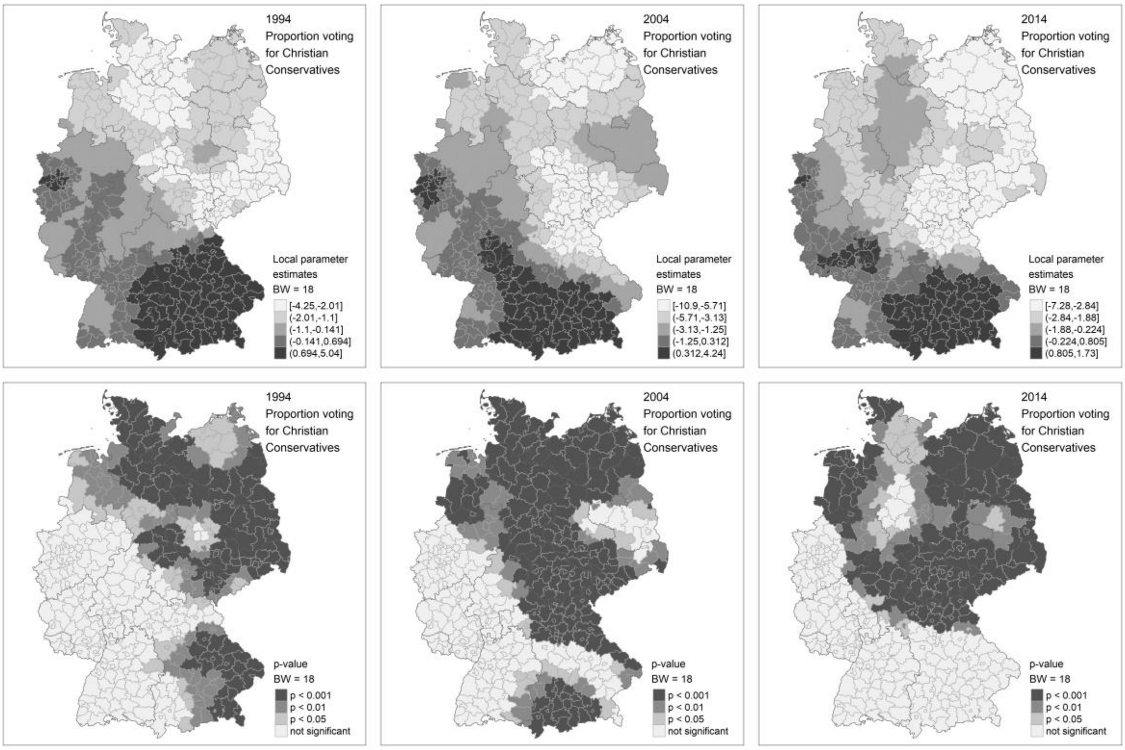


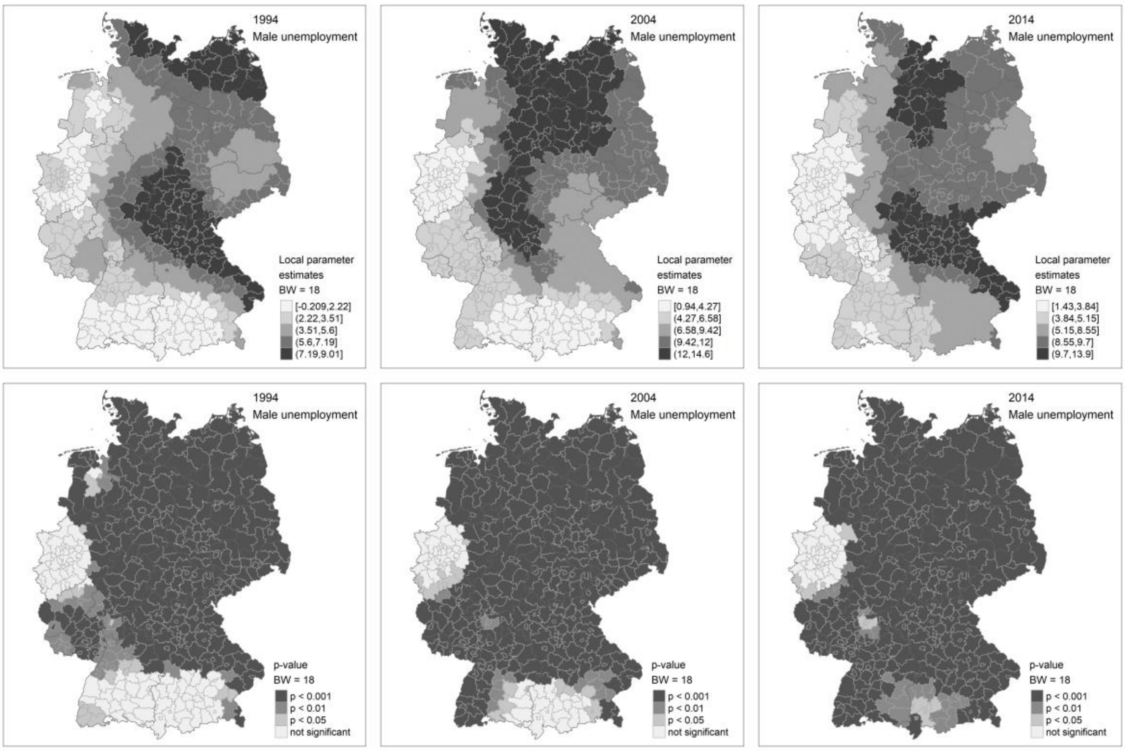
C.11 Figure: Differences of Parameter Estimates of Variable with Highest and Second Highest Explanatory Power



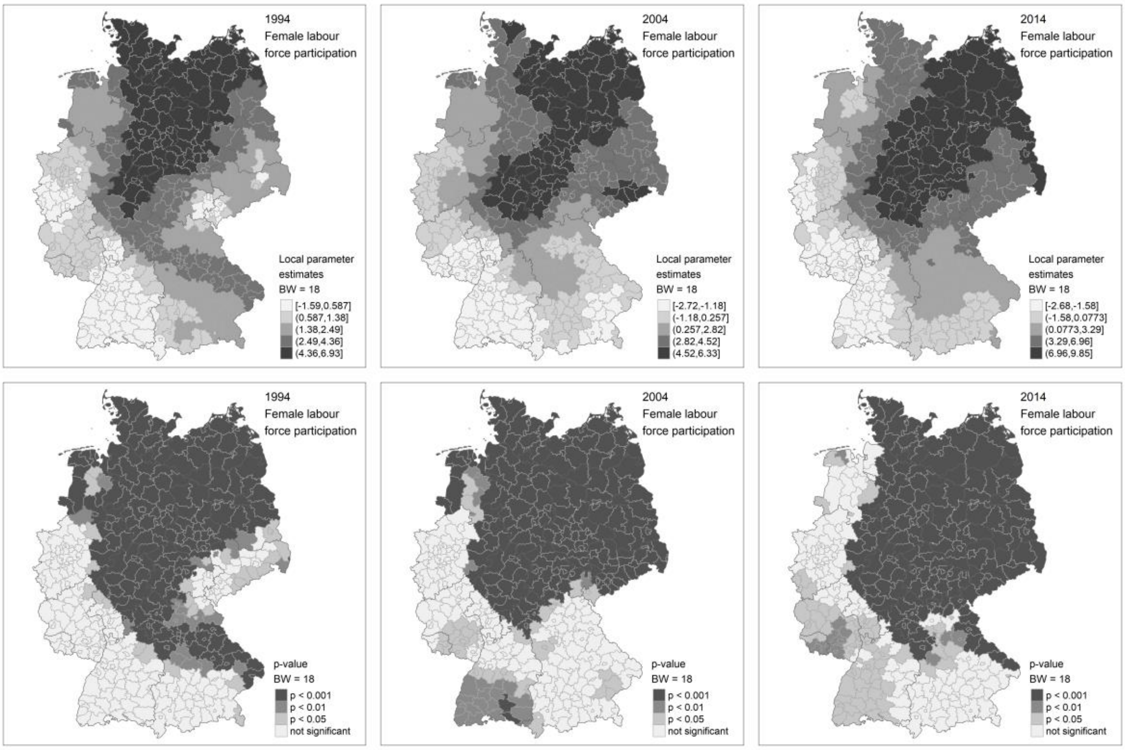
C.12 Figure: Alternative GWR Model including Votes for CDU/CSU (*Christian Conservatives*)

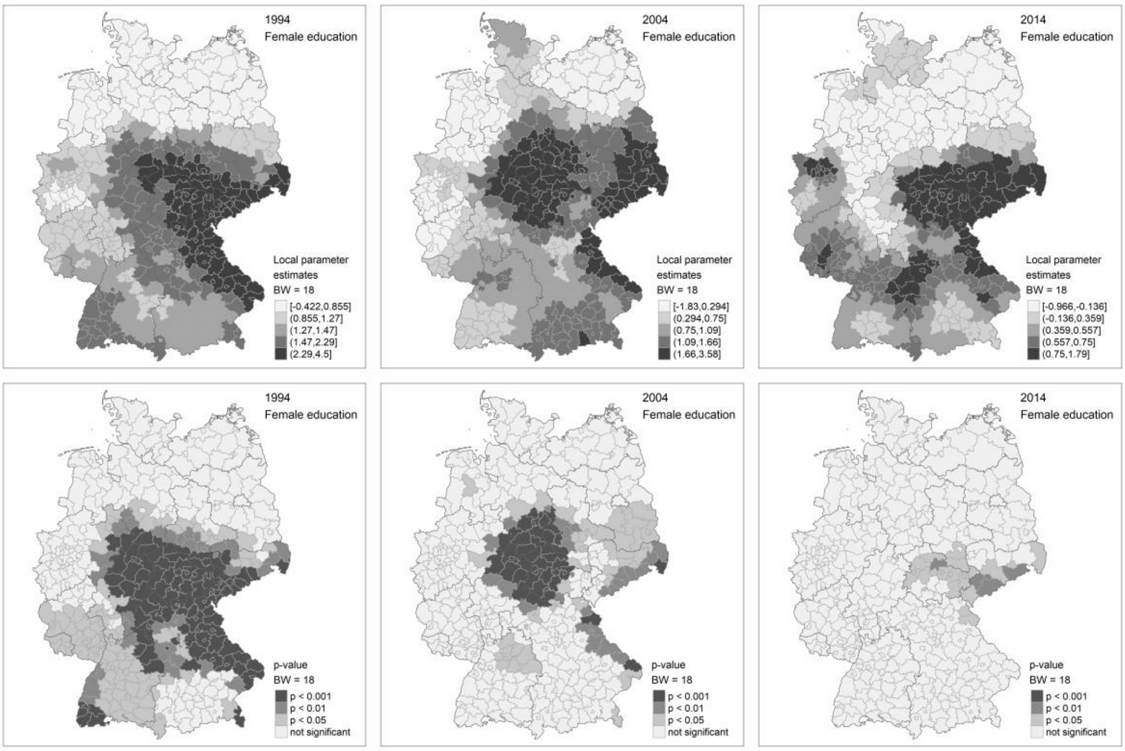
Year		
1994	2004	2014



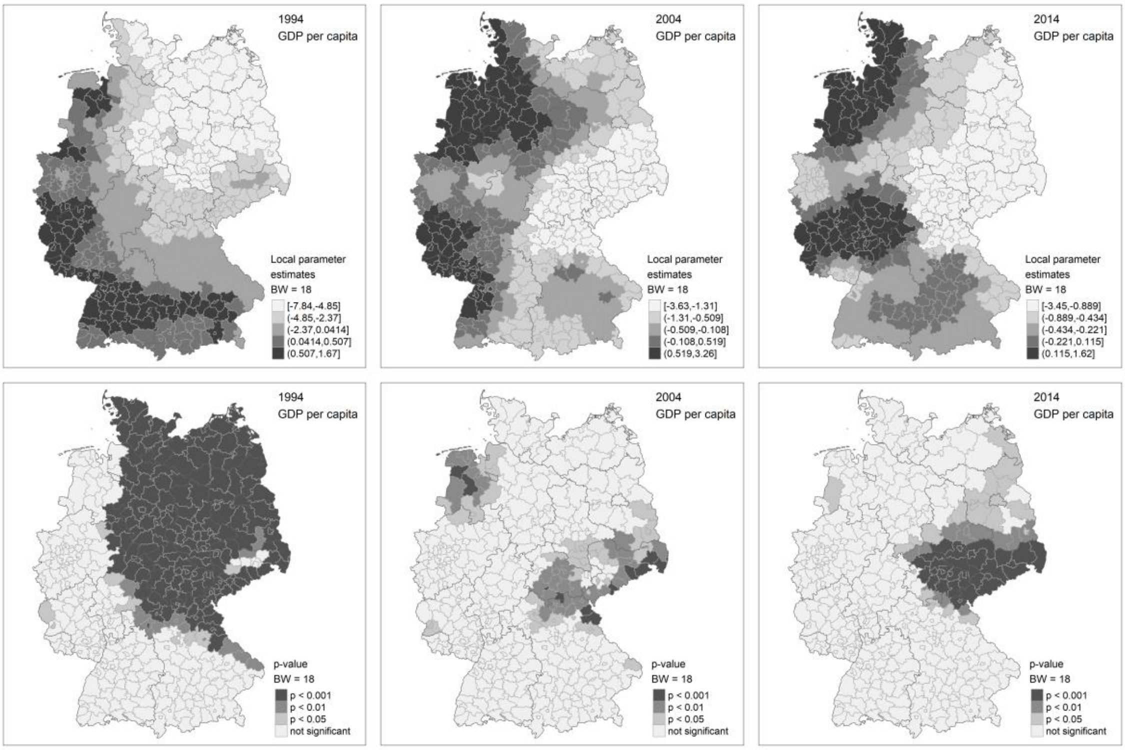


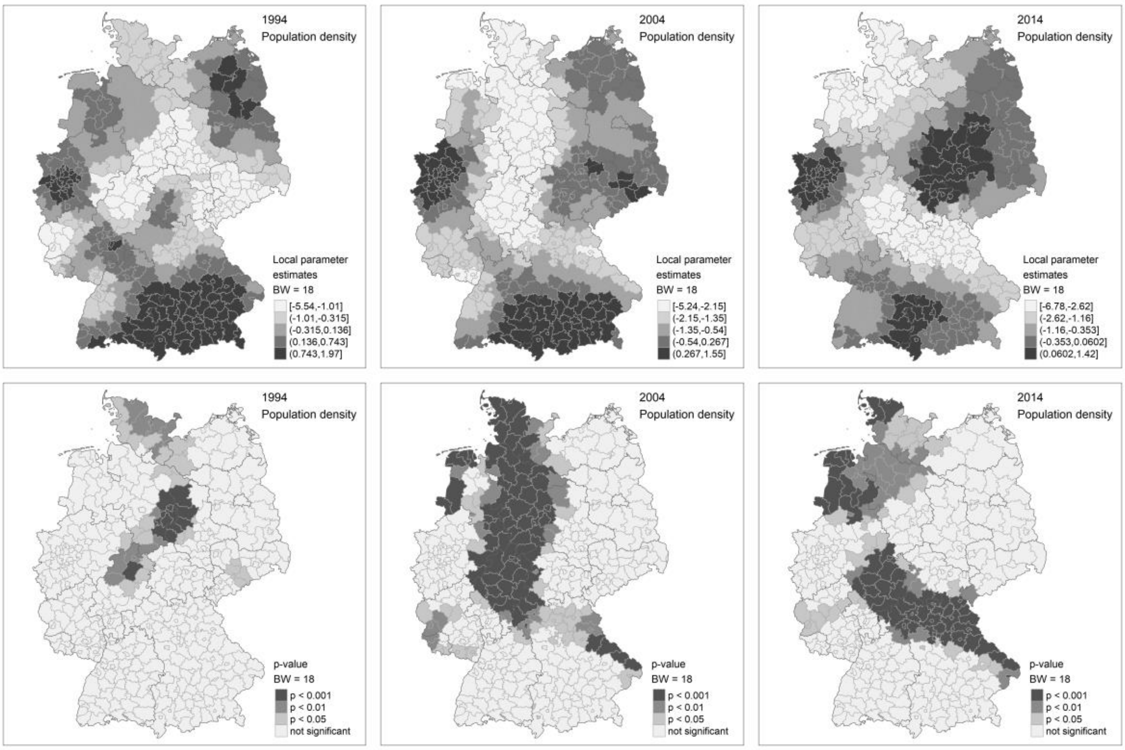
Year		
1994	2004	2014





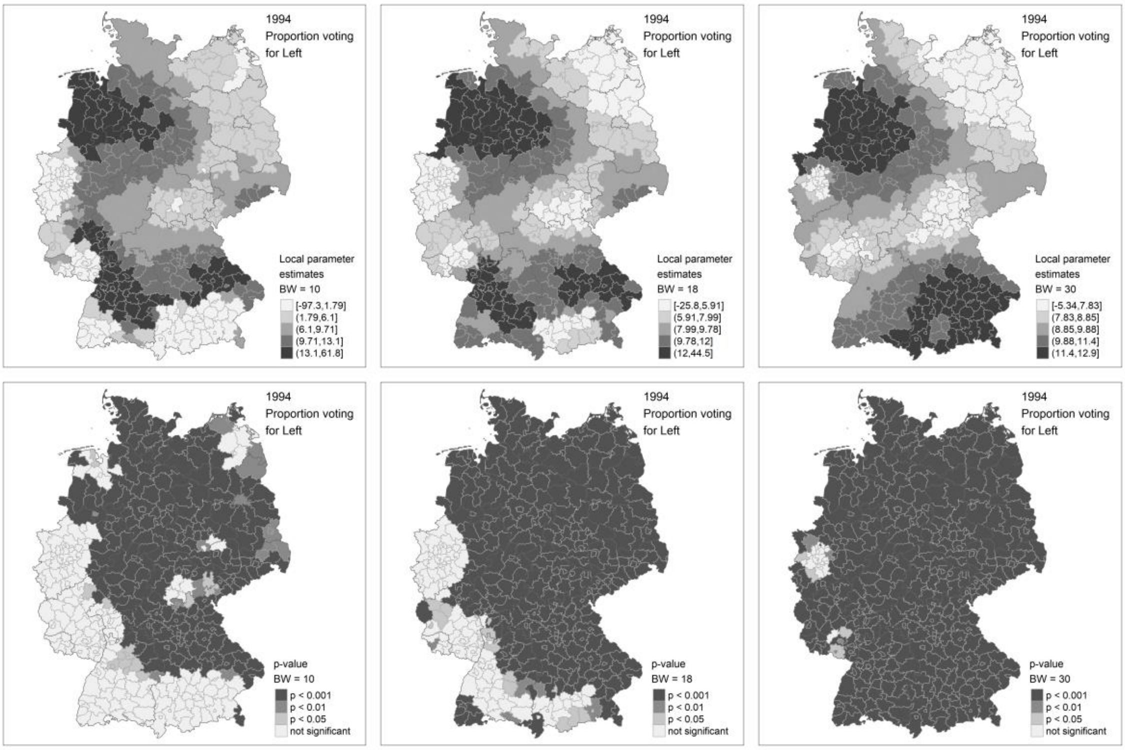
Year		
1994	2004	2014

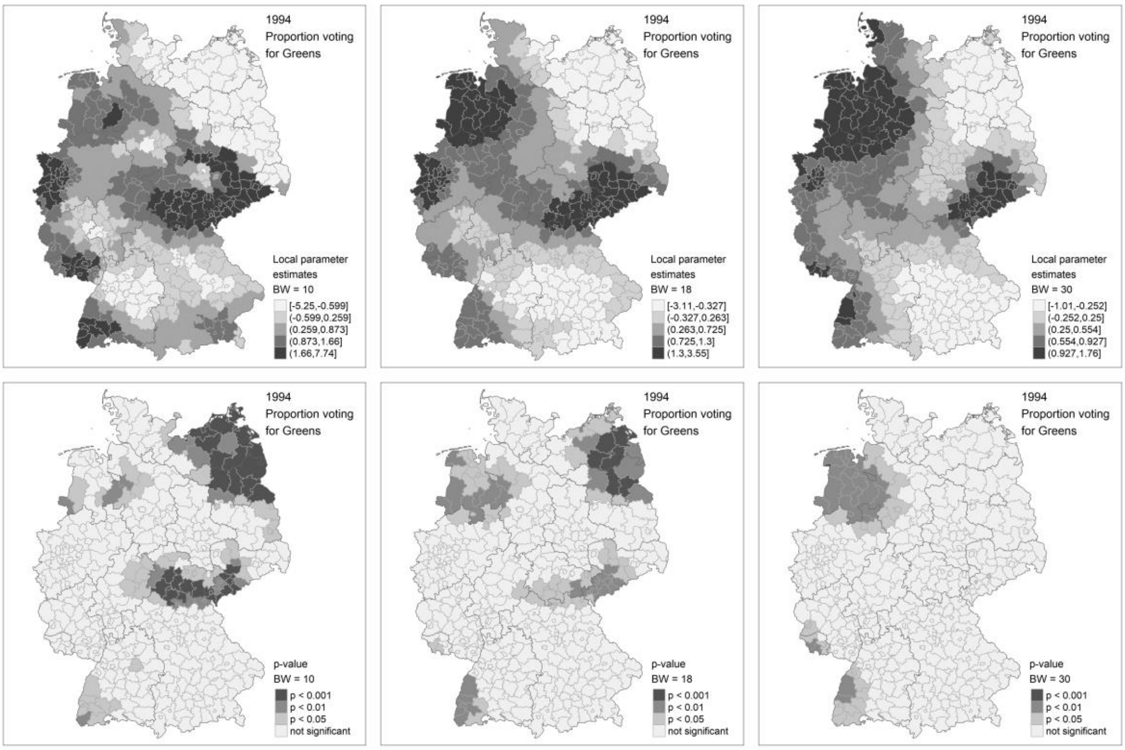




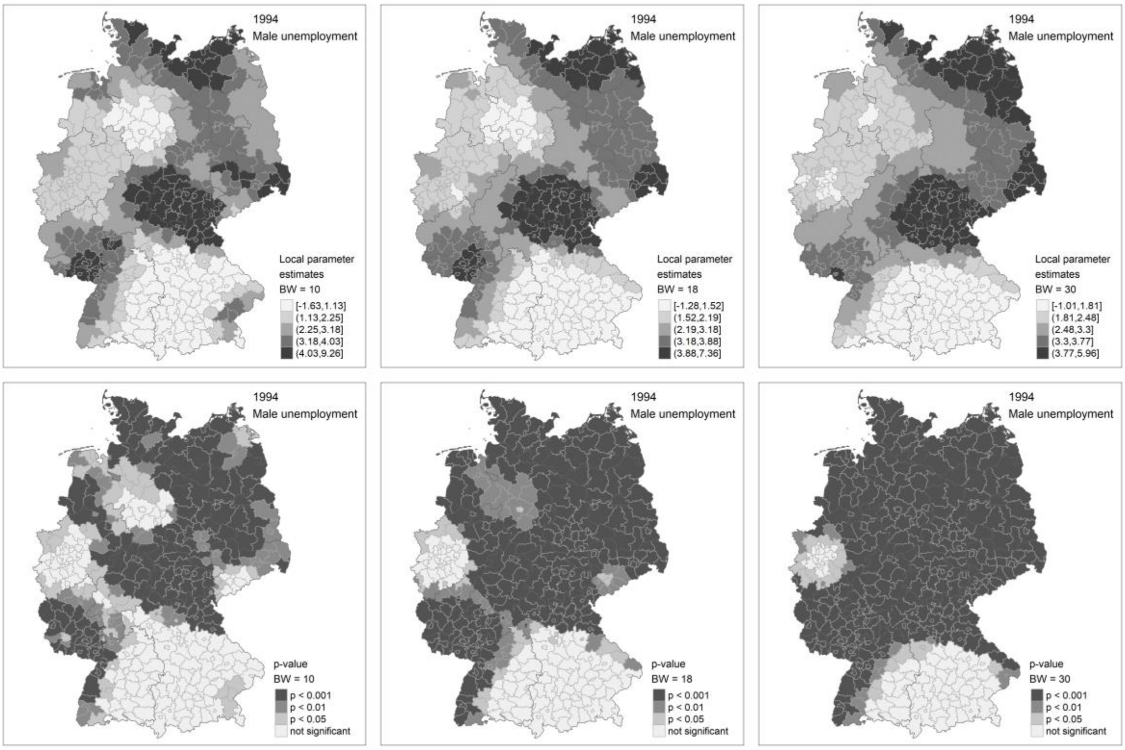
C.13 Figure: Alternative GWR with Smaller and Larger Bandwidth 1994

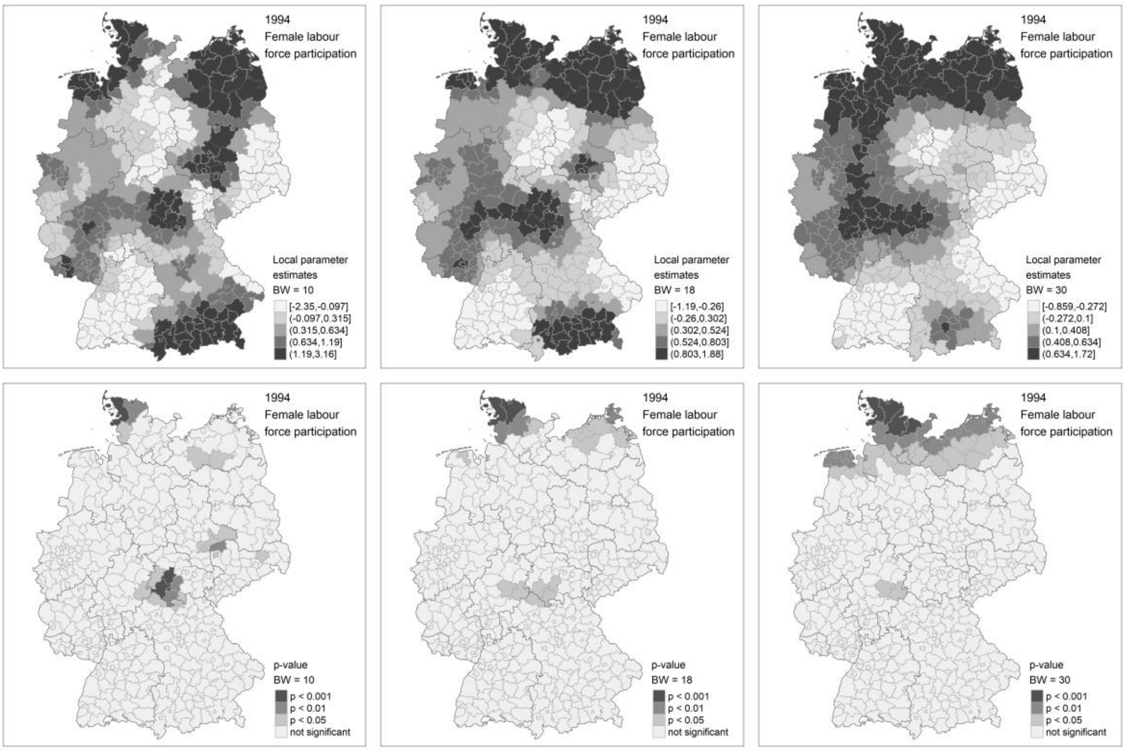
Bandwidth		
BW = 10	BW = 18	BW = 30



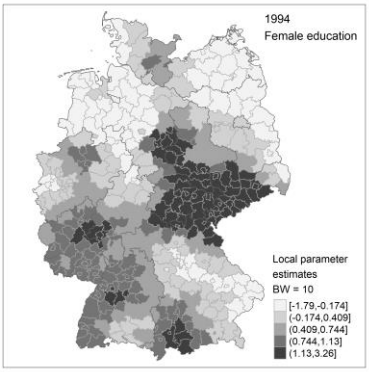


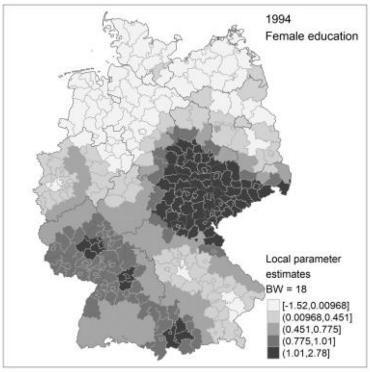
Bandwidth		
BW = 10	BW = 18	BW = 30

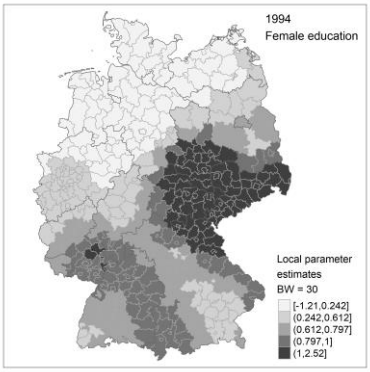


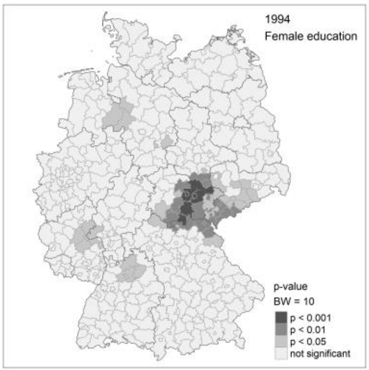


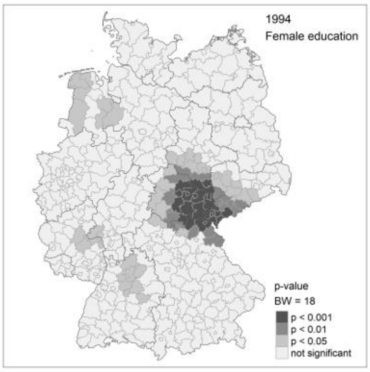
Bandwidth		
BW = 10	BW = 18	BW = 30

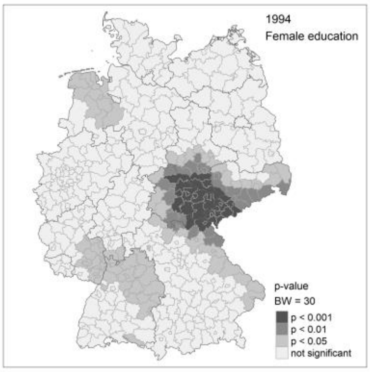


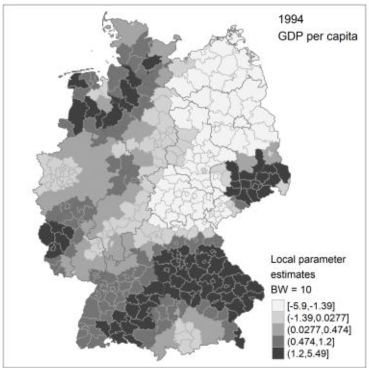


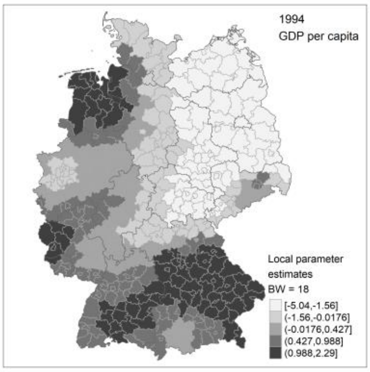


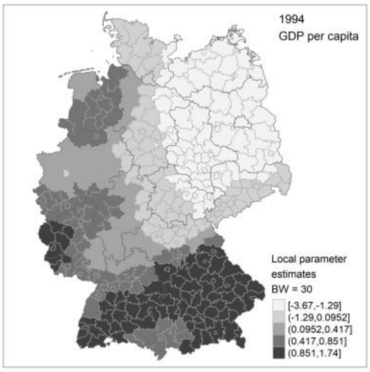


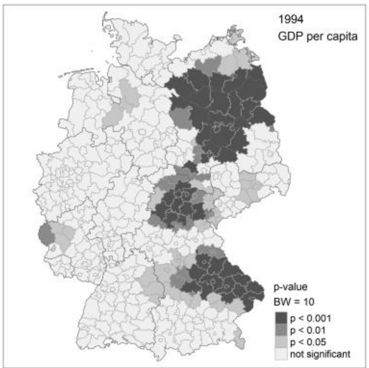


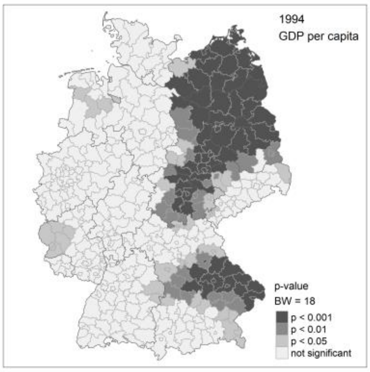


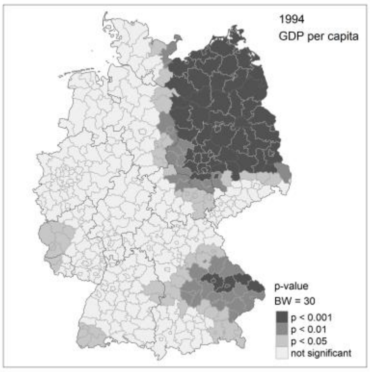




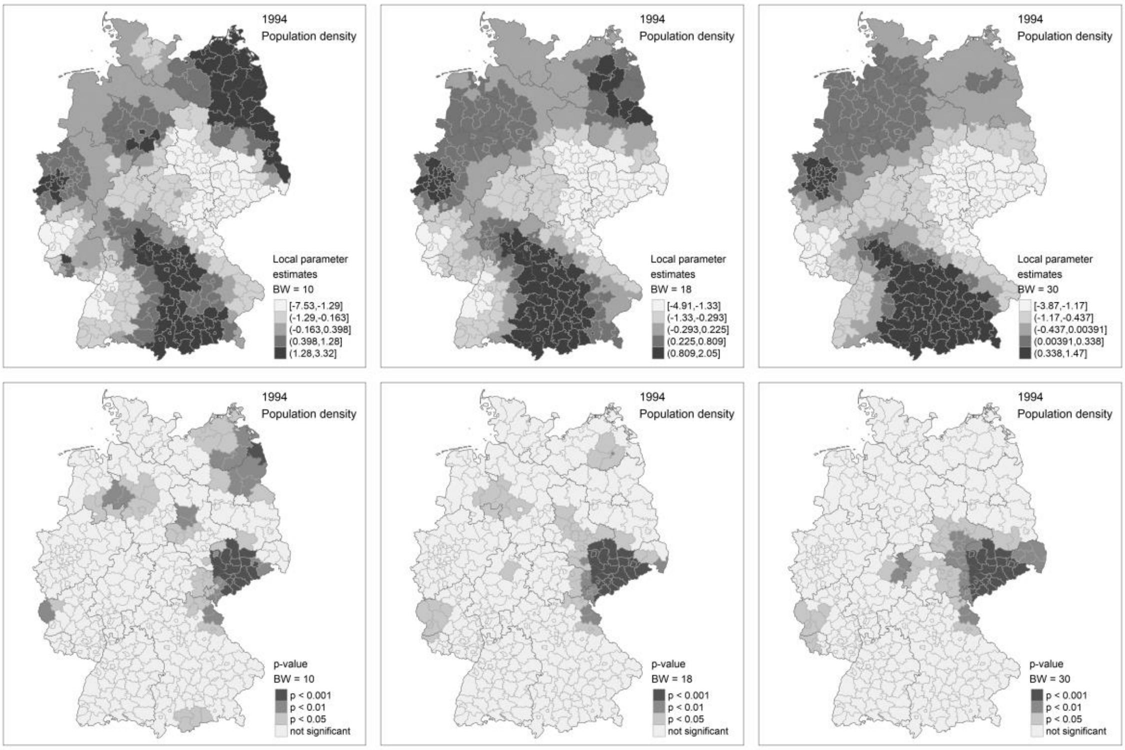






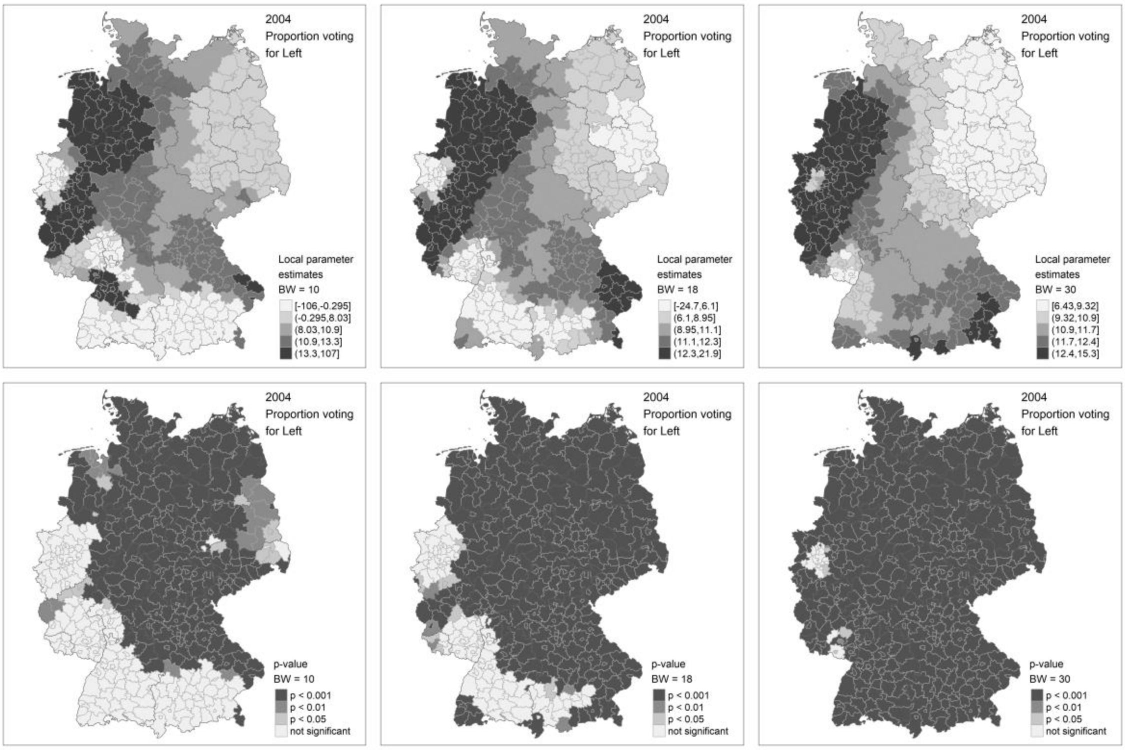


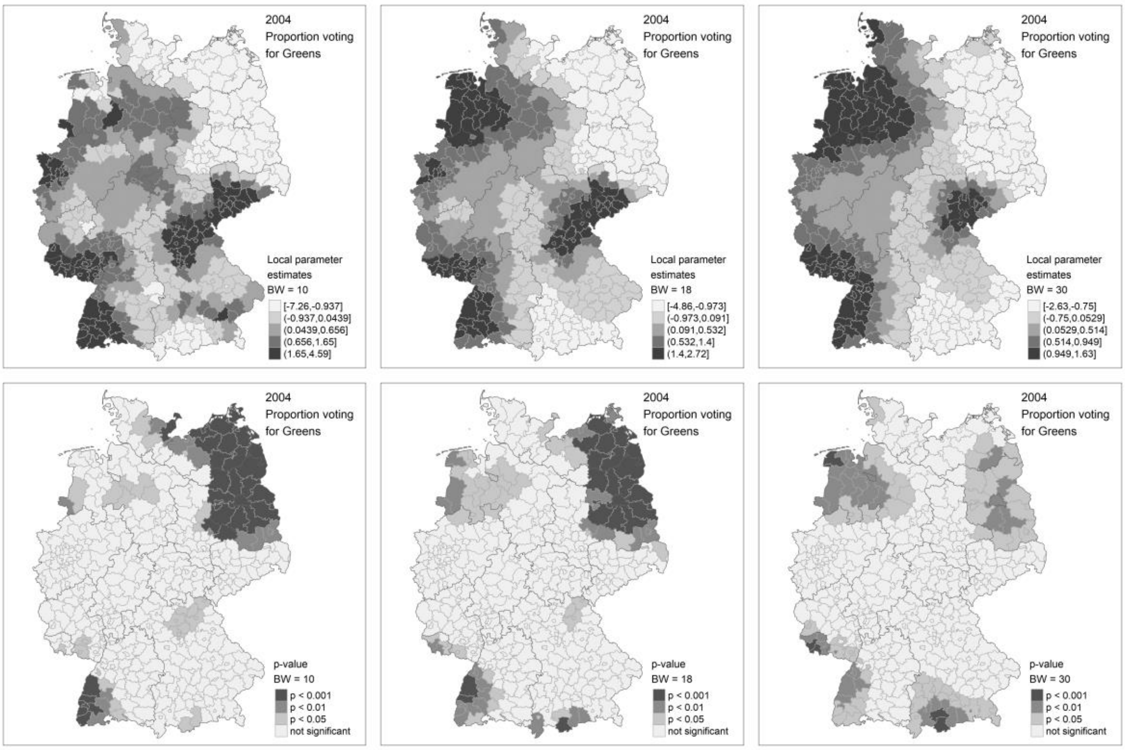
Bandwidth		
BW = 10	BW = 18	BW = 30



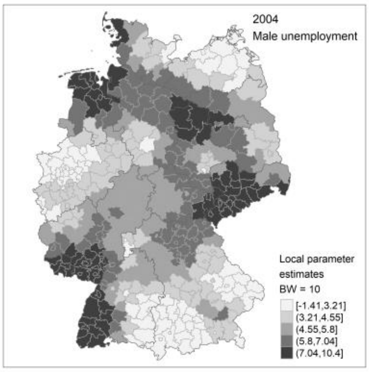
C.14 Figure: Alternative GWR with Smaller and Larger Bandwidth 2004

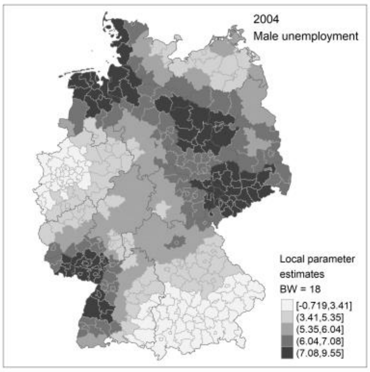
Bandwidth		
BW = 10	BW = 18	BW = 30





Bandwidth		
BW = 10	BW = 18	BW = 30





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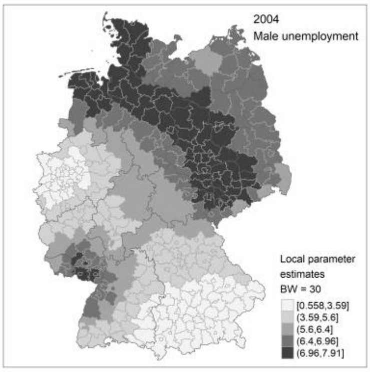

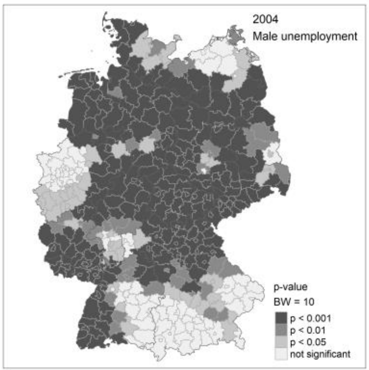

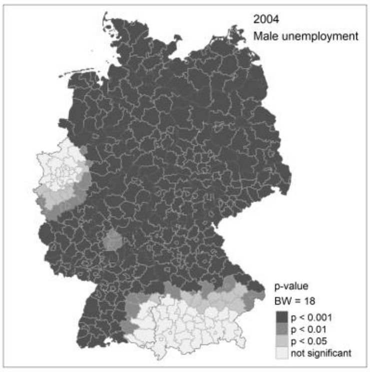

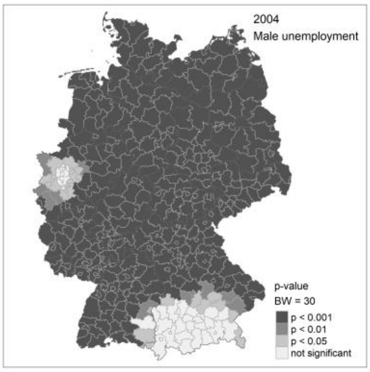

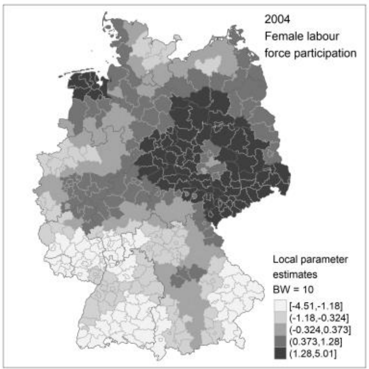

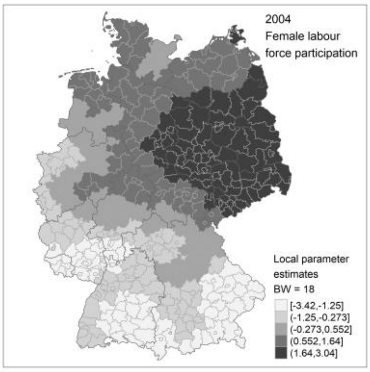

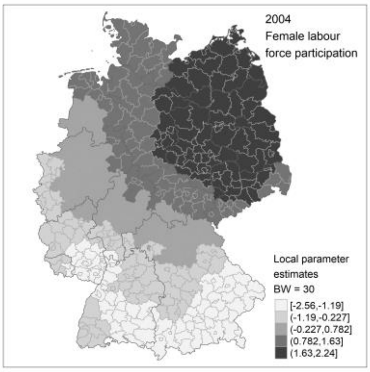

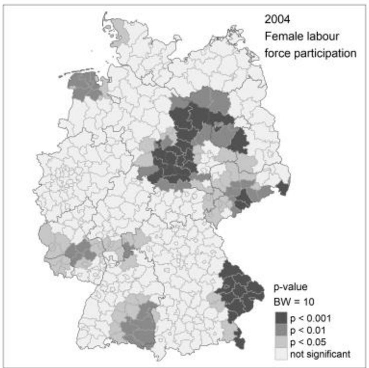

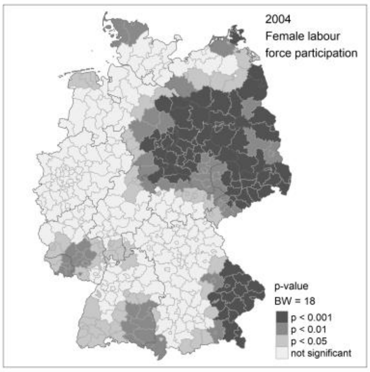

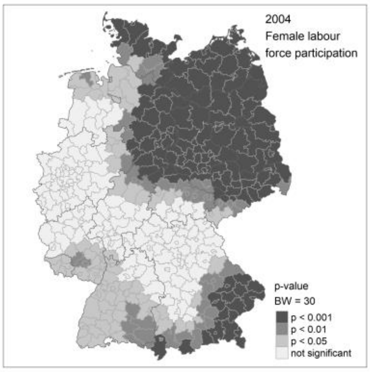

Bandwidth		
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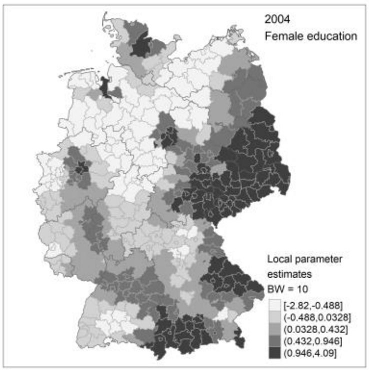
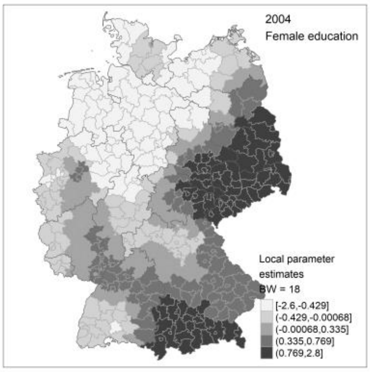
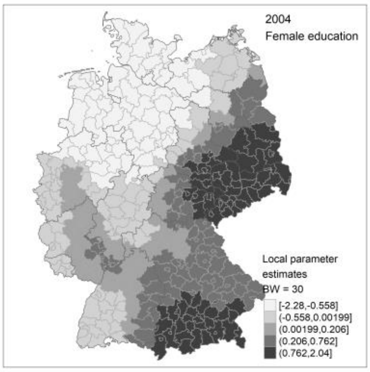
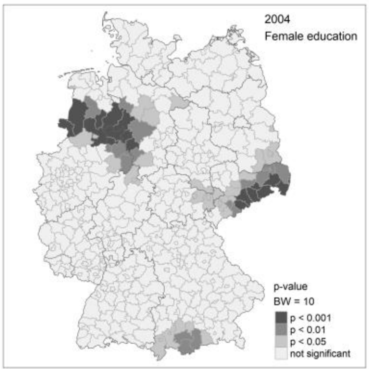
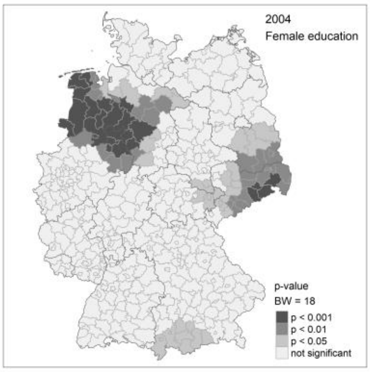
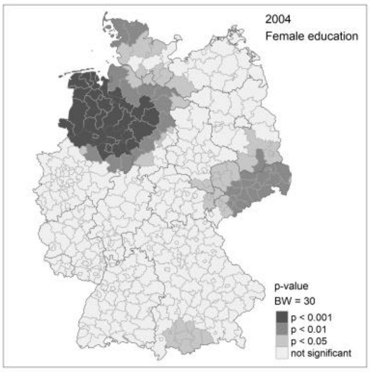


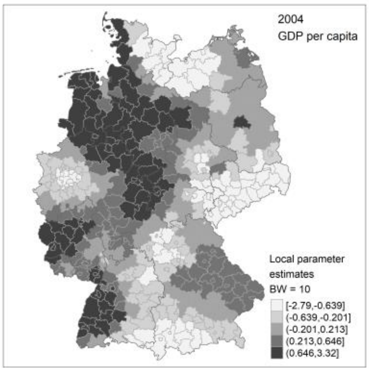


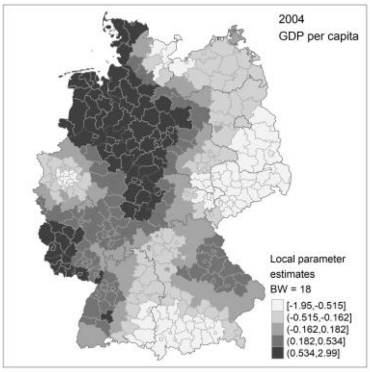


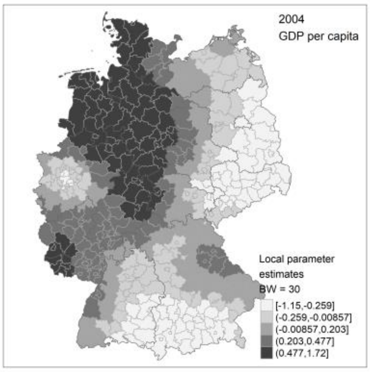


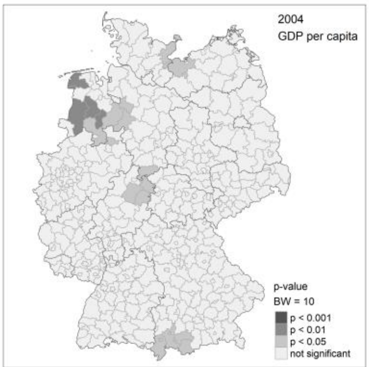


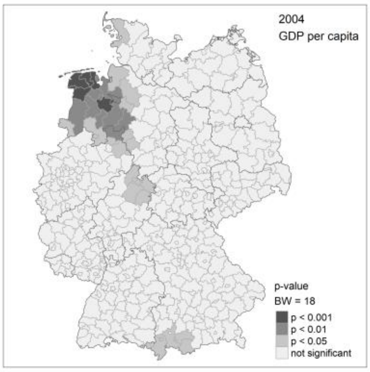


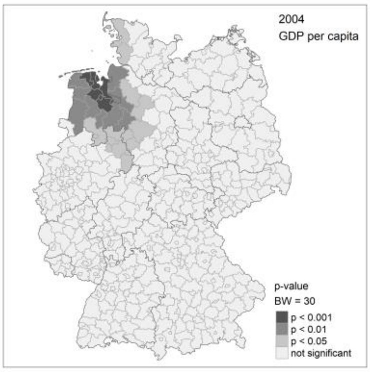




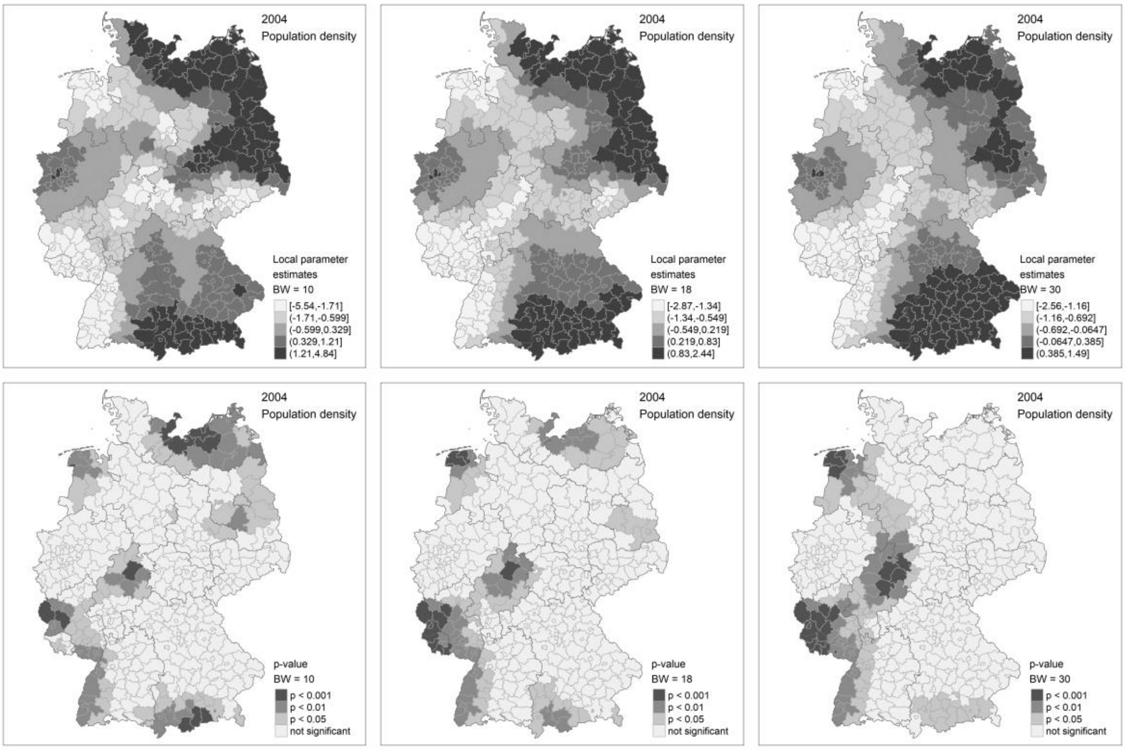








Bandwidth		
BW = 10	BW = 18	BW = 30



C.15 Figure: Alternative GWR with Smaller and Larger Bandwidth 2014

Bandwidth		
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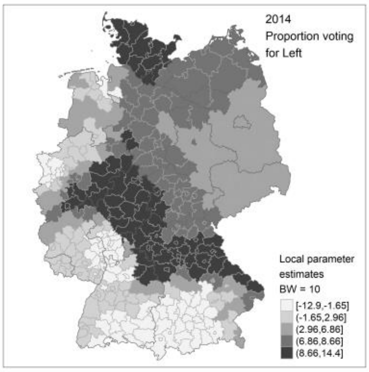

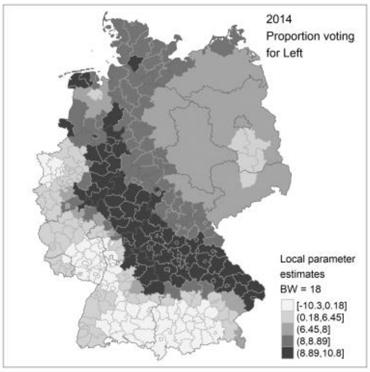

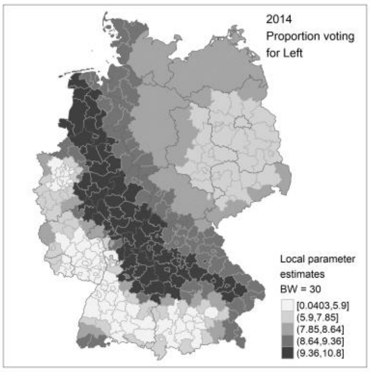

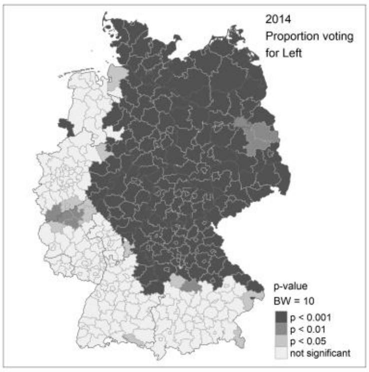

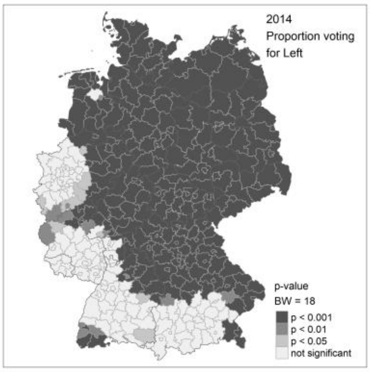

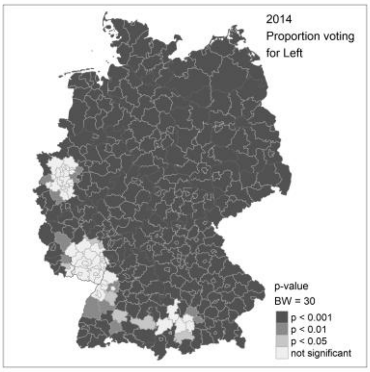

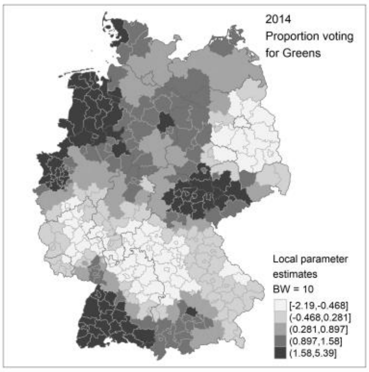

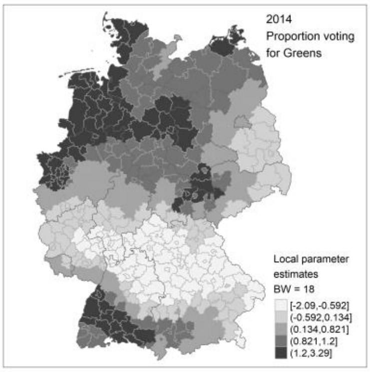

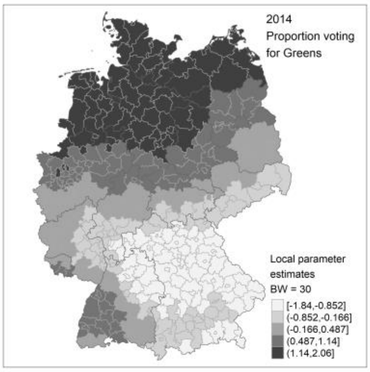

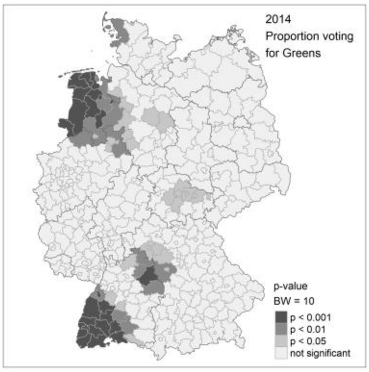

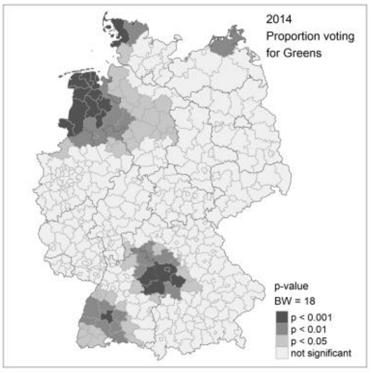

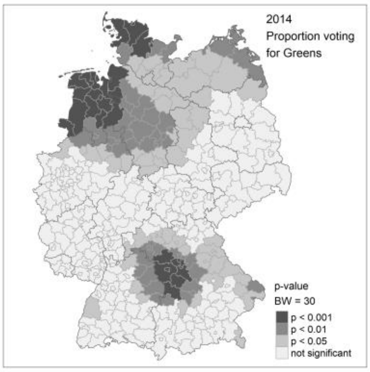

Bandwidth		
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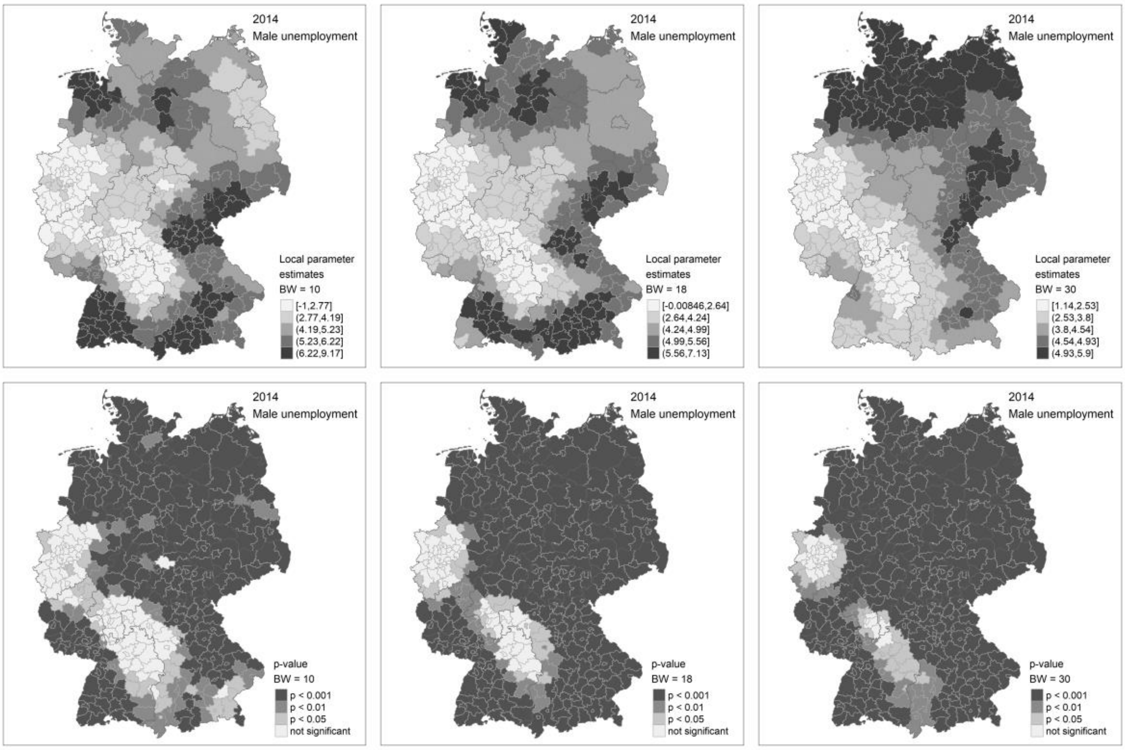
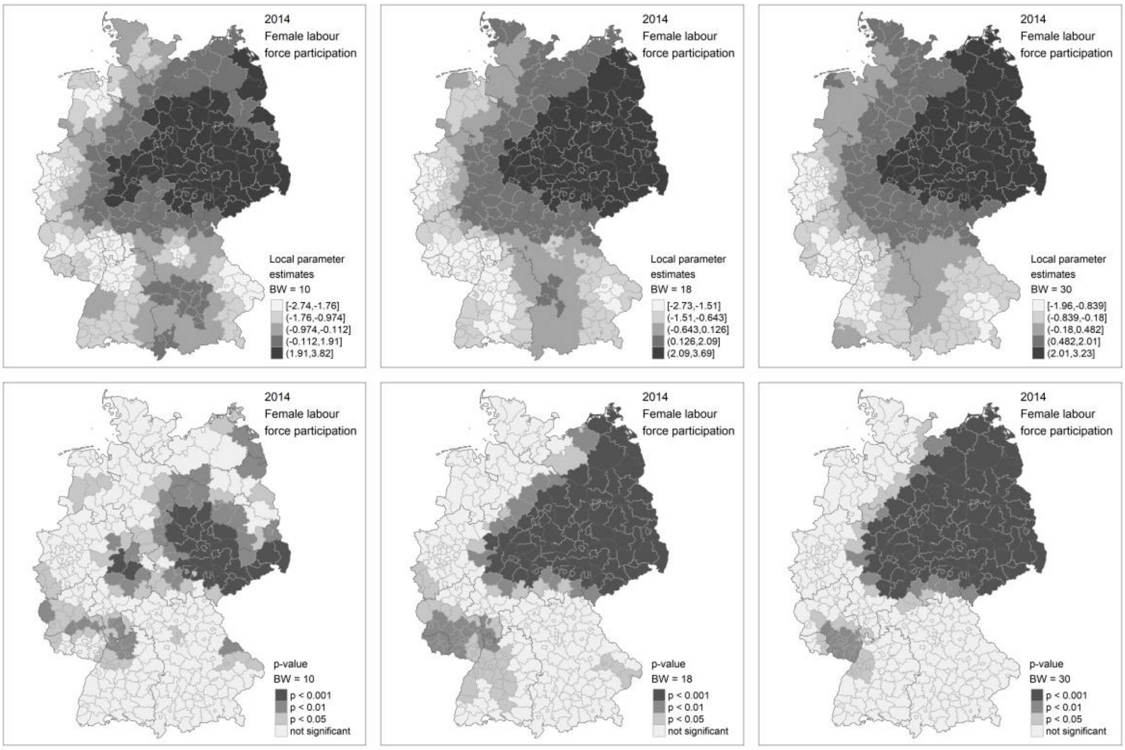
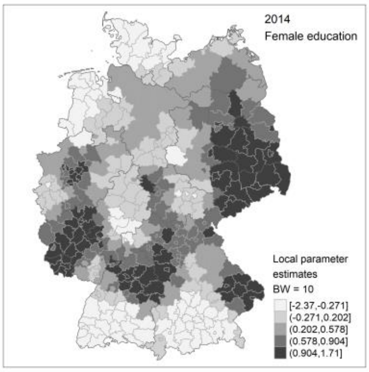
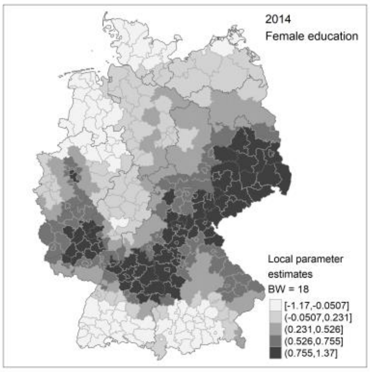
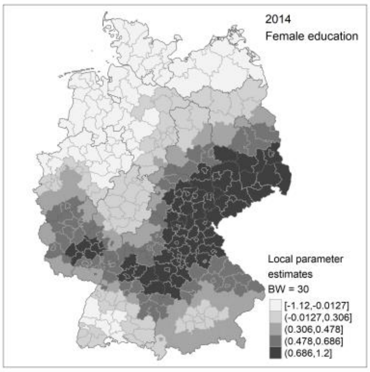


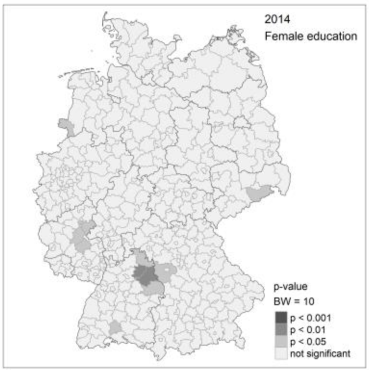


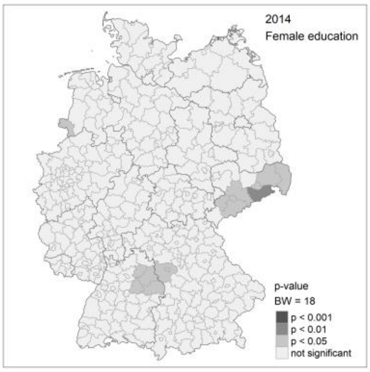
Bandwidth		
BW = 10	BW = 18	BW = 30

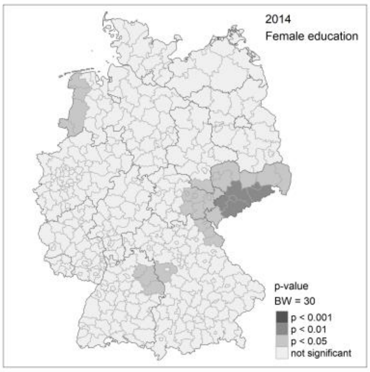


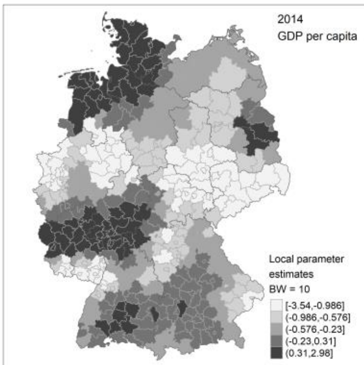


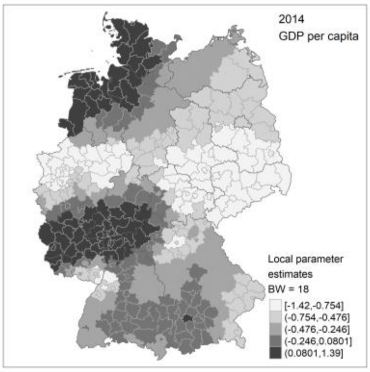


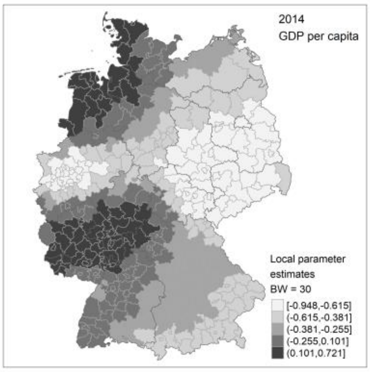


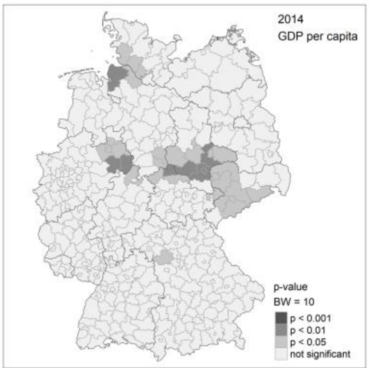


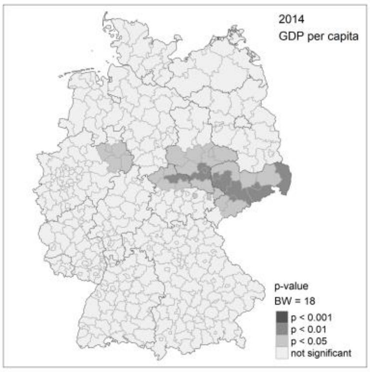


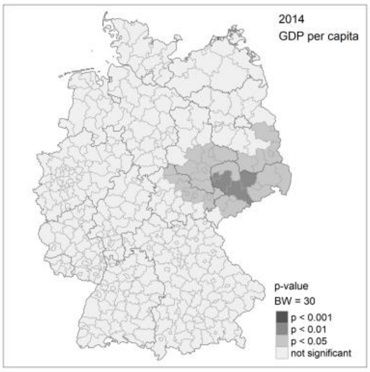












Bandwidth		
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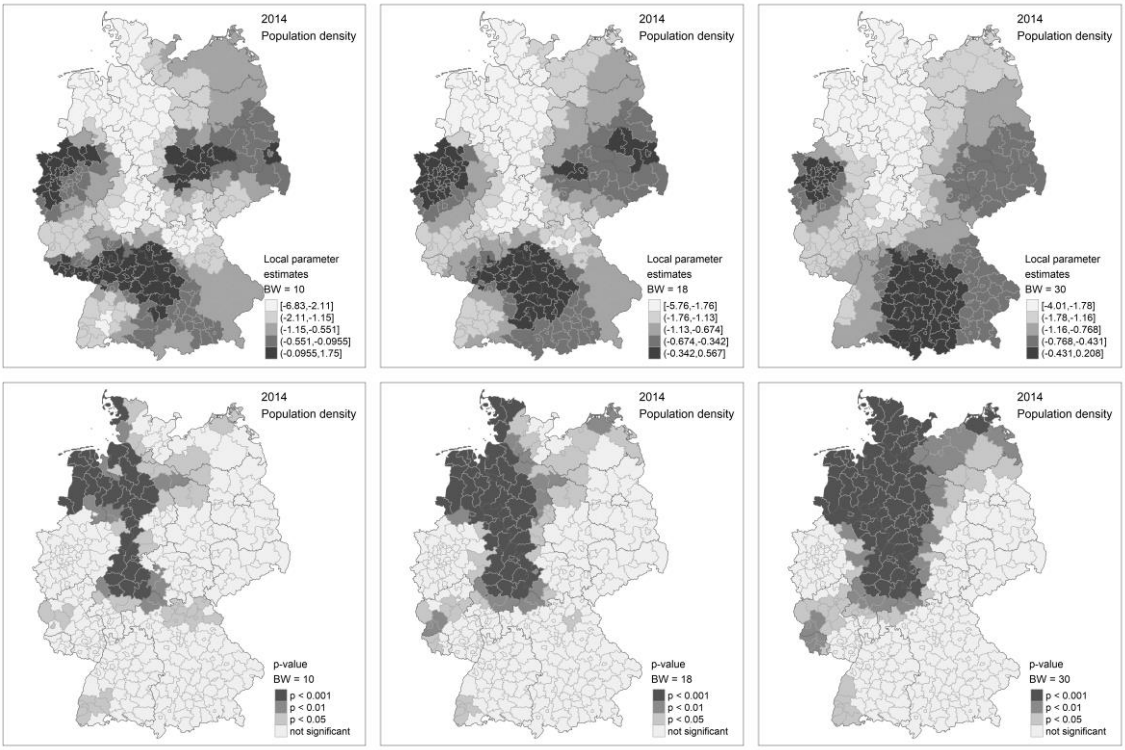
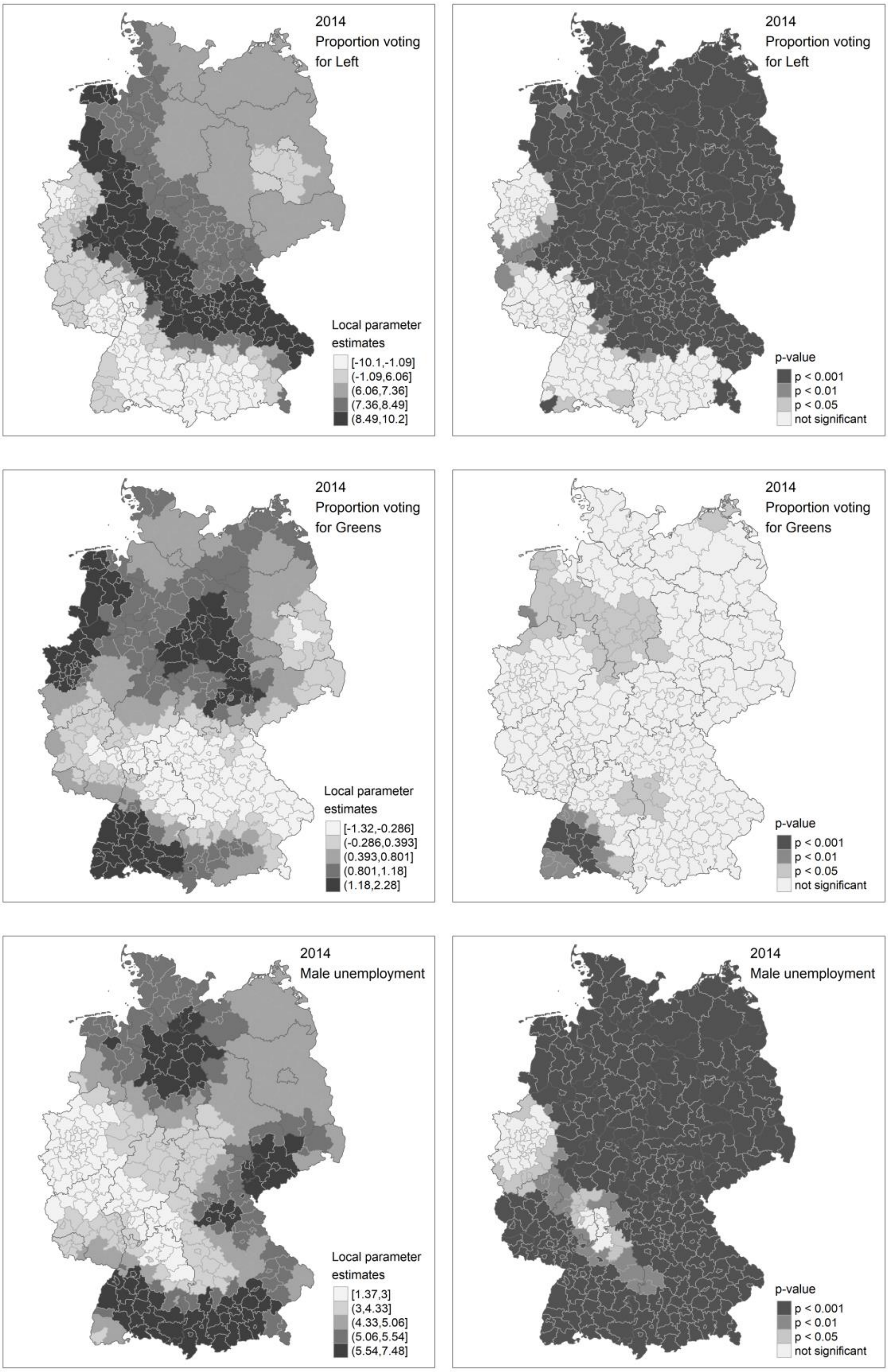
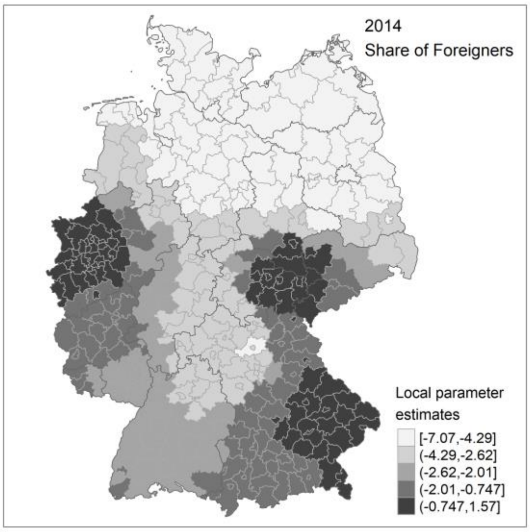
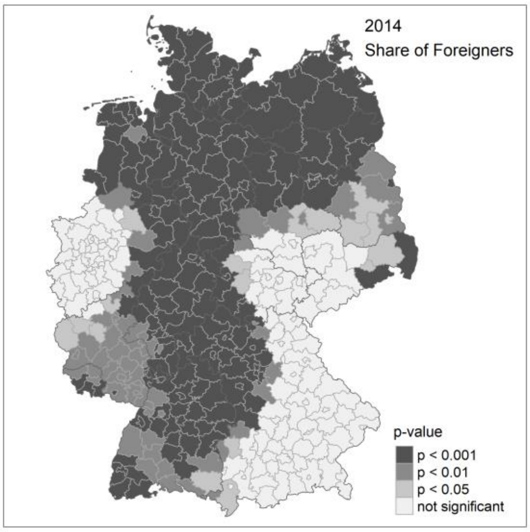
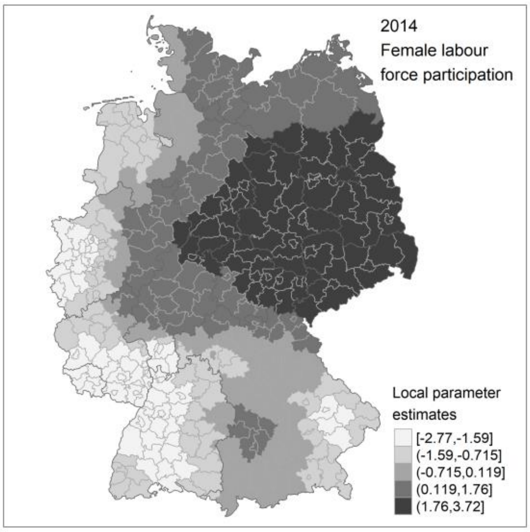


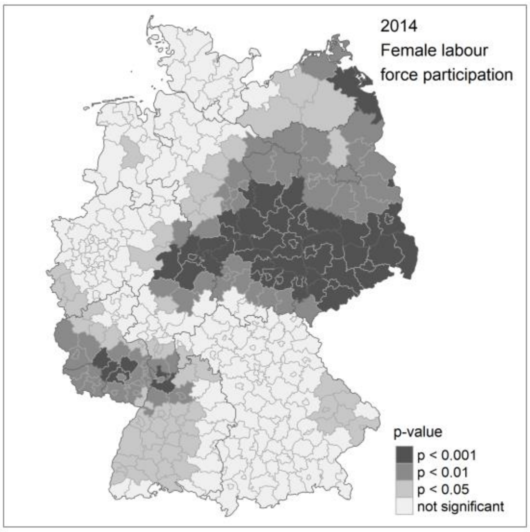
C.16 Figure: Alternative Model for 2014 including Share of Foreigners

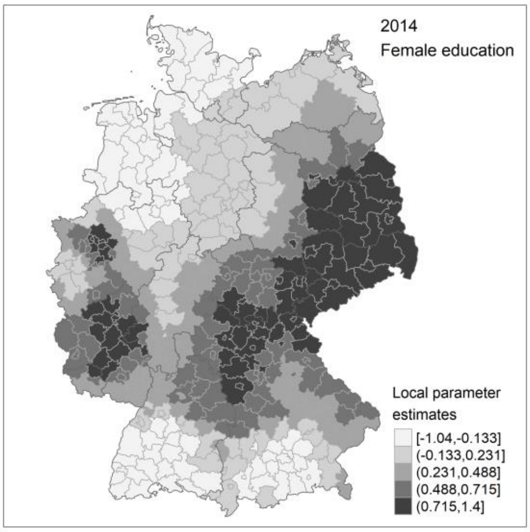


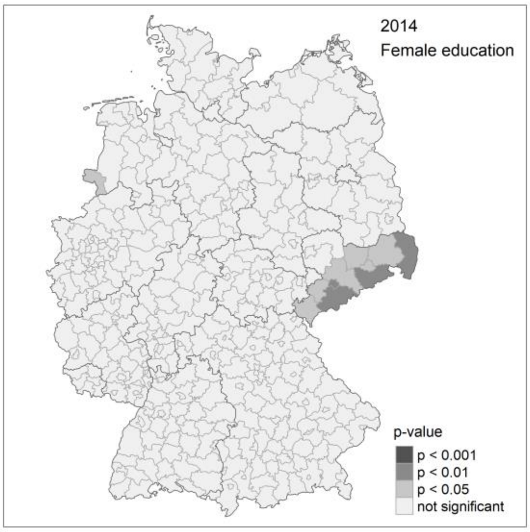

2014
Share of Foreigners
Local parameter
estimates
[-7.07,-4.29]
(-4.29,-2.62]
(-2.62,-2.01]
(-2.01,-0.747]
(-0.747,1.57]

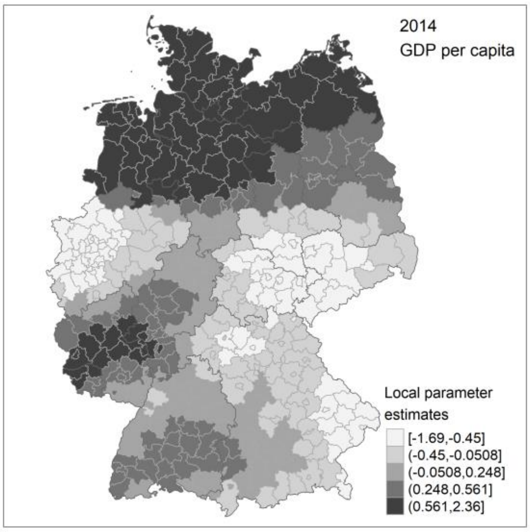

2014
Share of Foreigners
p-value
p < 0.001
p < 0.01
p < 0.05
not significant

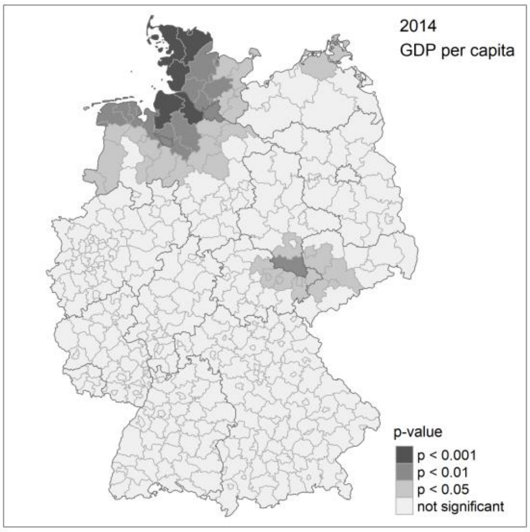

2014
Female labour
force participation
Local parameter
estimates
[-2.77,-1.59]
(-1.59,-0.715]
(-0.715,0.119]
(0.119,1.76]
(1.76,3.72]

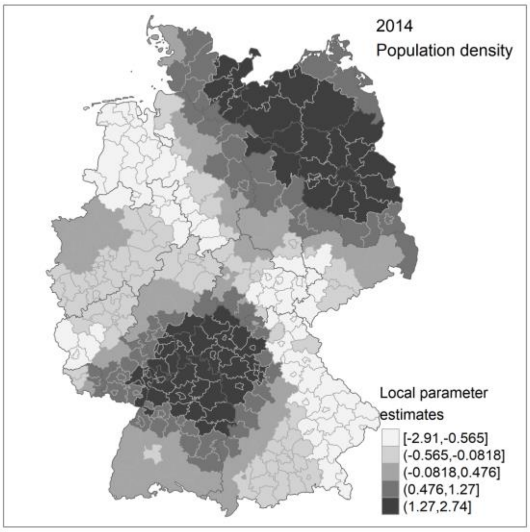

2014
Female labour
force participation
p-value
p < 0.001
p < 0.01
p < 0.05
not significant

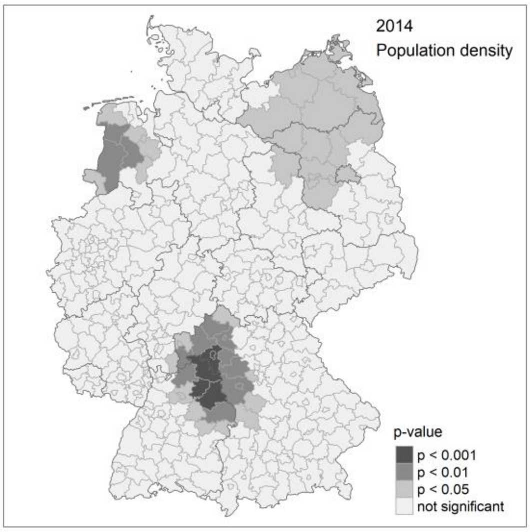

2014
Female education
Local parameter estimates
[-1.04,-0.133]
(-0.133,0.231]
(0.231,0.488]
(0.488,0.715]
(0.715,1.4]


2014
Female education
p-value
p < 0.001
p < 0.01
p < 0.05
not significant


2014
GDP per capita
Local parameter estimates
[-1.69,-0.45]
(-0.45,-0.0508]
(-0.0508,0.248]
(0.248,0.561]
(0.561,2.36]


2014
GDP per capita
p-value
p < 0.001
p < 0.01
p < 0.05
not significant


2014
Population density
Local parameter estimates
[-2.91,-0.565]
(-0.565,-0.0818]
(-0.0818,0.476]
(0.476,1.27]
(1.27,2.74]


2014
Population density
p-value
p < 0.001
p < 0.01
p < 0.05
not significant

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