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Demographic transition, population growth, demographic ageing – interrelations and development contexts at the regional level

Doctoral thesis

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Declaration:
I declare that this Thesis is my own work and that I cited all the used sources of information or literature. This Thesis or its substantial part has not been submitted to obtain another or equivalent academic degree.

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Demographic transition, population growth, demographic ageing – interrelations and development contexts at the regional level

Abstract

This thesis aims to examine how the timing and pace of the demographic transition correlated with the timing and pace of ageing at the regional level in Czechia and also to contribute to understanding the determinants and evolution of demographic transition, specifically mortality and fertility decline, and connect it with the population ageing. It is a common belief that ageing is the result of demographic transition, but there is a limited number of studies that investigate the interrelations between these two processes. The greatest challenge was the difficulty in comparing historical and current data caused by changes in the administrative division during 1868–2017. Thus, the recalculation of data was needed to analyse trends in mortality and fertility. 2011 statistical units at the level of districts were chosen as basic units for analysis. The data recalculation was preceded by the reconstruction of historical districts maps and population data estimation for intercensal periods. Data were recalculated using spatial overlays in GIS software and database processing operations both for population and vital statistics. This step was followed by the data analysis. Evolution of mortality and fertility levels was analysed. Districts were grouped by the timing and pace of demographic transition, but also by the onset and pace of ageing in order to identify similarities and differences among them. For the ageing chapter, age structures (0–14, 15–64, 65+) and old-age dependency ratio values were analysed. For understanding the roots of ageing, the interrelations between demographic transition and ageing were determined by using correlations and linear regression analysis. The results show a close link between the geographical position and demographic transition and ageing, and over time, the differences among districts are decreasing. Changes in age structure after the Second World War constituted a challenge for our research. However, we attempted to minimize their impact by selecting only the districts that didn't face substantial changes in age structure. The correlation between demographic transition and ageing showed relationships of moderate strength between the duration of demographic transition and speed of ageing, and the onset of demographic transition and proportion of population aged 65+ at the onset of ageing. Main contributions of this research are related to the original recalculation methodology of long historical data series going across multiple administrative division reforms of the country and the results related to the interrelations between demographic transition and ageing.

Keywords: demographic transition, fertility decline, population ageing, recalculation, interrelations, districts, Czechia

Demografický přechod, populační růst a demografické stárnutí - souvislosti a vývojové kontexty na regionální úrovni

Abstrakt

Tato práce si klade za cíl prozkoumat korelace načasování a tempa demografického přechodu s načasováním a tempem stárnutí na regionální úrovni v Česku. Zároveň přispívá k pochopení klíčových faktorů a vývoje demografického přechodu, konkrétně poklesu úmrtnosti a plodnosti, a spojit ji s procesem stárnutí populace. Stárnutí je všeobecně přijímáno jako důsledek demografického přechodu, nicméně existuje řada studií, které mezi těmito procesy podrobněji zkoumají vzájemné vztahy. Největší výzva spočívá v obtížnosti porovnání historických a aktuálních dat, zejména v důsledku změn ve správním členění v letech 1868–2017. Analýza trendů úmrtnosti a plodnosti tedy nutně vyžadovala detailní přepočet dat. Analýza byla provedena na úrovni okresů – statistické jednotky se stavem k roku 2011. Přepočtu dat předcházela rekonstrukce map historických okresů a odhad počtu obyvatel pro intercenzální období. Data byla následně přepočtena za použití prostorových překryvů v GIS a databázových operací jak pro populační, tak pro vitální statistiky. Po tomto kroku následovala analýza dat. Byl analyzován vývoj úmrtnosti a plodnosti. Okresy byly seskupeny podle načasování a tempa demografického přechodu, ale také podle nástupu a tempa stárnutí s cílem identifikovat jejich podobnosti a rozdíly. V kapitole stárnutí byly analyzovány věkové struktury (0–14, 15–64, 65+) a index závislosti starších osob. Pro pochopení příčin stárnutí populace byly vztahy mezi demografickým přechodem a stárnutím určeny s použitím korelací a lineární regresní analýzy. Výsledky ukazují zejména na těsnou vazbu mezi geografickou polohou a demografickým přechodem a stárnutím, a také na snižování rozdílů mezi okresy směrem do současnosti. Výzvou pro výzkum byly také změny věkové struktury po druhé světové válce, jejichž dopad na výsledky jsme se však snažili minimalizovat selekcí okresů, které nevykazovaly zásadní změny ve věkové struktuře. Korelace mezi demografickým přechodem a stárnutím ukázala méně výrazné vztahy mezi délkou demografického přechodu a rychlostí stárnutí a nástupem demografického přechodu, a podílem obyvatel ve věku 65+ na počátečních fázích stárnutí populace. Hlavní přínosy tohoto výzkumu souvisí s originální metodikou rekalkulace dlouhých časových řad napříč několikerými refomami v administrativním členění země, a také s výsledky souvisejícími s vazbami mezi demografickým přechodem a stárnutím.

Klíčová slova: demografický přechod, pokles porodnosti, stárnutí populace, přepočet dat, korelace, okresy, Česko

CONTENTS

LIST OF ABBREVIATIONS

CBR	Crude birth rate
CDR	Crude death rate
CZSO	Czech Statistical Office
EUROSTAT	European Statistical Office
IMR	Infant mortality rate
INED	The French Institute for Demographic Studies
OECD	Organization for Economic Co-operation and Development
TFR	Total fertility rate
UN	United Nations
WWI	First World War
WWII	Second World War

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Chapter 1
Introduction

1.1 Problem definition

The world is facing an accelerated population ageing. It is a common belief that ageing is the result of demographic transition, but there are not many studies that investigate the interrelations between these two processes. One of the greatest challenges is the lack of time series data, especially for the European transitions due to their duration. Thus, the longer the demographic transition is, the more frequent might be the changes in the administrative division that come with political changes. Another aspect is analyzing the demographic transition, ageing and their interrelations at the regional level. The demographic transition at the national level (e.g. Notestein 1945; Thompson 1949; Pavlík 1980; Kirk 1996) has been the centre of attention for a long time, the interest in regional demographic transition appeared later (e.g. Leasure 1963; Coale 1986; Fialová, Pavlík and Vereš 1990; Fialová 1991; Diebolt and Perrin 2017), and it wasn't researched in depth and its correlations with ageing, including for Czechia. The research on the demographic transition at the regional level will explain the current demographic situation from its roots because the comprehensive knowledge of the past is the prerequisite for any adequate explanation of current phenomena.

1.2 The research aim and objectives

The main goal of this study is to contribute to understanding the determinants and evolution of demographic transition, specifically mortality and fertility decline, and connect it with the population ageing. Basically connecting the past with the present, the historical data with the current data.

The aim of the research is to examine how the timing and pace of the demographic transition influenced or correlated with the timing and pace of ageing at the regional level in the Czech lands during the last century.

The research has the following objectives:

1. To identify the necessary data for the research:
   a. To create a database with available vital statistics data for the period 1831–2017 for Czechia.
   b. To create a database with the population data from 1869 to 2011 for Czechia from censuses.
2. To recalculate the data for every available year to the 2011 administrative division (76 districts identified in this thesis by LAU1 code, 77 districts including Praha).
3. To describe the demographic transition in the Czech lands.
4. To identify and assess the trends of the mortality and fertility decline at the regional level.
5. To identify and estimate the onset and duration of the demographic transition at the regional level.
6. To identify the similarities and differences among the districts in the onset and duration of the demographic transition.
7. To define and determine the timing and speed of ageing at the regional level.
8. To identify the similarities and differences in the timing and speed of ageing at the regional level.
9. To determine the correlations between the onset and duration of demographic transition and the timing and speed of ageing at the regional level.

1.3 Research questions and hypotheses

Research questions

1. Did the demographic transition follow the classical European model?
2. Where the demographic transition started first in the Czech lands?
3. Is there a link between demographic transition and geographical position?
4. How was the demographic transition diffused?
5. When did ageing start in Czechia?
6. Does demographic transition trigger ageing?

Research hypotheses

1. Demographic transition in the Czech lands followed the pattern of other European countries.
2. Demographic transition in the Czech lands started in the Northern districts and Praha, and then it diffused towards the peripheries.
3. There is a close link in the fertility decline of populations located in the same geographical region.
4. There is a close link between ageing and geographical position.
5. Timing and speed of ageing are correlated to the onset and speed of demographic transition at the regional level.

a. The onset of demographic transition (fertility decline) correlates with the speed of ageing at the regional level.
b. The onset of demographic transition (fertility decline) correlates with the onset of ageing at the regional level.
c. The duration of demographic transition correlates with the onset of ageing at the regional level.
d. The duration of demographic transition correlates with the speed of ageing at the regional level.
e. The onset of demographic transition (fertility decline) correlates with the proportion of population aged 65+ at the beginning of the ageing process at the regional level.

1.4 Outline of the study

This dissertation consists of 8 chapters. Chapter 1 or the Introduction chapter, includes the problem definition, the research aim, which is examining how the timing and pace of the demographic transition influenced or correlated with the timing and pace of ageing at the regional level in the Czech lands, and the objectives. This chapter also includes the research questions and hypotheses, the outline of the study and the relevance and limitations of the study.

Chapter 2 or Literature review constitutes of the relevant studies in the field of demographic transition and ageing, analyses the main mortality and fertility determinants. This chapter reviews critically and analyses the literature in the field of the research.

Chapter 3 consists of the relevant theories that create the theoretical framework and the basic concepts of the dissertation. The main theory in this study is the demographic transition theory, which is the base for the demographic transition and ageing analysis.

Chapter 4 refers to data availability and quality. It starts with the main data sources and then it describes each source individually, both vital statistics and censuses. A sub-chapter is dedicated to the territorial-administrative reforms during the period of current research. The relevance of this sub-chapter lies in the impact of administrative divisions on the data.

Chapter 5 contains the methodology. The first subchapter explains why and how the maps were constructed. The second subchapter describes the methodology of data estimation. The third subchapter includes the steps for data recalculation to the 2011 administrative division. And the fourth subchapter enumerates the methods used for data analysis.

Chapter 6 focuses on the development of demographic transition at the regional level. The chapter starts with an introduction and the analysis of the main trends in mortality and natality in the pre-transition period. The next subchapters describe the main trends in mortality decline, fertility decline and migration at the regional level. The final subchapter attempts to classify the demographic transition by the onset and duration of demographic transition at districts level.

Chapter 7 analyses the development of ageing at the regional level for the period 1950–2017. The variability of ageing was determined by using a classification of districts by the timing and pace of ageing. Further subchapters are investigating deeper the similarities and differences among districts, specifically: rates of natural increase and net migration rates, changes in the age structure and old-age-dependency ratios. The second chapter provides an attempt to determine the interrelations of ageing with the demographic transition.

Chapter 8 summarizes the major results and determines recommendations for further research.

1.5 Relevance of research and limitations of the study

This research will contribute to the scientific discussion on the demographic transition at the regional level and its interrelations with the ageing process. In this study, historical data were recalculated to the current district level (2011 administrative division). Thus, comparable time series data from 1868 to 2017 are created to connect the past with the present. The recalculation methodology can be used for other countries that face multiple changes in the administrative division throughout the demographic transition. This research attempts to bring adequate explanations and a better understanding of the timing and pace of ageing in Czechia.

Main limitations of this research are related to data and methodology. The data issues are mostly related to the limited availability of data at the district level compared to the national level. For the census from 1857, only data on total population by districts is available online. For the 1869 census, only total population and population by sex is available, except the military population. Some important indicators cannot be calculated from historical data, e.g. TFR, due to lack of data on births by the age of the mother. The data for both population and vital statistics are missing between 1914 (including) and 1918 (including). The difficulties in data recalculation for 1938 (including) to 1946 (including) are caused by changes in the administrative division during WWII. The transfer of the ethnic German population after WWII brought significant changes to the age structure in most of the districts (Fialová, Pavlík and Vereš 1990).

The methodology limitations are related to the recalculation method used for this research. Although we tried to minimize the errors by using the recalculated population data from CZSO (we consider it reliable because it was calculated at municipality parts level) as a benchmark, these data were only available for the census years. The data in between the census years had to be estimated. Another methodology limitation is related to the definition of the onset of fertility decline; we chose the definition used by Chesnais (1992) that says the fertility decline starts when the CBR drops under 35 per thousand people, which involves a degree of arbitrariness (Reher 2004). The problem occurs when trying to spot this decline for each district, sometimes fluctuations and stagnation under 35 per thousand people might create confusion in the results. Probably a different definition of fertility decline might bring different results.

Chapter 2

Literature review

2.1 Demographic transition

The idea of demographic transition was developed in Europe before WWI and was fully elaborated in Europe and America in the 1930–1950 (Kirk 1996). The term "demographic revolution" was coined by Landry, who connected it with the general progress and rising of economic productivity (Landry 1934). A more complex description of the theory was developed by Notestein (1945). The theory was connected with the growth of urban population, the disintegration of the extensive families, changes in lifestyle, individualism etc. (Pavlík 1980). Notestein was not the first to define the theory of the essentials of demographic transition, but his formulation is widely accepted as classic (Kirk 1996). Notestein (1945) presented a typology of populations related to the prospects for world population growth, and he assumed the world population would reach 3.3 billion in 2000, (actually it reached 6 billion). His assumptions were based on a sharper fertility decline (Kirk 1996).

An important founder of the demographic transition theory is also Thompson (1949). The determinants of demographic transition, according to him, were the urban industrial society, secularist thinking due to progress in technology, progress in education and women empowerment (modernisation, industrialisation and urbanisation). Another forerunner is Carr-Saunders (1936). Carr-Saunders did not formulate a general theory, but used data and put an emphasis on the "small family system" and its determinants. He had a compilation of materials on population, and demographic changes in different countries (Europe and overseas countries with European background population) and Notestein based his research on these materials (Kirk 1996). After the WWII, after numerous research on this topic, it was named the demographic transition, becoming an important "explanatory framework for the macro-demographic phenomena of the second half of the 20th century" (Caselli, Vallin and Wunsch 2005).

The demographic transition became "the central preoccupation of modern demography" (Demeny 1968). The demographic transition is the shift from the slow growth of the population due to relatively high fertility and mortality to slow growth due to low fertility and mortality (Coale 1984:531). Several authors reported that there is a homeostatic mechanism that causes the mortality increase if the population greatly enlarged, and causes fertility increase if the population is too low (Pavlík 1980; Coale 1984). Moreover, deliberate mortality (infanticides) can have a homeostatic effect on the population increase (Coale 1986). This idea contradicts Malthus's theory that population increases with the increase in resources (Malthus 1826:314 in Kirk 1996).

According to Rowland (2003), there are four main stages of demographic transition:

1. Pre-transitional stage, characterised by high birth and death rates.
2. The second stage of early transition, death rates start to decrease, but the birth rates remain still high, that leads to rapid population growth.
3. The third stage of late transition, death rates continue to fall, and birth rates start to decline as well.
4. Post-transitional stage, low death and birth rates.

According to Chesnais (1990:327), there are five phases:

1. Pretransition.
2. Declining mortality, high fertility, accelerated population growth.
3. Peak population growth.
4. CBR declines faster than CDR, slowing the population increase.
5. Posttransition.

There are no significant differences between both classifications. In Chesnais's classification, the focus is on population growth. One question that needs to be asked is whether the first and last stages in both classifications should be part of them because demographic transition starts with the onset of mortality decline.

According to Coale (1986), the pre-transitional regime was characterised by moderately high fertility and mortality; life expectancy is about 20 to 30–35 years, TFR from 4 to about 6.5 – this means almost zero population growth. The demographic transition started in Europe in the mid-18th century, and by the mid-19th century, it became universal in Europe (Caselli, Vallin and Wunsch 2005). It started with a long-term decrease of mortality, and it ended when the TFR approached two children per woman after a constant decline during a long period (Caselli, Vallin and Wunsch 2005). The demographic transition started at a certain level of socio-economic development and ended at a different one.

It is important to mention the development of TFR in European countries. Between 1900 and 1930 the decline in TFR was at least 30% in every country where the demographic transition has started, except France, where this level was achieved by 1900. From 1930 to 1960 the TFR increased in the countries that had negative population increase, due to the baby boom, in all North-Western Europe, including Czechia. In the South and Eastern Europe, TFR continued to fall between 1930 and 1960. From 1960 to 1980 all the countries experienced a decline in TFR, as a result of a decrease in marital fertility, increased cohabitation (fewer children than among married couples) and a sharp increase in divorces (Coale 1986). Several authors called it the second demographic transition (Van de Kaa 1987; Lesthaeghe 1995).

Demographic transition theory applied to the developing countries shows impressive regularities (Kirk 1996). In each example, mortality preceded fertility decline, resulting in accelerated population growth underestimated by some researchers (e.g. Notestein 1945). The length of the transition is shorter than in Western Europe (Kirk 1996). However, there are two categories of mortality transition:

1. Life expectancy reached levels of European countries due to modern medicine and public health. There is also an increase in income and progress in education in these countries.
2. Mortality is falling but at a slower pace. Mortality from famines was decreased due to improvement in the agricultural productivity (India, Pakistan and Bangladesh). So the increase was due to scientific progress and low-cost prevention, antibiotics, vaccinations, insecticides etc. (Coale 1984). Life expectancy did not continue to increase at a high pace because of the lack of profound changes in the whole society and also sanitary habits.

Fertility declined at a more rapid pace compared to Europe. A new element in the demographic transition in developing countries is family planning programmes (governmental or private). The impact of these programmes on fertility decline was different: accelerated, gradual or limited (Coale 1984). The impact depending on social and economic changes, universal education, distribution of contraception, culture and beliefs etc. Nevertheless, family planning made possible the decline (regardless of the extent of this process) even in societies with low levels of modernisation (Kirk 1996), e.g. Latin American countries, China.

The greatest asset of the literature dealing with developing countries is that there are more empirical data that can help determine the factors of fertility or mortality decline, e.g. on the influence of economic development on fertility decline (Caldwell 1982; Ruggles 2009).

The duration of the demographic transition is different for each country or region, but the later it emerges, the faster the pace and dynamics (Pavlík 1977). In Northern Europe, the demographic transition took 75–100 years, in Eastern Europe – 20–25 years, and it can last even less for less developed countries that are following (Preston 1975).

There is a scientific debate related to what declined first: mortality or fertility. The available data for the developed countries show us that in most countries mortality decline preceded the fertility decline. France is an exception; the long-term fertility decline began in the 18th century and continued (Diebolt and Perrin 2017). In the rest of developed countries, this trend started after 1870 (Sweden, England etc.), or more common in the early of the 20th century (Reher 2004; Caselli, Vallin and Wunsch 2005). The Princeton European Fertility Project brought new evidence that in some European provinces, the fertility declined first, or both declined simultaneously (Kirk 1996). According to Coale (1986), the level of fertility achieved by some pre-industrial populations was only 40–60% of what might have been possible. What is certain is that the mortality and fertility decline weren't simultaneous all over Europe, and not even simultaneous within the countries. Also, there is no common definition of the onset of mortality or fertility decline, which presents more difficulties.

The main consequences of the demographic transition are population growth due to the gap between mortality and fertility decline, the higher the gap, the greater the growth. Another consequence is the ageing, which is reflected in the age structure of the population.

2.1.1 Pre-transitional societies

As already mentioned that the pre-transition societies, or also called pre-modern societies, had moderately high fertility (Notestein 1977; Coale 1986), the CBR in the Czech lands accounted for about 40 per thousand people (Fialová, Pavlík and Vereš 1990). The traditional type of reproduction (Vishnevskii 1976) with natural fertility levels (Henry 1961) is specific for pre-transitional societies. CDR in the pre-transition phase for the Czech lands accounted for 30 per thousand people (Fialová, Pavlík and Vereš 1990). The mechanism of control of these processes, especially fertility, was performed by society through marriage (Coale 1986; Fialová, Pavlík and Vereš 1990). The institution of marriage was created to produce enough reproduction for survival (Davis and Blake 1956).

The main reasons why fertility was moderately high in pre-modern societies are:

1. Postponement of marriage and permanent celibacy.
2. Limitation of fertility within marriage.
3. Period separation.
4. Sterility.

In the pre-decline period, there was limited control of fertility within marriage (Knodel 1974). The initial method of limiting fertility or birth control was the age at first marriage, the social norms imposed a late age at marriage (Dupâquier 1972; Wrigley 1978; Coale 1986), thus, women were marrying late, and some did not marry at all until the age of 50 (Hajnal 1965), which is the end of the reproductive period. It is important to mention that nuptiality was a precondition of fertility (Caselli, Vallin and Wunsch 2005), marriage wasn't having a direct influence on population dynamics, but increased the exposure to the risk of conception and childbirth because most births were in the wedlock. Therefore, the need to accumulate wealth to get married was a crucial mechanism for controlling access to marriage, and, respectively, fertility (Caselli, Vallin and Wunsch 2005). Even the Talmud teaches that "a man should first build a house, then plant a vineyard and after that marry". This is called the ancien regime of fertility (Caselli, Vallin and Wunsch 2005), being characterized as already mentioned, by a large proportion of never-married women, high mean age at first marriage for women and also a lower number of children per woman.

The mean age at first marriage in Western Europe (pre-industrial Europe) was varying between 23 to 28 years for women. The share of remaining permanently single was at minimum 10%, but sometimes 20% or 30%. Subsequently, about 50% of women in the reproductive age were married. Thus, fertility was kept at 50% below of what it might have been in the case of universal marriage. Another method was the prohibition of widows to remarry but had a smaller effect, e.g. in India. In Asia and Africa, the situation was different; there were no restrictions for marriage. Therefore, women married in a short time after menarche, at about 16–18 years. Almost all who survived to the age of 30 had experienced marriage (Coale 1986).

The idea that fertility limitation existed within marriage is supported by several researchers, and there is evidence that was practised among the upper classes (Demeny 1968; Blake 1985; Wrigley and Schofield 1989).

The limitation of childbearing within the marriages was done through extended breastfeeding, which postpones the resumption of ovulation, thus lengthens the birth intervals (Kirk 1996). Another method was the taboo or abstinence of the intercourse during the breastfeeding period, e.g. in Asia and Africa there were beliefs that sperm can poison mother's milk (Henry, 1961), also in Europe such ideas were common, proof have been found in the medical literature from the 17th and 18th centuries (Van de Walle and Van de Walle 1989). The difference between the pre-modern and modern limitation of birth is that in the modern and post-modern societies, the practices for limiting the number of children is done after having a specific number of children – parity-specific limitation. The parity-specific limitation of fertility included the traditional and the modern methods of contraception and is about the change in the behaviour of the couples related to limiting the number of children after achieving the desired number of children. The nonparity-specific limitation or natural fertility means the behaviour that reduces the chance of conception or increases the interval between births and is not related to the achieved/desired number of children; it can occur after any birth (Henry 1961). The pre-transitional societies did not achieve the biological maximum of fertility due to these fertility limitation measures, but not parity-related restriction. The proof is in the mean age of the woman at the last child being constant. The parish registers from 18th to the 19th century show that women had the last child at about the age of 40, this age being characteristic to modern societies that do not use contraception (Coale 1986). Actually, in the pre-transitional conditions, lower fertility would lead to a decrease in population due to high levels of mortality. Some departments in France had low marital fertility already at the beginning of the 18th century, e.g. Lot-et-Garonne, in South-western France and Cavaldos (Normandy) lost 20% and 25% of the population, respectively, of the population from 1830 to 1900 due to negative population growth (Diebolt and Perrin 2017).

Another example is from Hungary, 19th century – some villages had a one-child family, which wasn't approved by the church (Coale 1986). There is evidence that the nobility in France, England and Italy (bourgeoisie of Geneva), the Jewish population in some Italian cities were limiting their fertility, but due to their low number, their impact on overall fertility is low (Coale 1986). More examples were in subgroups of the rural population in a region in Southern Hungary (Demeny 1968), also Copenhagen before 1880 (Coale 1986).

The periodical separation was contributing to fertility limitation. Shepherds, fishers or people involved in other seasonal jobs were separated for some time from their wives, decreasing the risk of them getting pregnant (Coale 1986).

Sterility was caused by some sexually-transmitted diseases and certain forms of tuberculosis. Other diseases could reduce fecundity and increase stillbirths and miscarriages. Diseases were also a cause of reduced sexual activity (Van de Walle 1975; Menken 1979).

It is important to mention that restriction to marry in some societies was linked to the availability of resources. For example, the settlers from Western Europe in North America had an enormous supply of agricultural land due to the sparsely inhabited land. Thus, they started to marry earlier due to availability of land, and, subsequently, have more children. A similar situation was in South of Russian and Asian part of the Russian Empire (Coale 1986).

There were differences between urban and rural vital rates (De Vries 1990). Fertility was slightly lower in the urban areas compared to rural in pre-transition Europe, and fertility started to decline earlier (Dyson 2010). The higher mortality was a normal phenomenon in the big cities. The rural areas had the lowest mortality.

2.1.2 Mortality decline

According to most of the definitions of demographic transition, mortality started to decline before the fertility. The decline in mortality had influenced the fertility subsequently by reducing the widowhood, second marriages, thus, exposing more women to fertility (Caselli, Vallin and Wunsch 2005). Therefore, the decrease of mortality brought, first, an increase in fertility, later the picture has changed, and the decline in fertility followed.

The decline in mortality has started in the second half of the 18th century leading to an unprecedented rise in the life expectancy in Northwest Europe (e.g. France, Sweden, England and Wales) (Caselli, Vallin and Wunsch 2005). The causes of mortality decline are less complex than the ones for fertility because the majority of people desires the prolongation of life.

Industrialisation (Industrial Revolution) is considered to be one of the main determinants of mortality decline and brought many changes in society. The Industrial Revolution led to the expansion of transportation and trade, mechanised manufacturing etc. (Notestein 1977; Coale 1986). The development of infrastructure (roads, canals, railways) facilitated internal transportation and the growth of the markets. This led to urbanisation, creation of jobs and accessibility to railways; thus, people were leaving the countryside. It is important to mention that in the beginning, the urbanisation led to mortality increase due to working and living condition in the city, the cities being called "demographic sinks" (Caselli, Vallin and Wunsch 2005; Dyson 2010). Infant mortality increased in this period in urban areas due to the employment of women, the infants were not breastfed for a long period, and also pollution in the cities, the living arrangements had a negative impact on the survival of infants and children (Lipovski 2007). In contrast, Knodel (1982) considers that there is no clear association between industrialisation and mortality decline.

Although the onset of the process wasn't due to the right socio-economic conditions, the interrelation between these conditions led to a comprehensive transition at the economic and social levels. It is difficult to determine what occurred first; for example, in Germany, the industrialisation took place simultaneously with the demographic transition (Knodel 1974; Kirk 1996).

The decline in mortality is related also to improved hygiene, the progress of medicine and improved living standards (Pavlík 1980). But the discoveries in medicine alone weren't sufficient, the economic and social context of the time was "ready" and "able" to disseminate and apply them (Kirk 1996; Caselli, Vallin and Wunsch 2005).

For example, in France, for decreasing the effects on mortality caused by urbanisation, work laws were introduced, projects of sanitation infrastructure (sewage systems, construction of drinking-water distribution networks, heating) and public health initiatives were implemented. Moreover, children were instructed about hygiene and health (Caselli, Vallin and Wunsch 2005) in schools (free and compulsory since the end of the 19th century). Slowly, people were changing their behaviour related to hygiene: taking baths, wash their hands this coming with the production and availability of soap, clothing, underwear (Coale 1984; Vishnevskii 1976).

The diffusion of "Pasteurian revolution" and implementations of new behaviour in daily life continued increasing life expectancy after the 1890s until WWII. After WWII, mortality continued to decrease due to first vaccines, antibiotics, the social-insurance systems etc. (Landry 1934; Coale 1986; Omran 1998; Caselli, Vallin and Wunsch 2005). Each country has an individual history connected to the economic and social change, but the health revolution has spread throughout Europe eventually (Caselli, Vallin and Wunsch 2005).

Several authors indicated that nutrition could be a major factor in increasing life expectancy (McKeown 1976; Fogel 1994). Famines were reduced due to the increase in the food supply as a result of the agricultural revolution. Potato and other nutritious crops were introduced, and storage and transportation of food were improved (Coale 1986). The improved nutrition in childhood was a determinant of a stronger body, thus, more resistant to diseases (Fogel 1994). McKweon (1956, 1976) reported, based on data for England and Wales, that improved nutrition has a higher impact than medicine and public health, the effects of these coming later, after 1900. McKweon demonstrated that mortality caused by tuberculosis decreased by 80% before methods of treatment were known, and there was a similar situation regarding other infectious diseases. Fogel (1994) discovered the effects of nutrients through calories intake in the 18th and 19th century as a major driver of mortality decline. However, it was later shown that (Cutler, Deaton and Lleras-Muney 2006) the decrease in mortality in England from 1750 and 1820 is not related to nutrition, but it is just a typical fluctuation for the pre-modern Europe. Similar results (Wrigley and Schofield 1989) revealed that the life expectancy in England and Wales in the 1600s was similar to the one in 1820s, the lowest values being in 1750. Other findings (Cutler, Deaton and Lleras-Muney 2006) show that English aristocracy had the same life expectancy as the rest of the population even though it is assumed they had access to better nutrition. Moreover, the life expectancy in populations with better nutrition, e.g. the United States has the same values for Western Europe for the same period (Livi-Bacci 1991; Cutler, Deaton and Lleras-Muney 2006). Therefore, the improvement in public health is a better-argued determinant of mortality decline.

Notestein (1945) discussed that the decline in infant mortality rate has the highest contribution in the overall mortality decline. Due to the high number of children in the family, the infant mortality was high too, death of a new-born being a normality. In the Czech lands there was a saying that expresses well the views on infant lives during that time: "Když zemře děcko, je to, jako by se hrnek vody vylil" (When a child dies, it is as if the mug of water has been poured out) (Lipovski 2007). Empress Maria Theresa had a valuable impact in decreasing infant deaths in the Austrian Empire; during her reign, births became medicalised, immunisation was promoted (Vishnevskii 1976). During the 19th century, the doctors promoted a close relationship between the mother and child, not only during breastfeeding, but also bathing, and keeping the baby clean (Vishnevskii 1976).

Other authors discussed (Preston 1975; Kirk 1996) that there is a close association between mortality and the income or standard of living, thus, economic growth causes a rise in the life expectancy. Some researchers think that this alone is not enough to explain the rapid decline in mortality after WWII (Caselli, Vallin and Wunsch 2005). Preston (1975) mentioned that the same trend is followed if economic growth is substituted by education/literacy; this has been proved by some recent research (Lutz and Kebede 2018).

We can conclude that infants and children gained the most from mortality decline compared to any other age groups. Mortality varied according to the type of residence (rural or urban). The impact of each determinant on mortality decline is difficult to quantify, but clearly, the improvement in medicine and the elimination of infectious diseases was central for the decline in infant and child mortality. However, the mortality decline can be described through three stages. The first stage starts in the middle of the 18th century and is characterised by the improvement of nutrition and economic growth, which contributed to the increase in the standard of living. From the end of the 19th century to the 20th century, the second stage follows, and it is driven by public health initiatives. Finally, the third stage starts at the end of the WWI and is related to the progress in medicine. After WWII, the medical revolution of the communicable diseases starts.

Mortality decline is also considered to be a condition for the fertility decline, but also for further socio-economic development. A longer life gives people meaning to their life, so they can plan their actions, save, invest, learn etc.

2.1.3 Fertility decline

The modern fertility is characterized by the shift from natural fertility to controlled fertility, causing the long-term decline in European fertility. The modern fertility decline began during the second half of the 18th century. Started in France (around 1750), and to some extent in Switzerland and Belgium. During the second half of the 19th century, fertility was decreasing in Britain and Scandinavian countries, later in Germany and Austro-Hungary. In Southern and Eastern Europe, the decline of fertility began at the end of the 19th century or the begging of the 20th century (Pavlík 1980, Reher 2004). After the mortality and fertility decline between the 18th and 20th centuries, Europe shifted to a new demographic regime (Caselli, Vallin and Wunsch 2005).

One of the widely accepted definition is that fertility transition in Europe is the "replacement of a regime of moderate fertility maintained by late marriage and non-parity-related methods within marriage, by a regime of low fertility within marriage attained by parity-related contraception." (Coale 1984:543). According to Knodel (1974), once the fertility is decreasing the trend is irreversible until lower levels are reached, the systematic fertility decline in Europe started after 1870, and the WWI brought a temporary disruption in the trend.

It is important to mention that between the end of the 18th century and beginning of 20th the natural fertility significantly increased due to the increase in fecundity and reduction of a non-susceptible period following birth (Coale and Watkins 1986) – the so-called pre-decline increase. Also, early marriages contributed to this (Fialová, Pavlík and Vereš 1990; Fialová 1991).

The determinants of fertility decline are various, and there is no universal combination for all the countries because it is closely related to the development of society and the pre-existing conditions. The most relevant determinants for the current research will be explained.

According to Davis and Blake (1956), there are two types of fertility determinants:

1. Direct (intermediate/proximate): biological and behavioural variables.
2. Indirect (contextual): socioeconomic, cultural, and environmental.

Van de Kaa (1987) proposed to group the fertility decline theories into three categories:

1. Mortality decline.
2. Economic and socio-economic theories.
3. Communication theories (ideational, cultural, linguistic).

For the research, the following classification of determinants of fertility decline will be used:

1. Direct determinants.
2. Indirect determinants.

2.1.3.1 Direct determinants

The direct determinants of fertility were identified for the first time by (Davis and Blake 1956), there were 11 intermediate variables grouped in three categories: factors affecting exposure to intercourse (intercourse variables); factors affecting exposure to conception (conception variables); factors affecting gestation and successful parturition (gestation variables). The list was elaborated further by Bongaarts (1978) and Bongaarts and Potter (1983):

1. The proportion of women married or in sexual unions.
2. Use of birth control (contraception).
3. Breastfeeding and lactational amenorrhoea.
4. Induced abortion.

In some studies, the proximate determinants are also mentioned, but more compressed (Casterline et al. 1984; Caselli, Vallin and Wunsch 2005).

The initial decline in fertility was slow, and it started with a decrease in the proportion of married women. Thus, women were exposed to conception in the marriage for shorter periods, and the illegitimate births did not compensate for the decline in marital fertility. This case is relevant, especially for Central European countries (Fialová, Pavlík and Vereš 1990). There is a link between the onset of fertility decline and the impact on nuptiality – the later fertility decline starts, the less significant impact on nuptiality (after the 20th century – no impact at all). At the start of the transition, there was a clear control through marriage, this stage was mentioned by (Landry 1934), later confirmed by the Princeton European Fertility Project (Coale and Watkins 1986), through the Coale indices. It is important to note that the Princeton European Fertility Project contributed to the analysis of the demographic transition, specifically fertility decline, at the regional level. In the Czech lands, the fertility decline at the regional level was analysed by Fialová, Pavlík and Vereš (1990) by using Coale indices.

The new regime of fertility consisted of adoption, increased use and diffusion of fertility control within the marriage in all social strata. Thus, the fertility within marriage decreased, this also being called the European marriage pattern (Hajnal 1965), e.g. France (Landry 1934), Switzerland, Belgium (Fialová, Pavlík and Vereš 1990), Germany (Coale and Watkins 1986) etc. First signs of parity-restriction were observed in the decline of the age of mother at the last birth (Coale and Watkins 1986), in several German villages this type of family limitation started at the beginning of the 19th century, in other at the beginning of the 20th century. Another method of fertility limitation was birth intervals. Empirical evidence by Diebolt and Perrin (2017) suggests that in Melun, France, the share of parents with short (less than 18 months) and medium (between 19 and 30 months) birth intervals declined. Between periods 1669–1709 and 1790–1814, the share of couples with short intervals dropped from 11.6% to 2.9%, and couples with medium intervals declined from 60.2 to 23.5%. Contrastingly, long birth intervals (31 months – 48 months) and very long (49 months and more) birth interval increased from 18.8 to 27.1 and from 9.4 to 59.4% respectively. Gradually, family limitation became customary (Coale 1986). Subsequent fluctuations in the fertility were possible, as social and economic conditions changed, but never a return to the pre-decline level (Knodel 1974).

The preconditions for a continuous decline in marital fertility are (Coale, Anderson and Härm 2015): being ready – the parents must consider it as an acceptable thought and behaviour, they are able to assess the advantages and disadvantages of having another child; willing – the reduced number of children must be advantageous for them as a result of economic and social conditions; and being able to acquire effective techniques of limiting fertility. These three preconditions come to exist if modernization proceeds far enough. Some or all conditions can exist in agrarian societies. In some populations, one or more preconditions can conflict with some customs or beliefs (e.g. Mexico) (Coale 1973).

2.1.3.2 Indirect determinants

The indirect factors of fertility decline are numerous. The socioeconomic ones were considered that had a significant contribution to fertility decline, but all of the factors should be analyzed in the context of other factors. Therefore, the proximate determinants alone could not be achieved without the right socio-economic and cultural preparation of the society.

However, we will describe a few of the indirect determinants which we consider significant. A very important indirect determinant of fertility decline is *mortality decline*, which usually precedes it, as already mentioned above. The decision to have fewer children came as a response to the decline in infant mortality. Children were more likely to reach reproductive age, and thus, the need for maintaining high fertility was diminished (Notestein 1977; Caselli, Vallin and Wunsch 2005; Dyson 2010; Harper 2016). However, the influence of the decrease in infant mortality is not immediate. The tradition of a big family can be deeply rooted in the culture (Landry 1934). This determinant has a strong universality for Western, North and Eastern Europe and countries settled by people of European Origin; infant mortality fell first even in developing countries including Latin America, Asia and Africa. In contrast, Knodel (Coale and Watkins 1986) indicated that the decline in infant mortality took place only later at the end of 19^{th}.

There is evidence at the micro-level that the decline in child mortality determined the fertility decline (Knodel 1982). Knodel argues that the couples that had more surviving children were more likely to practice family limitation and, vice versa. The response to child loss is additional births (Preston 1978; Friedlander 1977). Also, some couples tend to have children as insurance because they anticipate child mortality and then want to assure a minimum surviving offspring (Knodel 1982).

The Enlightenment, decline of feudalism and religion (ethical and religious dogmas) determined social, economic and political changes or the so-called *modernization*. The modernization brought in turn changes in the production structure, especially the decline of family as a unit of production (Coale and Hoover 1958; Vishnevskii 1976; Caldwell 1982; Coale 1986), emergence of impersonal systems of job allocation, participation of women in the labour market (Van De Walle 1998; Lipovski 2007), emancipation of the individuals from religious authority (Wolf 1912) etc. All these contributed to the decline of the economic advantages of large families and changes in reproductive behaviour. The standard of living and prosperity of families were increasing. This is supported by the prosperity theory of P. Mombert that explains that when the standard of living is improving, further improvement is achieved by not having children. Thus, fertility declined, while the prosperity increased. A different theory, the theory of increasing prosperity (Brentano 1910) explains the link between prosperity and pleasure. In lower classes, the children are the satisfaction of sexual instincts. The prosperous families that have pleasures outside of marriage tend to plan the number of children they want.

Modernisation leads to other related determinants like development – which was called as the best contraceptive during the World Population Conference from Bucharest in 1974; universal education (Van De Walle 1998; Harper 2016); women's' emancipation etc.

Modernisation was presented as a major determinant of fertility decline by various researchers (Notestein 1977; Coale 1984), but there were critics too. Caldwell (1976) argued that there is no close link between modernisation and fertility decline in the modern world, he found in his studies that many traditional societies evolved slowly, and the beginning of fertility transition can be found in pre-modern Europe already.

The initial sources of growth in the urban areas were due to the rate of natural increase and the rural-urban migration. The rate of *urbanisation* was growing fast; at some point, the urban and rural rates of natural increase reached the same level. Eventually, fertility started to decrease in the urban areas, being followed by rural areas (Chesnais 1992; Van De Walle 1998; Dyson 2010). This is characteristic not for all European countries; there is evidence that in Portugal, Hungary and some regions in Spain the fertility started to decline before the countries were urbanized (Leasure 1963). Some study on Sweden and Belgium (Bocquier and Costa 2015), but also Dyson (2010) considered the relationship between urbanisation and fertility decline not as a cause and effect one, but more like urbanisation being the interaction of the natural change (births and deaths) and migration. In addition, there is evidence that urbanisation accelerated after the mortality decline due to population growth (Caselli, Vallin and Wunsch 2005). Thus, people migrated from rural to urban areas for employment this contributing to the urban growth (Brabencova 1989; Fialová 1989; Dyson 2010). Theory of multi-phasic demographic response (Davis 1963) provides a different view on the role of migration during urbanisation. The out-migration has the role of relieving the pressure of population growth, and because the migration was preponderantly from rural to urban areas, the fertility decline in the rural areas was late (Davis 1963).

There is an *economic theory* that explains the *fertility decline*. The main idea of this theory is that childbearing became economically disadvantageous. The Chicago School of Economics argued that the reduced demand for children is caused by incomes, prices and preferences, and called this "new home economics" (Schultz 1974; Becker 1981). In addition, some studies combined the economic theory with the sociological theories (Easterlin 1978; Easterlin and Crimmins 1985). As demand they used – standard socio-economic determinants of transition connected to modernization, as supply – cultural elements that limit fertility, costs – financial resources, time, and psychological limits in the use of birth control. The determinants operate through one or other of the variables. One of the weak points of the theory is the lack of explanation for the demand in the pre-modern fertility societies.

Caldwell (1976) elaborated the *intergenerational wealth flows theory*. In the pre-modern societies, the wealth flow (money, goods, resources) came from the bottom, from children or young people to the older generation. With the shift from the extended family model to nuclear, the wealth flow moved from parents to children, thus, being childless becomes a rational economic behaviour, but people continue due to psychological and social reasons. This theory is tested later in the Yoruba society, indigenous inhabitants of Nigeria's Western State (Caldwell 1982). Caldwell stresses that the behaviour of pre-modern societies of not limiting fertility was rational, same as the modern fertility –when there is an economic gain (or eventually will be) from fertility restriction.

A long term determinant of fertility decline is the evolution and *diffusion of attitudes* regarding procreation within couples (Caselli, Vallin and Wunsch 2005). The decision to have children is taken by individual couples, who decide according to their views and beliefs on family and procreation, either influenced by the collective norms or environmental constraints (Caselli, Vallin and Wunsch 2005). One of the theories that explain the vertical diffusion is the social capillarity theory (Dumont 1993). The main idea is that each society has a hierarchic social order in which individuals from the upper layers enjoy greater prestige than those from lower layers. A large family was seen as an obstacle for moving on the social ladder, and the low strata strive to raise their social status. The relationship between social ladder hierarchy and the decline of fertility is also supported by other researchers (Davis and Blake 1956).

The findings of the Princeton European Fertility Project also point to a cultural and linguistic, rather than economic determinants of fertility decline (Harper 2016). However, the project wasn't intended to test a cultural hypothesis (Kirk 1996).

The *cultural and ideational theory* is supported by Lesthaeghe (1983). His theory is related to the changes in fertility behaviour due to cultural differences. The theory is based on the previous economic theory of fertility decline, but with the addition of a new level (Lesthaeghe 1983). Another study that combined the economic theory of fertility decline with the importance of culture in shaping the behaviour of people is the article of Pollak and Watkins (1993). Cleland and Wilson (1987) proposed that linguistic and cultural boundaries and diffusion of new ideas have a bigger impact than modernization theory.

According to Lesthaeghe (1983), the factors that influence the speed and levels of change of fertility are the religious beliefs and practices, degree of secularism, materialism and individuation. The ideational shift covers several dimensions: the shift from collective welfare to the individual, the shift from the welfare of the extended family to the nuclear one, shift from the quantity to quality of children, shift from family networks to human capital. In different research (Knodel and Van de Walle 1979), the cultural influence is seen as independently influencing fertility decline, not being related to socio-economic factors. Despite prior studies, the social and economic conditions create a demand for fertility limitation. Thus, it is less likely that cultural factors alone were sufficient for fertility decline.

There are numerous causes of fertility decline, usually, researchers try to spot some factor for some specific time and place, but the whole picture usually remains hidden (Pavlík 1980). It is most probable that the determinants are interconnected. Thus, the fertility limitation came as a result of all the changes that occured in the society, and different economic or social changes affected fertility differently in a different cultural context (Coale 1984). Unfortunately, there is limited data to prove all the above-mentioned determinants. Thus, some of them remain mostly assumptions.

2.2 Ageing

At the end of the demographic transition, the life expectancy has increased from about 30 years to 60 years, and TFR decreased from 5 to 2 children (Caselli, Vallin and Wunsch 2005). Between the mortality decline and fertility decline, there was a gap, which determined a massive population growth (Coale 1986). As a result, the population of European countries increased by about 4 times (Chesnais 1992). Currently, the European population is near or below the replacement level, this being observed by researchers starting with 1930 (e.g. Knodel 1974), and now Europe faces a new population problem – the population decline (Vaupel and Goodwin 1987).

The demographic transition had a direct impact on the age structure because any change in fertility and mortality (also migration) leads to changes in the age structure of the population. Mortality started to fall first after the increase of survival of the infants and children, fertility continuing to be high, and the age pyramid was being progressive with numerous young generations at the base. Further mortality decline for the older age groups continued, and the fertility started declining, causing double ageing from the top and the base of the pyramid (Berzins and Zvidrins 2000; Demeny, McNicoll and Hodgson 2003). Moreover, the countries that experienced demographic transition first are ageing first (United Nations 2017). Migration can influence ageing, but usually offers solutions for a short time (Demeny, McNicoll and Hodgson 2003; Katus et al. 2000; Harper 2016). Migrants tend to be younger and with higher fertility, but they will adapt their reproductive behaviour and will still age. Constant accelerated immigration may help (Demeny, McNicoll and Hodgson 2003), but is it possible? Especially when migration is susceptible to economic changes, like the economic crisis from 2007 that caused a decrease of migrants in the countries the most affected by it (European Commission 2009). Also, another side of the coin is that migration increases ageing in the sending countries if fertility is at low levels.

A common term for population ageing is the increase in the number and proportion of the older population and at the same the decrease in the number and proportion of the younger population. Several authors (Kinsella 2002; Kinsella and Philips 2005; Ahmad, Astina and Budijanto 2015; Mustafina 2015) and also UN use the term ageing as the increase of population aged 65+ over 7% in the total population. The population is considered aged when the threshold of 14% of the population aged 65+ is exceeded. And the last threshold is at 20%. 20% and more of the population aged 65+ mean society is super-aged. It is important to note that mortality continues to decline; most of the deaths occur after the age of 80 (Harper 2016).

Czechia is ageing from the base of the pyramid due to low fertility and from the top due to a decrease in mortality at older ages. The proportion of elderly is increasing fast, especially with the large generations from the post-WWII baby boom that are entering old-age (Mašková and Stašová 2000).

Ageing is a global phenomenon and requires national and local actions. The UN recommendations include: reorganization of social security systems, promotion of active and healthy lifestyles (most of the health problems are related to the lifestyle choices (Harper 2016), changes in labour policies, elaboration of innovative policies and public services specifically targeted al elderly, fluid interpretation of retirement etc. (Demeny, McNicoll and Hodgson 2003; Harper 2016; United Nations 2017). Several studies tried to connect demographic transition with ageing or changes in the age structure (Dokoupil and Nesladkova 1989; Chesnais 1990; Harper 2011; Martinez-Fernandez et al. 2013; Ahmad, Astina and Budijanto 2015; Harper 2016). But the interrelations between demographic transition and ageing weren't directly tested.

Chapter 3

Theoretical framework

3.1 Basic concepts

This subchapter explains the concepts and terms that may have ambiguous or several meanings.

Aged population – the proportion of the population aged 65+ surpasses the threshold of 14% (Kinsella 2002; Kinsella and Phillips 2005).

Ageing population – the proportion of the population aged 65+ surpasses the threshold of 7% (Kinsella 2002; Kinsella and Phillips 2005).

Elderly population – people aged 65 and over (OECD).

End of demographic transition – is marked by a rate of natural increase similar to the one at the start of the transition, and it was assumed to be 0.5% (and lower) as the classical model of demographic transition suggests (Chesnais 1990).

Healthy life years – the number of years that a person is expected to continue to live in a healthy condition (EUROSTAT).

Natality – (or birth rate) The number of live births occurring in a population in a given period (usually a calendar year) in relation to population size, usually expressed per 1000 people (INED).

Onset of fertility decline – CBR decreases under 35 per thousand people (Chesnais 1992). It's complicated to determine the exact moment of fertility decline, and the method "involves a certain degree of arbitrariness" as Reher mentioned (2004:21).

Speed of ageing – is calculated as the percentage point increase of population aged 65+ from 7% to 14% in the total population, also mentioned in the text as the pace of ageing.

Speed of demographic transition – is based on the duration from the start of the fertility decline until the end of the transition and is measured in years – the longer duration of demographic transition – lower the speed, and vice-versa. This definition will be used in the classification in Chapter 6.6.1.

Super-aged population – the proportion of the population aged 65+ surpasses the threshold of 20% (Kinsella 2002; Kinsella and Phillips 2005).

Working-age population – people aged 15 to 64 (OECD).

3.2 Relevant theories

The framework of the research is based first of all on the demographic transition theory. The theory of demographic transition attempts to explain the changes in mortality, fertility and age structure. One of the most common definitions of demographic transition is the transition from a regime of (moderately) high birth and death rates (at approximate balance) to very low levels of fertility and mortality (also at approximate balance) (Knodel 1974; Coale 1986). Other definitions are: the demographic transition is the process of change from the primitive type of reproduction to the modern type of reproduction (Visnevski 1976; Pavlik 1980), the shift from the nonparity-related restriction of fertility to parity-related restriction of fertility (Coale 1986) or the shift from unplanned parenthood to family planning. In the same time, this theory presents the framework for the ageing analysis too. The drivers of ageing are the declining fertility and increasing longevity.

Coale (2017) brought an important contribution to the classical theory of demographic transition at the regional level through the Princeton European Fertility Project. Although they started with economic hypotheses, they did find evidence of social-cultural determinants of fertility decline (Coale and Watkins 1986; Kirk 1996). Czechia was not part of the project, but the works of Fialová, Pavlík and Vereš (1990) and Fialová (1991) are an important contribution to the project and the regional analysis of fertility decline.

As a structure for the thesis classification of demographic transition by Rowland (2003) was partly used: pre-transition stage, the mortality decline, fertility decline, post-transitional stage (or ageing).

For a deeper understanding of the mortality and fertility decline, additional theories were applied. The epidemiological transition theory (Omran 1998:102) explains the declines in mortality by using four stages (specific for western transition). In the first stage – "pestilence and famine", these being the main causes of death and it was specific for the pre-transition societies, most people were dying before the age of 40 (Harper 2016). The second stage – "receding pandemics", the death caused by infectious diseases are decreasing, children benefiting in the first place, life expectancy reaches 50 (Harper 2016). The third stage – "the age of degenerative, stress and man-made diseases", people survive to their 70s and over (Harper 2016). The fourth stage – "age of declining cardiovascular mortality, ageing etc.", the degenerative diseases are delayed, and more time is spent with chronic disease or disability.Moreover, life expectancy at older ages is still increasing (Harper 2016).

For explaining the determinants of fertility decline, several theories were applied: the intergenerational wealth flows theory of fertility decline (Caldwell 1976), the economic theory of fertility decline (Schultz 1974; Becker 1981), the diffusion of innovations theory (Cleland and Wilson 1987), the cultural and ideational theory (Lesthaeghe 1983), theory of multi-phasic demographic response (Davis 1963) and second demographic transition.

Intergenerational wealth flows theory explains the economic reasoning behind the fertility decline. In pre-transition societies, the wealth (money, good, resources) comes from the children or young people to adults and older generations. With the shift in the production and changes on the labour market, the wealth flows changed their directions, now coming from the adults to children, thus, having fewer children or being childless becomes a rational economic behaviour.

The theory of fertility decline explains that childbearing became economically disadvantageous due to modernisation. Some researchers combined the economic theory with sociological theories (Easterlin 1978; Easterlin and Crimmins 1985). As demand, they used standard socio-economic determinants of transition connected to modernization, as supply – cultural elements that limit fertility, costs – financial resources, time, and psychological limits in the use of birth control. The determinants operate through one or other of the variables. Nevertheless, some researchers prefer cultural-ideational theories.

Diffusion of innovations theory refers to reproductive behaviour as a result of personal decisions, but a result of complex social interactions. The relationship with the family and linguistic and cultural community prevail in the decision-making process. Moreover, diffusion had an important role in the mortality decline spreading health education among the population. The diffusion has a significant impact. The changes in reproductive behaviour are happening faster than economic changes. This theory is correlated to the cultural and ideational theory. Lesthaeghe (1983) mentioned that reproductive behaviour is influenced by religion, degree of secularism, materialism and individualism. The ideational shift means: shift from collective welfare to individual, shift from welfare of the extended family to the nuclear one, shift from the quantity of children to quality, shift from family networks to human capital. However, the social and economic conditions create a demand for fertility limitation. Thus, it is less likely that cultural factors alone were sufficient for fertility decline. It is worth to note the role of urbanization in the diffusion of ideas. Urban areas were centres of diffusion (Knodel 1974). Both formal (e.g. newspapers) and informal networks between urban areas and rural areas around the cities were diffusing the new ideas. Thus, fertility decline accelerated.

Theory of multi-phasic demographic response (Davis 1963) explains that the out-migration has the role of relieving the pressure of population growth. As a result, the fertility decline in rural areas was delayed. Population from rural areas was the main source of urban growth during demographic transition.

The theory of the second demographic transition explains why the population didn't stop at the equilibrium of birth and deaths, as stated in the classical theory. The demographic changes after the 1970s bring fertility under the replacement level, a disconnection between marriage and reproduction etc.

The framework for explaining the development of ageing consists of the following theories: demographic transition theory, epidemiological transition theory, but also the fertility decline theories are connecting to ageing because the decline in fertility is the main driver of ageing. There is no general theory on ageing. However, the necessity of such a theory was emphasized by Robine and Michel (2004). For the analysis of the results, we also used Fries' hypothesis (1980) of compression of morbidity and the healthy life expectancy measure (or healthy life years). The hypothesis is that the burden of disability and chronic diseases is compressed at older ages.

The main framework of my thesis is based on the demographic transition theory. The other theories explained above contribute to a deeper understanding of the processes analysed in this study. This research brings a new insight into the demographic transition at the regional level by using crude rates and creating time series that connect the historical data with current data. Thus, searching for interrelations between demographic transition was made possible.

Chapter 4
Data availability and quality

4.1 Data sources

The main data sources for the research are the following:

1. Censuses (1869, 1880, 1890, 1900, 1910, 1921, 1930, 1950, 1961, 1970, 1980, 1991, 2001, 2011).
2. Vital statistics (1868, 1872–2017).
3. Other sources.

The data collected for the research are predominantly at district level (1831–1847 – regions, 1868–1913 – political districts, 1919–1949 – judicial districts, 1950–2017 – districts).

During the last about 200 years the Czech lands experienced various political changes: until 1918 they were part of the Austrian Empire, and later Austro-Hungarian Empire, since 1918 to 1938 as an independent republic – Czechoslovakia, 1939–1945 as the Protectorate of Bohemia and Moravia, 1945–1992 as Czechoslovakia, 1993 – present as the Czech Republic. Thus, these changes influenced the statistics.

The sources for the data during the Austrian and Austro-Hungarian Empire are the following:

1. 1828–1848: Tafeln zur Statistik der Oesterreichischen Monarchie.
2. 1863–1881: Statistisches Jahrbuch.
3. 1880–1913: Österreichische Statistik.

The data from these sources will be mentioned further in the text as Austrian Statistics.

The data are available online in the digital library (https://www.onb.ac.at/en/digital-library-catalogues/), however, only in PDF or PNG format, thus, additional measures had to be taken, like OCR technology to convert the data to Excel format.

The census data for the period 1921–1950 are not available online. Thus, the printed publications had to be scanned and digitised. Again OCR technology was used to convert the data to Excel format.

The census population data from 1950 to 2011 was available in the Historický GIS (Jíchová et al. 2014), online on the CZSO official website or provided from CZSO upon request.

Vital Statistics data are available online, starting with 1919 until present in Demografická ročenka (Demographic yearbook).

4.1.1 Censuses

Table 4.1 includes the available selected data for the censuses 1869–2011.

Tab. 4.1 – Selected available data from censuses, by districts, Czech lands, 1869–2011

Data	1869	1880	1890	1900	1910	1921	1930	1950	1961	1970	1980–2011
Pop. by sex	■	■	■	■	■	■	■	■	■	■	■
Pop. by sex and single age groups		■									■
Pop. by sex and broad age groups			3	3	4	2; 5	6; 7	8	1	1	
Pop. by sex and civil status		■	■	■	■	■	■				
Pop. by sex, single age groups and civil status		■									■
Pop. by religion		■	■	■	■						
Pop. by spoken language		■	■	■	■						
Pop. by sex and literacy		■	■	■	■		■				
Pop. by sex and occupation		■					■				
Pop. by nationality						■	■				

Notes: the coloured cell means the data is available; 1869 does not include military population.
1 – five year age groups
2 – 0–4; 5–14; 15–24; 25–39; 40–59; 60–79; 80+
3 – 0–14, 15–60, 61+; 14–45; 14+; 24+
4 – 0–13, 14–59, 60+; 14–45; 14+; 24+
5 – 6–13; 21+; 14+ (single, widowed, divorced); 14–44 (women by civil status)
6 – 0–4; 5–14; 15–24; 25–44; 45–64; 65–79; 80+
7 – 6–13; 21+; 14+ (single, widowed, divorced); 15–49 (women by civil status)
8 – 0–2; 3–5; 6–10; 11–14; 15–64; 65+; 80+; 15–49 (women; % of married)

Sources: based on Austrian Statistics and CZSO data.

Before the modern censuses, on the territory of the Czech Republic, there were listings (conscriptions) of the population (emerged in the Middle Ages). The purpose of listings was related to military and taxation (Berrová 2007). Therefore, not all the population was included. The oldest preserved listing is an inventory of the property of the Litoměřice church of 1058 (CZSO 2018).

A significant achievement was the date of 13 October 1753 when a patent of Empress Maria Theresa on an annual census was issued (CZSO 2018). The census was conducted in 1754, and it was conducted at the same time in all the states of Habsburg Monarchy (CZSO 2018). According to the imperial decree of 16 February 1754, more listings were to take place every three years, but as a result of the outbreak of the Sevens Years' War, the listing from 1757 did not take place, and the second listing was conducted during 1760–1761. The results were significantly inaccurate because subjects of listings were not clearly defined (Berrová 2007).

The listings were held regularly until 1769. Besides the number of population and its structure by age and sex, also data on marital status, occupation (clergy, nobility, clerks, servants, burghers (bourgeoisie), craftsmen, vassals and poor in social care institutions were partly collected (Sekera 1978).

The main aim of these listings was to create a new recruitment system that includes all potential Christian subject to military duties. Thus, data on women weren't important. The listings were distinguishing domestic (in the place of birth and residence, or later immigrated and settled in some place) and foreign population (temporarily present) (Sekera 1978). The listings should start on 1 October 1770, according to the patent from 10 March 1770, imposing a fine or prison sentence for the people that tried to avoid the listings (Berrová 2007).

In 1777, a new patent was issued that became the basis for listings up until the year 1851. Again, the entire present population was included, however with a more detailed classification for men. Since the 1780s, so-called population books (Population-Ortschaftsbuch) were established in manors and towns. All families with all household members were included in these registers, including all the changes (deaths, births, marriages, resettlements, etc.). The head of the family had the duty to report on these changes within 14 days (CZSO 2018).

Contributions made after 1780 included all the population of the country and until 1804 inclusive children from the age of 1 year. The listing and deduction patent of 25 October 1804 obliged to record all people able to perform military duties, but women and children were included too (Berrová 2007).

Since 1807, the population was registered and distinguished from present and absent. For military reasons, more detailed information was collected for the male population. The listing, which was to take place in 1849, was postponed to the end of 1850 because of the revolution 1848/49. Subsequent political changes have also emerged in the field of population records. The last listing of the domestic population in Czech lands was conducted in 1851. The size of the population present at this time can only be estimated, based on the sum of the resident population, excluding people absent for a long time, and so-called present foreigners. The main purpose of listings conducted between 1771 and 1851 was to capture only the civilian population. Nevertheless, the results of the oldest listings are largely incomplete (Kárníková 1965). Since 1828, the results of listings were regularly printed in the official Tafeln zur Statistik der Österreichischen Monarchie (1828–1865).

Modern censuses in the Austro-Hungarian Empire started with the census from 1869, which is considered the first "modern household analysis" (Teibenbacher, Kramer and Göderle 2012). Based on the census, the present population (domestic and foreign) was recorded in the place where it was present at the moment of the census on 31 December. The chosen date for the census was both positive and negative. The advantage is seen in minimal seasonal migration at that time. On the other hand, the slow-down of industrial activities near the end of the year led to a distortion in data about economic activities of the population (Berrová 2007).

According to Berrová (2007), the law stipulated that the censuses should take place at ten-year intervals as of 31st of December. The municipal councils that were in charge of district offices in the selected municipalities conducted the census. The municipalities have been obliged to prepare a municipal summary, and the District Governments – district summaries. The record sheets never left the municipalities of origin, except in the case of obvious errors. Final processing of data (the elaboration of land summaries and the overview of the whole empire) was carried out by the central statistical committee based in Vienna.

In the census of 1869, the following data were collected: the name and surname, sex, year of birth, religion, marital status, occupation, place of birth, residence, permanent or short-term presence, respectively, permanent or short-term absence of the person in the place at the time of the census. Also, information about the municipality of residence of non-resident people was collected. Data were sorted and summarised by hand (Teibenbacher, Kramer and Göderle 2012). At the level of political districts, only total population data by sex were available online.

During the following censuses, the number of questions increased. Specifically, in the 1880 census information related to secondary employment, reading and writing skills, physical, mental and speech defects were included. A new question was added on spoken language – (Umgangssprache), that was indirectly mapping the ethnic composition of the population (Berrová 2007). The record sheets were collected at the commissions of districts. Data were sorted and summarised by hand (Teibenbacher, Kramer and Göderle 2012). Data by political districts are limited compared to the national level data but considerably more detailed than in 1869.

In the 1890 census, in addition to the previously collected data, data on household and property/land ownership were collected (Berrová 2007). For the first time, data were processed by using electrical sorting machines of the Hollerith system (Teibenbacher, Kramer and Göderle 2012). The processing became faster and larger quantities of data were processed.

In the 1900 census, for the first time data were collected about the place of economic activity, i.e. whether the person has or not a permanent place for economic activity (for example, shopkeepers). Additionally, a question on the immovable property was added. Specifically, it was whether the person in question owns a field or forest land, whether it is a house or other immovable property (Berrová 2007).

A problem with one of the question in the 1910 census was the one related to literacy. In the census instructions, it is mentioned that the commissioner should register if a person can read and write, and there was no information about the proof that will confirm the statement of the interviewee. Usually, the head of the household was making the declaration for all members of the household, especially farmers. It is important to question the quality of this information (Demeny 1968).

For the censuses 1890, 1900 and 1910, the data was sent to the Central Statistical Office in Vienna and later returned to commissions of districts. This means the sheets might be found at the municipalities' archives. However, it is assumed that few original materials are preserved, some materials being discarded right after the summary report and some after 1918 or 1945 the latest (Teibenbacher, Kramer and Göderle 2012). The censuses during 1890–1910 as for their contents, quality of processing and scope of published data "were organised and carried out very well at that time" (CZSO 2018).

The first census after the formation of Czechoslovakia was conducted in 1921. The Constitution from 1920 constituted a base for this census and the next one from 1930. Civil servants were responsible for collecting the data. According to the practices from the Austro-Hungarian Empire, the census was planned to be conducted in 1920 (the Austrian census law still being in force), but due to the lack of preparation and especially lack of clarity in eastern frontiers of the state, it did not take place until the following year (Berrová 2007).

The day for the census was set 15 February 1921. The regulation stipulated that all people present should be included, regardless of whether if this is the place they live permanently, temporarily, or stay here by chance. The results of the census were published in an issue by Czechoslovak Statistics (Berrová 2007).

The second Czechoslovak census had to be conducted in 1925. Due to the economic situation and also the prevailing practice in most countries of the world to conduct a census with a ten-year periodicity, the length of the census intervals was determined as ten years (Berrová 2007), and the census was conducted in 1930. People were informed about the information needed and about sanctions on providing incorrect data. The nationality of the Czechoslovak people was surveyed through the mother tongue. It was also possible to mention a different nationality than the mother tongue. This issue was relevant because the nationality mattered for defining the speaking languages in the municipal authorities and also the distribution of municipal subsidies for cultural affairs (Berrová 2007).

Berrová (2007) explains how the preserved census forms from 1930 became very important documents after WWII because of the registration of nationality. According to the Beneš's decree on confiscation and the distribution of the agricultural property of Germans, Hungarians, and other enemies of Czech and Slovak nations, all agricultural property owned by persons of German and Hungarian nationality, irrespective of citizenship, was confiscated with immediate effect and without compensation. The accused persons could request removal of their properties from national management and return to private ownership if they could reliably prove that they were victims of political or racial persecution and they stood loyal to democratic republican ideas of Czechoslovakia. According to Decree no. 28 of the President from 20 July 1945 about the resettlement of confiscated agricultural lands by Czech, Slovak and other Slavic farmers, preferential right of land allocation was awarded especially to re-emigrants and Czech farmers from Sub Carpathian Rus. Qualification for acquiring allocation was not citizenship but belonging to Czech, Slovak or other Slavic nationality. The census results of 1930 were published in an issue of the Czechoslovak statistics. Specifically, the changes in the age structure after the WWII are a result of this Decree.

The 1950 census brought a new definition of nationality – "affiliation with a nation, with the cultural and working community" (CZSO 2017a).

Starting with the 1961 census and onwards, the population data were collected by residence (CZSO 2017b).

However, for this research, starting with 1919, the mid-year population for calculation is used from the Demografická ročenka (Demographic yearbook). The population by ethnic/nationality affiliation was used from 1930 and 1950 census data (Jíchová et al. 2014).

4.1.2 Vital statistics

Table 4.2 contains the chosen data for calculation of selected indicators. The table does not include information after 1948 because no changes occur in data availability.

Tab. 4.2 – Selected available data from Vital Statistics, by districts, Czech lands, 1872–1948

Data	1831–1847	1868	1872–1880	1881–1948
Births by sex	■	■	■	■
Live births by sex	■	■	■	■
Stillbirths by sex/or total	■	■		■
Live births by sex and legitimacy				■
Deaths by sex	■	■	■	
Deaths 0–1 by sex		■		■
Deaths 0–4 by sex		■		■

Notes: the coloured cell means the data is available; since 1925, the events are registered by residence, not by place of occurrence.

Sources: based on Austrian Statistics and CZSO.

According to Srb (1985), the base for statistics of the population change became registers based on Roman ecclesiastical law. In the Hapsburg lands, the parish register (for Catholics) was introduced by the Court Decree of 22 February 1722 with coming into force in the same year. Initially, there were only registers for marriages and births, the ones for deaths were introduced later. For the Czech lands, the imperial patent of 20 February 1784 on civilian registers became the legal basis for the introduction of statistics on the population change of the population. This law brought a significant change in the sphere that was under the jurisdiction of Church Law. The parish registers continued to be conducted by the Church, but the civil matters became the subject of the civil law. The release of the new registry was in the spirit of the Enlightenment ideas. The importance of the registers of marriages, births and deaths for the public administration and to individual families were emphasized. Therefore, the patent contained rules on how to keep the registers, their content, and the reporting. Three separate registers were commissioned: for marriages, births, and deaths. For the registers, the residence data was not required.

The most important changes (before 1895), include the regulation from 1805 that introduced the distinction between stillbirths and live births. Marriages started to be classified by the age of spouses and month of marriage. Significant changes were applied for the statistics of deaths: deaths were recorded by months, age, and the classification of infant and child mortality was broadened. Since 1886 the data on the legitimation of the illegitimate children started to be collected (Austrian Statistics).

Starting with the Reform Act No. 68/1870, not only the health care system has improved, but also the reporting of deaths and causes of death (Srb 1985). This was considered the base of the fundamental reform on natural population change statistics from 1895, initiated by the Central Statistical Commission in Vienna. The new registers were in the form of census sheets and contained data for marriages, births, legitimized children and deaths. The enumeration sheets had to be filled in for each municipality or part of the municipality that belonged to the relevant registry area. The results containing the completed census sheets were sent quarterly to the office of the first instance. The following instructions were given: instructions for filling in the sections correctly, instructions for immediate filling in the appropriate line of entry after adding in the register, instructions to prevent duplicate reporting in the case of a marriage delegation, instructions for sending records of additional entries in the register, particular emphasis was laid on the obligation to indicate the age by means of the day, month, year of birth of the person to whom the registration relates.

The second reform of the population change statistics in the Czech lands came into force from 1 January 1925. This created an agreement between the Ministry of Public Health and the State Statistical Office, and has a historical significance for Czechoslovak demography (Srb 1985):

1. The unification of the system in the Czech lands and the system in Slovakia.
2. A shift from multiple registration sheets to individual registration filled in for each case of marriage, birth, the legitimation of the illegitimate child and death.
3. A shift from quarterly reports to monthly.
4. The State Bureau of Statistics became Central processing authority.
5. The data started to be collected by the residence, and not by the place of occurrence of the events.

The data on the number of legitimations of illegitimate children ceased to be published in 1940.

The civil registers were introduced from 1 January 1 1950. The registration agenda was modified, being different in the Czech lands and Slovakia. The new management of the statistics has started; around 2600 local (or central/national, district or unified) committees were entrusted with the management of the registers under a new law. This ended the reporting of approximately 4,000 parishes (Srb 1985).

Although migration statistics do not belong to the natural change sphere, it is worthwhile mentioning it at this point. According to Srb (1985), until 1949, there was only a foreign migration station in Czechoslovakia. Since 1922, the results of its processing have been published only in the SXIS Reports. Internal migration statistics did not exist. Its beginning is related to the issuance of Act No. 52/1949 Coll., on the reporting of the population and the authorization of the residence of foreigners. This act introduced at the initiative of the State Office of Statistics, the "Statistical Record of the Application for the Residence of the Citizen", which began to be processed from 1 May 1949, but reliable data can be identified since 1950. For the period 1869–1913 estimations of migration were calculated by using the balance method (see Chapter 5 – Methodology).

4.2 Territorial-administrative reforms and their impact on data

Each significant change of political and social situation brought reforms of the administrative division. Moreover, the changes in the administrative division had an impact on the development of the statistics; this is why it is important to follow its development, and also the administrative divisions are the main obstacle in having comparable time-series for a longer period. A solution to this problem is provided in Chapter 5 (Methodology).

The description of the administrative division of the Czech lands will be concentrated mostly on regions and districts, the goal of the research is the analysis of demographic processes on regional, and specifically on the district level. The analysis will begin with the history of administrative divisions from approximately the beginning of the 18th century.

First, I will start with the translation and definition of terms (Table 4.3).

Tab. 4.3 – Definition of terms, the administrative division of Czech lands, 1800 – present

Czech term	German term	English term	Definition
Země	Land	Province/land	Historical lands (existing long before 1850 in a practically unchanged form). A territorial unit which constitutes a framework for defining regions and districts.
Kraj	Kreis	Region	Higher territorial unit. The oldest administrative unit of the state. A region can include several districts.
Župa		County	New type of regions proposed in 1920, and abolished in 1927.
Okres	Bezirk	District	Lower territorial unit. District can create a political/administrative or judicial district.
Soudni Okres	Gerichtsbezirk, Bezirksgericht	Judicial District	A basic unit of the judicial administration. Usually, two or three judicial districts formed one political district.
Politický Okres, Okresni Hejtmanstvi	Politischer Bezirk, Bezirkshaupt-mannschaft	Political District, Administrative District	Unit designated for the administration of the district government. Usually, it consisted of one or more judicial districts.
Obec	Gemeinde	Municipality	The smallest self-administrating unit, formed by one village (town), one cadastral unit, or by several villages, cadastral units.
Obec s rozšířenou působností		Municipality with extended powers/competencies	Replacement of the districts (2003).

Source: based on Mleziva (2017).

4.2.1 Beginning of 18th century – 1848

In the past, the delimitation of regions and borders was the result of "the influence of the environment, development of the settlement system and it reflected the political, patrimonial, religious, urban, financial, military, legal, economic and cultural changes in the society" (Chromý et al. 2016). In the 10th century, there were lots administered by the royal family. Since the mid-11th century, the administration was based on fortified burg settlements. These settlements had administrative, tax and judicial functions. By the 13th century, the castle system was terminated, and a new administration system started to be formed – regions, which were self-standing and multifunctional (Burda 2010; Chromý et al. 2016). In the 15th century in Bohemia, there were 12 regions, then 14 regions until the 17th century. In 1714 there were 12 regions, in 1751 – 16 regions (Chromý et al. 2016). In Moravia, the regions originally were established in 1529 as a defence against the Turkish threat. Thus in 1529, there were 4 regions, in 1569 – 5 regions, 1735 – 6 regions. In Silesia, the regions were established in 1742, and initially, there were 3.

Czech lands were called Země Koruny české (the Lands of the Bohemian Crown, Länder der Böhmischen Krone). The Czech lands were formed by the Kingdom of Bohemia (Království české – Königreich Böhmen), the Margraviate of Moravia (Markrabství moravské – Markgrafschaft Mähren) and Duchy of Silesia (Vévodství slezské – Herzogtum Schlesien). The highest level of administrative division in the Austrian Empire was the central government in Vienna. Each land had a governing body, Bohemia – in Praha, Moravia – in Brno, Silesia – in Opava. The lands were divided into regions, which corresponded to the development of the territory in the past and did not necessarily meet the needs of modern administration (Burda 2010). In 1751 the number of regions in Bohemia increased from 12 to 16. From 1751 to 1848, Bohemia was divided into 16 regions (Table 4.4).

Tab. 4.4 – Administrative division of Bohemia, 1751–1848

	Region (German name)	Region (Czech name)
1	Kaurzim (Hauptstadt Prag, der Kreis)	Kouřimský kraj (Kouřim)
2	Beraun (Prag)	Berounský kraj (Beroun)
3	Bidschow (Gitschin)	Boleslavský kraj (Mladá Boleslav)
4	Budweis	Budějovický kraj (České Budějovice)
5	Bunzlau (Jungbunzlau)	Bydžovský kraj (Nový Bydžov)
6	Chrudim	Chrudimský kraj (Chrudim)
7	Czaslau	Čáslavský kraj (Čáslav)
8	Elbogen	Loketský kraj (Loket)
9	Klattau	Klatovský kraj (Klatovy)
10	Königgratz	Hradecký kraj (Hradec Králové)
11	Leitmeritz	Litoměřický kraj (Litoměřice)
12	Pilsen	Plzeňský kraj (Plzeň)
13	Prachin (Pisek)	Prácheňský kraj (Písek)
14	Rakonitz (Schlan)	Rakovnický kraj (Slaný)
15	Saaz	Žatecký kraj (Žatec)
16	Tabor	Táborský kraj (Tábor)

Source: based on Tafeln zur Statistik der Österreichischen Monarchie, 1831–1848.

Officially the region administration was abolished in 1848, and regions were reintroduced in the WW2 period, but substantially changed, exceptions during 1850–1867, 1921–1928 (counties). From 1734 until 1848 (Balíková 2012), Moravia was divided into 6 regions (Table 4.5).

Tab. 4.5 – Administrative division of Moravia, 1734–1848

	Region (German name)	Region (Czech name)
1	Brünn (Hauptstadt, der Kreis)	Brněnský kraj (Brno)
2	Ollmutz	Olomoucký kraj (Olomouc)
3	Prerau (Weisskirchen)	Přerovský kraj (Hranice)
4	Hradisch	Hradišťský kraj (Uherské Hradiště)
5	Iglau	Jihlavský kraj (Jihlava)
6	Znaim	Znojemský kraj (Znojmo)

Source: based on Tafeln zur Statistik der Österreichischen Monarchie, 1831–1848

In Silesia three regions were established in 1742: Niský kraj (Vidnava), Opavsko-krnovský kraj (Krnov) and Těšínský kraj (Těšín). In 1783 Niský kraj and Opavsko-krnovský kraj were merged, and the Opavský kraj was created (Balíková 2012). From 1783 to 1848, Silesia was separated in 2 regions (Table 4.6).

Tab. 4.6 – Administrative division of Silesia, 1783–1848

	Region (German name)	Region (Czech name)
1	Troppau (die Stadt, der übrige Kreis)	Opavský kraj (Opava)
2	Teschen	Těšínský kraj (Těšín)

Source: based on Tafeln zur Statistik der Österreichischen Monarchie, 1831–1848

4.2.2 Period 1848–1948

The Austrian system of administration was applied in the Czech lands from 1848 to 1918 (dissolution of the Empire), and it was continued until 1948 (with changes during the German occupation).

As a result of the revolution of 1848, the reform of the state administration, and new administrative and judicial system was implemented, this being a transition from the absolutist system to the constitutionalism (Burda 2010). The lands were divided into judicial districts. The judicial district was the basic unit of administration (Burda 2010). The political districts were created by uniting two-three, sometimes four judicial districts. This system lasted almost one century. The borders of the districts were mostly stable during this period. The political districts, which were the first level of political governance, were headed by a district chief executive (hejtman).There were also regions headed by a regional government and a regional governor (Burda 2003). The administrative division during 1850–1855 is presented in Table 4.7.

Tab. 4.7 – Administrative division of Czech lands, 1850–1855

	Region (German name)	Region (Czech name)	Political districts	Judicial districts
Bohemia			80	210
1	Prag	Pražský kraj (Praha)	8	24
2	Budweis	Budějovický kraj (České Budějovice, Tábor)	9	27
3	Eger	Chebský kraj (Cheb, Most)	12	39
4	Jicin	Jičínský kraj (Jičín, Hradec Králové)	16	24
5	Boehmisch-Leipa	Českolipský kraj (Česká Lípa, Liberec)	10	34
6	Pardubic	Pardubický kraj (Kutná Hora, Vysoké Mýto)	11	31
7	Pilsen	Plzeňský kraj (Plzeň, Písek)	13	31
8	Prag	Praha	1	–
Moravia			25	78
1	Brunn	Brněnský kraj (Brno)	12	38
2	Olmutz	Olomoucký kraj (Olomouc)	13	40
Silesia			7	22
Total			**112**	**310**

Note: Praha was not part of any region, was a statutory city.

Source: based on Tafeln zur Statistik der Österreichischen Monarchie, 1849–1851.

A statutory city is a city with a special status. A statutory city has a city hall (magistrát) and a mayor (primátor). The special status was accorded starting with the 19th century. In 1869 to 1910 a statutory city meant a city with its own administrative regulations, and in 1921 from 1930 – city with its own constitution. These cities had the same power as political districts. The oldest statutory cities are from 1850 – Brno, Liberec, Olomouc and Opava, in 1869 the following were added – Jihlava, Uherské Hradiště and Znojmo, 1880 – Frýdek and Kroměříž. Praha, as the capital, it had a special status and a self-determination status, a mayor and a city hall. From 1934 there were only three statutory cities – Praha, Brno and Olomouc. Eventually, just Praha remained with this status. Later in 1960, their number increased again to four: Praha, Brno, Ostrava and Plzen. In 1990 there were 13 and Praha, on 31.12.2005 there were 20, including Praha (Růžková and Škrabal 2006).

During 1855–1867, a new administrative reform was tried to be implemented, due to the return to absolutist government during Neoabsolutist era (Burda 2003). Although, with no success. The reform was pursuing to create mixed district offices, which would perform both functions: judiciary and administration (Burda 2010). An important point was the formation of the Federation of Austria and Hungary in 1867 (Burda 2003). Thus, since 1867, the previous administrative division was reestablished (judicial and political districts). The number of the districts continued to increase due to population growth, and development in of the industrial areas (Burda 2003).

Starting with 1868 a definitive model of administrative division was introduced, which lasted until the end of the Austrian-Hungarian monarchy, and it is still functional in present Austria. The first unit of political governance was the political district, which, as already mentioned above, is formed of several judicial districts. The second unit of division was the lands.

Czechoslovakia was founded in 1918. After 1918 some territories have been incorporated to the Czech lands, but a part of Těšínsko was lost. The territory of the Czech lands was connected by Hlučínsko in Silesia, Valticko in the south of Moravia and part of Vitorazsko by railway in České Velenice, these territories were connected to the existing districts, and the district of Hlučín was created (Burda 2003). By joining with Slovakia and Sub-Carpathian Russia to Czechoslovakia, the issues of transformation of state administration arose (Burda 2003). The judicial and political system was kept, more problematic was in the Slovakia and Sub-Carpathian Russia, due to the different system they had before (Burda 2010). In 1920 a new administrative division into smaller counties (Župa) was proposed, this would have replaced the division at that time. The law was disputed due to the predominance of some ethnic groups in some regions, e.g. Česká Lípa, Karlovy Vary etc. – would have been populated mainly by ethnic Germans. Thus, the law was implemented only in Slovakia in 1923, and then it was abolished in 1927 (Burda 2010). Although, the census from 1921 was conducted according to this territorial division. In 1928, Moravia and Silesia were merged into Moravo-Silesia.

Following the Munich Agreement, in 1938, the political districts in the Sudetenland annexed to Germany were renamed to Land Districts (Landkreis). After the formation of the Protectorate of Bohemia and Moravia, the political districts (German political Bezirk) were renamed to the districts of the Protectorate (Bezirk). After 1945, the Czech lands returned to the previous division (Burda 2003).

The Decree of the President No. 121/1945, on the territorial organization of the administration, carried out by the national committees, restored districts to the state of 29 September 1938, but also introduced changes. He established the statutory cities of Praha, Liberec, Plzen, Brno, Olomouc, Opava and Moravská Ostrava, which were exempted from adjacent districts, but their local, national committees (local commissions) also performed the function of the national district committee for these districts. At the same time, the newly established statutory cities were extended by a number of adjacent municipalities (Burda 2003).

4.2.3 Period 1949–1960

The old system of judicial and political districts was working after the war, but it wasn't suitable for the new communist administration. Therefore a new reform came into force in 1949. The political and judicial districts were substituted with districts. The total number of districts was 192, according to the CSZO (Růžková and Škrabal 2006), 180, according to Mleziva (2017). Regions were created again after almost a century (Table 4.8). The lands were abolished. The capital Praha had the status of a region.

Tab. 4.8 – Administrative division in Czech lands, 1949–1959

	Region (kraj)	No. of districts
1	Hlavní město Praha	1
2	Pražský (Praha)	26
3	Českobudějovický (České Budějovice)	16
4	Plzeňský (Plzeň)	15
5	Karlovarský (Karlovy vary)	10
6	Ústecký (Usti nad Labem)	14
7	Liberecký (Liberec)	12
8	Hradecký (Hradec Kralove)	15
9	Pardubický kraj (Pardubice)	13
10	Jihlavský (Jihlava)	14
11	Brněnský kraj (Brno)	19
12	Olomoucký kraj (Olomouc)	13
13	Gottwaldovský (Zlin)	12
14	Ostravský (Ostrava)	12
	Total	192

Source: based on Růžková and Škrabal 2006.

Some of the regions crossed the border between the Czech, Moravian and Silesian countries, but the regional borders respected the Slovak border according to the law. According to social geographer Martin Hampl, the best socio-geographic regions at both regional and district level were in 1949 (Burda 2003). For the first time, the border between Bohemia and Silesia was changed by creating the Jihlava region (Burda 2003).

4.2.4 Period 1960–2000

The previous division from 1949 soon proved to be not suitable, for planning the national economy, the regions were too small (Häufler, Korčák and Král 1960), and a need for developing essentially economic areas. The solution was to create regions with similar economic character and issues while taking into account the natural conditions and location. Therefore, a new reform was implemented on 11 April 1960 on the territorial structure of the state and their bodies, and new regional national committees were created (krajské národní výbory). Seven new regions (eight with Praha) were created (Table 4.9). 75 (76 including Praha) new districts were created that do not respect the natural development and the land border (Burda 2003).

Tab. 4.9 – Administrative division in Czechia, 1960–1999

	Region (kraj)	No. of districts
1	Hlavní město Praha	1
2	Středočeský	12
3	Jihočeský	8
4	Západočeský	10
5	Severočeský	10
6	Východočeský	11
7	Jihomoravský	14
8	Severomoravský	10
	Total	76

Source: based on Růžková and Škrabal 2006.

This model was preserved during the whole socialist era. In 1990 the regional committees were abolished, and the municipal committees were both municipal and district authorities. In 1996 Jeseník district was created by dividing the district Šumperk and parts of Bruntál district (Burda 2003). On 1st of January 1993, Czechoslovakia was split into the Czech Republic and Slovakia. A new territorial division was needed, and politicians and scientists were looking for solutions for almost a decade (Burda 2003). The Constitutional Act 1/1993, Chapter 7, mentions that the municipalities (obce) are the primary self-governing unit (Burda 2010).

4.2.5 Period 2000 – present

In December 1997, the Parliament of the Czech Republic adopted a new constitutional law regarding the administrative division. On 1.1.2000, 14 regions emerged. The purpose was to be mainly self-governed (first elections to regional councils took place in November 2000) (Burda 2003). Regions started to work from 1.1.2001 (Table 4.10). The Capital City of Praha got higher territorial self-government.

Tab. 4.10 – Administrative division in Czechia, 2001

	Region (kraj)	No. of districts
1	Hlavní město Praha	1
2	Středočeský	12
3	Jihočeský	7
4	Plzeňský	7
5	Karlovarský	3
6	Ústecký	7
7	Liberecký	4
8	Královéhradecký	5
9	Pardubický	4
10	Vysočina	5
11	Jihomoravský	7
12	Olomoucký	5
13	Zlínský	4
14	Moravskoslezký	6
	Total	77

Source: based on Růžková and Škrabal 2006

District offices in the Czech Republic terminated their activities on 31 December 2002 as part of the second phase of the territorial administration reform. But the districts were still preserved after January 1, 2003, for the needs of courts, police, archives, labour offices, etc. Until 31 December 2007, the districts were NUTS 4, since January 1, 2008, this level was transferred to the LAU within the European Union. Thus the districts are LAU1 (CZSO). The regions are NUTS 3 and municipalities LAU 2 (CZSO). The regions have been operating for almost 10 years, with several changes (Vysočina, Moravskoslezký and Olomoucký).

After the cancellation of districts in 2003 and transferring the competencies to the regions, and the new municipalities with extended powers were created (205 ORP), their boundaries often coincide with the districts form 1949–60 (Burda 2010). Districts (LAU1) are still used in some areas of administration, and also in the present research.

If the present regions are compared to the regions from 1950, we observe that regions are more stable compared to districts from the point of view of borders, although, some borders do not exist, e.g. Pardubice or Hradec Kralove, and on the contrary, some do coincide. The internal borders were changing due to development of infrastructure, transportation etc. Stability of the borders can be explained by the geographical position – the mountain range, rivers etc., and the variability due to socio-demographic conditions (Burda 2010).

We conclude with a general overview of the administrative division since 1831–2018 (Table 4.11).

Tab. 4.11 – Summary of administrative division, Czech lands, 1831–2018

Administrative division	1831–1848	1850–1867	1868–1910	1921–1927	1928–1949	1950–2002	2003–2018
Land	■	■	■	■	■		
Region	■	■				■	■
County				■			
Political district			■	■	■		
District		■				■	■ *
Judicial district			■	■	■		
Municipality	■	■	■	■	■	■	■

Notes: the coloured cell means the change in the administrative division; *Municipality with extended powers (ORP).
Source: Růžková and Škrabal 2006.

Tables 4.12 and 4.13 contain summary with main changes in the districts during the analysed period.

Tab. 4.12 – Number of districts, Czech lands, 1869–1910

	1869		1880		1890		1900		1910	
	pd	jd	pd	jd	pd	jd	pd	jd	pd	jd
Bohemia	91	209	91	217	91	219	100	225	104	227
Moravia	35	77	37	77	37	77	40	78	42	82
Silesia	7	20	8	21	8	21	9	21	10	22
Czech lands	133	306	136	315	136	317	149	324	156	331

Tab. 4.13 – Number of districts, Czech lands, 1921–2003

	1921		1930		1950	1961	1970	1980	1991	2001	2003
	pd	jd	pd	jd							
Bohemia	106	223	104	224							
Moravia	42	83	47	106							
Silesia	11	23	–	–							
Czech lands	159	329	151	330	192	76	76	76	76	77	206*

Notes: pd – political district, jd – judicial district; *Municipality with extended powers (ORP).
Source: based on Růžková and Škrabal 2006.

4.3 Limitations of the data

The most important limitations of the data are the lack of available data in general. For the census from 1857, just data on total population by districts is available online. For the one from 1869, just total population and population by sex is available, and the military population is not included.

From the census from 1880, there is available data by sex, single age groups and marital status by districts. In the later censuses, this detailed data is missing. For example, in 1890 data is available just by broad age groups: 0–13, 14–59,60+; 14–45; 14+; 24+, and the data on marital status is not according to the age, just by sex.

Some important indicators cannot be calculated from historical data, e.g. TFR, because of lack of data on births by the age of the mother.

External borders of the Czech Republic have changed. Thus, the data for Hlučín and some municipalities in the South are difficult to get prior to 1919, because they were not part of the Czech lands before.

The data for both population and vital statistics are missing between 1914 (including) and 1918 (including).

The difficulties in recalculating data for 1938 (including) to 1946 (including) because of the changes that occurred in the country: WWII and German occupation (the Czech lands became the Protectorate of Bohemia and Moravia).

The transfer of the ethnic German population after WWII brought significant changes to the age structure in almost all the districts because of the intense movements of population.

Chapter 5

Methodology

For methodology of this research, one of main challenges was choosing suitable administrative units large enough to minimize bias of small population size, and small enough to see differences at the regional level. As a result, districts (identified in current CZSO classification as LAU1 units) were chosen as basic unit for analysis and observations. There were 77 districts in 2011, including Praha having special status. Officially, the district offices terminated their activity on 31December 2002 as part of the second phase of the territorial administration reform. However, the districts were preserved after 1 January 2003 for the needs of statistics, courts, police, archives, labour offices, etc. 2011 was chosen as final year for all recalculations because CZSO provides time series data at the district level for census years 1869–2011, so it could be used as benchmark, data checkup and tool to properly adjust data after spatial overlay. During research, several approaches were examined, but only adjustment using CZSO municipality-level data provided more reliable and accurate results.

5.1 Reconstruction of maps

The data recalculation was needed due to numerous changes in administrative division on the territory of the Czech lands between 1831 and 2017. Time series data cannot be used directly because none of historical district border match the current situation and thus population needed to be recalculated based on geographical location. Historical digital maps for census years were needed to create recalculated data that would match 2011 administrative division. As none of these digital maps were found or provided (before 1921), they had to be reconstructed manually based on published maps (Burda 2016) for the years 1831–1848, and through editing digital versions of maps (Historický GIS) for 1869, 1880, 1890, 1900, and 1910. Starting with 1921, Historický GIS district maps were used directly (Jíchová et al. 2014).

QGIS3 open source Geographical information system software was used for 1869–1910 maps reconstruction, editing, analysis and all spatial overlay operations. As already mentioned, main problems faced during data processing were related to the lack of digital historical maps. When maps were available, different sources provided different level of precision resulting in gaps and sibling polygons after map overlay analysis (see Appendix 5.9). Also, historical scanned maps used as an underlying layer did not follow stable cadastre unit borders or other administrative units valid in present time. Nevertheless, given the purpose of demographic studies at the national and district level, we assumed that these errors and uncertainties are not influencing calculations at the regional level to a significant degree (they accounted for less than 1-2% of district areas) and as such, we proceeded to map recreation.

For the 1910 map (Appendix 5.6), we used 1921 layer of administrative units (political districts) from Historický GIS. We addressed problems connected with generalized borders causing many issues during map overlay. Specifically, resulting layer from ArcČR district layer and historical district layer overlay was done using partly manual edits and automated cleaning based on the area of sibling regions (all newly created regions with area less than 10.000 m^2 were deleted, most of them are seen as red dots in Appendix 5.9 map). All historical district borders adjacent to country border were extended to cross national border before overlay and then intersected to perfectly match ArcČR layer.

With most important spatial problems corrected, we used new 1910 map as base for building older maps. Specifically, map for 1900 (Appendix 5.5) was derived from the 1910 map with several administrative changes addressed, namely:

1. Brandýs nad Labem district was part of Karlín political district.
2. Humpolec district was part of Německý Brod political district.
3. Kamenice nad Lipou was part of Pelhřimov political district.
4. Mariánské Lázně was part of Teplá political district.
5. Nejdek was part of Kraslice political district.
6. Nová Paka was part of Jičín political district.
7. Přísečnice was part of Kadaň political district.
8. Varnsdorf was part of Rumburk political district.
9. Moravský Beroun has a more complicated history consisting of 2 judicial districts – Dvorce and Libavá and did not exist as judicial district before, so we considered it was part of Šternberk political district.
10. Vsetín was part of Valašské Meziříčí political district.
11. Frýdek was part of Těšín political district.

The final number of political districts is 145 (96 in Bohemia, 40 in Moravia and 9 in Silesia) and 1 district with missing data (Hlučín) which was not part of the Czech lands until 1918. The information on number of districts and their names was verified in the Austrian Statistics and Mleziva (2017).

Map for 1890 (Appendix 5.4) was derived from the 1900 map with the following administrative changes addressed:

1. Duchcov district was part of Teplice-Šanov political district.
2. Kladno district was part of Smíchov political district.
3. Náchod district was part of Nové město nad Metují political district.
4. Žižkov district was part of Královské Vinohrady political district and Böhmisch Brod.
5. Moravské Budějovice district was part of Znojmo political district.

6. Moravská Ostrava district was part of Místek political district.
7. Tišnov district was part of Brno political district.
8. Bílovec district was part of Opava political district.
9. Rokycany district was part of both Hořowitz and Pilsen.

Map for 1880 (Appendix 5.3) is derived from the 1890 map with the following administrative changes addressed:

1. Polná political district later became part of Německý Brod political district. In order to create Polná district, we used approximate area based on the Wikipedia map of judicial districts of 1938. According to Mleziva (2017), Polná district was constituted from 3 judicial districts: Polná, Přibyslav and Štoky (change from 1869 situation, see below).
2. Královské Vinohrady district was part of Karlín political district.

Map for 1869 (Appendix 5.2) is derived from the 1880 map with the following administrative changes addressed:

1. Přerov district was part of Kroměříž political district.
2. Frýdek město district was part of Frýdek judicial district, which was part of Těšín political district.
3. Polná district was constituted by 2 judicial districts: Polná and Přibyslav.

The map for 1848 (see Appendix 5.1) was reconstructed following the borders from Burda (2016:15). Georeferenced scanned TIFF image was loaded to QGIS 3 below ArcCR cadastral map layer and regions were created manually by selecting appropriate cadastral units and dissolving their borders.

5.2 Data estimation

For the estimations of missing data on population, we used both census and vital statistics data. Estimations were computed for three separate periods: 1869–1880, 1881–1913 and 1919–1942 using different methods depending on whether population data, births and deaths data or all data were missing or incomplete. Big challenge was caused by changes in administrative division (number of districts and their borders) that occurred between census years. We estimated population (males, females, total) by standardizing data between adjacent census years for historical districts to match number of districts in first census in interval e.g. if some political district was split into 2 or more political districs having the same geographical extent (in e.g. 1885), we summed data for new districts and assigned result to original district (valid for 1880).

5.2.1 Period 1868–1880

We collected vital statistics data for 1868, census data for 1869 and available vital statistics data from 1872 to the next census in 1880. In order to calculate population data for 1868, we used this formula:

$$_{31.12.1868}P = {}_{31.12.1869}P - {}_{1869}B + {}_{1869}D$$

where: P = population (males, females or total); B = live births (males, females or total) and D = deaths (males, females or total). Migration wasn't taken into consideration for this year as it could not be estimated. Formula was applied to all political districts.

Data for the period 1870–1872 is missing and was more complex to estimate. For this task we used interpolation and equal interval methods. For calculation of population between 1872 and 1880, we used balance method in backward direction, starting from 1880. For 1880, we had both data for population, and births and deaths. So the same formula as mentioned above was used (adding deaths and subtracting births) for the calculation of missing population data for 1879 until 1871:

$$ {}_{y-1}P = {}_{y}P + {}_{y}D - {}_{y}B $$

where: P = population (males, females or total) at the end of the year; D = deaths (males, females or total); B = live births (males, females or total).

To estimate population for 1870 and 1871, we applied equal interval distribution between ${}_{1872}P_x$ and ${}_{1869}P_x$. To estimate births and deaths for 1869–1871, we also applied equal interval distribution (3 intervals), calculating absolute difference between interval values divided by number of intervals:

$$ {}_{y}B = {}_{y-1}B + \frac{abs(B_s - B_e)}{I_n} $$

where: B_s = live births at start of interval year; B_e = live births at the end of interval year; I_n = number of intervals.

We also calculated data for livebirths by sex by setting up ratio between males and females in 1872 assuming the ratio remains the same and we applyed it to total livebirths for given year. Final formula for males is:

$$ B_m = \frac{B_t}{2} * \frac{{}_{1872}B_m}{{}_{1872}B_f} $$

Final formula for females is:

$$ B_f = B_t - B_m $$

where: B_m = live births – males; B_t = live births – total; B_f = live births – females.

5.2.2 Period 1881–1913

The biggest challenge for this period was the change in the number of districts between the census years. To solve the problem of recalculating data for districts that changed in between census years, we used political districts situation at the start of interval (e.g. 1880 census) and assumed no administrative changes happened in between the census years. As result, we could use the recalculation ratios computed for census years and overcome limitation of data recalculated by CZSO, used as a benchmark (see Chapter 5.3).

We calculated the ratios of newly formed districts by using the proportion of deaths and births in the previous district they were or became part of. An average of these proportions was used as ratios (Figure 5.1) later used for distributing the population to the original districts. These calculations inherently contain approximation, so we tried to be as exact as possible in identification where the changes occurred territorially using map layers.

Fig. 5.1 – Example of the ratios for the political districts that appeared during the census years

id	year	old_data_id	new_data_id	ratio
1	1,885	159	18	0.506448910
2	1,885	159	15	0.493551090
3	1,885	36	36	0.409502520
4	1,885	36	41	0.590497480
5	1,894	91	91	0.730294800
6	1,894	91	37	0.269705200
7	1,896	98	98	0.473249980
8	1,896	98	20	0.526750020
9	1,896	157	157	0.798307650
10	1,896	157	158	0.201692350
11	1,896	67	67	0.778288790
12	1,896	67	81	0.221711210
13	1,896	28	28	0.713035240
14	1,896	28	81	0.286964760
15	1,897	146	146	0.732996470
16	1,897	146	124	0.267003530
17	1,897	115	115	0.722357640
18	1,897	115	124	0.277642360
19	1,897	114	114	0.881476030
20	1,897	114	139	0.118523970
21	1,898	8	8	0.697349650
22	1,898	8	104	0.302650350

Notes: old_data_id – the id of the district before the change, new_data_id – the id of the district after the change.

Source: Author's calculations based on data from Austrian Statistics.

After having the ratios, the population for the periods between the census years was calculated by the balance method used in the previous period. Example:

$${}_{31.12.1881}P = {}_{31.12.1880}P + {}_{1881}B - {}_{1881}D$$

where: P = population; B = live births and D = deaths.

It is important to note, that we estimated the end-year population first to follow the data collected in censuses. For further research, mid-year population needed to be calculated too (the average between end-year population of 2 following years, we did not have beginning of year population data, so we assumed end-year population = beginning of year population of the next year).

5.2.3 Period 1919–1942

The population between the census years was calculated by using the vital statistics (Demografická ročenka). In the period 1919–1942, besides data for births and deaths at the regional level, also CBR and CDR were available. Thus, we calculated the mid-year population:

$$Px = \frac{Bx}{CBR} \times 1000$$

$$Px = \frac{Dx}{CDR} \times 1000$$

We calculated population from both indicators to increase precision even though there was rather insignificant difference between the Px values. Thus, an average of the population from the crude birth rates and crude death rates was calculated and used as final population. Starting with 1943, the mid-year population data were available in the vital statistics and therefore could be used directly.

5.2.4 Estimation of migration

The migration estimates were derived from the comparison of intercensal population growth with the natural increase data. This is called the balancing equation, also used by Knodel (1974). For example:

$$_{1880\text{–}1890}M = {}_{1890}P - ({}_{1880}P + {}_{1880\text{–}1890}B - {}_{1880\text{–}1890}D$$

where: $_{1880\text{–}1890}M$ = migration between the census years; $_{1880}P$ = population data from 1880 census; $_{1890}P$ = population data from 1890 census; B = total births between the census years; D = total deaths between the census years.

The migration for each year was calculated by dividing the migration estimate data to the number of years between the censuses assuming migration was equally distributed across years.

5.3 Data recalculation

All historical data were recalculated by defining a ratio of each political district / judicial district / district area (1869–2001) in actual districts (LAU1) areas from 2011 (based on ArcČR 3.3 shapefiles). The ratios were calculated using polygon identity spatial overlay function (Appendix 5.7). Calculated proportions of political districts areas were used to recalculate the rest of the data. CZSO (Růžková and Škrabal 2006) has recalculated the total population on the actual districts for census years during 1869–2011. These data are available on CZSO public database website, and they were downloaded at the level of municipality parts (části obce) for cross-checking (finding errors in data and calculations) and for more precise political districts administrative borders reconstruction (map layers).

Recalculated data at the district level by CZSO were used for correcting results of the recalculation in this research. First, we compared our map overlay results with the CZSO district level data. Furthermore, recalculation of historical political districts to actual districts revealed wide variance in reliability and differences ranging from almost 0% to more than 200% between CZSO data and recalculated data (Table 5.1). This variance is directly correlated to heterogeneity in spatial distribution of population, especially around densely populated areas. See Appendix 5.8 (example of Plzeň město district situation) and Table 5.1.

Tab. 5.1 – Selected results of recalculation of population data from political districts to 2011 districts compared to CZSO population data, the first approach, 1869 and 1880

	1 869				1 880			
District name	CZSO	Recalc	Diff	Diff %	CZSO	Recalc	Diff	Diff %
Benešov	115 753	117 783	-2 030	-1.8%	116 485	121 339	-4 854	-4.2%
Beroun	67 373	86 999	-19 626	-29.1%	69 439	91 057	-21 618	-31.1%
Blansko	77 979	80 553	-2 574	-3.3%	81 311	84 359	-3 048	-3.7%
Brno-město	104 977	85 505	19 472	18.5%	120 122	95 407	24 715	20.6%
Brno-venkov	125 785	146 322	-20 537	-16.3%	134 107	158 800	-24 693	-18.4%
České Budějovice	116 772	114 772	2 000	1.7%	128 343	125 287	3 056	2.4%
Český Krumlov	89 046	87 999	1 047	1.2%	92 992	91 721	1 271	1.4%
Cheb	111 277	97 937	13 340	12.0%	124 429	109 666	14 763	11.9%
Chomutov	92 652	83 128	9 524	10.3%	105 468	94 078	11 390	10.8%
Chrudim	112 143	110 847	1 296	1.2%	118 811	117 391	1 420	1.2%
Děčín	174 262	178 287	-4 025	-2.3%	186 961	191 619	-4 658	-2.5%
Havlíčkův Brod	106 265	98 617	7 648	7.2%	109 122	103 245	5 877	5.4%
Hodonín	94 276	90 215	4 061	4.3%	103 975	100 831	3 144	3.0%
Hradec Králové	101 532	132 366	-30 834	-30.4%	114 055	145 012	-30 957	-27.1%

Notes: CZSO – total population recalculated by CZSO. Recalc – total population recalculated, Diff – the difference in absolute numbers between CZSO and Recalc data, Diff % – the percentage difference between CZSO and Recalc.

Sources: Author's calculations based on data from Austrian Statistics and CZSO.

We considered percentage differences to be unacceptable for further research and we assumed adjustments to the historical border can improve the quality of the results. Therefore another approach (based on matching population size of districts to CZSO data) was chosen in an attempt to get more precise administrative borders of political districts and, subsequently get the most correct results possible:

1. Data for the total population were downloaded from the CZSO public database for each municipality part (části obce), and they were joined with appropriate shapefile layer from ArcČR 3.3 (added as attributes to municipality parts layer).
2. Using the original layer of political districts and various other sources (Mleziva 2005 etc.) as a template, new political districts were created to match the sum of the population in underlying municipality parts to best possible precision.
3. New recalculation to actual districts was computed (Table 5.2).

Tab. 5.2 – Selected results of recalculation of population data from political districts to 2011 districts compared to CZSO population data, the second approach, 1869

District name	CZSO	Recalc	Diff	Diff %
Ústí nad Labem	52 939	54 813	-1 874	-3.5%
Česká Lípa	114 587	114 012	575	0.5%
Jablonec nad Nisou	78 183	82 191	-4 008	-5.1%

District name	CZSO	Recalc	Diff	Diff %
Liberec	165 637	161 675	3 962	2.4%
Semily	106 240	105 661	579	0.5%
Hradec Králové	101 532	104 025	-2 493	-2.5%
Jičín	112 576	108 335	4 241	3.8%
Náchod	119 718	112 412	7 306	6.1%
Rychnov nad Kněžnou	101 194	115 171	-13 977	-13.8%
Trutnov	146 218	144 272	1 946	1.3%
Chrudim	112 143	110 491	1 652	1.5%
Pardubice	81 208	82 540	-1 332	-1.6%
Svitavy	142 481	141 714	767	0.5%
Ústí nad Orlicí	150 395	145 410	4 985	3.3%
Havlíčkův Brod	106 265	110 249	-3 984	-3.7%
Jihlava	99 709	94 016	5 693	5.7%
Pelhřimov	99 331	96 525	2 806	2.8%
Třebíč	87 050	89 563	-2 513	-2.9%
Žďár nad Sázavou	113 125	115 900	-2 775	-2.5%
Blansko	77 979	78 489	-510	-0.7%

Notes: CZSO – total population recalculated by CZSO. Recalc – total population recalculated, Diff – the difference in absolute numbers between CZSO and Recalc data, Diff % – the percentage difference between CZSO and Recalc.

Sources: Author's calculations based on data from Austrian Statistics and CZSO.

Comparing results of both recalculation methods show clearly lower variance in % difference and also higher precision, especially in regions with the evenly distributed population without big cities. Praha, Ostrava, Brno and other centres distort this recalculation method based on area overlay and lead to higher percentage errors. There is, therefore, room for adjustments.

Even with this more precise approach, differences between recalculated and CZSO data were significant, so further adjustment was needed by calculating an adjustment ratio based on the percentage difference between recalculated population and the CZSO population data. Procedure was as follows:

1. We calculated ratio of given political / judicial district in 2011 districts using SQL database queries (each historical district can be part of one or more 2011 districts).
2. We calculated total population of given district for historical census years in 2011 districts using ratios calculated in step 1.
3. Total population in 2011 district then equals to sum of population of all historical districts overlapping 2011 districts.
4. This total population number was compared to official CZSO data and % difference was calculated.

5. To match CZSO data, we calculated ratios between CZSO population and recalculated population for each 2011 district and then used this ratios to adjust original ratio of each historical district in given 2011 district.

This approach delivered perfect data match and is assumed to be the best possible solution to correct data for census years (having it as a benchmark for intercensal data based on CZSO). Data (both population and vital statistics) for years between the censuses were adjusted using these ratios as well to retain the same quality and comparability of time series.

5.4 Data analysis

We calculated indicators for both historical data and recalculated data for 2011 districts. From 1919, these indicators were already calculated in Demographic yearbook, crude rates mostly. So they could be used directly. For the mortality analysis, the following indicators were calculated:

1. Crude death rates.
2. Infant mortality rate.
3. Child mortality rate.

For the fertility analysis, the following indicators were calculated:

1. Crude birth rate.
2. The proportion of illegitimate births.

For the analysis of ageing:

1. Old dependency ratio.
2. Share of population 65+ (older people).
3. The growth rate of older people (65+, related to the speed of ageing and classification).

Other indicators or measures:

1. Rate of natural increase.
2. Net migration rate.
3. Growth multiple.

For the interrelations between ageing and demographic transition:

1. Correlations.
2. Linear regression.

The correlations and simple linear regression analysis were performed with the IBM SPSS Statistics. The linear regression equation is the following:

$$Y_i = \beta_0 + \beta_1 X_i$$

where: Y_i – dependent variable; X_i – independent variable.

In each case, we had one dependent and one independent variable.

Chapter 6

Demographic transition at the regional level

6.1 Introduction

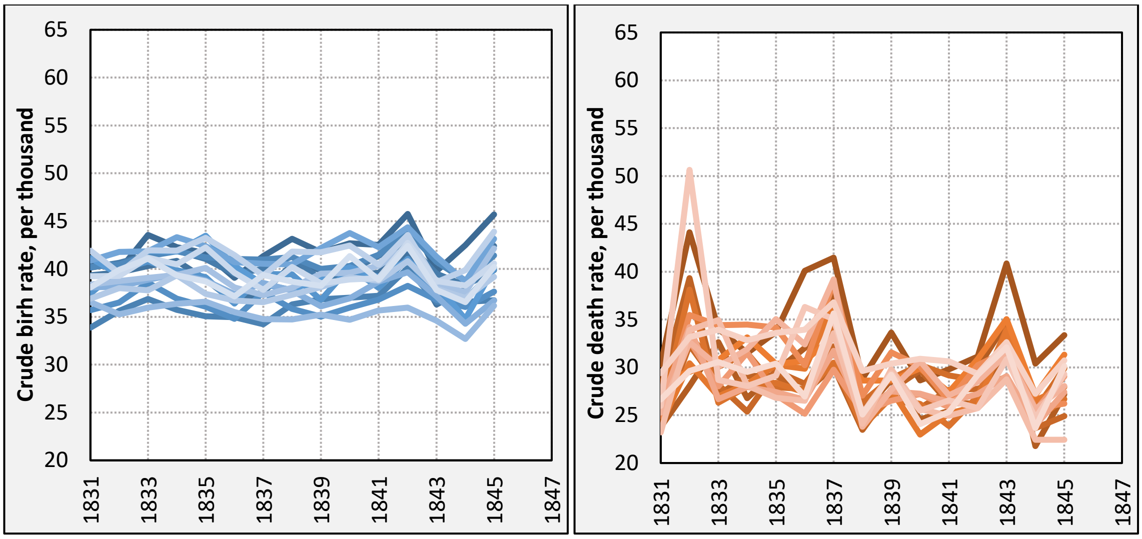
This chapter is focused on the development of demographic transition at the regional level. The analysis starts with the pre-transitional period. Then it continues with the description of trends in mortality decline, specifically crude death rates and infant mortality rates. Next step is the evolution of fertility levels. We will analyze specifically crude birth rates and illegitimate births. Migration during 1869–1910 was briefly analysed too, as an important contributor to the changes of population. The final subchapter of this section deals with the classification of the demographic transition by the onset and duration of demographic transition at districts level. In this chapter, the following hypotheses are tested:

1. Demographic transition in the Czech lands followed the pattern of other European countries.
2. Demographic transition in the Czech lands started in the Northern industrialized districts and Praha, the capital, and then it diffused to the peripheries.
3. There is a close link in the fertility decline of population located in the same geographical region.

6.2 Pre-transitional period

The earliest data available for the analysis of pre-transitional phase at the regional level are for the period 1831–1847. During these years, Bohemia had 17 regions, Moravia 7 regions and Silesia 3 regions. Figure 6.1 presents the vital rates for Bohemia. During this phase, crude birth rates were fluctuating from 34 to 46 per thousand people. Bohemia was in the phase of natural fertility (Henry 1961). Nevertheless, fertility is assumed to be moderately high (Coale 1986; Diebolt and Perrin 2017). We can assume that no means of nonparity-related restriction of fertility were used. Crude death rates were fluctuating between 23 and 35 per thousand people, with peaks reaching values of 40 or even 50 per thousand people.

Fig. 6.1 – Crude birth rates and crude death rates, Bohemia regions, 1831–1847

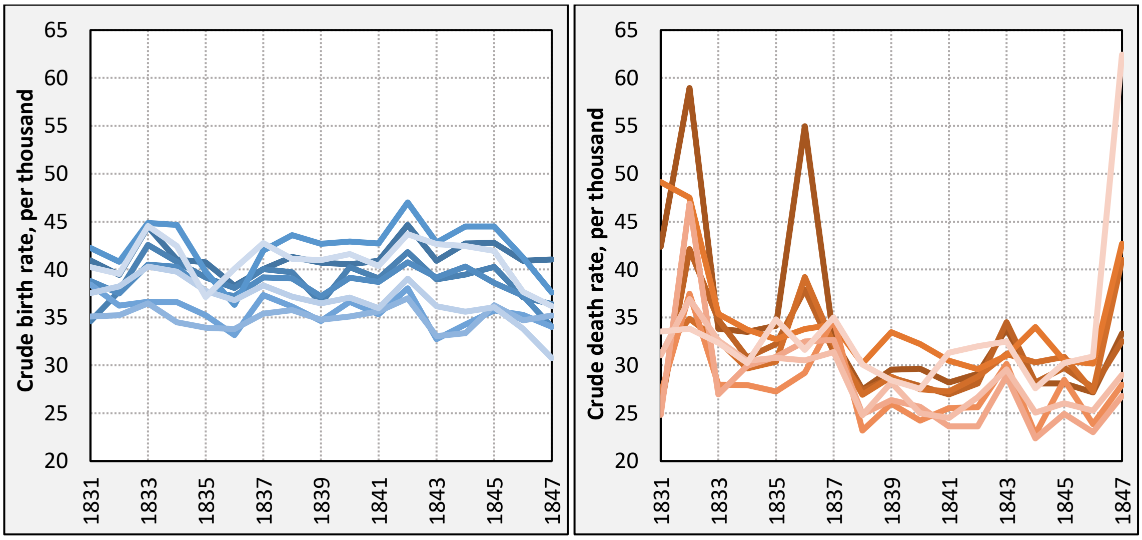


Notes: Praha is not included; data from 1845 to 1847 is missing.

Source: Author's calculations based on data from Austrian Statistics.

Figure 6.2 shows the vital rates for Moravia and Silesia. During this phase, crude birth rates were fluctuating between 35 and 47 per thousand people. Moravia and Silesia, as well as Bohemia, were in the phase of natural fertility (Henry 1961). Crude death rates were fluctuating between 25 and 35 per thousand people, but sometimes reaching 40 or even 60 per thousand people. The probable reason for high fluctuations is small population numbers.

Fig. 6.2 – Crude birth rates and crude death rates, regions, Moravia and Silesia, 1831–1847

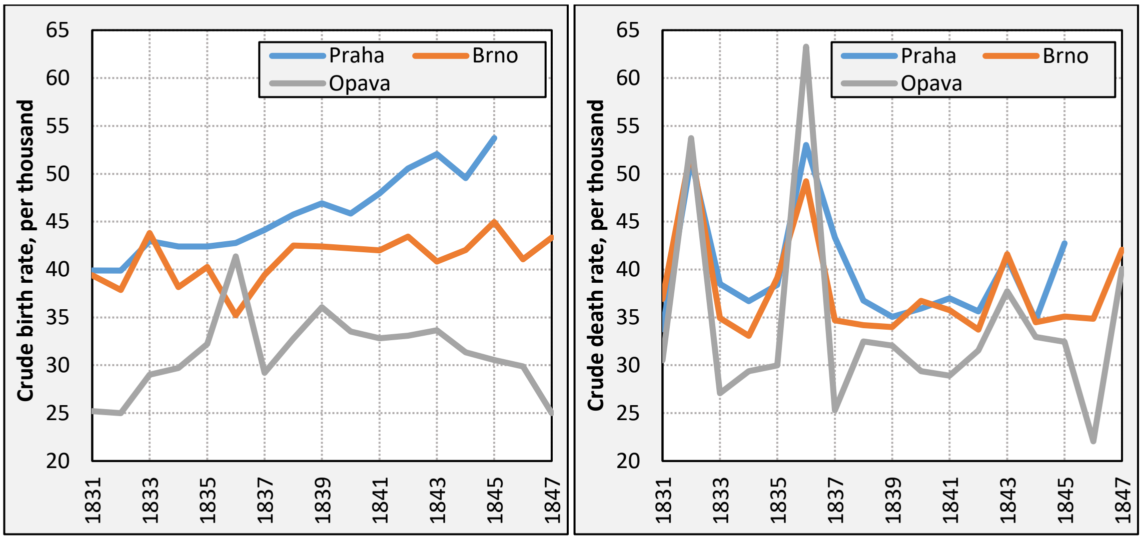


Note: Brno and Opava are not included.

Source: Author's calculations based on data from Austrian Statistics.

Figure 6.3 compares the vital rates of three main cities in the Czech lands: Praha (Bohemia), Brno (Moravia) and Opava (Silesia). CBR for Praha and Brno was close to the national average at around 40 per thousand, but it showed an upward trend. Opava had a CBR of about 25 per thousand at the beginning of the observed period and at the end. The high fluctuations can be attributed to the small population number. Except for the years 1832 and 1836, CDR stalled at around 35 per thousand people. CDR was slightly lower for Praha and Brno than CBR, which is contradictory to prior studies (Dyson 2010). Opava has lower CDR than Praha and Brno.

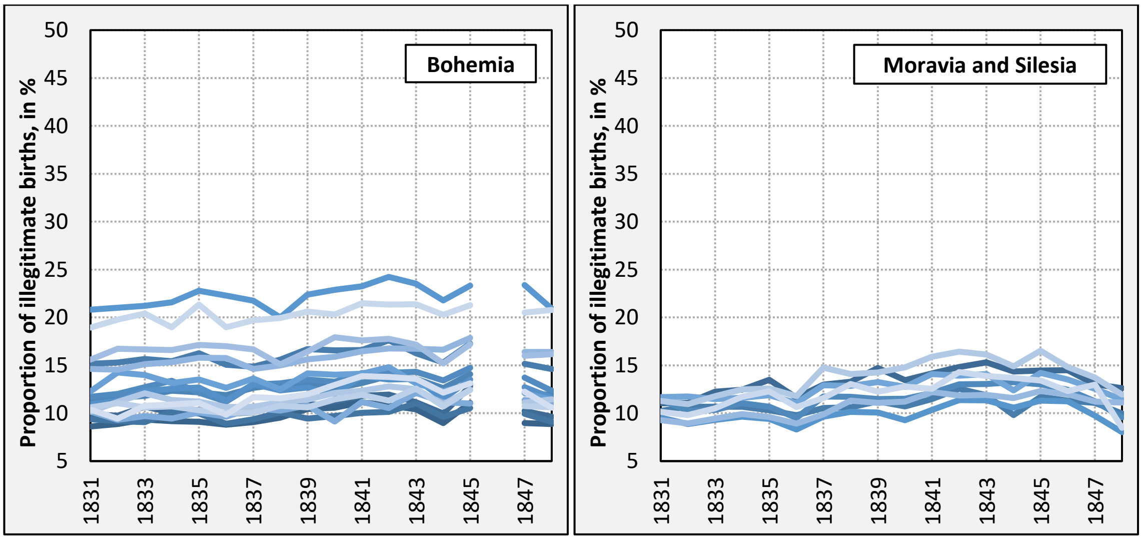
Fig. 6.3 – Crude birth rates and crude death rates, Praha, Brno and Opava, 1831–1847



Note: data for Praha from 1845 to 1847 is missing.
Source: Author's calculations based on data from Austrian Statistics.

Figure 6.4 presents the proportion of illegitimate births in the Czech lands. In Bohemia, the proportion of births out of wedlock ranged from 10% to about 20% out of total live births. And the trends were constant during the analysed period. In Moravia and Silesia, the proportion of births out of wedlock births were approximatively 10% for all the regions and slightly decreased.

Fig. 6.4 – The proportion of illegitimate births, regions, Bohemia, Moravia and Silesia, 1831–1847

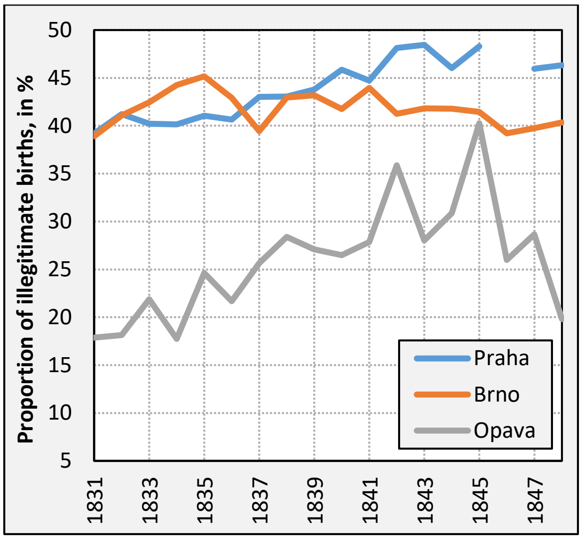


Notes: Praha, Brno and Opava are not included; only live births are considered.
Source: Author's calculations based on data from Austrian Statistics.

The share of illegitimate births in the cities was considerably higher than in the remaining regions. In Praha and Brno, approximately 40–45% of live births are out of wedlock (Figure 6.5).

In Opava, the proportion of illegitimate births was approximately 20% with higher fluctuations and is twice higher compared to the regions in Moravia and Silesia.

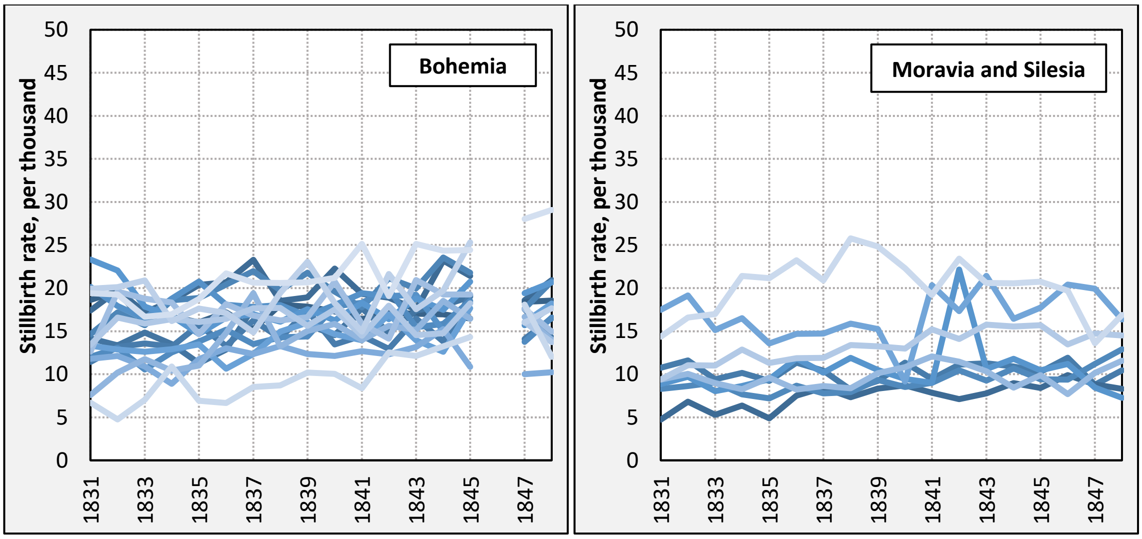
Fig. 6.5 – The proportion of illegitimate births, regions, Bohemia, Moravia and Silesia, 1831–1847



Source: Author's calculations based on data from Austrian Statistics.

Stillbirth rates were constant during the analysed period. For all the Czech lands, the rates were fluctuating between 5 and approximately 20 per thousand total births (Figure 6.6).

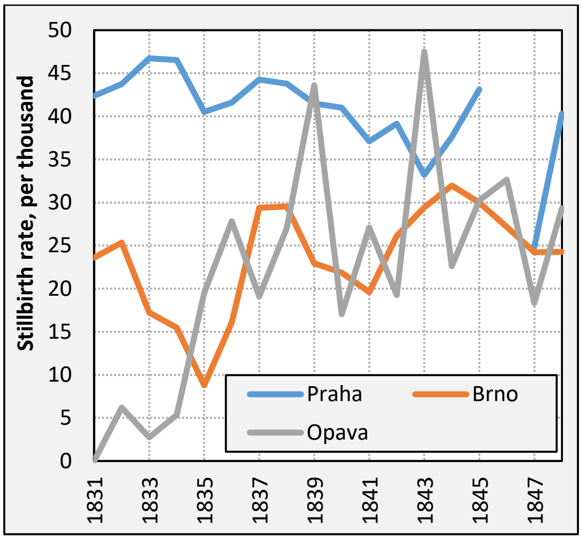
Fig. 6.6 – The stillbirth rate, regions, Bohemia, Moravia and Silesia, 1831–1847



Notes: Praha, Brno and Opava are not included.
Source: Author's calculations based on data from Austrian Statistics.

Among the cities, the stillbirth rate varied a lot (Figure 6.7). In Praha, the stillbirth rate was about 40 per thousand total births in 1831. In the same year, Brno was at almost half of Praha's value – 25 per thousand total births. The data for Opava fluctuated considerably, but with an upward trend.

Fig. 6.7 – The stillbirth rate, Praha, Brno and Opava, 1831–1847



Source: Author's calculations based on data from Austrian Statistics.

Analysis of the pre-transitional phase during 1831–1847 showed that CBR was ranging between approximately 35 and 47 per thousand people for all the Czech lands. CDR was ranging between 25 and 35 per thousand people with high fluctuations between 40 and 60 per thousand people. No substantial differences were observed among the Czech lands for CBR and CDR, except that the rates were fluctuating more for Moravia and Silesia. The CBR for some cities (Praha and Brno) showed moderate natality but also high mortality compared to the national average. The illegitimate fertility was higher in Bohemia, the proportion of births out of wedlock account between 10 and 20% of live births. In Moravia, the births out of wedlock accounted for about 10% of live births. In Praha and Brno, approximately 40% of live births were illegitimate. The stillbirth rate is constant among the Czech lands ranged between 5 and approximately 20 per thousand total births. The highest stillbirth rate was in Praha, and accounted for 40 per thousand births.

6.3 Evolution of mortality levels

6.3.1 Mortality

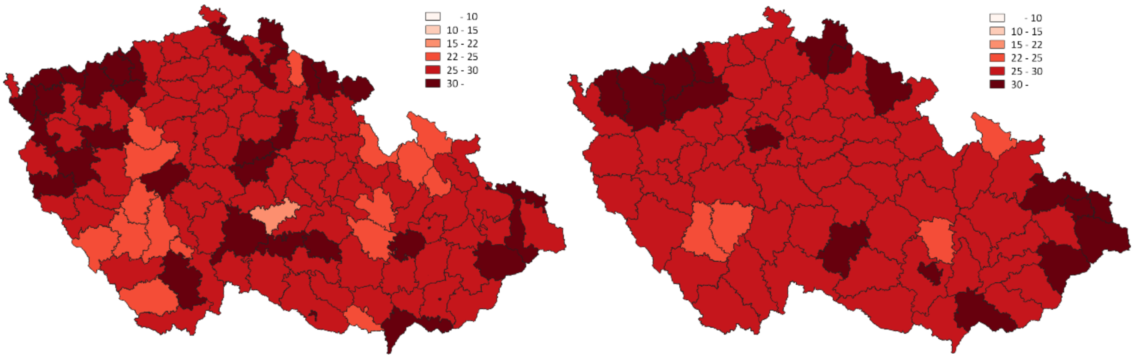
The geographical distribution helps us to create a more complete and accurate explanation of the demographic changes. In this section, we present the evolution of CDR for the period 1869–1937 at the regional level. CDR was presented on maps for eight census years except 1881 and 1937. The year 1881 was used for its availability of IMR data, and the year 1937 is considered to be the end of demographic transition and also end of available data (next data being available from 1947). To summarize, the data were presented for the following years: 1869, 1881, 1890, 1900, 1910, 1921, 1930 and 1937.

CDR are mapped for both historical and recalculated data. Historical data are used for two main purposes: to show the reliability of recalculated data and for in-depth and historically correct representation of data. Historical data are available at the level of political districts (1868–1910) and judicial districts (1921–1937). Recalculated data is computed at the level of districts (LAU1).

During the pre-transition period, as mentioned above, the death and birth rates were high (or moderately high). In the first phase of demographic transition, death rates started to fall continuously until the end of transition when deaths rates stabilized around 10–15 per thousand people.

For 1869, CDR were ranging between 22 and over 30 per thousand people (Figure 6.8). Most of the districts were in the range of 25 to 30 per thousand people, which is considered a pre-decline level of mortality (Reher 2004). Some of the districts had high CDR over 30 per thousand people, and several districts entered the mortality decline phase with crude death rate under 25 per thousand people (Reher 2004).

Fig. 6.8 – Geographical distribution of crude death rates, by districts, historical and recalculated data, Czech lands, 1869

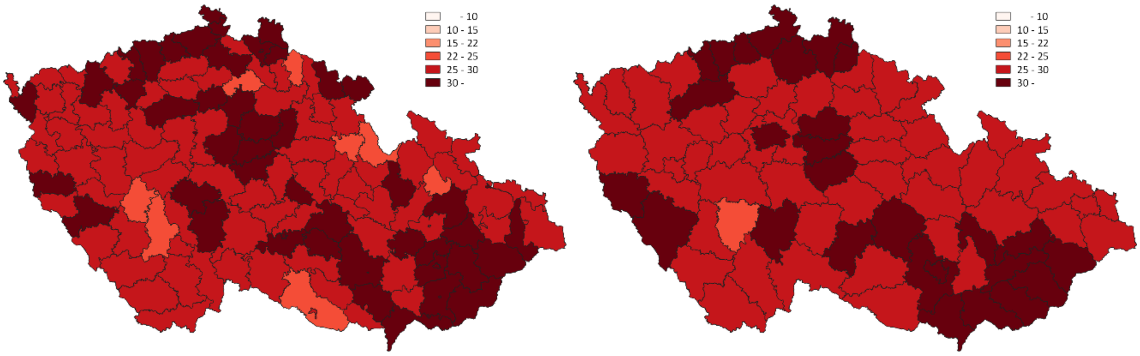


Note: only the civil population in the total population was included.

Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

Figure 6.9, compared to Figure 6.8, shows that mortality was still fluctuating. No significant changes occurred between 1869 and 1881. The high mortality is predominant in several districts from Northern and Central Bohemia and South-Western Moravia. Mortality remained high in Praha at 36 per thousand people (recalculated data). The change between recalculated districts in 1869 and 1880 showed a variance of 4% on average. The highest increase accounted for 32% for Kroměříž and Zlín, 27% for Uherské Hradiště; CDR increased by almost 10 per thousand. The highest decrease accounted for 13% for České Budějovice, and 10% for Brno-město and Sokolov (Appendix 6.1).

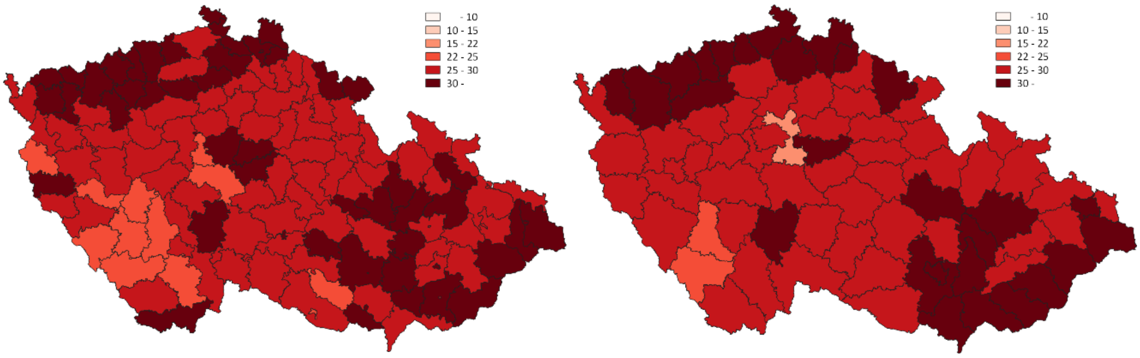
Fig. 6.9 – Geographical distribution of crude death rates, by districts, historical and recalculated data, Czech lands, 1881



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

From 1881 to 1890, in several districts entered the demographic transition (accordind to Reher (2004)), where the level of crude death rates dropped under 25 per thousand people (Figure 6.10). The districts with the lowest mortality were mostly located in Western Bohemia and a few in Central Bohemia. The mortality was still high for Praha and accounted between 30 and 35 per thousand people, but also in other cities, e.g. Liberec, Brno, Kroměříž, Jihlava. During this period, death rates were mostly decreasing, on average (for recalculated data) by -1.5% (Appendix 6.1). The highest decrease was observed in Praha-východ by -29%, in Praha by -17% and in Kroměříž by -17%. The highest increase was in Blansko, Svitavy, Sokolov, Bruntál and Frýdek-Místek, and accounted for about 10% (Appendix 6.1).

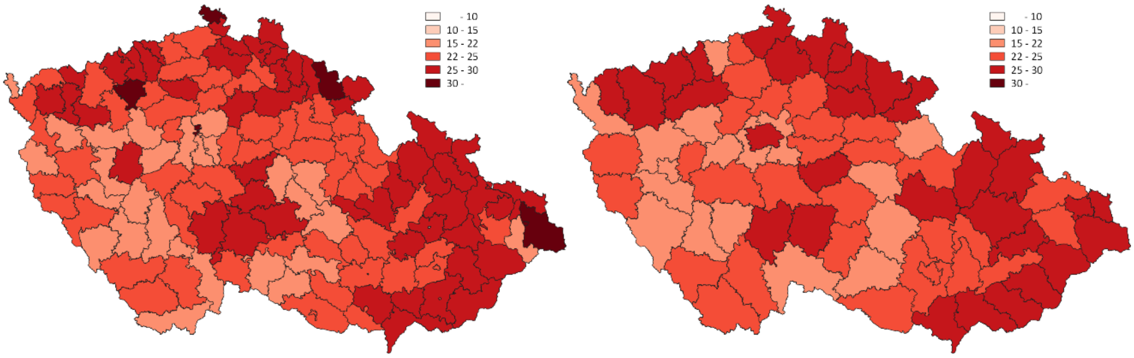
Fig. 6.10 – Geographical distribution of crude death rates, by districts, historical and recalculated data, Czech lands, 1890



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

Mortality was declining gradually until 1890. Crude death rates changed radically from 1890 to 1900, as seen from the comparison of Figure 6.10 and Figure 6.11. In 1900 only five political districts had a crude death rate higher than 30 per thousand people. In the recalculated map, all districts had a crude death rate under 30 per thousand people. Mortality was quite heterogeneous during this period, ranging between 15 and over 30 per thousand people. The change in mortality accounted for -16% on average within a range from -38% to -2% (Appendix 6.1). CDR is decreasing in all the districts. The highest decrease was in Teplice, Praha-západ and Plzeň-město. The lowest decrease was in Jeseník, Semily and Praha-východ.

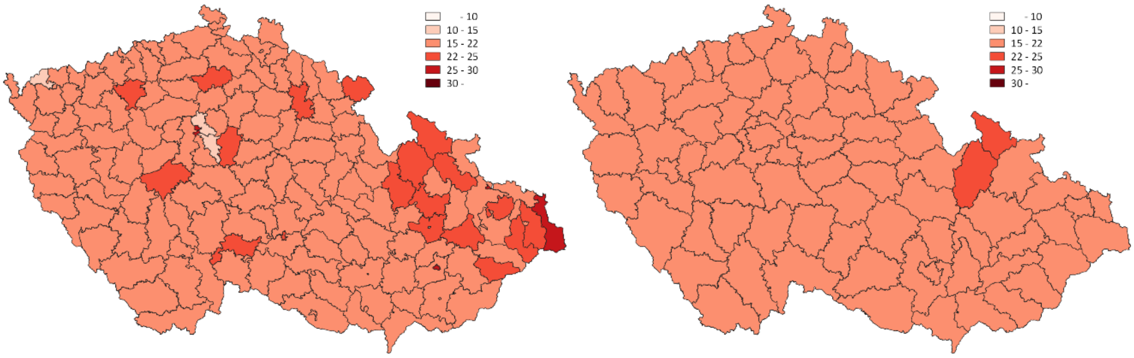
Fig. 6.11 – Geographical distribution of crude death rates, by districts, historical and recalculated data, Czech lands, 1900



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

In sharp contrast with the 1900 situation, Figure 6.12 shows that in 1910, mortality decreased substantially in almost all districts. The homogeneity among districts increased considerably. Mortality levels were high in Praha and Brno, in the range of 25 and 30 per thousand people, although it decreased from 1900 levels (Figure 6.12). Some districts located in Eastern Moravia and Silesia had higher mortality also – between 22 and 25 per thousand people. For this period, the highest change in mortality across the districts was observed. The change accounted on average for -19% (Appendix 6.1). The highest decrease accounted for 35% in Vsetín and Pelhřimov, and the lowest decrease accounted for 1% in Rychnov nad Kněžnou.

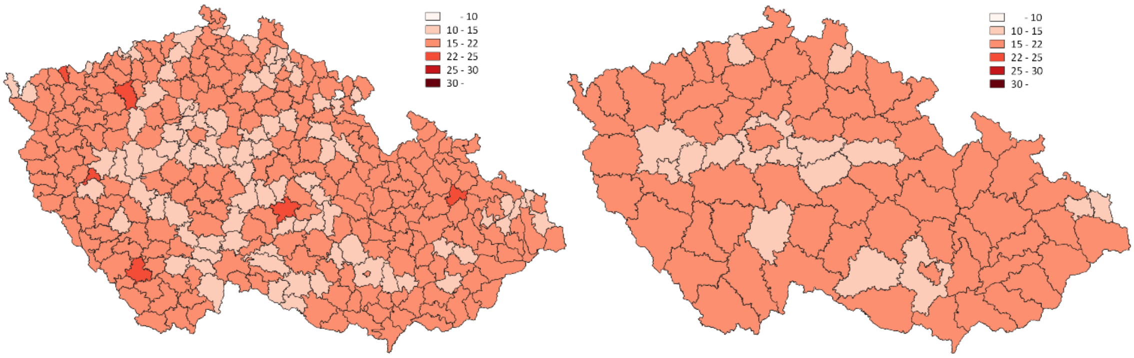
Fig. 6.12 – Geographical distribution of crude death rates, by districts, historical (and recalculated data, Czech lands, 1910



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

CDR continued to decrease after 1910. In 1921, in several districts in Central Bohemia and several districts from periphery areas, crude death rates reached 10–15 per thousand people (Figure 6.13). The mortality in Praha and other cities finally reached mortality similar to the national average – 15 to 22 per thousand people. The change between 1910 and 1921 accounted for an average of -16% (Appendix 6.1). Mortality continued to decline in this period. The highest decrease accounted for about 30% in Praha and Ostrava-město.

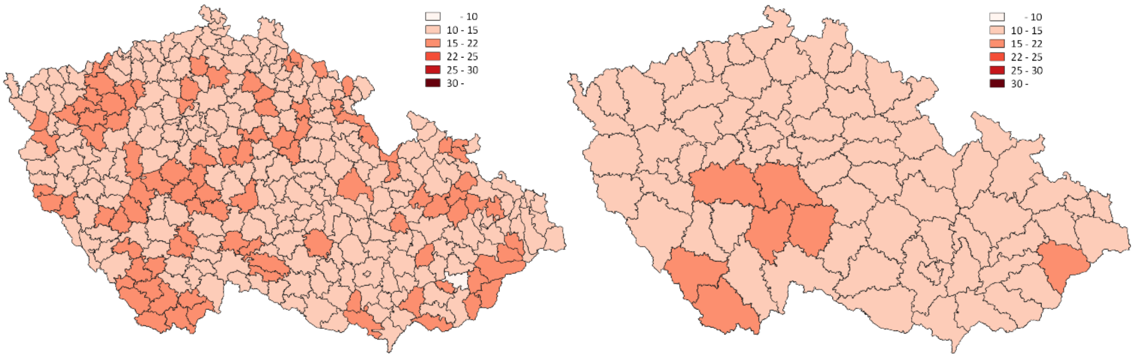
Fig. 6.13 – Geographical distribution of crude death rates, by districts, historical and recalculated data, Czech lands, 1921



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

A substantial reduction in crude death rates occurred between 1921 and 1930. In the majority of districts, CDR ranged between 10 and 15 per thousand people (Figure 6.14). The change in mortality accounted for -14% on average (Appendix 6.1). The highest decrease accounted for about 37% in Brno-město and about 28% in Praha, Sokolov and Frýdek-Místek.

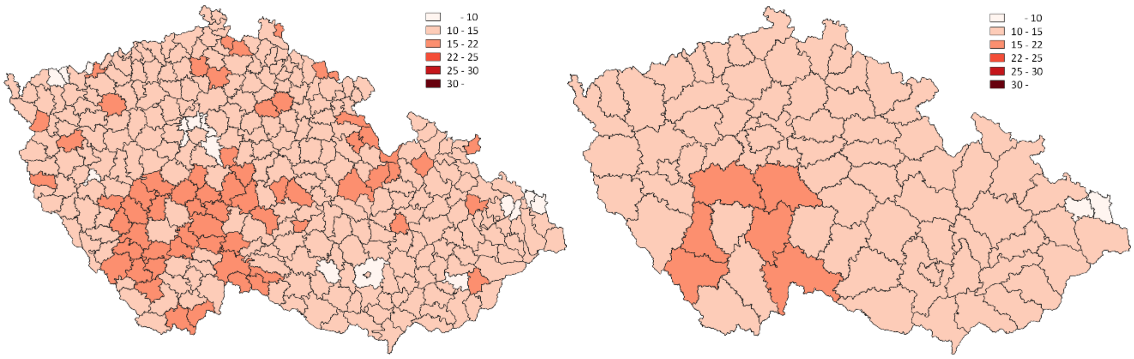
Fig. 6.14 – Geographical distribution of crude death rates, by districts, historical and recalculated data, Czech lands, 1930



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

Mortality continues to decline. At the end of demographic transition, the average CDR was between 10 and 15 per thousand people and quite homogeneous across districts. Approximately 10 judicial districts reached a crude death rate of 10 or less per thousand people. The mortality levels were stabilizing. The lowest value of CDR was for Ostrava-město with 9.7 per thousand people. The highest CDR was in Prachatice and Strakonice and accounted for 16 per thousand people. The districts with the highest CDR ranging between 15 and 22 were: Příbram, Benešov, Strakonice, Prachatice, Tábor and Jindřichův Hradec. The change in mortality between 1930 and 1937 accounted on average for -5% (Appendix 6.1). The highest decrease accounted for about 16% in Praha-západ, Chomutov, Hodonín and Zlín. The mortality continued to fall, but not as sharp as in the previous periods.

Fig. 6.15 – Geographical distribution of crude death rates, by districts, historical and recalculated data, Czech lands, 1937



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

Mortality transition varied across the districts. The mortality decline seems to have started earlier than in 1869 in some districts. The highest CDR was observed in several districts in Northern Bohemia, Central Bohemia and South-Western Moravia. The mortality decline started to "spread" to more districts in Western and Central Bohemia between 1881 and 1890. Between 1890 and 1900, mortality declined in all districts, but it remained heterogeneous ranging from 15 to over 30 per thousand people. Between 1900 and 1910, crude death rates decreased significantly, and for the first time, a homogeneity in mortality is observed. Crude death rates range between 15 and 22 per thousand people, except few districts in Eastern Moravia and Silesia (22–25 per thousand people) and Praha and Brno (25 and 30 per thousand people). After 1930 the CDR declines at a lower pace compared to previous period. The decrease continues, and by the end of demographic transition, the districts reach a crude death rate ranging between 10 and 15 per thousand, and few judicial districts (historical data) fall even under 10 per thousand people. During the demographic transition, the mortality in Czech lands decreased by approximately 50% in all districts (Appendix 6.1).

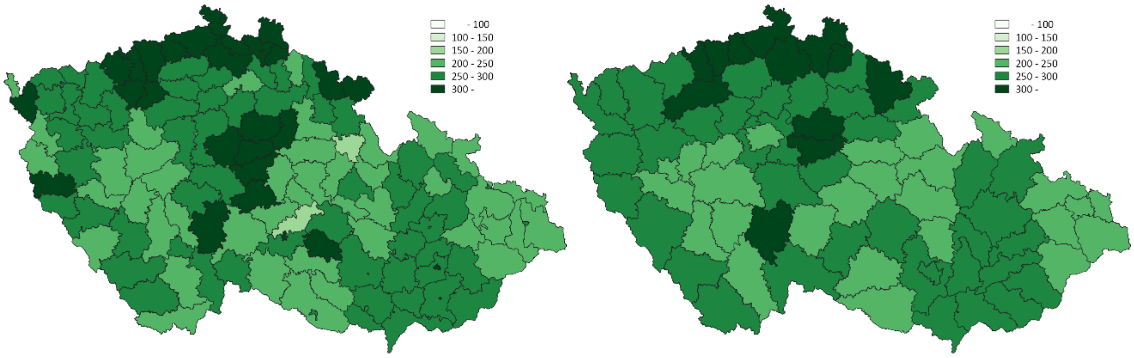
6.3.2 Infant mortality

IMR is an important part of the mortality analysis because IMR had the initial contribution to the mortality decline (Notestein 1945). Also, some researchers (Knodel and van de Walle 1967; Coale and Watkins 1986) believed there was a link between the decline in infant mortality and the fertility decline. It is important to mention the importance of child mortality (deaths among children aged 0 to 4). IMR was contributing significantly to the overall mortality, but if we consider also child mortality then we notice that almost half of the all deaths were occurring at these ages (Austrian Statistics). However, we will focus in this thesis only on IMR, because the analysis of IMR can contribute to a deeper understanding of both mortality and fertility decline.

Infant mortality rates are mapped for 7 years: 1881, 1890, 1900, 1910, 1921 and 1937. The data for the year 1869 are not available. The rates are depicted for historical and recalculated data. Historical data are available at the level of political districts (1881–1910) and judicial districts (1921–1937). Recalculated data is computed at the level of districts (LAU1).

In 1881 the IMR was high in several districts in Northern Bohemia, a few in Eastern and a few in Central Bohemia (Figure 8.16). Roughly 30% and more children died before reaching the age of 1. In several cities, we also observe very high IMR (historical data), except for Praha. Praha has an IMR of approximately 200. Districts with lowest values (between 200 and 250 per thousand live births) were in Eastern Bohemia, several districts in Central Bohemia and Eastern Moravia.

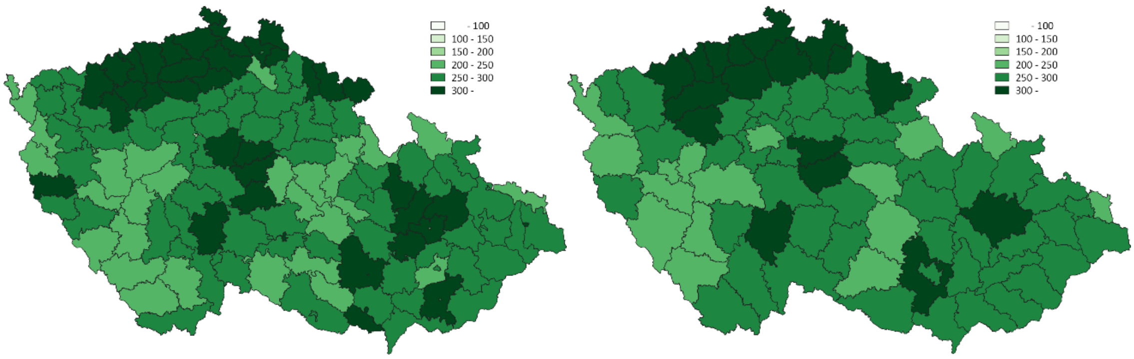
Fig. 6.16 – Geographical distribution of the infant mortality rates, by districts, historical and recalculated data, Czech lands, 1881



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

Figure 6.17 shows a constant IMR in 1890 with slight increases in the Northern, Central and Southern Bohemia and Central and Eastern Moravia (over 300 per thousand live births). By comparing the change between 1881 and 1890, we see that the increase in IMR surpassed the decrease, and on average IMR increased by 4% (Appendix 6.2). The highest decrease accounted for about 10% in Nymburk, Cheb and Kroměříž. The highest increase accounted for about 20% in Blansko, Nový Jičín, Frýdek-Místek and Písek.

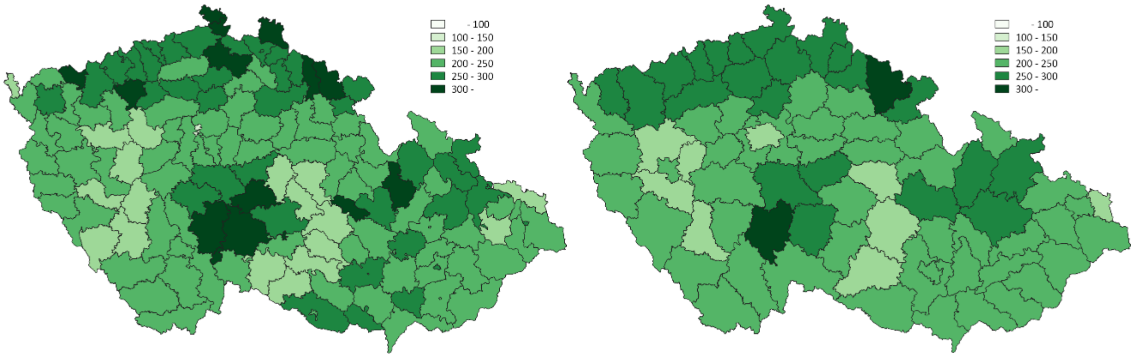
Fig. 6.17 – Geographical distribution of the infant mortality rates, by districts, historical and recalculated data, Czech lands, 1890



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

Figure 6.17, compared to Figure 6.18, shows that IMR started declining in almost all districts, including Praha. Nevertheless, the heterogeneity of the districts increased. The IMR ranged from 150 to over 300 per thousand live births. Majority of districts in Northern Bohemia and several in Southern Bohemia have higher IMR (between 250 and 300 per thousand live births). The lowest values are in Praha, several districts in Western Bohemia and Western Moravia. The IMR in these districts ranged between 150 and 200 per thousand live births. The overall change (for recalculated data) between 1890 and 1900 accounted for -14%. It decreased for all the districts, except Semily (+2%), Svitavy (+3%) and Pelhřimov (+9%) (Appendix 6.2).

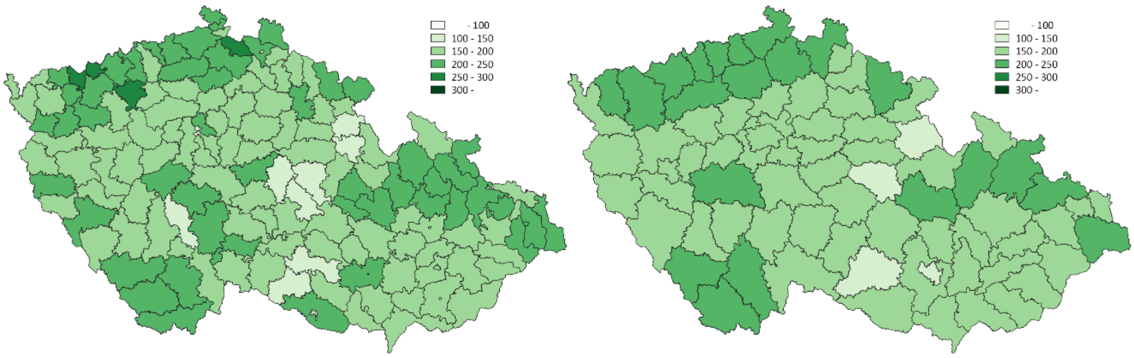
Fig. 6.18 – Geographical distribution of the infant mortality rates, by districts, historical and recalculated data, Czech lands, 1900



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

After 1900, the IMR continued to decrease. We distinguished four regions with the highest IMR: North-Western Bohemia, Northern Moravia, Northern Silesia and some districts in Southern Bohemia (Figure 6.19). IMR in these regions ranged between 200 and 250 per thousand live births. Cities had lower IMR ranging between 150 and 200 per thousand live births. The change between 1900 and 1910 accounted on average for -20% for recalculated districts (Appendix 6.2). The maximum change reached was -40% for Tábor and the minimum was -2% for Karviná.

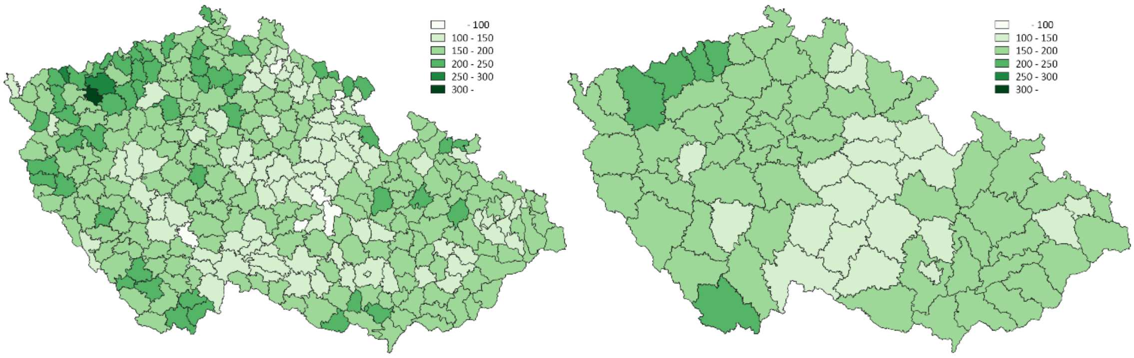
Fig. 6.19 – Geographical distribution of the infant mortality rates, by districts, historical and recalculated data, Czech lands, 1910



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

After 1910, the decline of IMR continued. Only a few districts in Northern Bohemia continued to have an IMR of over 200 per thousand live births: Karlovy Vary, Chomutov, Most and Teplice (Figure 6.20, recalculated data) and one district in the Southern Bohemia – Český Krumlov. The lowest values of IMR were found in East-Southern Bohemia and in some districts in Western Moravia ranging between 100 and 150 per thousand live births. The overall change accounted for -12% (Appendix 6.2). The maximum change reached was -34% for Kutná Hora and the minimum was +6% for Břeclav.

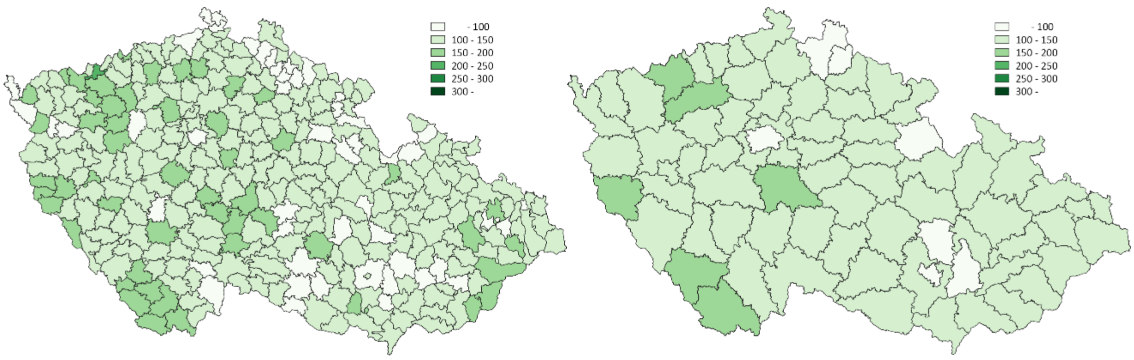
Fig. 6.20 – Geographical distribution of the infant mortality rates, by districts, historical and recalculated data, Czech lands, 1921



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

A substantial reduction in IMR occurred between 1921 and 1930. Almost in all districts, the IMR ranged between 100 and 150 per thousand live births (Figure 6.21). Only a few districts had higher IMR than 150 per thousand live births: Chomutov, Louny, Benešov, Domažlice, Prachatice and Český Krumlov. Several districts had an IMR less than 100 per thousand live births: Liberec, Jablonec nad Nisou, Blansko, Vyškov, Praha and Brno-město. The change between 1921 and 1930 was the highest observed in the analysed period at the national level – 25% (Appendix 6.2). Děčín has the highest decrease in IMR of -46%. Pelhřimov registered an increase of 4%.

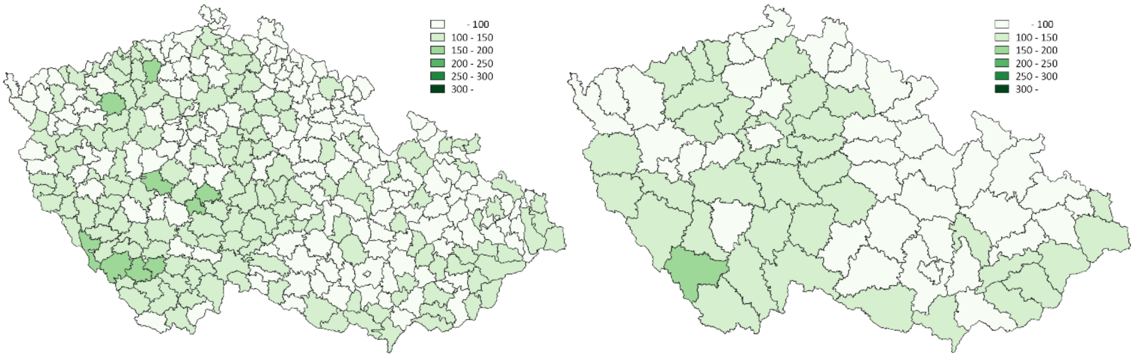
Fig. 6.21 – Geographical distribution of the infant mortality rates, by districts, historical and recalculated data, Czech lands, 1930



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

After 1930, IMR was continuously declining. In 1937, almost half of the districts reached an IMR under 100 per thousand live births (Figure 6.22). Districts with lowest IMR were located in the North-Eastern Bohemia, West-Northern Moravia and Silesia. The change between 1930 and 1937 accounted for -18% at the national level (Appendix 6.2). Přerov has the highest decrease in IMR of -41%. Two districts recorded a slight increase of about 2%: Kutná Hora and Havlíčkův Brod.

Fig. 6.22 – Geographical distribution of the infant mortality rates, by districts, historical and recalculated data, Czech lands, 1937



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

The decline in IMR has an important role in both mortality and fertility decline. The decline in IMR was uneven because of differences in mortality among districts. In 1881, the IMR was under 250 per thousand live births in Eastern Bohemia, several districts in Central Bohemia and Eastern Moravia, while in the majority of districts the IMR accounted for approximately 250 per thousand live births and more. In several districts from Northern, Eastern and Central Bohemia, IMR was even higher than 300 per thousand live births. Between 1881 and 1890, the IMR did not change considerably. After 1890s IMR started to decline in almost all the districts, including Praha. The IMR heterogeneity of the districts increased during this period. The IMR was ranging between 150 to 300 and more per thousand live births. Majority of districts in Northern Bohemia and several in Southern Bohemia had higher IMR (between 250 and 300 per thousand live births). The lowest values were observed in Praha, several districts in Western Bohemia and Western Moravia (150 and 200 per thousand live births). The most substantial decrease is observed between 1921 and 1930 and accounts for 25% at the national level. In almost all districts the IMR ranged between 100 and 150 per thousand live births. And at the end of demographic transition (in 1937), half of the districts reached an IMR of under 100 per thousand live births. From the start of the analysis in 1881 until 1937, the IMR decreased on average by 60% in all the districts, the change for the districts ranged between 40% and 80% (Appendix 6.2).

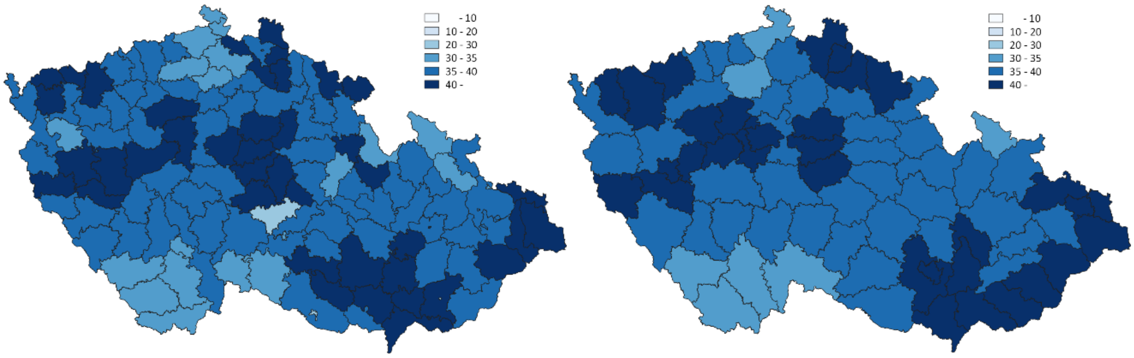
6.4 Evolution of fertility levels

6.4.1 Natality

In this section, we present the evolution of CBR for the period 1869 to 1937. Similarly to mortality analysis, CBR are presented on maps for 8 years: 1881, 1890, 1900, 1910, 1921, 1930 and 1937. The representation of both historical and recalculated data has the same purpose as in the analysis of CDR and IMR. Historical data are available at the level of political districts (1868–1910) and judicial districts (1921–1937). The recalculated data is computed at the level of districts (LAU1).

In the third stage of demographic transition (Rowland 2003), fertility started to fall gradually. The natality varied across the districts in 1869 (Figure 6.23). Most of CBR shows pre-transitional values. CBR was ranging from 30 to over 40 per thousand people. A CBR of 40 per thousand people is considered a pre-transition level of fertility or natural fertility (Henry 1961). Although this is not considered high but moderately high fertility (Coale 1986; Diebolt and Perrin 2017). Moreover, a CBR of 35 per thousand people is considered as the start of fertility decline (Chesnais 1992).

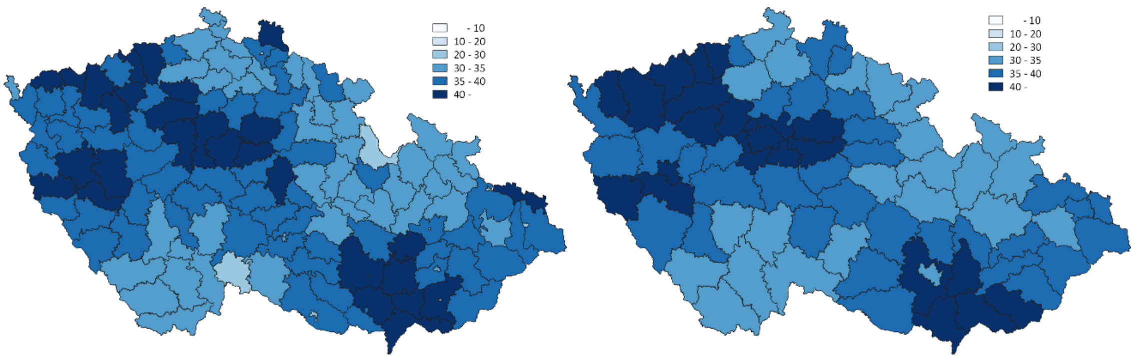
Fig. 6.23 – Geographical distribution of the crude birth rates, by districts, historical and recalculated data, Czech lands , 1869



Note: only the civil population in the total population is included.
Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

Although the situation in 1881 (Figure 6.24) was similar to the one in 1869, we can see that Northern Bohemia, including the city of Liberec, Southern Bohemia, Silesia and Northern Moravia entered the phase of fertility decline with a CBR under 35 per thousand people (Diebolt and Perrin 2017). The change between recalculated districts in 1869 and 1880 accounted for -2% on average. The highest change was in Brno-město and accounted for -10%, the CBR decreased from 44 to 34 per thousand people (Appendix 6.3).

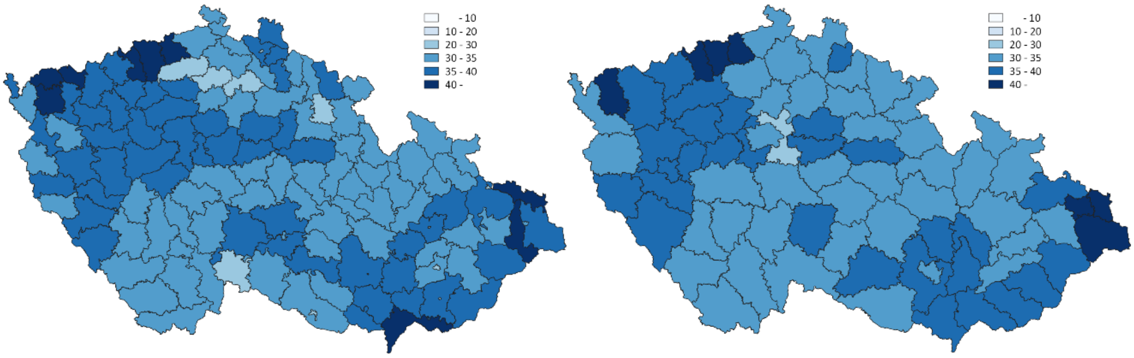
Fig. 6.24 – Geographical distribution of crude birth rates, by districts, historical and recalculated data, Czech lands, 1881



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

After 1881, fertility continues to decline. Almost half of the districts entered the fertility decline at this point (Figure 6.25). Just a few districts had a CBR higher than 40 per thousand people: Sokolov, Most, Teplice, Ústí nad Labem in the Northern Bohemia and Frýdek-Místek, Ostrava-město, Karviná in Silesia (Figure 6.25, recalculated). We observe that CBR dropped under 35 per thousand people in more districts in the Central Bohemia, including Praha, marking the beginning of the fertility decline phase. Districts that are still in the pre-decline phase (35 to 40 per thousand) were mostly located in West-North part of Bohemia, South-West of Moravia and some districts in Silesia. There was heterogeneity among districts at this stage. The average change between 1881 and 1890 accounted for approximately -5% (Appendix 6.3). CBR declined the most in Praha-východ by 35%. CBR increased the most in Frýdek-Místek and Karviná by about 14%.

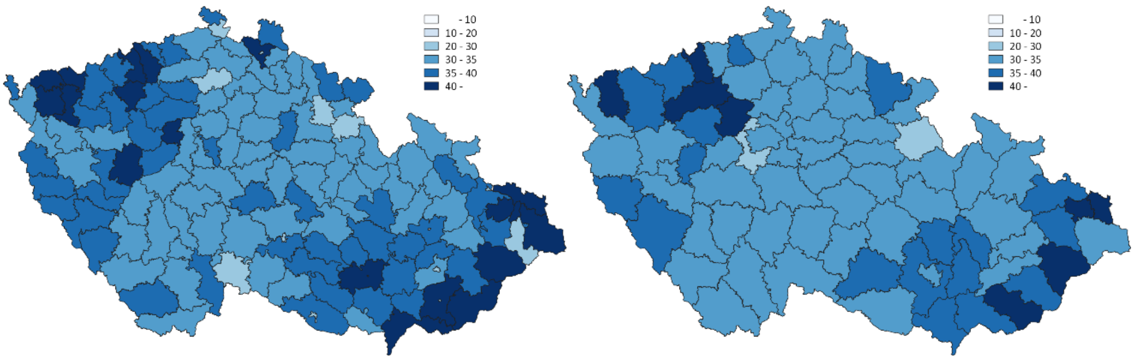
Fig. 6.25 – Geographical distribution of crude birth rates, by districts, historical and recalculated data, Czech lands, 1890



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

After 1890 the CBR continued to decline under 35 per thousand people in Western and Central Bohemia but seemed to stagnate in Southern and Eastern Moravia and some districts in Western Moravia and even increasing in some districts (Figure 6.26). The average change between 1890 and 1900 accounted for approximately +0.3% (Appendix 6.3). CBR declined the most in Praha-západ by 23%. CBR increased the most in Ostrava-město and Praha-východ by 17%.

Fig. 6.26 – Geographical distribution of the crude birth rates, by districts, historical and recalculated data, Czech lands, 1900

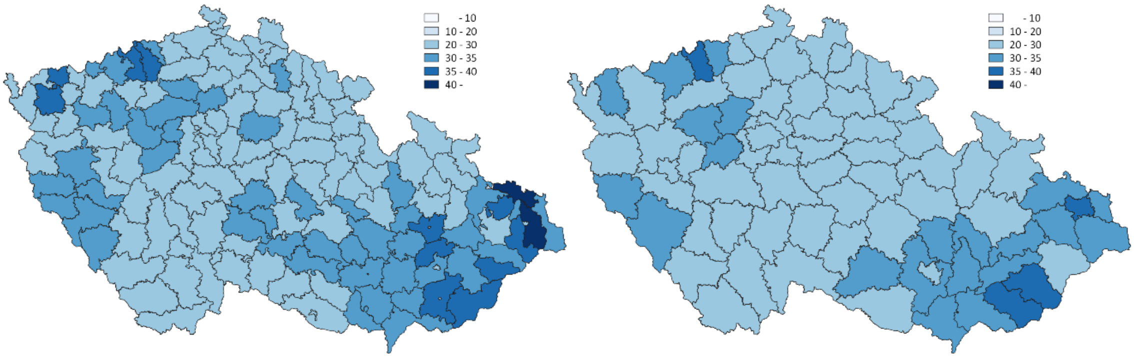


Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

A substantial reduction in CBR was observed between 1900 and 1910. In 10 years, the majority of districts moved to the modern regime of controlled fertility with a CBR of 30 per thousand people (Chesnais 1992) (Figure 6.27). Despite the general trend, Moravia and Southern Silesia had high CBR, between 30 and 35 per thousand people, some over 35 per thousand people. Also, several districts in Western (Sokolov, Domažlice, Klatovy), Northern (Chomutov, Most, Teplice) and Central Bohemia (Rakovník, Kladno, Beroun) had high crude birth rates between

30–35 or over 35 per thousand people. The average change between 1900 and 1910 accounted for approximately -17% (Appendix 6.3). The decline was universal, except one district – Rychnov nad Kněžnou, where CBR increased by 3%.

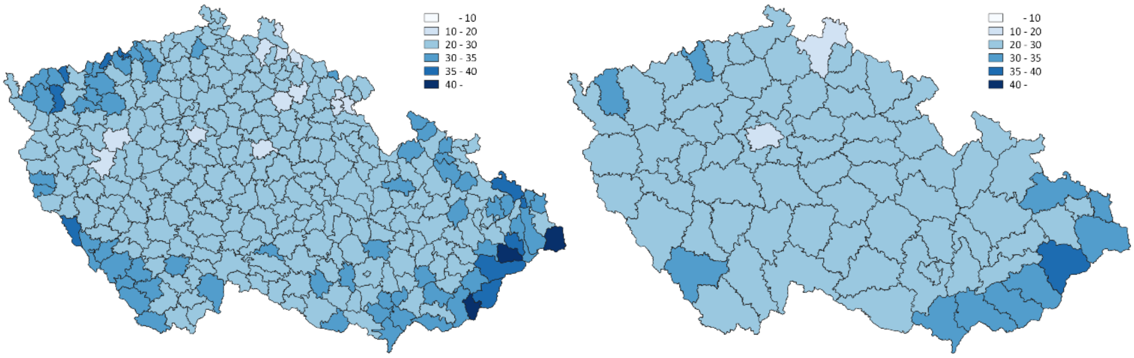
Fig. 6.27 – Geographical distribution of the crude birth rates, by districts, historical and recalculated data, Czech lands, 1910



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

After 1910 fertility continues to decline. A convergence of the CBR under 30 per thousand people was observed (Figure 6.3). The modern regime of controlled fertility (CBR 30 per thousand people) was spread almost all over the Czech lands, with some exceptions at the peripheries, especially in Moravia and Silesia. Praha and Liberec had one of the lowest crude birth rates ranging between 10 and 20 per thousand people. The average change between 1910 and 1921 accounted for approximately -11% (Appendix 6.3). The highest decrease of approximately 25% was recorded in Praha, Plzeň-město, Náchod and Pardubice. The highest increase of 20% was recorded in Vsetín.

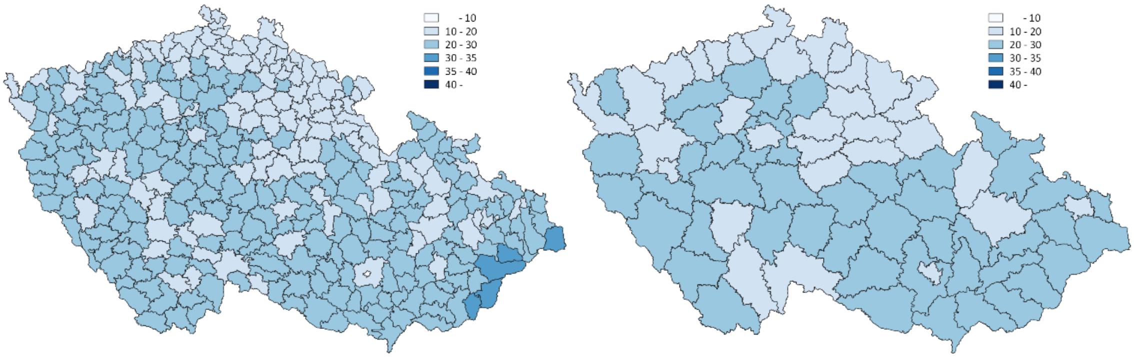
Fig. 6.28 – Geographical distribution of the crude birth rates, by districts, historical and recalculated data, Czech lands, 1921



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

There was a sharp drop in fertility between the years 1921 and 1930 — fertility declined in about half of the districts (Figure 6.29). The North-Eastern Bohemia, several districts in South and Central Bohemia, and several in Moravia, including Brno, recorded the lowest values for CBR ranging between 10 and 20 per thousand people. Moreover, a CBR under 20 means that most of the women use parity limitation of fertility (Diebolt and Perrin 2017). The average change between 1921 and 1930 accounted for approximately -22%, one of the highest changes recorded during the demographic transition (Appendix 6.3). The decline was universal. The sharpest drop accounted for 48% in Brno-město, and the smallest decline accounted for 1% in Praha-východ.

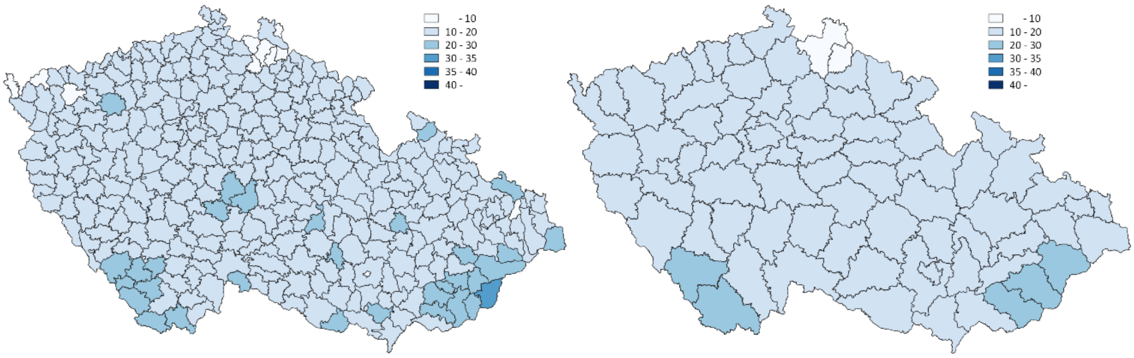
Fig. 6.29 – Geographical distribution of the crude birth rates, by districts, historical and recalculated data, Czech lands, 1930



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

After 1930 the decline of fertility continued. CBR was between 10 and 20 per thousand people in almost all the districts. There was a very high level of homogeneity among the districts (Figure 6.30). The lowest CBR of under 10 per thousand people was reached in 2 districts: Liberec and Jablonec nad Nisou. Districts with the highest CBR (between 20 and 30 per thousand people) were located at the peripheries: Prachatice, Český Krumlov in Bohemia and Vsetín, Zlín, Uherské Hradiště in Moravia. Surprisingly, the average change between 1930 and 1937 accounts for approximately -26%, which was the highest change recorded during the demographic transition (Appendix 6.3). The sharpest drop was about 43% in Karviná and Praha-západ, and the smallest decline was about 10% in Písek and Brno-město.

Fig. 6.30 – Geographical distribution of the crude birth rates, by districts, historical and recalculated data, Czech lands, 1937



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

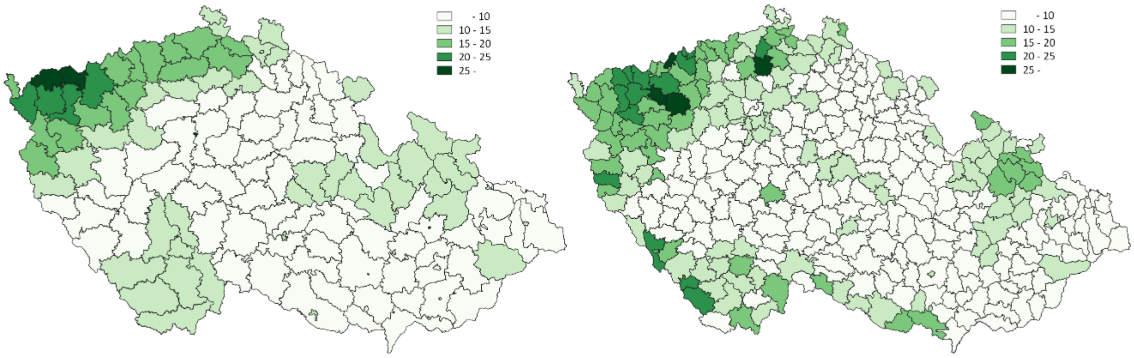
In the third phase of demographic transition, fertility started to decline gradually. It is important to mention that at this stage, births were moderately high (Coale 1986; Diebolt and Perrin 2017). The first phase of decline started probably earlier than 1869, but just in a few districts. The fertility decline started when CBR dropped under 35 per thousand people (Chesnais 1992). In 1869, CBR was ranging from 35 to 40 and more per thousand people in the majority of districts. In 1881 the situation did not change, but we can distinguish districts that entered the fertility decline stage, located in North Bohemia, including the city of Liberec, South Bohemia, Silesia, North Moravia. After the 1890s, about half of the districts entered the fertility decline stage. Districts were quite heterogeneous. A substantial reduction of 17% in CBR is reached between 1900 and 1910. In only ten years, the majority of districts moved to the modern regime of controlled fertility with a CBR of 30 per thousand people. The last districts entering fertility decline were located in West-Northern Bohemia (a part of the North), South-Eastern Moravia and Silesia (a part of Silesia). The second phase of fertility decline started after 1921. The change in CBR accounted for -22%, one of the highest recorded levels until this point. CBR values dropped from 20 to 30 per thousand people to 10 to 20 per thousand people. The sharpest drop in CBR during the demographic transition occured between 1930 and 1937, and it accounted for 26%. Almost all districts reached a CBR between 10 and 20 per thousand people, which means that the parity limitation of fertility was spread all over the Czech lands.

6.4.2 Illegitimate fertility

In 1881 the highest proportion of illegitimate births was in North-Western Bohemia. The proportion of out of wedlock births was ranging between 10% and almost 30% of total live births. In Southern Bohemia and some political districts in Eastern, in Northern Silesia and Northern Moravia, the proportion of illegitimate births ranged between 10% and 15% of total live births. The lowest proportion of out of wedlock births (under 10% out of total live births) was in the Central Bohemia, Southern and Eastern Moravia, except the cities. Cities tend to have a higher proportion of illegitimate births than the political districts: Praha – 47%, Olomouc – 31%, Brno – 23%, Frýdek – 14%, Opava – 14%.

In 1937, at the end of demographic transition, the proportion of illegitimate births did not decrease significantly except for the cities. In Praha, the proportion of births out of wedlock reached 11%, Brno – 13%. The difference in the cities can be attributed to the methodology of data collection – in 1881, events were collected by the place of occurrence and in 1937 by the residence. The highest proportion of illegitimate births was recorded in North-Western Bohemia and South-Western Bohemia, ranging between 10% and 25% of total live births. In 1937, the proportion of illegitimate births was higher at the periphery of the country. Also in Silesia and Northern Moravia, the illegitimate fertility was higher than in the rest of the country (10% to 20% of total live births) (Figure 6.31).

Fig. 6.31 – Geographical distribution of the proportions of illegitimate births, districts, historical data, 1881 and 1937, in %



Notes: in 1881 the births were collected by place of occurrence, in 1937 by residence. Data for 1881 are by political districts, for 1937 by judicial districts.

Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

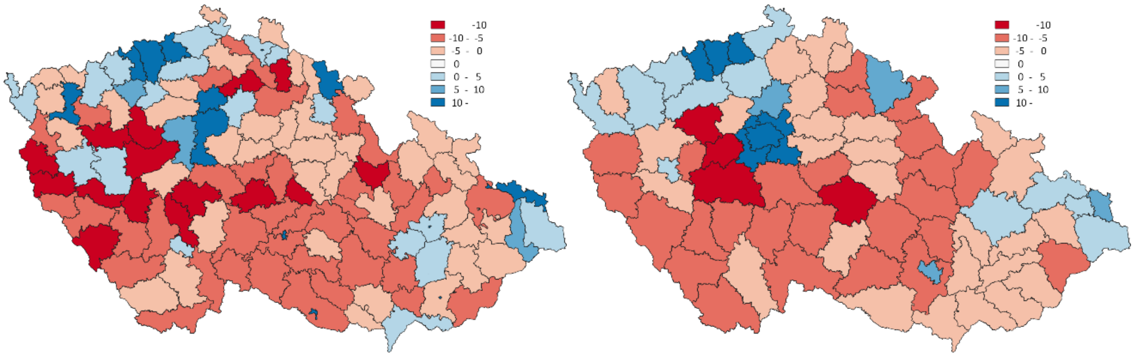
We can conclude that illegitimate fertility did not change considerably between 1881 and 1937. The sharpest decrease is seen in cities, e.g. illegitimate births in Praha decreased fourfold, Brno – twofold. North-Western and South-Western Bohemia, Silesia and Northern Moravia continued to have significantly higher proportions of illegitimate births compared to the rest of the country.

6.5 Migration

During the demographic transition, the population was not influenced only by natural processes but also by migration, specifically internal migration. Internal mobility was increasing due to industrialization process. People tended to move from agricultural areas to the industrialized ones. In this section, we are analyzing the population movement in the Czech lands during 1869–1910. We use estimations of the migration using the balance method explained in Chapter 5 (Methodology).

In 1869 the average net migration rate was -2 per thousand people. Districts with high positive net migration rate were located in Northern and Central Bohemia and Eastern Moravia. Districts with high negative net migration rate were located in the Western, Southern and Central Bohemia (around Praha) and Eastern and Southern Moravia. Districts with the highest positive net migration rate (over 10 per thousand people) were Praha, Praha-západ, Praha-východ, Most, Teplice and Ústí nad Labem. Districts with the highest negative net migration rate (over 10 per thousand people) were Rakovník, Beroun, Příbram and Havlíčkův Brod (Figure 6.32, recalculated). While checking the historical map in Figure 6.32, we notice a negative net migration rate around the cities preponderantly. Moreover, the cities have a positive net migration rate, e.g. Liberec – 25 per thousand people, Jihlava – 11 per thousand people, Znojmo – 14 per thousand people, Praha – 6 per thousand people. A possible explanation is the migration of people from rural areas surrounding the cities.

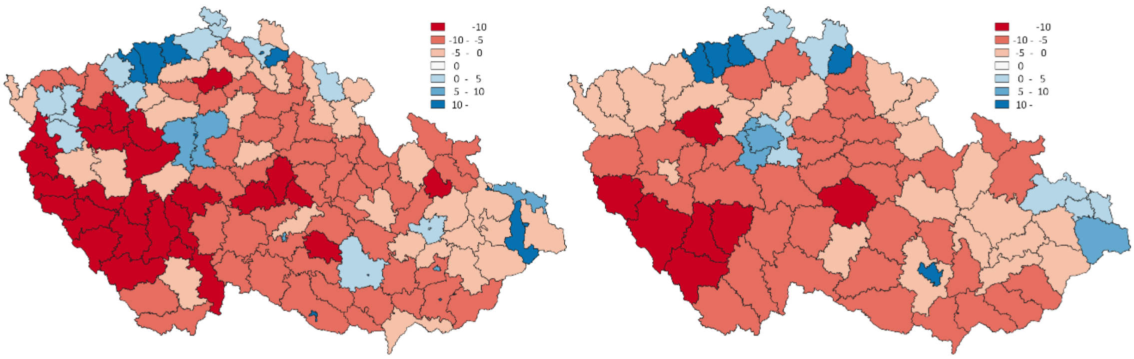
Fig. 6.32 – Geographical distribution of net migration rates, by districts, historical and recalculated data, Czech lands, 1869



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

During the period 1869–1881, the migration did not change significantly. In 1881 the average net migration rate was -3 per thousand people. The districts with high positive net migration rate were located in Northern and Central Bohemia, and Eastern Moravia (Figure 6.33), but a decrease was observed compared to 1869. The districts with high negative net migration rate were located in the Western, Southern and Central Bohemia (around Praha), and Eastern and Southern Moravia. The districts with the highest positive net migration rate (over 10 per thousand people) are Most, Teplice, Ústí nad Labem, Jablonec nad Nisou and Brno-město. The districts with the highest negative net migration rate (over 10 per thousand people) were Rakovník, Havlíčkův Brod, Domažlice, Klatovy, Prachatice, Strakonice and Písek (Figure 6.33, recalculated data). The cities continued to have positive net migration rate (Figure 6.33, historical data): Liberec – 18 per thousand people, Znojmo – 16 per thousand people, Praha – 10 per thousand people, Brno – 18 per thousand people, Opava – 16 per thousand people etc.

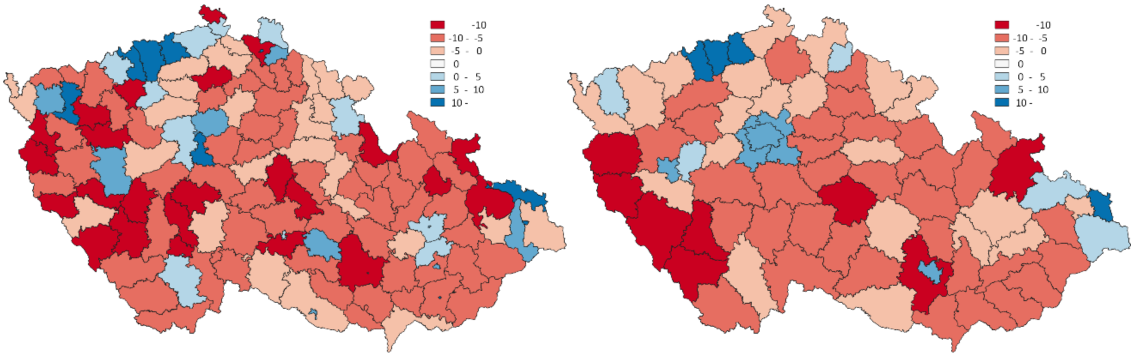
Fig. 6.33 – Geographical distribution of net migration rates, by districts, historical and recalculated data, Czech lands, 1881



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

During the period 1881–1890, the migration continued to be constant. In 1890, the average net migration rate accounted for -3 per thousand people. Districts with high positive net migration rate were located in Northern and Central Bohemia and Eastern Moravia (Figure 6.34) and Northern Silesia, but their amount decreased compared to 1881. Districts with high negative net migration rate were located in Western and Southern Bohemia and Eastern and Southern Moravia. The districts with the highest positive net migration rate (over 10 per thousand people) were Most, Teplice, Ústí and Labem and Karviná. Most, Teplice, Ústí nad Labem were among the districts with the highest positive net migration rate since 1869. The districts with the highest negative net migration rate (over 10 per thousand people) were Tachov, Domažlice, Klatovy, Prachatice, Strakonice, Havlíčkův Brod, Brno-venkov and Bruntál (Figure 6.34, recalculated data). The cities continued to have positive net migration rate, but lower compared to 1881 (Figure 6.34, historical data): Liberec – 15 per thousand people, Znojmo – 7 per thousand people, Praha – 7 per thousand people, Brno – 12 per thousand people etc. In Opava, the net migration rate increased to 20 per thousand people. Brno and Opava were growing due to migration from the surrounding districts.

Fig. 6.34 – Geographical distribution of net migration rates, by districts, historical and recalculated data, Czech lands, 1890

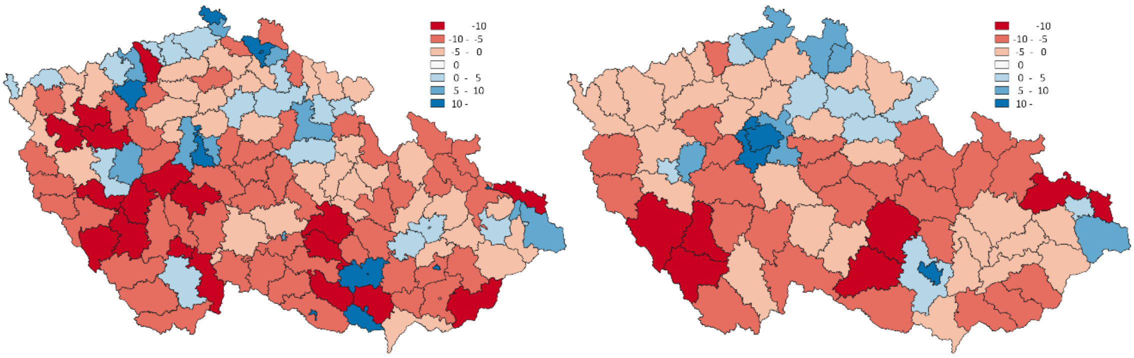


Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

During the period 1890–1900, we observe slight changes in the migration trends, although the average net migration rate remained constant at -3 per thousand people. The districts with high positive net migration rate were mostly scattered in Northern and Central Bohemia (Figure 6.35).

The districts with high negative net migration rate were located in Western and Southern Bohemia and Eastern and Northern Moravia and Silesia. The districts with the highest positive net migration rate (over 10 per thousand people) were Praha, Praha-západ and Brno-město. The districts with the highest negative net migration rate (over 10 per thousand people) were Klatovy, Prachatice, Strakonice, Třebíč, Žďár nad Sázavou, Opava and Karviná (Figure 6.35, recalculated). Cities continue to grow, including the suburban areas (e.g. Praha and Brno).

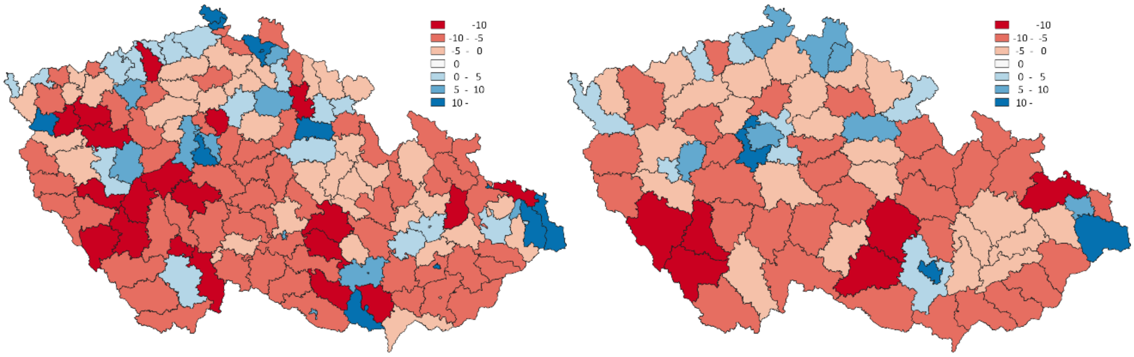
Fig. 6.35 – Geographical distribution of net migration rates, by districts, historical and recalculated data, Czech lands, 1900



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

Figure 6.36 showed a slow change during 1900–1910. The average net migration rate was constant at -3 per thousand people. The districts with the highest positive migration rate included also Frýdek-Místek with a net migration rate of 17 per thousand people. Klatovy, Prachatice, Strakonice were among the districts with the highest negative net migration rate since 1881. Cities and suburbs continued to grow.

Fig. 6.36 – Geographical distribution of net migration rates, by districts, historical and recalculated data, Czech lands, 1910



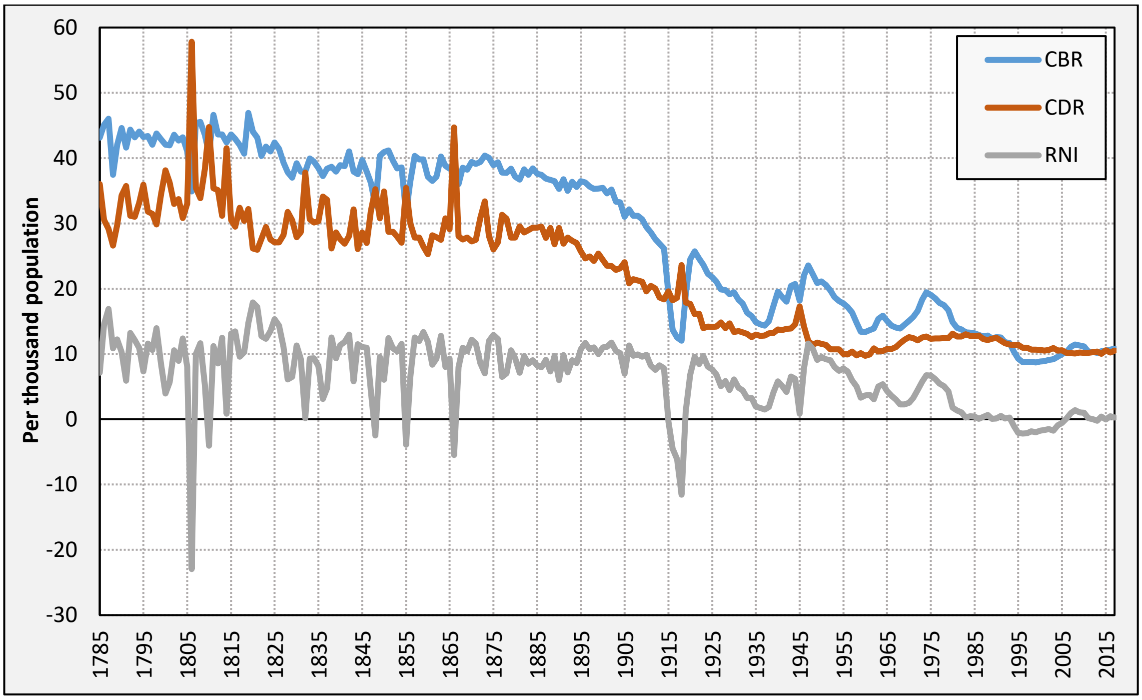
Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

From 1869 to 1910, migration slightly changed. Same areas consistently lost population or gained. For example, Klatovy, Prachatice, Strakonice lost population due to migration during the period 1881–1910. Most, Teplice, Ústí nad Labem gained population during the period 1869–1890. The districts with the high positive net migration rate were located mostly in Northern and Central Bohemia. The districts with high negative net migration rate were located in the Western, Southern and Central Bohemia (surroundings of Praha) and Moravia (except Brno and surroundings of Brno). An important trend during this period was the rural-urban migration. Cities always had positive net migration, and then the suburbs started to gain population due to migration from surrounding rural areas.

6.6 The onset and duration of the demographic transition

Before starting to analyze the demographic transition at the regional level, it is worth describing it briefly at the national level. The CDR was fluctuating at about 30 per thousand people, and it started to decrease approximately in 1875 with slow stagnation under 30 per thousand people and then continued to decline from 1895 onwards (Figure 6.37). The CBR started to decline approximately in 1890, when the level of 35 per thousand births was reached, and continuously fell since then. So we can assume that the demographic transition at the national level had started in 1875–1880 and ended between 1930 and 1937 when the rate of natural increase accounted for 5 or less per thousand people.

Fig. 6.37 – Crude birth rate, crude rate and rate of natural increase, Czech lands, 1785–2017



Note: Between 1795 and 1805, data for total births was used for CBR calculation

Source: Author's calculations based on data from CZSO.

6.6.1 Regional classification by the onset and speed of demographic transition

The districts (statistical units valid for 2011) were classified by the onset and speed of demographic transition. First of all, the onset (or timing) and speed (or duration) of demographic transition were determined for each district. Because the onset of mortality decline is more difficult to determine (mostly due to lack of earlier data and more precise definitions of the mortality decline), we consider the onset of demographic transition in this section to be the beginning of fertility decline. The onset of fertility decline is defined according to Chesnais (1992) as the point when fertility starts to decline continuously from 35 births per thousand people. The speed of demographic transition was considered the duration or length, which is the period from the beginning of the fertility transition until the end of the demographic transition. The beginning of the fertility transition, as already mentioned above, is defined as a CBR of 35 per thousand people. The end of demographic transition is marked by a rate of natural increase similar to the one at the start of the transition, and it was assumed to be 0.5% (and lower) as the classical model of demographic transition suggests (Chesnais 1990). The speed of demographic transition was assumed to be the duration from the start of the fertility decline until the end of the transition.

When identifying the data, the following limitations were considered:

1. The demographic transition ended approximately in 1935–1937 in the Czech lands (Fialová, Pavlík and Vereš 1990). The fertility was high only in a few districts, and its decline continued after this period. Another reason for stopping the analysis at

these years is the quality of data during WWII (1938–1948), but also reforms in the administrative division, creating significant obstacles for data recalculation.

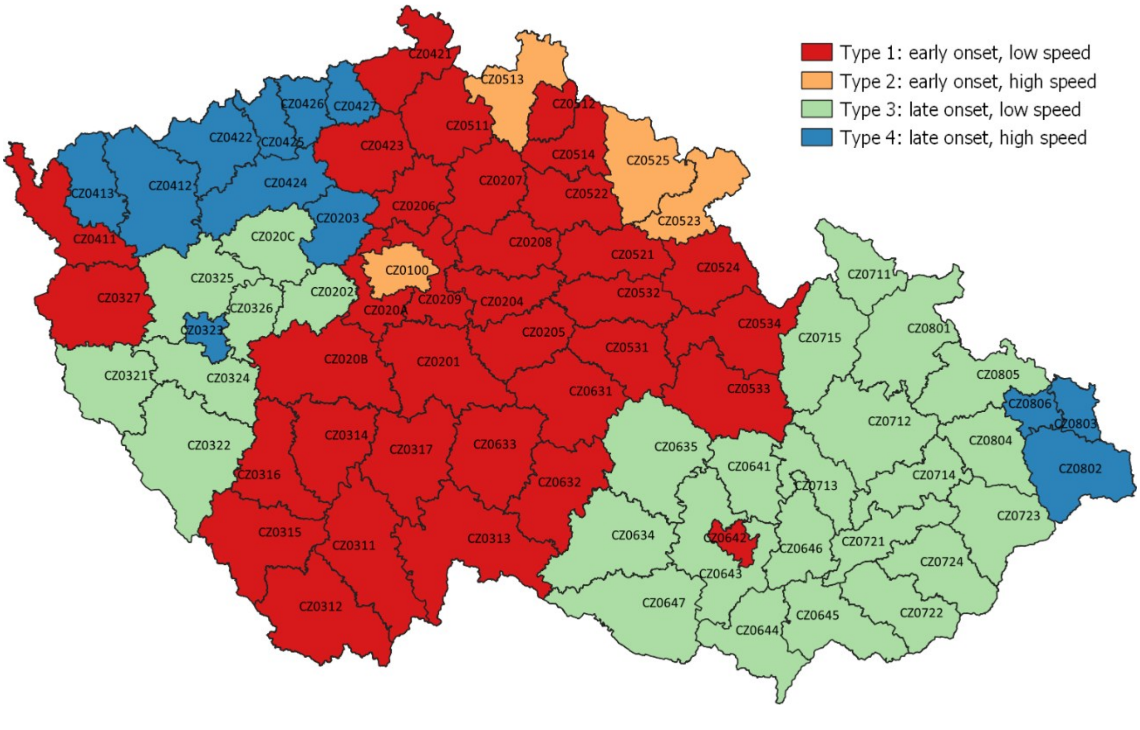
2. The impact of migration is not taken into consideration.
3. Changes in the methodology of data collection. (Vital statistics data since 1.1.1925 are based on the residence of population, not the place of occurrence of events).
4. Classification is based on theoretical definitions.

The districts were classified into four groups: early onset and high speed, early onset and low speed, late onset and high speed, late onset and low speed (Figure 6.38).

An early start is defined by the start of fertility decline before 1900 (including), and late start means in 1901 and onwards. 1900 is marked as a delimiting year because, in 1900, fertility started to decline all over the country, becoming a universal phenomenon (Fialová et al. 1990).

High speed means that transition ended in less than 25 years (including) from the onset of fertility decline and low speed means 26 years and more. We chose these delimitations because they provide the best depiction of the differences among districts.

Fig. 6.38 – Classification of the districts in the Czech lands by timing and speed of demographic transition



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

Here is the detailed description of the 4 groups mentioned above:

1. Type 1: early onset, low speed – started in 1900 or before, lasted 25 years or less (34 districts).
2. Type 2: early onset, high speed – started in 1900 or before, lasted 26 years or more (4 districts).
3. Type 3: late onset, low speed – started in 1901 or after, lasted 26 years or more (27 districts).

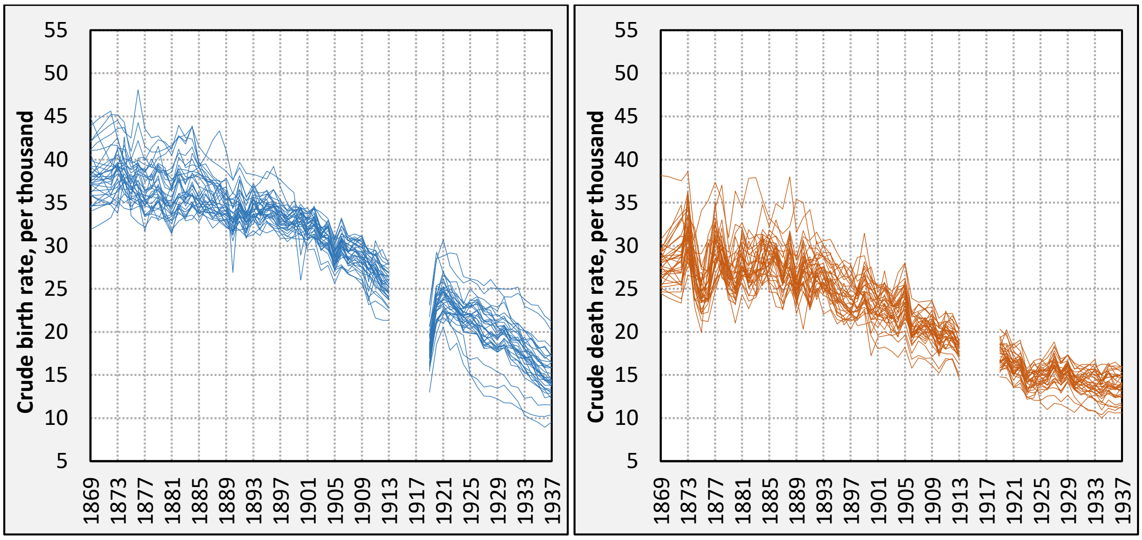
4. Type 4: late onset, high speed – started in 1901 or after, lasted 25 years or less (12 districts).

The Type 1 group is the most numerous and contains 34 districts. The second most numerous group is Type 3 and includes 27 districts. For detailed data of results of the classification, see Appendix 6.4 in the Appendices.

Type 1 group includes a part of districts from the Northern Bohemia, majority of districts from Central, Eastern and Southern Bohemia, Brno-město, Cheb and Tachov. Type 2 group includes four districts: Praha, Liberec, Trutnov and Náchod. Type 3 group includes several districts from Western Bohemia and the majority of districts from Moravia and Silesia. Type 4 districts are located in Northern Silesia and several districts in the North-Western Bohemia.

Further investigation of the CBR and CDR for each group was done to identify the differences and similarities among them. In 1869, the CBR for Type 1 districts ranged between 32 (Český Krumlov) and 45 (Jablonec nad Nisou) per thousand people (Figure 6.39). CBR fluctuated until the 1890s when it started to decline with short stagnation periods. After 1900, the fertility decline became sharper. At the end of demographic transition, the CBR trends were still quite heterogeneous ranging from 10 (Jablonec nad Nisou and Brno-město) to 22 (Prachatice) per thousand people. The CDR fluctuated and showed a downward trend. The most visible continuous decline started in the 1890s. In 1869, the CDR ranged between 25 (Písek, Prachatice, Strakonice, Svitavy, Ústí nad Orlicí) and 38 (Brno-město) per thousand people. At the end of the demographic transition, the CDR trend was converging. In 1937, the CDR ranged between 11 (Brno-město, Praha-západ and Jablonec nad Nisou) and 16 (Příbram, Prachatice, Strakonice and Tábor) per thousand people.

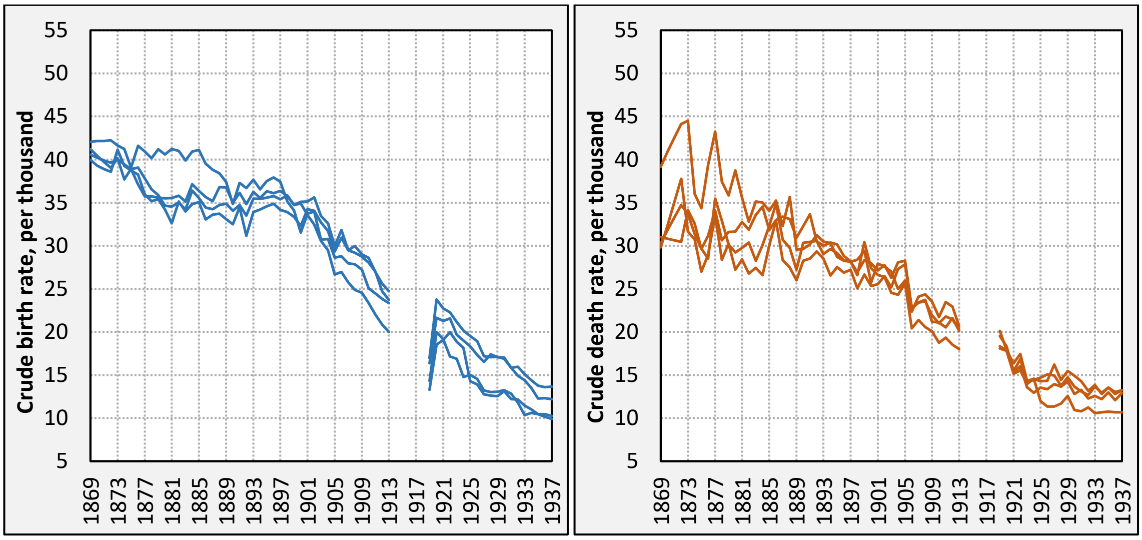
Fig. 6.39 – Crude birth rates and crude death rates, Type 1 (early onset, high speed), districts, 1869–1937



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

In 1869 the CBR for Type 2 districts ranged between 40 (Náchod) and 42 (Praha) per thousand people (Figure 6.40). The first decline in CBR occurred during the 1880s, except for Praha, where the CBR started falling in approximately 1885. After 1900, the fertility decline becomes sharper. At the end of demographic transition, the CBR was ranging from 10 (Liberec) to 14 (Trutnov) per thousand people. The CDR fluctuated but showed a downward trend as in the Type 1 group. The most visible continuous decline started in the 1890s. In 1869 the CDR ranged between 30 (Náchod and Trutnov) and 40 (Praha) per thousand people. At the end of the demographic transition, the CDR trend was converging. In 1937 the CDR ranged between 11 (Praha) and 13 (Náchod, Liberec and Trutnov) per thousand people.

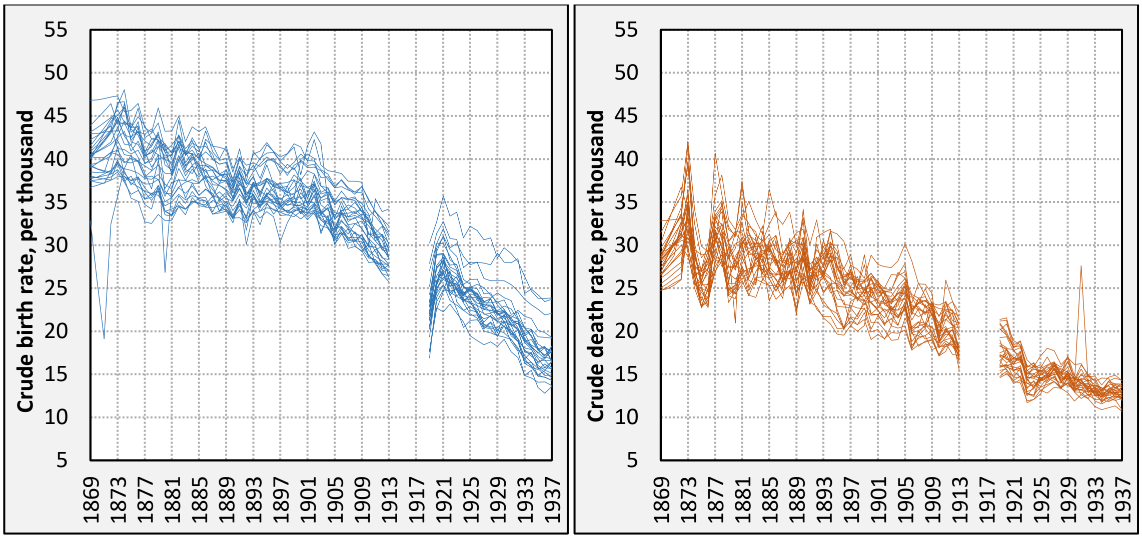
Fig. 6.40 – Crude birth rates and crude death rates, Type 2 districts, 1869–1937



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

In 1869 the CBR for Type 3 districts ranged between 33 (Jeseník) and 47 (Hodonín) per thousand people (Figure 6.41). The first fall in CBR occurred during the 1890s followed by stagnation at slightly higher levels. In the 1900s the fertility registered a steep decline. In 1937 the CBR was ranging from 14 (Beroun, Plzeň-sever, Rokycany and Olomouc) to 24 (Vsetín and Zlín) per thousand people. The CDR was fluctuating but showed a steady downward trend. The most visible continuous decline started in the 1890s. In 1869 the CDR ranged between 25 (Beroun, Blansko and Jeseník) and 33 (Vsetín) per thousand people. At the end of demographic transition, the CDR trend was converging, as in the case of previous groups (Type 1 and 2). In 1937 the CDR ranged between 11 (Brno-Venkov and Zlín) and 14 (Rakovník, Domažlice, Klatovy, Rokycany, Žďár nad Sázavou, Šumperk, Vsetín and Bruntál) per thousand people.

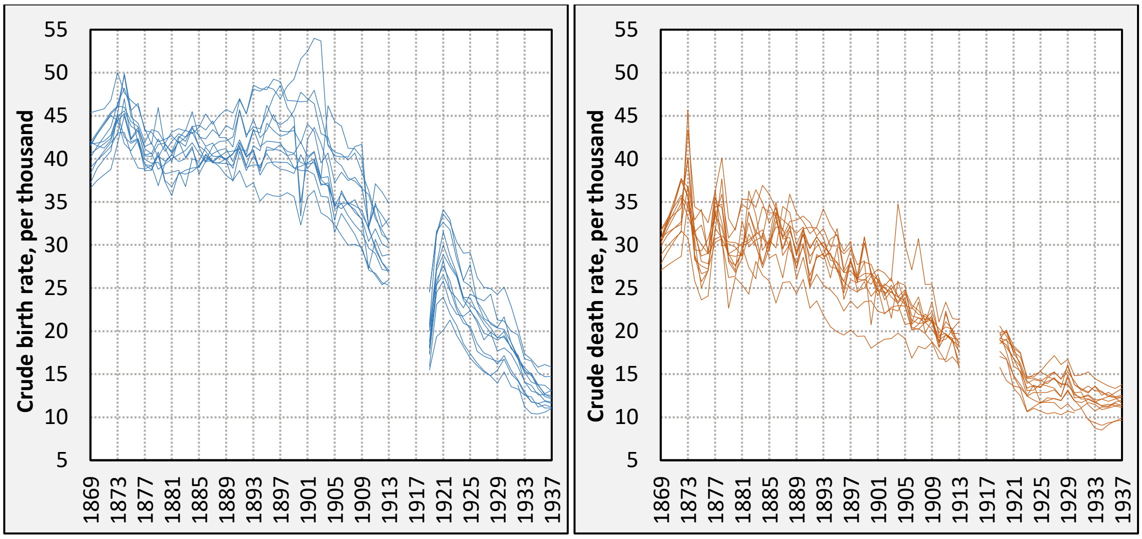
Fig. 6.41 – Crude birth rates and crude death rates, Type 3 districts, 1869–1937



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

In 1869 the CBR for Type 4 districts ranged between 37 (Teplice and Ústí nad Labem) and 45 (Karviná) per thousand people (Figure 6.42). CBR started to fall after 1900. In 1937 the CBR was ranging from 11 (Teplice, Ústí nad Labem and Karviná) to 16 (Frýdek-Místek) per thousand people. CDR was fluctuating but in a downward trend since the 1890s. In 1869 the CDR ranged between 27 (Kladno) and 32 (Sokolov and Most) per thousand people. At the end of demographic transition, the CDR trend was converging, becoming a universal trend in all districts. In 1937 the CDR ranged from 10 (Karviná and Ostrava-město) to 14 (Louny) per thousand people.

Fig. 6.42 – Crude birth rates and crude death rates, Type 4 districts, 1869–1937



Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

All districts (77 as of 2011 including Praha) were classified by the onset and speed of demographic transition into four groups. Type 1 group included 34 districts with early onset (fertility decline started in 1900 or before) and low speed (demographic transition lasted 26 years or more from the onset of fertility decline). Type 1 districts were mainly located in the Northern

Bohemia, Central, Eastern and Southern Bohemia, Brno-město, Cheb and Tachov. This group was characterized by the lowest CBR (about 38 per thousand people) but also slightly high fluctuations in CDR (25–38 per thousand people) at the beginning of the research period. At the end of demographic transition, both CBR (10–22 per thousand people) and CDR (11–16 per thousand people) had wider ranges compared to the rest of the groups.

Type 2 group included 4 districts with early onset (fertility decline started in 1900 or before) and high speed (demographic transition lasted 25 years or less from the onset of fertility decline). Type 2 group included the following districts: Praha, Liberec, Trutnov and Náchod. In 1869, this group was characterized by the highest CBR (about 41 per thousand people) and a high CDR (about 35 per thousand people). At the end of the transition, this group had the lowest CBR (about 12 per thousand people) and CDR (about 12 per thousand people).

Type 3 group included 27 districts with late onset (fertility decline started in 1901 or after) and low speed (demographic transition lasted 26 years or more from the onset of fertility decline). Type 3 districts were mainly located in Western Bohemia, Moravia and Silesia. In 1869, this group had high CBR (about 40 per thousand people) and the lowest CDR (about 29 per thousand people) among the groups. At the end of the transition fluctuations between the districts regarding CBR were quite high (14–24 per thousand people), and CDR was similar to the other groups (11–14 per thousand people).

Type 4 group included 12 districts with late onset (fertility decline started in 1901 or after) and high speed (demographic transition lasted 25 years or less from the onset of fertility decline). Type 4 districts were located in Northern Silesia and several districts in North-Western Bohemia. In 1869 CBR was very high (about 41 per thousand people), and CDR was one of the lowest among districts (about 29 per thousand people). In 1937 CBR was one of the lowest (between 11 and 16 per thousand people) and CDR slightly lower than in the rest of the groups (10–14 per thousand people).

The CDR was considerably higher in Type 1 and Type 2 groups, but in 1937, the mortality trend was converging for all districts. The natality fluctuated more among districts. The highest CBR at the end of demographic transition was recorded for Type 1 and Type 3 group. Thus, a higher natural increase and a lower speed of demographic transition were specific to these districts.

6.7 Discussion and conclusions

This chapter provided a comprehensive description of the demographic transition at the regional level. The data used in this chapter (except for the pre-transitional period) were recalculated to 2011 statistical units (districts). In some sections of the analysis (Chapter 6.3.1, Chapter 6.3.2, Chapter 6.4.1, Chapter 6.4.2 and Chapter 6.5), historical data are used to support the reliability of the recalculated data, but also for a deeper understanding of the presented processes. Recalculated data show similar results as historical data, but more generalized (e.g. Figure 6.8).

Pre-transition phase or first stage of demographic transition (Rowland 2003) in the Czech lands is characterized by similar levels of mortality and fertility to other European countries. Both the CDR and CBR were moderately high as noted in prior studies (Notestein 1977; Coale 1986; Diebolt and Perrin 2017). According to some research (e.g. Fialová, Pavlík and Vereš 1990), after 1820 CBR declined due to an increase in the age at first marriage and the proportion of women never married, implying rather moderate-high levels of natality. During 1831–1847, the Czech lands were experiencing natural fertility (Henry 1961). CBR was fluctuating at around 40 per thousand people. The analysis of the pre-transitional period found no big changes between the vital rates in the cities and the rest of the regions. Some scholars (De Vries 1990, Dyson 2010) hold the view that there were differences in the vital rates between urban and rural areas based on the examples of other European countries and some developing countries. Thus, fertility was slightly lower in urban areas during the pre-transition phase in Europe. In the case of Praha and Brno, we observe different trends (Figure 6.3). CBR exceeded CDR and was slightly increasing. A possible explanation is the high proportion of illegitimate births (Figure 6.5). The increased CBR can be attributed to the single women coming to cities proving a higher level of anonymity to give birth. It is important to mention that the vital statistics data were collected by place of occurrence. An important limitation of this interpretation is rather a short period of analysis. Also, high fluctuations in data (e.g. Opava in Figure 6.5 and 6.7) seems to be possible due to a small number of population in some regions. When later data on illegitimate births is analysed (Chapter 6.4.2), we notice that births out of wedlock were still high in the cities in 1881, but it decreasing by the end of demographic transition in 1937.

The next stage of the demographic transition is characterized by the mortality decline (Rowland 2003). The mortality varied during this period. It was generally higher in cities during industrialization. Cities were called demographic sinks (Dyson 2010). In rural areas, CDR was lower than CBR generating population growth, which through migration supported the urban growth (Dyson 2010; Bocquier and Costa 2015). There is a link between the CDR and IMR, confirming some previous studies (Notestein 1945, Vishnevskii 1976, Lipovski 2007). Nevertheless, during industrialization, the IMR and child mortality rate stagnated or even increased (Lanik 1989). Industrialization affected the quality of air and living arrangements, increased number of women on the labour market that led to less attention to children and limited breastfeeding period etc. (Lipovski 2007). The children, and especially infants (aged 0–1) were significantly affected by various diseases (in the 1880s, the most common causes of death in Frýdek and Místek were infections, tuberculosis, pulmonary and intestinal diseases etc.) and also accidents (drowning, asphyxia etc.) (Lipovski 2007). On the other hand, industrialization brought development, vaccines and better nutrition, these contributed subsequently to a reduction in infectious diseases and decline in IMR and in overall mortality. This is related to the epidemiological transition (Omran 1998). The link between the decline in IMR and all mortality is clearly visible during 1921–1930 when a substantial decline in CDR and IMR occurred and the districts became mostly homogeneous (Figure 6.13 and 6.14 for CDR and Figure 6.20 and 6.21 for IMR).

The third stage of demographic transition (Rowland 2003) starts with a fertility decline. The fall in fertility did not occur evenly but with wide differences between districts. It is worth mentioning the thresholds used for the analysis of CBR. A CBR of 40 per thousand people is considered a natural fertility level (Henry 1961). A CBR of 35 per thousand people is considered as the onset of fertility decline (Chesnais 1992). A CBR of 30 per thousand people and less is considered as a shift to the modern regime of controlled fertility (Diebolt and Perrin 2017, Chesnais 1992). When CBR reaches 20 per thousand people, it means that a significant share of women uses parity restriction fertility (Diebolt and Perrin 2017). Higher levels of CBR at the peripheries suggest that the geographical position influenced the fertility and diffusion of information (e.g. Figure 6.28). Peripheral districts are usually more disconnected from the communication system and the capital, thus having a higher "behavioural" autonomy and are more prone to follow and respect cultural norms and traditions. This finding is supported by the example of France (Diebolt and Perrin 2017).

For a deeper understanding of the fertility decline, further research about marriages is required. Marriages were used as a method of birth limitation in the pre-transition stage (Fialová, Pavlík and Vereš 1990; Caselli, Vallin and Wunsch 2005), but after the first decline of births in 1870s the age at first marriage decreased (Fialová 1991) and as a result the natality increased (see e.g. Figure 6.41 and 6.42).

The higher illegitimacy of births in some districts can be associated with the nationality (Fialová 1991). Illegitimate fertility was high in the districts populated by a high proportion of Germans. This could be caused by generally higher illegitimate fertility in Germany. From 1880 to 1900, the illegitimate fertility in Germany was higher than in the rest of Europe (Knodel 1974). After 1900 it decreased but remained higher than the European average (Shorter, Knodel and Van de Walle 1971). North-Western Bohemia and West-Southern Bohemia were bordering German regions that had the highest proportion of illegitimate births – South-Eastern Germany, Thüringen and Saxony (Knodel 1974). The changes in Germany are related to the different customs (higher tolerance of the society towards illegitimacy), or the legitimization of children that occurred shortly after the birth (Fialová 1991), less men available for marriage because of migration to more industrialized regions which is directly connected to an excess of single women (Knodel 1974). It is worth mentioning that also in the bigger cities, the proportion of illegitimate births was considerably high (Fialová 1991) (see Chapter 6.4.2).

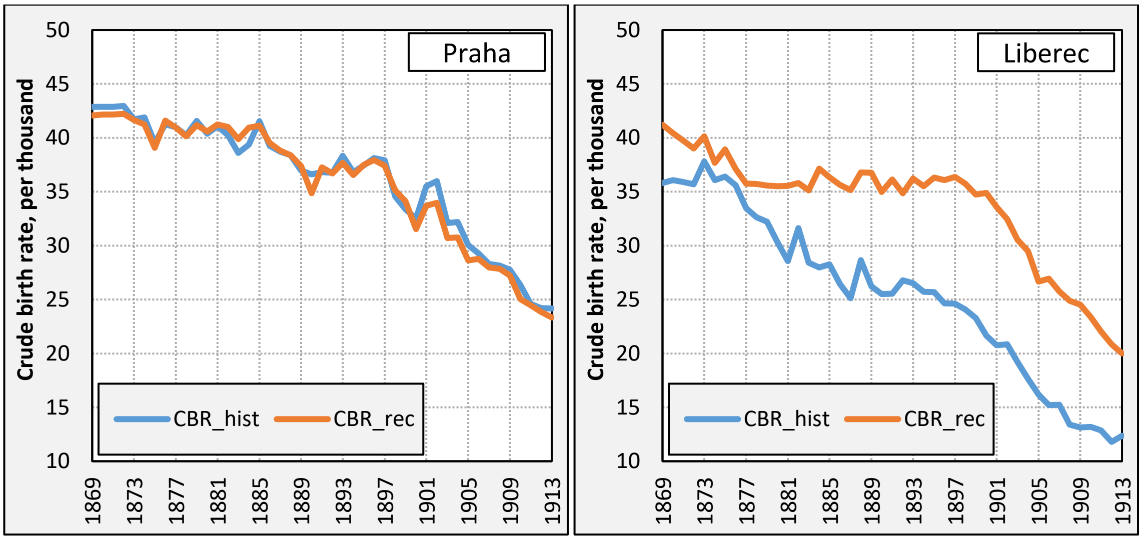
The migration subchapter shows clear trends of rural-urban migration. The growth of cities between 1869 and 1910 was significant. Cities had constant population gain due to migration; this was a common phenomenon across all Europe (Davis 1955; Davis 1963; Knodel 1974). Urban areas were the most attractive destinations in addition with a part of the North of Bohemia, which was more industrialized (migration from agrarian to industrialized districts) (Brabencova 1989; Barlow, Dostal and Hampl 1994). During the urbanisation, the districts around the cities (suburbs) started to gain population too. Nevertheless, at the national level, the net migration rate was preponderantly negative. A possible explanation is an external migration. Although, the industrialization decreased the proportion of the population involved in agriculture from 2/3 to 1/3 (1850–1910) the standards of living were poor. This led to high external migration, mostly among young people aged 20–29 (Fialová 1989).

In general, the demographic transition at the regional level follows the theory of demographic transition. Although at the beginning of transition we see wide differences between the districts in the Czech lands, at the end of transition the districts became almost homogeneous.

The results of the classification show that the earliest fertility decline occurred in Northern Bohemia and a majority of districts from Central, Southern and Eastern Bohemia. Last districts to enter the demographic transition were from Western Bohemia and a majority from Moravia and Silesia. However, some of the findings are not supported by previous research (Fialová, Pavlík and Vereš 1990; Fialová 1991), particularly that Southern Bohemia was among the forerunners of the demographic transition. Nevertheless, it must be noted that this research used different methodology and different measures. Another explanation of this inconsistency may be due to the stagnation of CBR that followed right after the decline under the defined threshold. In other words, the threshold defined at the level of 35 per thousand people is very close to stagnation levels at 33–34 per thousand people for most districts in Type 1 group (Figure 6.38).

Results presented in Table 4 for Praha and Liberec cities are in contrast with previous findings (Fialová, Pavlík and Vereš 1990). As already mentioned, the results can be attributed to the chosen methodology. Surprisingly, the historical and recalculated data coincide. In the case of Liberec (Figure 6.43), we can see differences in the values for CBR caused by recalculation method. Historical, non-recalculated data for Liberec city had different territorial boundaries (significantly smaller size) while recalculated data for Liberec district (larger size) contains larger area surrounding the city having higher CBR (see Figure 6.24, 6.25 and 6.26, historical data).

Fig. 6.43 – Crude birth rates, historical and recalculated data, Praha and Liberec, 1869–1913



Notes: CBR_hist – historical data; CBR_rec – recalculated data.
Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

Nevertheless, there are also similarities between the rest of the findings and other studies (Fialová, Pavlík and Vereš 1990; Fialová 1991).

All the hypotheses were confirmed. The demographic transition in the Czech lands followed the European model: the pre-transitional stage with moderately high crude death and birth rates, mortality decline followed by fertility decline and stabilization of natural increase. Also, high population growth in the period between the mortality decline and fertility decline can be proved by the increase in the number of political districts from 133 to 156 in the period 1869 and 1910 (Table 4.12). Fertility decline started first in the North and Centre of the country, and then it diffused to the peripheries. The relationship between ageing and onset and speed of demographic transition will be determined in the next chapter.

Chapter 7
Ageing at the regional level

7.1 Introduction

This chapter focuses on the development of ageing at the regional level. Districts are used as a basic unit for analysis. The research period is between 1950 and 2017. The analysis begins with the description of regional variability of ageing. The first step is to define the timing and pace of ageing. The second step is the classification of districts by onset and speed of ageing. Further subchapters are investigating deeper the similarities and differences among districts, specifically: rates of natural increase and net migration rates, changes in the age structure and old-age-dependency ratios. The second chapter provides an attempt to determine the interrelations of ageing with the demographic transition.

In this chapter, the following hypotheses are tested:

1. There is a close link between ageing and geographical position.
2. Timing and speed of ageing are correlated to the onset and speed (duration) of demographic transition at the regional level.
    a. The onset of demographic transition (fertility decline) correlates with the speed of ageing at the regional level.
    b. The onset of demographic transition (fertility decline) correlates with the onset of ageing at the regional level.
    c. The duration of demographic transition correlates with the onset of ageing at the regional level.
    d. The duration of demographic transition correlates with the speed of ageing at the regional level.
    e. The onset of demographic transition (fertility decline) correlates with the proportion of population aged 65+ at the beginning of the ageing process at the regional level.

7.2 Regional variability of ageing

Ageing is a consequence of changes in age structure that occurred during the demographic transition. Figure 7.1 compares age pyramids for Czechia for several years during the period 1880–2017. In 1880 the age pyramid had the transitional shape of a triangle resulting from high mortality and fertility. At this stage, the proportion of children aged 0–14 was high 34.5%, and the proportion of people aged 60+ was six times lower 4.9%. In 1950 we see that the age structure was affected by wars, steep fertility decline, and fertility increase. Effects of WWI on the age structure were visible at ages between 30 and 35. Small generations between the age of 5 and 15 were the consequence of fertility decline caused by WWII. The increase between ages 0–5 was the result of fertility increase that followed WWII. The proportion of children aged 0–14 dropped by almost 10 percentage points. The proportion of the population aged 65+ more than doubles. The proportion of the working age population increased by 7 percentage points. In 2011 the age pyramid had a more rectangular shape resulting from very low mortality and fertility at the replacement level. In the period 1950–2011 the proportion of children aged 0–14 decreased by almost 10 percentage points or 40%. The proportion of the population aged 65+ increased by 8 percentage points or 95%. The working age population remained constant. The changes continued during the period 2011–2017. The proportion of the population aged 65+ increased by 3 percentage points or almost 20%. The share of population 65+ increased twice faster compared to 1950–2011. The answer is in the age structure. During 2011–2017, the large generations of the WWII baby boom entered old-age. During this period for the first time, the working age population aged 15–64 decreased by 4 percentage points or 5%, and the population aged 0–14 increased by 1 percentage point or 7%.

Fig. 7.1 – Distribution of population by sex and age groups, Czechia, 1880, 1950, 2011 and 2017

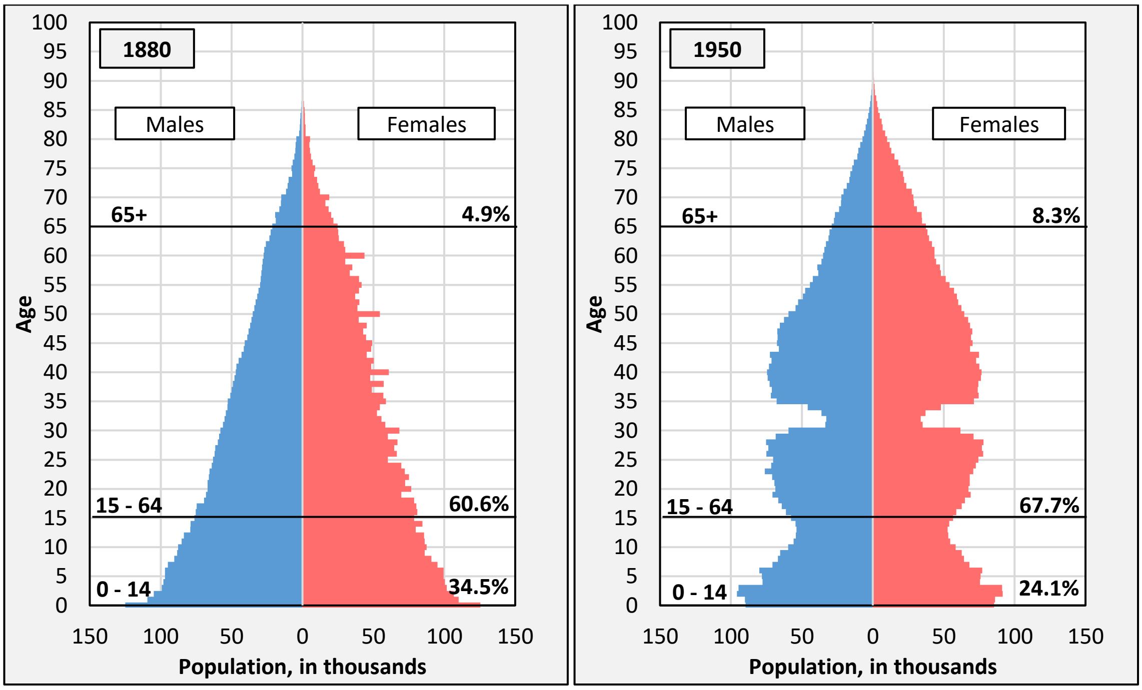
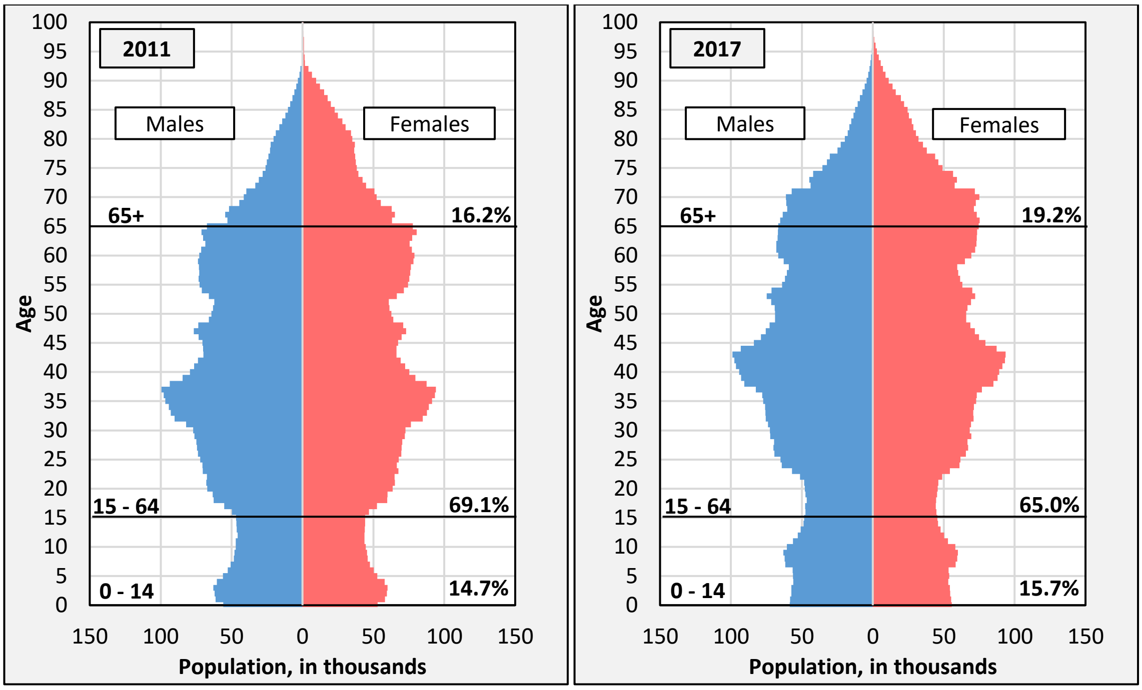


Fig. 7.1 (continued)

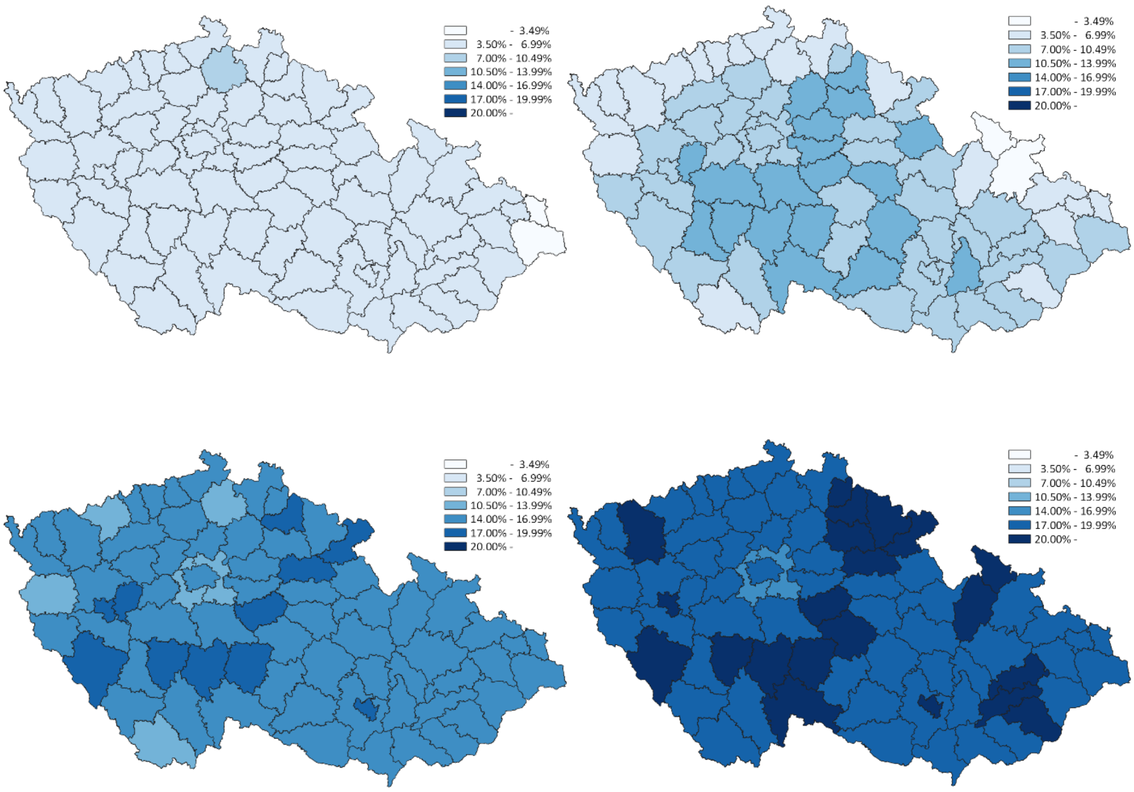


Notes: for 1880 and 1950 census data (present population), for 2011 and 2017 at 31.12 from Demografická ročenka (Demographic yearbook).

Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

Figure 7.2 provides an overview of the development of the population aged 65+ for several years during the period 1880–2017 at the district level. Before proceeding to the analysis, it is important to reiterate some methodological details. 7% of the population aged 65+ means that population started ageing (Kinsella 2002). 14% of the population aged 65+ means that population is already aged and 20% of the population aged 65+ means that population is super-aged. In 1880, in the Czech lands, the vast majority of districts had less than 7% of the population aged 65+. Thus, ageing hasn't started yet. In 1950 more than half of the districts were entering the ageing phase. The districts with population aged 65+ between 7% and 10% were located preponderantly in Central and Western Bohemia and Western and Central Moravia. Some districts reached a proportion of population aged 65+ of more than 10.5%. These were located in South-Central Bohemia, and several – in Eastern Bohemia. Districts that did not enter the ageing process were located in Northern Bohemia, Eastern Moravia and Silesia. In 2011 most of the districts were in the aged phase, with some exceptions for the districts around Praha (Praha-západ and Praha-východ) and some peripheral districts in the North and one in Southern Bohemia. In 2017, a fourth of the districts entered the category of super-aged. Praha-západ and Praha-východ were the only districts that were not aged yet. As we already mentioned above, the substantial change between 2011 and 2017 was caused by the large generations of the WWII baby boom that entered the 65+ age group.

Fig.7.2 – Development of population aged 65+, Czechia, districts, 1880, 1950, 2011 and 2017, in %



Note: for 1880 and 1950 recalculated data was used.

Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

7.1.1 Onset and speed of ageing

For classification of ageing at the regional level, the onset and speed of ageing are used. The onset of ageing is the period when the threshold of 7% of the population aged 65+ is reached (Kinsella 2002). Speed of ageing is calculated as percentage point increase of population aged 65+ from 7% to 14% in the total population. 14% of the population aged 65+ in the total population means that society is aged (Kinsella and Phillips 2005). Importantly, a district is considered aged only if the proportion of the population aged 65+ did not return under 14%, only a continuous increase was considered.

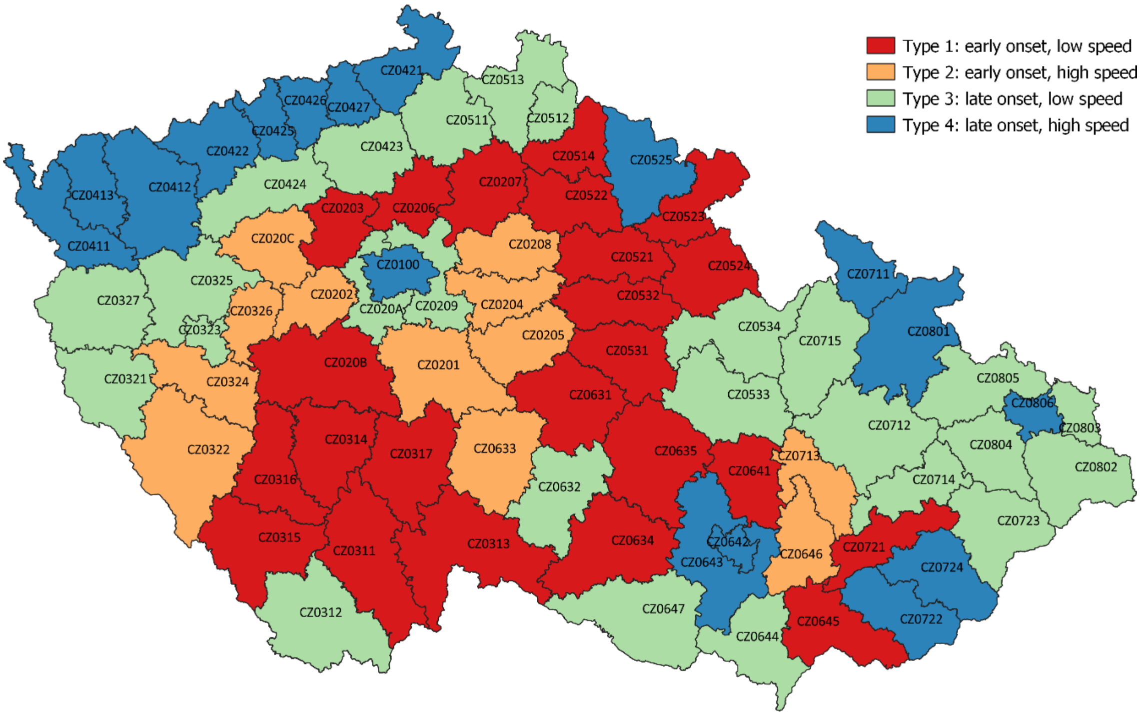
The classification has the following limitations:

1. Population data by age groups and districts are available only for census years (1950–2011) and separately for the years of 2012–2017 (population at 31.12).
2. The analysis starts in 1950 due to the changes that occurred in the age structure after WWII.
3. In some districts, the shift from 7% to 14% of the population aged 65+ begins before the data were available.

The districts are classified into four groups (Figure 7.3): early onset and low speed (Type 1), early onset and high speed (Type 2), late onset and low speed (Type 3), late onset and high speed (Type 4).

Early onset means reaching 10% or more of the population aged 65+ in 1950, late start – reaching less than 10% of the 65+ population in 1950. We had to adjust the initial definition in order to spot the differences between the districts. We assumed that if a district reached a proportion of more than 10% of the population aged 65+ in 1950, then ageing started before this year. The slow speed means the increase of population aged 65+ from 7% to 14% by 0.06–0.15 percentage points and high speed means an increase by 0.16 percentage points and more.

Fig. 7.3 – Classification of the districts by the onset and speed of ageing, Czechia



Sources: Author's calculations based on data from CZSO and Historický GIS.

The description of the groups is the following:

1. Type 1: early onset, low speed – the ageing started before the 1950s, and the share of population aged 65+ is 10% or more, speed of ageing is 0.06–0.15 percentage points (23 districts).
2. Type 2: early onset, high speed – the ageing started before the 1950s, and the share of population aged 65+ is 10% or more, speed of ageing is 0.16 percentage points or more (12 districts).
3. Type 3: late onset, low speed – the ageing started after 1950, or the share of population 65+ is 9% or lower in 1950, speed of ageing is between 0.06–0.15 percentage points (25 districts).
4. Type 4: late onset, high speed – the ageing started after 1950, or the share of population 65+ is 9% or lower in 1950, speed of ageing is 0.16 percentage points or more (17 districts).

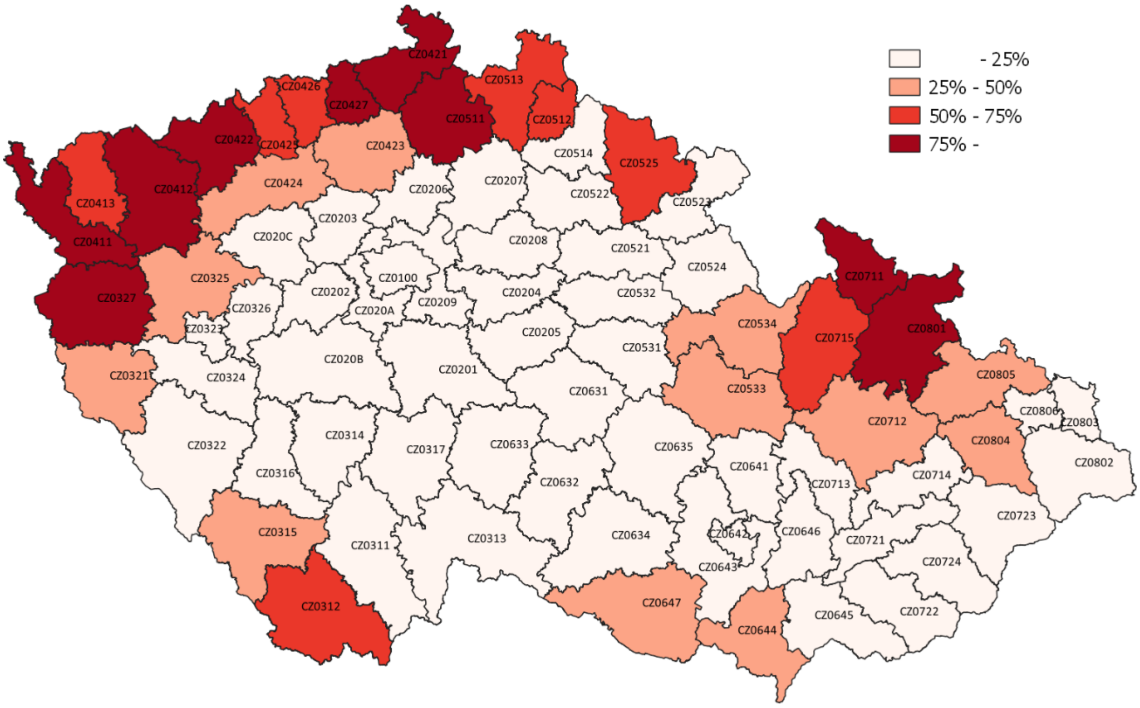
Type 1 includes some districts in Central, South and Eastern Bohemia, and several in Moravia specifically around Brno and its suburbs. Districts in Type 2 are scattered in the Central Bohemia, two are in the Western Bohemia and two in the Central Moravia.

Districts from Type 3 are located in surroundings of Praha, namely Praha-západ and Praha-východ, Northern and Western Bohemia (but not the districts at the border of the country), Northern and Eastern Moravia, some peripheral districts: Český Krumlov, Znojmo, Břeclav and Jihlava. Type 4 group includes districts from the Northern and some in North-West Bohemia, Praha, Brno-venkov, Brno-město. Detailed data are included in Appendix 7.1.

Classification revealed that until 2011, the proportion of the population aged 65+ was still fluctuating in some districts; however, after 2011, the increase became universal. In the period 1980–1991 the proportion of population aged 65+ decreased in the majority of districts. This decrease was probably caused by the large baby boom generations from the 1970s entering working age.

A link between the forced migration after the WWII and onset and speed of ageing is revealed when the map with the groups (Figure 7.3) is compared with the map of the change of ethnic German population between 1930 and 1950 (Figure 7.4). The transfer of ethnic German population influenced the age structure of districts from Western and Northern Czechia, a few districts in Southern Czechia and Northern Moravia (Figure 7.4). Districts in which the ethnic German population changed more than 50% are mostly part of Type 4 group – late onset and high speed of ageing. The districts with lower than 50% change in the proportion of ethnic German population are part of the Type 3 group – late onset and low speed. These findings suggest that late onset is related to the transfer of younger people than the previous population to the districts previously populated by Germans. As a result, the age structure of the population in these regions got younger. The difference in the speed of ageing may be associated with the impact of migration.

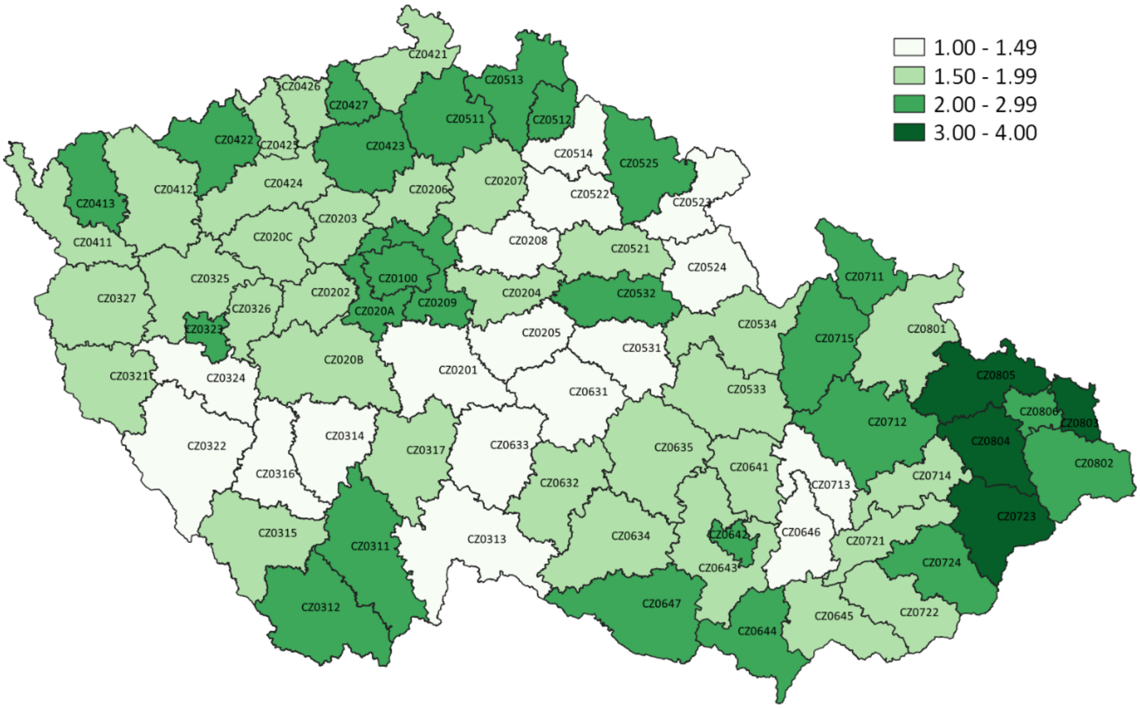
Fig.7.4 – The change in the proportion of the ethnic German population between 1930 and 1950, in %



Sources: Author's calculations based on data from CZSO and Historický GIS.

Growth multiple of population aged 65+ shows how many times the elderly population increases in absolute values during the transition from ageing phase (7%) to aged phase (14%). The population aged 65+ increased almost fourfold in Eastern Moravia (Figure 7.5). Districts in which population aged 65+ increased between twofold and threefold are located in Central Bohemia (Praha, Praha-západ and Praha-východ), districts located close to Northern border (Sokolov, Chomutov, Ústí nad Labem, Česká Lípa, Jablonec nad Nisou, Liberec, Trutnov, Český Krumlov, České Budějovice, Znojmo, Břeclav etc.) and cities (Plzeň-město, Brno-město and Ostrava-město). The population of 65+ almost remained the same in several districts in Western Bohemia, Eastern Bohemia and Central Moravia. An almost twofold increase is seen in Western Moravia and West-Northern Bohemia. Nevertheless, the growth multiple does not correlate to the onset and speed of ageing.

Fig.7.5 – Growth multiple of population aged 65+, Czechia, 1950–2017



Sources: Author's calculations based on data from CZSO and Historický GIS.

Ageing at the regional level started before 1950 and at the latest in 1980 (Appendix 7.1). The aged phase was reached between 1970 and 2013. The duration between the shifts from 7% to 14% of population 65+ varied across districts between 11 and 63 years. This shows a high level of heterogeneity of ageing among districts. All districts (77, including Praha) were classified by onset and speed of ageing into four groups. Type 1 group includes the districts with early onset and low speed. Type 2 group includes the districts with early onset and high speed. Type 3 group includes the districts with late onset and low speed. Type 4 group includes the districts with late onset and high speed. A link was revealed between the change in the ethnic German population between 1930 and 1950 and the classification of districts by the onset and speed of ageing. The districts with the greatest change in the ethnic German population (more than 50%) are mostly part of Type 4. The districts that had a lower change (less than 50%) are mostly part of Type 3.

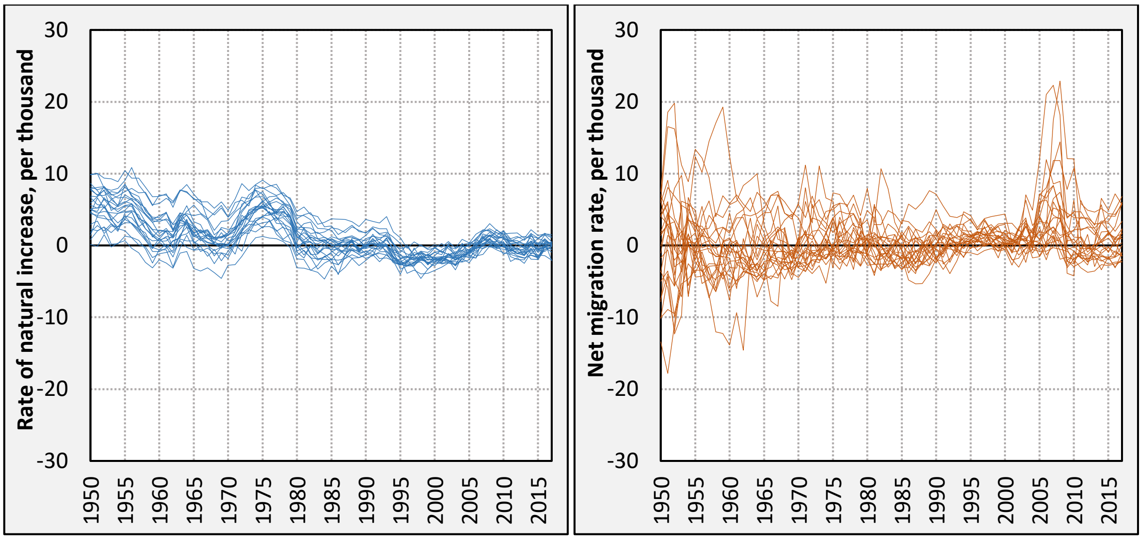
The growth multiple of population 65+ was analyzed. The highest increase (twofold or even threefold), in the population aged 65+, was observed in the Northern and Central Bohemia and Eastern Moravia. The districts with no significant changes were located in Western Bohemia, Eastern Bohemia and Central Moravia. Nevertheless, there was no correlation between the growth multiple and the onset and speed of ageing.

7.1.2 Natural and migration increase

We are further investigating the natural increase rate and net migration rate for each group to reveal the differences and similarities among them, and also to asses, their contribution to the population changes in each group resulted from the classification in the previous chapter.

In Type 1, the districts with early onset and slow speed of ageing are included. Rate of natural increase ranged between 0 and 10 per thousand people in the 1950s, but by 2017 the trends were converging to 0. Net migration rate ranged between -20 and +20 per thousand people in the 1950s. In 2017 the trends were converging too, with values ranging between -2 and +7 per thousand people (Figure 7.6).

Fig. 7.6 – Rate of natural increase and net migration rate, Type 1 districts, 1950–2017

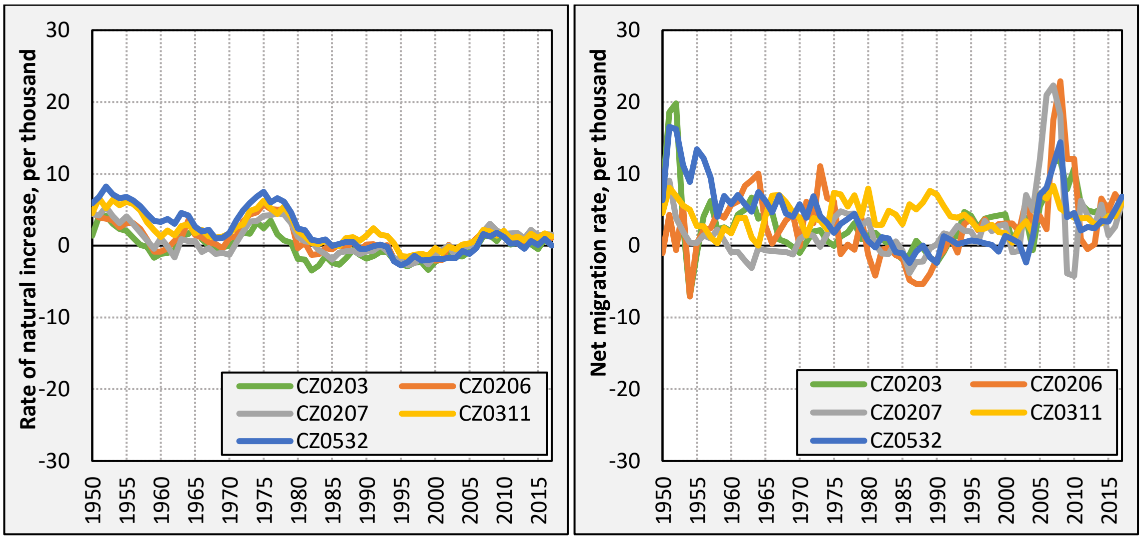


Sources: Author's calculations based on data from CZSO and Historický GIS.

The net migration rate was moderately high (between 4 and 7 per thousand people) in the 50s in 9 of the districts (Kladno, Mladá Boleslav, Příbram, České Budějovice, Strakonice, Hradec Králové, Náchod, Pardubice, Hodonín) and low (between -13 and -4 per thousand) in 8 districts (Jindřichův Hradec, Prachatice, Tábor, Jičín, Rychnov nad Kněžnou, Třebíč, Žďár nad Sázavou, Kroměříž) and around 0 in 6 districts (Mělník, Písek, Semily, Chrudim, Havlíčkův Brod, Blansko). In 2017 migration fluctuated around 0 almost in all districts, except five districts in which net migration rate was about 6 (Kladno, Mělník, Mladá Boleslav, České Budějovice, Pardubice) (Figure 7.7). Also, these districts had the highest increase in net migration rate over the reference period. Nevertheless, the rate of natural increase was constant and followed the general trend in the Type 1 group. The trends in net migration rate in Kladno, Mělník and Mladá

Boleslav may be caused by suburbanisation and location of the automotive industry (e.g. Mladá Boleslav).

Fig. 7.7 – The rate of natural increase and net migration rate in selected districts, 1950–2017

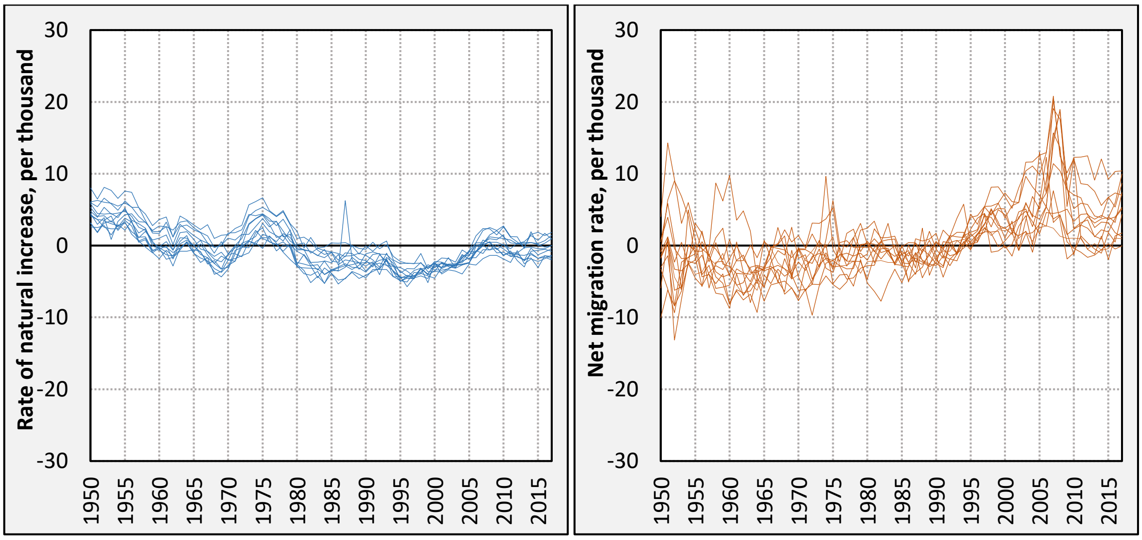


Notes: CZ0203 – Kladno, CZ0206 – Mělník, CZ0207 – Mladá Boleslav, CZ0311 – České Budějovice, CZ0532 – Pardubice.

Sources: Author's calculations based on data from CZSO and Historický GIS.

In Type 2, the districts with early onset and high speed of ageing are included. The rate of natural increase was ranging between 3 and 8 per thousand people in the 1950s, but by 2017 the trends converged to 0. The net migration rate was ranging between -5 and 4 per thousand people in the 1950s. In 2017 the differences in migration were wide, and net migration rate ranged between 0 and 10 per thousand (Figure 7.8) showing an upward trend.

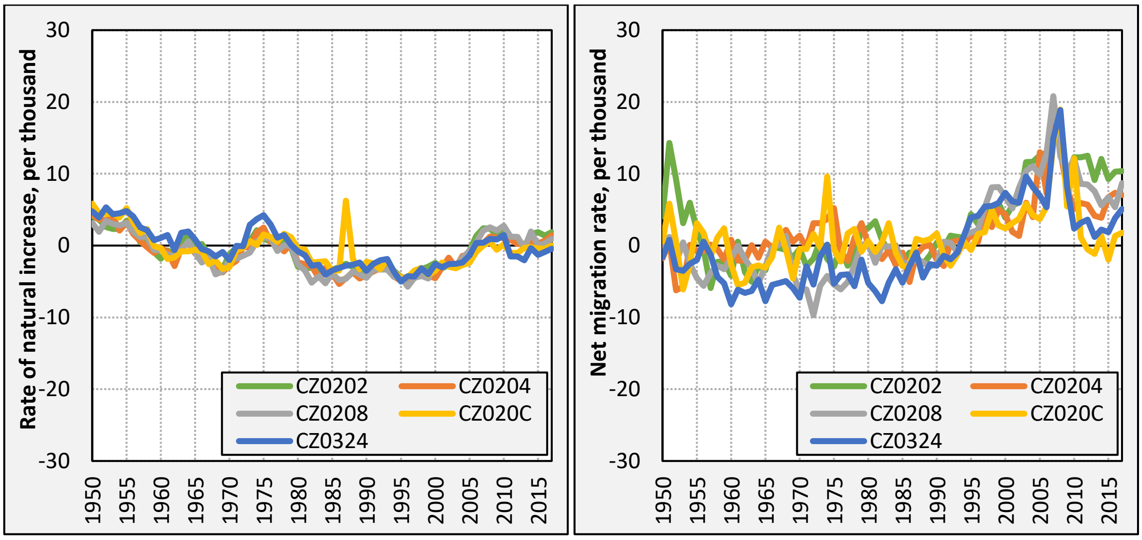
Fig. 7.8 – Rate of natural increase and net migration rate, Type 2 districts, 1950–2017



Sources: Author's calculations based on data from CZSO and Historický GIS.

This group had the lowest values for the rate of natural increase and net migration rate among the groups. In the 1950s net migration rate was mostly negative or 0, except for Beroun (in 1950 the net migration rate accounted for +4 per thousand people). In 2017 all the net migration rates were above 0. A significant increase was observed in 2007 and 2008; the net migration rate increased twofold or even threefold in 5 districts: Beroun, Kolín, Nymburk, Rakovník and Plzeň--jih (Figure 7.9). As in previous cases, a possible cause may be suburbanisation, also the influence of the automotive industry in some cases, e.g. Kolín.

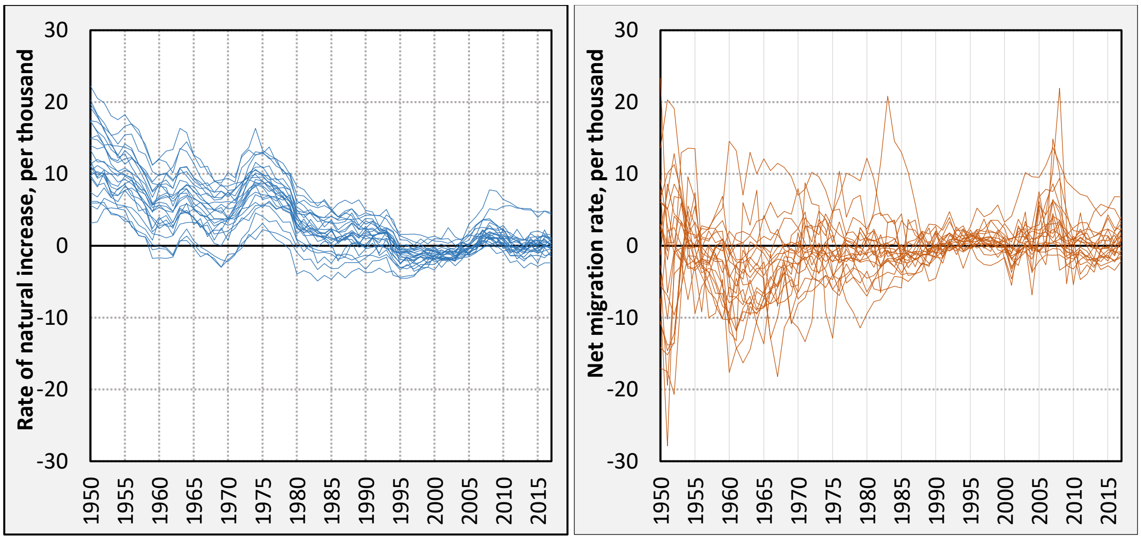
Fig. 7.9 – The rate of natural increase and net migration rate in selected districts, 1950–2017



Notes: CZ0202 – Beroun, CZ0204 – Kolín, CZ0208 – Nymburk, CZ020C – Rakovník, CZ0324 – Plzeň-jih.
Sources: Author's calculations based on data from CZSO and Historický GIS.

In Type 3 the districts with late onset and low speed of ageing are included. Rate of natural increase was ranging between 6 and 22 per thousand in the 1950s, but by 2017 the trend was converging to 0, with two exceptions – Praha-východ and Praha-západ with the rate of natural increase between 4 and 5 per thousand people. The net migration rate was ranging between -24 and +23 per thousand people in the 1950s (Figure 7.10).

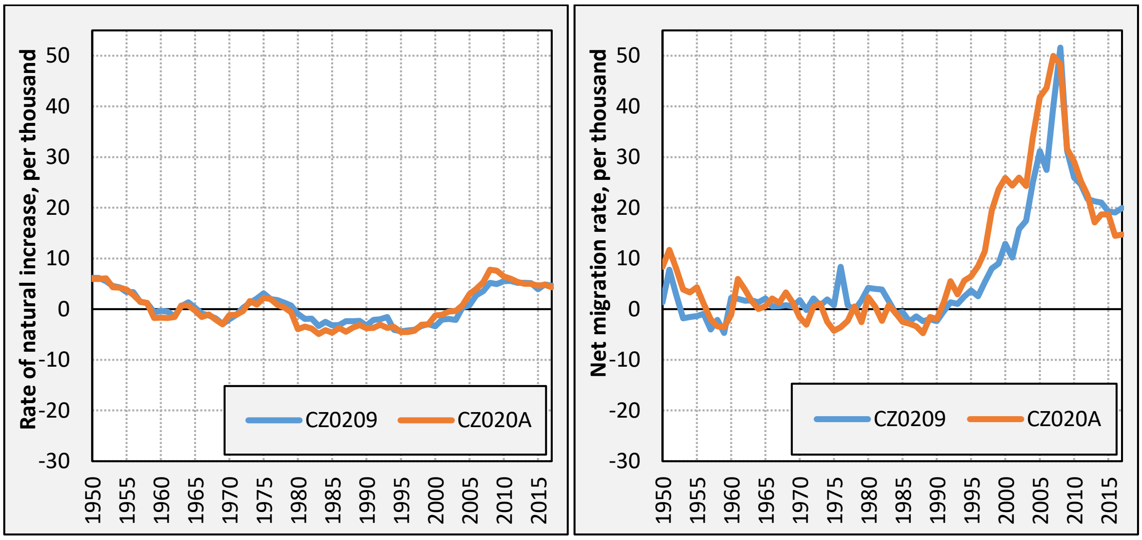
Fig. 7.10 – Rate of natural increase and net migration rate, Type 3 districts, 1950–2017



Note: In the graph with net migration rate Praha-východ, Praha-západ, Litoměřice, Karviná were excluded due to high fluctuations.
Sources: Author's calculations based on data from CZSO and Historický GIS.

In 2017 the differences in migration were converging significantly, and net migration rate ranges between -6 and 7 per thousand people, with two exceptions. Similarly, as in the natural increase case, Praha-východ and Praha-západ, had a net migration rate between 15 and 20 per thousand (Figure 7.11). This can be associated with the suburbanisation process.

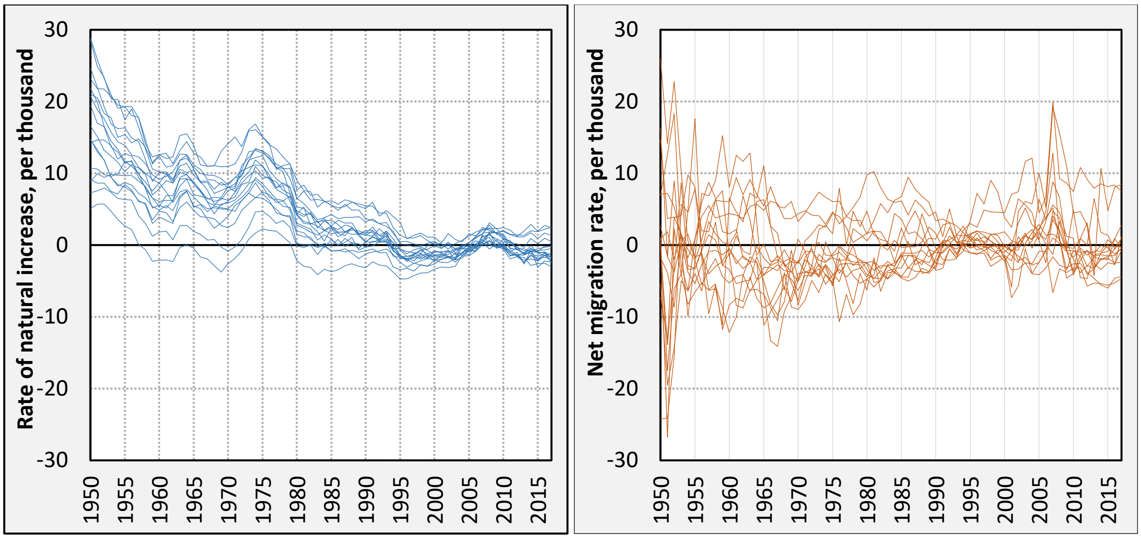
Fig. 7.11 – The rate of natural increase and net migration rate in selected districts, 1950–2017



Notes: the scale was changed to 55 per thousand people; CZ0209 – Praha-východ, CZ020A – Praha-západ.
Sources: Author's calculations based on data from CZSO and Historický GIS.

In Type 4, the districts with late onset and high speed of ageing are included. Rate of natural increase was ranging between 5 and 29 per thousand people in the 1950s, but by 2017, the trends were converging to 0 (between -2 and 2 per thousand) (Figure7.12). The net migration rate was ranging between -24 and 26 per thousand in the 1950s. In 2017 the differences in migration were converging, and net migration rate was ranging between -5 and 3 per thousand, with two exceptions – Praha and Brno-venkov, having net migration rate of about 8 per thousand people. The migration was fluctuating without a clear trend. In several districts the negative net migration rate was predominant in the 1950s (Cheb, Karlovy Vary, Děčín, Jeseník), in some districts the net migration rate was positive (Most, Teplice, Trutnov) and in the rest of districts (Sokolov, Chomutov, Ústí nad Labem, Uherské Hradiště, Zlín, Bruntál) the net migration rate was close to zero. In 2017 almost all districts showed net migration rate close to zero with few exceptions.

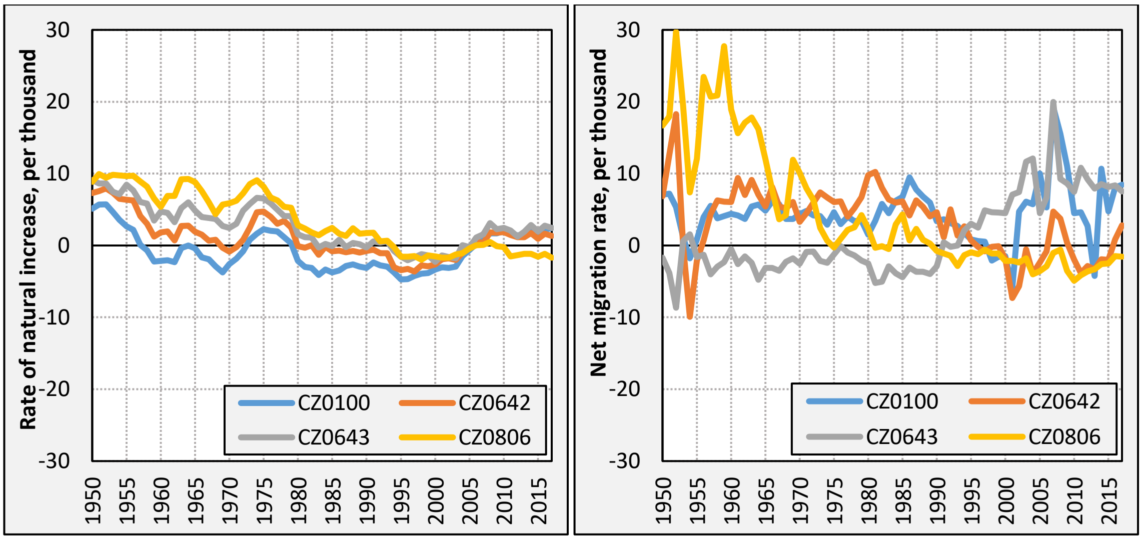
Fig. 7.12 – Rate of natural increase and net migration rate, Type 4 districts, 1950–2017



Note: Graph with net migration rate excludes Karlovy Vary, Sokolov, Ostrava-město values due to high fluctuations.
Sources: Author's calculations based on data from CZSO and Historický GIS.

Additional value can be gained by analyzing districts that were mentioned above as exceptions: Praha, Brno-město, Brno-venkov, Ostrava-město. These are urban areas, except Brno-venkov, which is considered a suburban area. These districts shared specific patterns compared to the rest of the districts in the group. All these districts had a rate of natural increase lower than 10 per thousand people, and the net migration rate was mostly positive and high during the whole period (Figure 7.13). These districts were affected by the suburbanisation. From 1950 to 1990, the people were migrating to the urban areas, and after 1990 the process reversed, people started moving to suburban areas. For cities, migration played a central role in the delay of ageing, taking into consideration also low natural increase. But at the same time, these areas were ageing faster due to the ageing of the whole population (including those who migrated).

Fig. 7.13 – The rate of natural increase and net migration rate in selected districts, 1950–2017



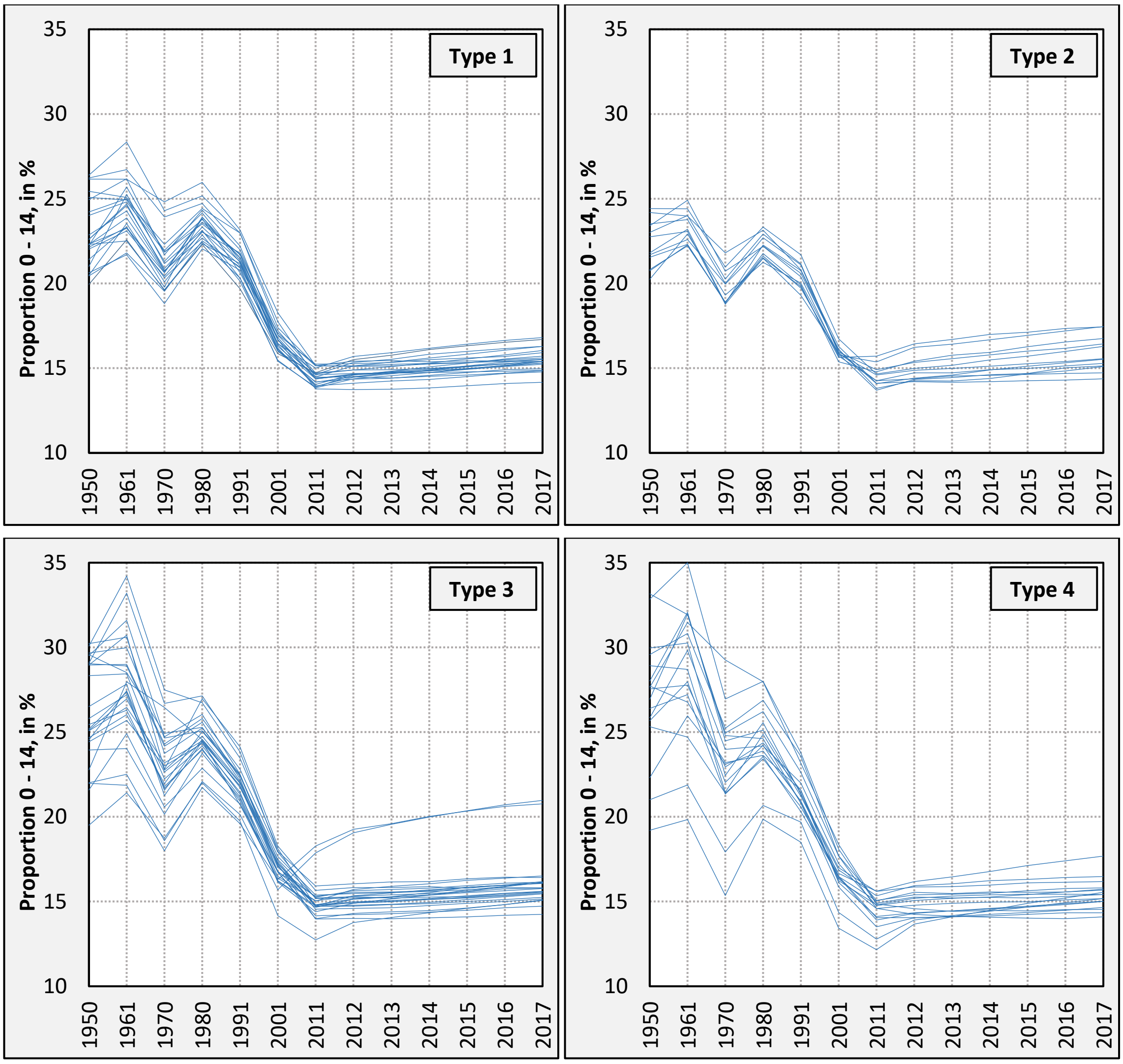
Notes: CZ0100 – Praha, CZ0642 – Brno-město, CZ0643 – Brno-venkov, CZ0806 – Ostrava-město.
Sources: Author's calculations based on data from CZSO and Historický GIS.

The rate of natural increase may have been an important delimiting factor for the groups because the net migration rate was fluctuating in the vast majority of districts. In 1950, the Type 1 and 2 groups had a rate of natural increase ranging between 0 and 10 per thousand people. The Type 3 and 4 groups had a rate of natural increase ranging between 5 and 29. Thus, the Type 1 and 2 groups had a lower rate of natural increase, the lowest being in Type 2 (between 3 and 8 per thousand). The rate of natural increase played a role in establishing the onset of ageing. In 2017 all the rates of natural increase were converging to 0, except for the Type 4 group that had a rate of natural increase ranging between -2 and +2 per thousand people. Also, the Type 4 group had the highest rate of natural increase in the 1950s. Nevertheless, the differences between districts decreased over time. The net migration rate showed a common trend for all groups. Districts that are located in the surrounding of larger cities experienced a population gain due to suburbanisation starting in 1995–2000. In cities, the net migration rate decreased; there was recorded even a negative net migration rate after 2010 (e.g. Figure 7.13).

7.1.3 Changes in age structure

Ageing means changes in the age structure: an increase in the older population and decrease in the younger population. In this subchapter, we are presenting the changes that occurred in the structure of three broad age groups: 0–14, 15–64 and 65+. In 1950 the proportion of population aged 0–14 in Type 1 group was ranging between 20 (Kladno) and 26.4% (Prachatice), in Type 2 group – between 20.3% (Rokycany) and 24.4% (Vyškov), in Type 3 group – between 19.5% (Plzeň-město) and 30.2% (Znojmo) and in Type 4 group – between 19.2% (Praha) and 33.2% (Jeseník). Type 4 group included districts with the highest heterogeneity and Type 2 group was the most homogeneous. In the period 1950–1980 the proportion of population aged 0–14 fluctuated, but from 1980 a steep decline was observed until 2011. From 2011 a stabilization occurred with a slight increase. Moreover, the proportion of the population aged 0–14 showed a converging trend among the districts. The proportion of the population aged 0–14 ranged between 14 and 17%; exceptions were Praha-východ and Praha-západ with 21% and Brno-venkov with 18% (Figure 7.14).

Fig. 7.14 – Proportion of population aged 0–14, Type 1–4, 1950–2017

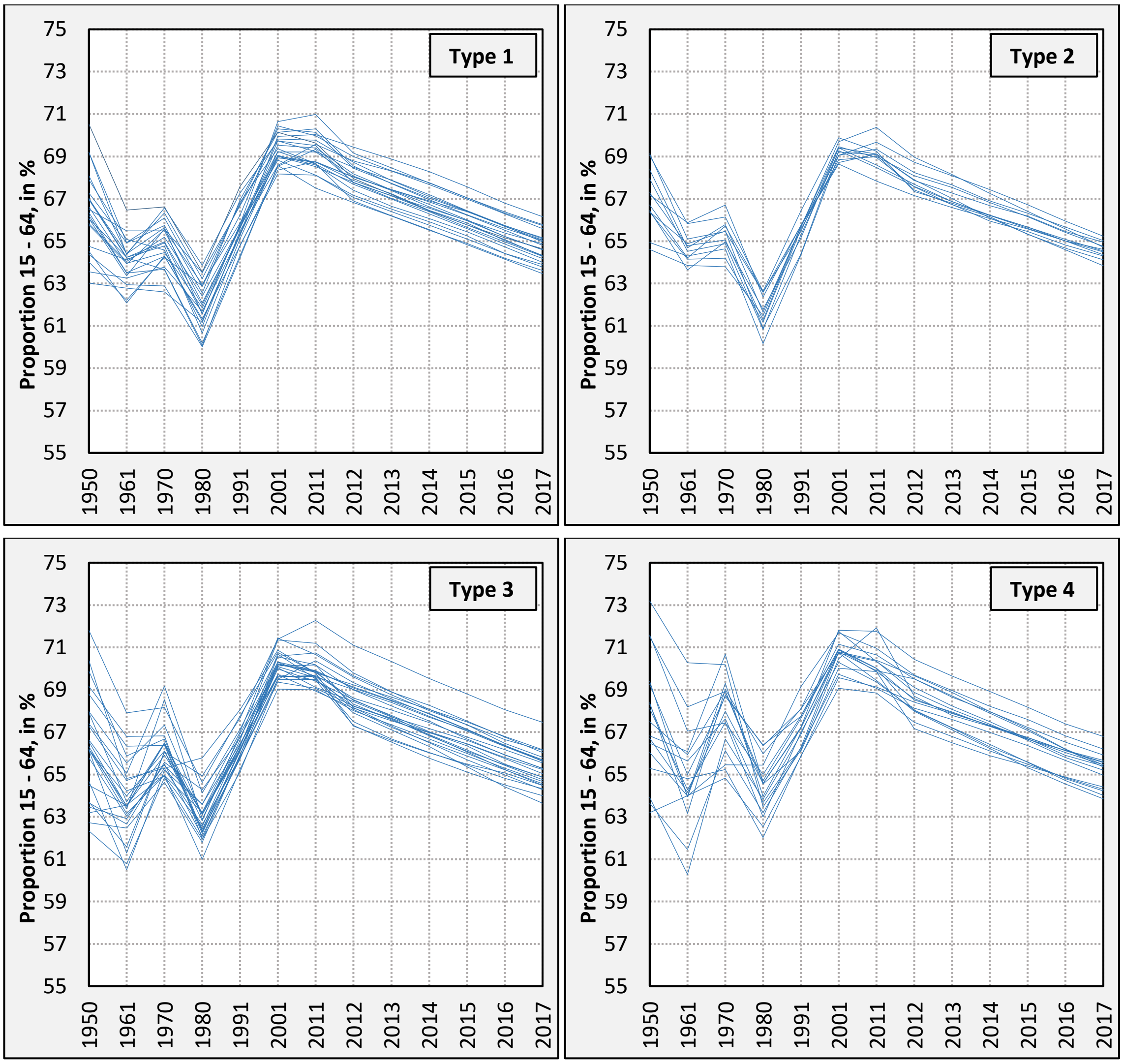


Notes: for 1950–2011 data are presented for every 10 years, after 2011 for every year. Type 1–4 refers to the groups from subchapter 7.1.1.

Sources: Author's calculations based on data from CZSO and Historický GIS.

In 1950 the proportion of population aged 15–64 in Type 1 group was ranging between 63% (Žďár nad Sázavou) and 70.5% (Kladno), in Type 2 group – between 64.6% (Pelhřimov) and 69.1% (Rokycany), in Type 3 group – between 62.3% (Znojmo) and 71.8% (Plzeň-město) and in Type 4 group – between 63.2% (Uherské Hradiště) and 73.2% (Praha). There was a link between the proportion of the population aged 0–14 and 15–64. Districts with the lowest values for proportion 0–14 generally had the highest proportion of 15–64: Kladno (Type 1), Rokycany (Type 2), Plzeň-město (Type 3). Type 4 group included districts with the highest heterogeneity and Type 2 group was the most homogeneous. In the period 1950–1980 the proportion of the population aged 15–64 fluctuated, but from 1980 there was a sharp increase until 2001. From 2001 we observed a downward trend. The proportion of the population aged 15–64 ranged between 64 and 67%. We can conclude that the working-age population (population aged 14–64) was shrinking (Figure 7.15) during the reference period.

Fig. 7.15 – Proportion of population aged 15–64, Type 1–4, 1950–2017

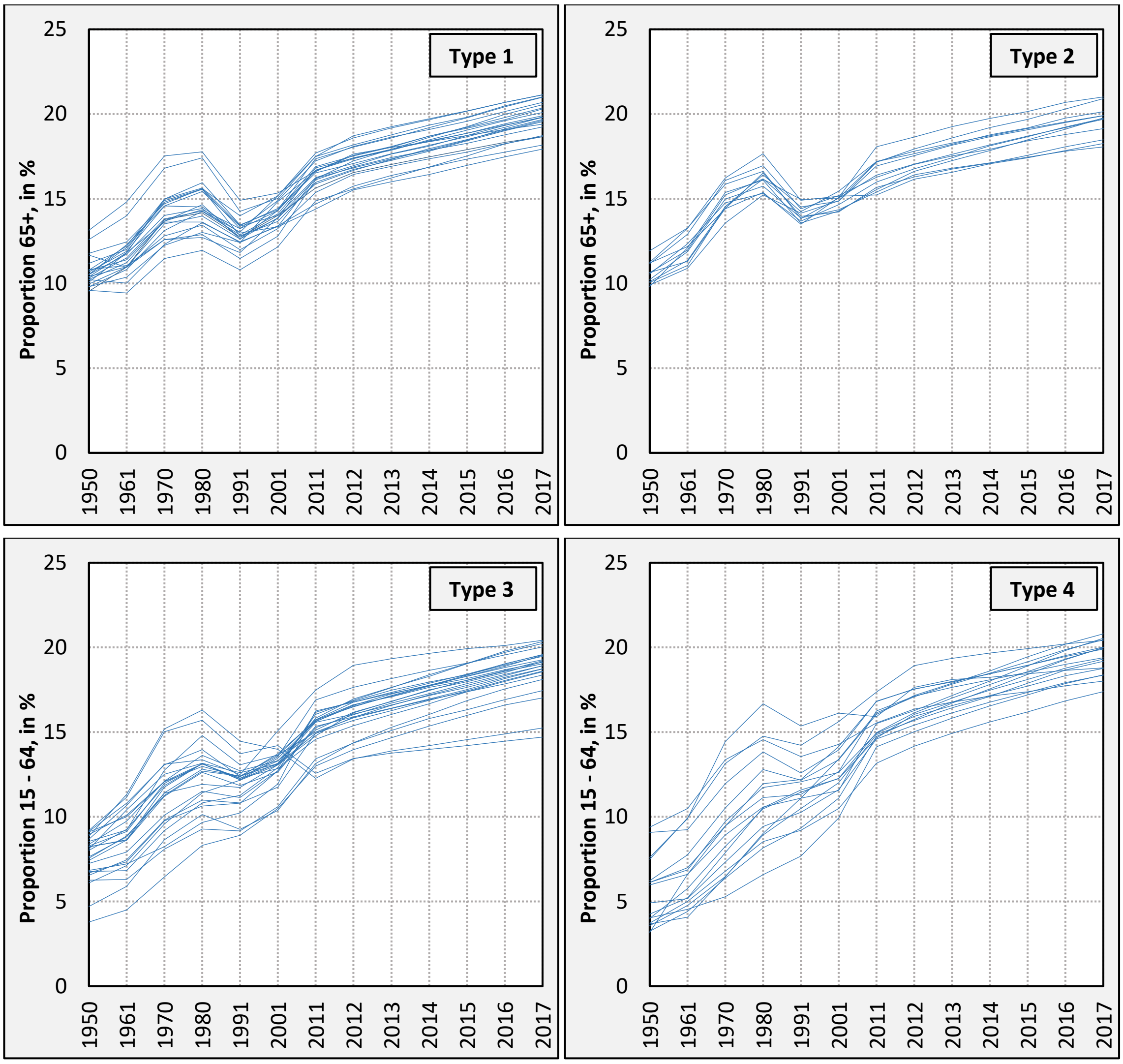


Notes: for 1950–2011 data are presented for every 10 years, after 2011 for every year. Type 1–4 refers to the groups from subchapter 7.1.1.

Sources: Author's calculations based on data from CZSO and Historický GIS.

In 1950 the proportion of population aged 65+ in Type 1 group was ranging between 9.5% (Kladno) and 13.1% (Jičín), in Type 2 group – between 9.8% (Rakovník) and 11.9% (Kutná Hora), in Type 3 group – between 3.8% (Tachov) and 9.2% (Praha-východ) and in Type 4 group – between 3.2% (Jeseník) and 9.4% (Brno-venkov). There was a link between the proportion of the population aged 0–14 and 65+. Districts with lowest values for proportion 0–14 generally had the lowest proportion of the population aged 65+: Kladno (Type 1), Praha-východ (Type 3), and Praha-západ (Type 3) and Jeseník (Type 4). Type 4 group included districts with the highest heterogeneity and Type 2 group was the most homogeneous. In the period 1950–1980 the proportion of population aged 65+ was increasing. From 1980 to 1991 the population aged 65+ decreased, but starting with 1991 a continuous increase was observed. Districts tend to homogenize. The proportion of the population aged 65+ ranged between 17 and 21%, with exceptions in Praha-východ and Praha-západ, where the proportion was 15% (Figure 7.16).

Fig. 7.16 – Proportion of population aged 65+, Type 1–4, 1950–2017



Notes: for 1950–2011 data are presented for every 10 years, after 2011 for every year. Type 1–4 refers to the groups from subchapter 7.1.1.

Sources: Author's calculations based on data from CZSO and Historický GIS.

The shifts in the age structure are a signal of ageing. The proportion of population aged 0–14 was ranging from 20–33% in 1950 to 14–18% (with exceptions in Praha-východ and Praha-západ in Type 3 group) in 2017. The proportion of the population aged 0–14 was fluctuating between 1950 and 1980, followed by a decline until 2011 when a stabilization with a slight increase occurred. The average decrease between 1950 and 2017 accounted for 11 percentage points or about 40%.

The proportion of the population aged 15–64 or working-age population was ranging from 62–72% in 1950 to 64–67% in 2017. In the period 1980–2001, the working-age population started to increase sharply. From 2001 the trend reverses, and the proportion of the population aged 15–64 decreases continuously. The average decrease between 1950 and 2017 accounted for 1 percentage point or 2%.

The proportion of population 65+ (elderly population by OECD definition) was ranging from 3–13% in 1950 to 17–21% in 2017 (with exceptions in Praha-východ and Praha-západ in Type 3 group). During 1950–2017 the proportion of the elderly population was increasing gradually, the exception being during 1980–1991 when a slight decrease was observed. The average increase between 1950 and 2017 accounted for 11 percentage points or about 140%.

The proportion of the population aged 0–14 is stabilized, the proportion of the population aged 15–64 is decreasing continuously, and only the proportion of the elderly population continues to increase. The homogeneity in the age structure increases with time in all districts and for all age groups.

7.1.4 Old-age-dependency ratios

Ageing comes with an increase in the old-age-dependency ratios. This measure is important because its increase affects the cost of supporting elderly people by the working-age population (Demeny, McNicoll and Hodgson, 2003). In 1950 the old-age-dependency ratio in Type 1 group was ranging between 14 (Kladno and Pardubice) and 20 (Jičín) per 100 persons of working age, in Type 2 group – between 14 (Rakovník) and 18 (Kutná Hora) per 100 persons of working age, in Type 3 group – between 6 (Tachov) and 14 (Ústí nad Orlicí and Jihlava) per 100 persons of working age and in Type 4 group – between 5 (Cheb, Karlovy Vary and Jeseník) and 14 (Brno-venkov and Uherské Hradiště) per 100 persons of working age. Type 4 group included districts with the highest heterogeneity and Type 2 group was the most homogeneous. In the period 1950–1980 the proportion of population aged 65+ was increasing. From 1980 to 2001, the old-age dependency ratio decreased, but from 2001, there was a continuous increase (Figure 7.17). The decline in 1991 and 2001 was due to the generations born between 1969 and 1974 entering the working age.

Fig. 7.17a – Old-age-dependency ratios, districts, Type 1 and 2, 1950–2017

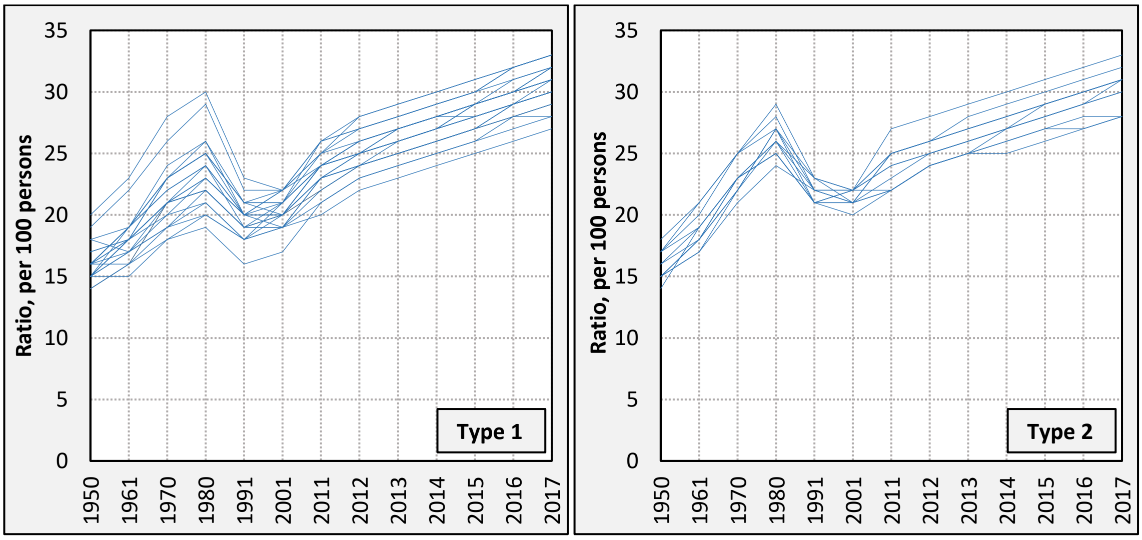
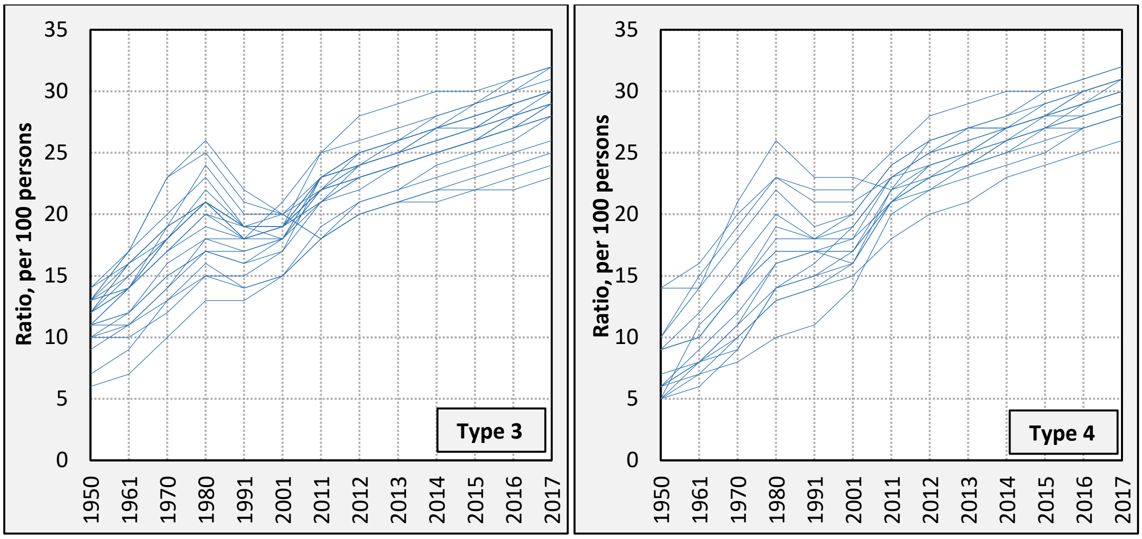


Fig. 7.17b – Old-age-dependency ratios, districts, Type 3 and 4, 1950–2017



Notes: for 1950–2011 data are presented for every 10 years, after 2011 for every year. Type 1–4 refers to the groups from subchapter 7.1.1.

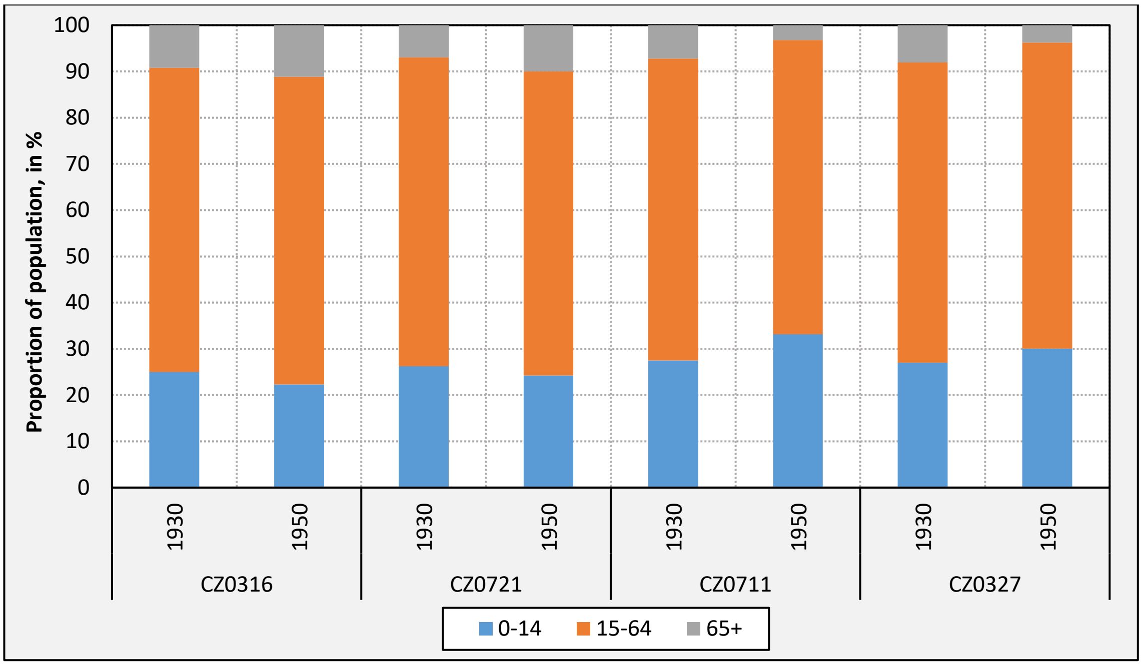
Sources: Author's calculations based on data from CZSO and Historický GIS.

In 2017 the old-age-dependency ratio varied between 23 and 32 per 100 persons of working age. Between 1950 and 2017, the old-age-dependency ratio increased on average by 124% at the national level. There is a close link between the proportion aged 65+ and the old-age-dependency ratios when we compare the trends (Figure 7.16 and Figure 7.17).

7.2 Interrelations of ageing with the demographic transition

One of the main obstacles of the research of interrelations between ageing and demographic transition is the drastic change in population age structure after WWII. Figure 7.18 presents the age structure of the four selected districts. The change in the ethnic German population between Strakonice and Kroměříž was insignificant. Thus, we notice that the proportion of the elderly population is increasing and the population aged 0–14 is decreasing. In the case of Jeseník and Tachov, the ethnic German population decreased by about 90%. In these districts, the proportion of elderly decreased and the proportion of the population aged 0–14 increased. These are the results of changes in the age structure of population resulted from the transfer of the ethnic German population after WWII.

Fig. 7.18 – Proportion of population aged 0–14, 15–64, 65+ in selected districts, 1930 and 1950



Notes: CZ0316 (Strakonice) had a 0% change in the German population between 1930 and 1950, CZ0721 (Kroměříž) – 1%, CZ0711 (Jeseník)– 91%, CZ0327 (Tachov) – 93%.

Sources: Author's calculations based on data from CZSO and Historický GIS.

Although a change in the population occurred all over the country, we attempted to determine if there is any link between demographic transition and ageing after eliminating districts that experienced the most significant changes. We considered 25% of population change as a threshold after comparing the changes in age structure across the districts. Thus, districts that had a change in the ethnic German population higher than 25% were eliminated from the analysis. The age structure of 30 districts was affected the most with a change between 25% and 93% (Table 7.1).

Tab. 7.1 – The change in the German population between 1930 and 1950, districts, in %

Code	District	Difference	Code	District	Difference
CZ0633	Pelhřimov	-1	CZ020C	Rakovník	13
CZ0314	Písek	0	CZ0324	Plzeň-jih	13
CZ0326	Rokycany	0	CZ0311	České Budějovice	13
CZ0317	Tábor	0	CZ0524	Rychnov nad Kněžnou	14
CZ0204	Kolín	0	CZ0632	Jihlava	18
CZ020B	Příbram	0	CZ0313	Jindřichův Hradec	22
CZ0208	Nymburk	0	CZ0642	Brno-město	22
CZ0316	Strakonice	0	CZ0322	Klatovy	24
CZ0205	Kutná Hora	0	CZ0523	Náchod	25
CZ0531	Chrudim	0	CZ0325	Plzeň-sever	25
CZ0202	Beroun	0	CZ0534	Ústí nad Orlicí	26
CZ0201	Benešov	0	CZ0644	Břeclav	32
CZ0635	Žďár nad Sázavou	0	CZ0712	Olomouc	32

Code	District	Difference	Code	District	Difference
CZ0209	Praha-východ	0	CZ0805	Opava	34
CZ0724	Zlín	0	CZ0423	Litoměřice	40
CZ020A	Praha-západ	0	CZ0804	Nový Jičín	42
CZ0722	Uherské Hradiště	0	CZ0321	Domažlice	43
CZ0721	Kroměříž	1	CZ0315	Prachatice	46
CZ0203	Kladno	1	CZ0533	Svitavy	47
CZ0521	Hradec Králové	1	CZ0424	Louny	47
CZ0532	Pardubice	1	CZ0647	Znojmo	49
CZ0645	Hodonín	1	CZ0425	Most	53
CZ0723	Vsetín	1	CZ0512	Jablonec nad Nisou	56
CZ0522	Jičín	1	CZ0715	Šumperk	58
CZ0634	Třebíč	2	CZ0525	Trutnov	61
CZ0641	Blansko	2	CZ0426	Teplice	62
CZ0207	Mladá Boleslav	2	CZ0413	Sokolov	71
CZ0631	Havlíčkův Brod	3	CZ0312	Český Krumlov	73
CZ0646	Vyškov	3	CZ0513	Liberec	74
CZ0713	Prostějov	4	CZ0427	Ústí nad Labem	75
CZ0100	Praha	5	CZ0422	Chomutov	80
CZ0323	Plzeň-město	5	CZ0412	Karlovy Vary	82
CZ0802	Frýdek-Místek	5	CZ0511	Česká Lípa	84
CZ0206	Mělník	5	CZ0411	Cheb	87
CZ0714	Přerov	7	CZ0421	Děčín	87
CZ0803	Karviná	8	CZ0711	Jeseník	91
CZ0514	Semily	8	CZ0327	Tachov	93
CZ0643	Brno-venkov	9	CZ0801	Bruntál	93
CZ0806	Ostrava-město	13			

Note: the data was recalculated for 1930 and 1950.

Sources: Author's calculations based on data from CZSO and Historický GIS.

47 districts (with the change lower than 25% in the share of Germans between 1930 and 1950) were used to determine the interrelations between demographic transition and ageing.

Several hypotheses were tested:

1. The onset of demographic transition (fertility decline) correlates with the speed of ageing at the regional level.
2. The onset of demographic transition (fertility decline) correlates with the onset of ageing at the regional level.
3. The duration of demographic transition correlates with the onset of ageing at the regional level.
4. The duration of demographic transition correlates with the speed of ageing at the regional level.

5. The onset of demographic transition (fertility decline) correlates with the proportion of population aged 65+ at the beginning of the ageing process at the regional level.

First three hypotheses were null; no correlation was observed. But the fourth and fifth hypotheses showed negative correlations.

The correlation between duration of demographic transition and the speed of ageing was statistically significant (0.004). The correlation was significant at the 1% level. There was a negative correlation (inversely proportional); thus, as the length of demographic transition increased, the speed of ageing decreased. However, the strength of the correlation was moderate. The correlation coefficient of the length of demographic transition and speed of ageing was –0.413. About 15% of the total variability in the speed of ageing was explained by the variation in the duration of demographic transition (Table 7.2).

Tab. 7.2 – Effects of the length of the demographic transition on the speed of ageing

Independent variable	B	SE	Adjusted R^2	N
Length of demographic transition	-0.413	0.065	0.152	47

Notes: Dependent variable is the speed of ageing; Correlation is significant at the 0.01 level (2-tailed).

Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

The correlation between the onset of demographic transition and the proportion of the population aged 65+ at the onset of ageing was statistically significant (0.000). The correlation was significant at the 1% level. There was a negative correlation (inversely proportional). Thus, the later demographic transition (fertility decline) began - the smaller was the proportion of the population aged 65+ at the onset of ageing. However, the strength of the correlation was moderate, as in the previous case. The correlation coefficient of the two variables was -0.595. About 34% of the total variability in the proportion of population 65+ at the onset of ageing was explained by the variation in the timing of the onset of demographic transition (Table 7.3).

Tab. 7.3 – Effects of timing of demographic transition on the proportion of population 65+ at the onset of ageing

Independent variable	B	SE	Adjusted R^2	N
Onset of demographic transition	-0.595	1.222	0.340	47

Notes: Dependent variable is the proportion of population 65+ at the onset of ageing; Correlation is significant at the 0.01 level (2-tailed).

Sources: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

The interrelations of ageing with demographic transition were identified after removing from the analysis the districts with a significant change (over 25%) in the proportion of ethnic German population between 1930 and 1950. The transfer of the ethnic German population considerably affected the age structure in almost half of districts. 47 districts were chosen for the examination of the relationship between ageing and demographic transition. Several hypotheses were tested. Only two correlations were consistent with the hypotheses. The first finding was that as the duration of demographic transition increases, the speed of ageing decreases. The second finding was that the later demographic transition starts, the smaller the proportion of the population aged 65+ is at the onset of ageing.

No associations were found between the onset of demographic transition and speed of ageing, the onset of demographic transition and onset of ageing, duration of demographic transition and onset of ageing.

7.3 Discussion and conclusions

Ageing is a consequence of the demographic transition. Mortality first started to fall among infants and children, fertility still being high at that moment and, as a result of population growth, numerous generations were produced. Further mortality decline for older age groups and fertility decline caused a double ageing process (Demeny, McNicoll and Hodgson 2003). Nevertheless, the demographic transition is not the only process that influences ageing; migration also does. In this research, this is mainly confirmed by the transfer of the ethnic German population after WWII and its impact on the age structure (Figure 7.4 and Figure 7.18). This led to ageing "postponement" in the districts previously inhabited preponderantly by ethnic Germans and in the same time "premature" ageing in the districts facing out-migration. The classification of the districts by onset and speed of ageing (Figure 7.3) and the map with the change in the proportion of ethnic German population between 1930 and 1950 (Figure 7.4) show that the districts in which the ethnic German population changed more than 50% are mostly part of Type 4 classification – late onset and high speed of ageing. The districts with lower than 50% change in the proportion of ethnic German population are part of the Type 3 classification – late onset and low speed. These findings suggest that the late onset of ageing is related to the movement of a younger population than the previous population to the districts previously predominantly populated by Germans. As a result, the population in these regions got younger.

The difference in the speed of ageing may be associated with migration because regular migration also had its impact. During the communist regime (1950–1989) and the planned economy, people were moving across the country for job opportunities. The Western and Northern Bohemia were attracting people for work in the coal mining, Kladno and Ostrava in coal mining and iron industry etc. In these districts, usually, the speed of ageing is lower (Figure 7.3). This is one of the key findings of regional classification. Nevertheless, the migration has only a short-term effect on ageing (Demeny, McNicoll and Hodgson 2003; Katus et al. 2000). Also, migration is sensitive to economic changes, e.g. the economic crisis from 2007 (European Comission 2009) preponderantly affected immigration. The number of immigrants decreased substantially after 2008. In 2008 the number of immigrants was 108,267, in 2009 – 75,620, in 2010 – 48,317, in 2011 – 27,114 etc. (EUROSTAT). It is important to mention here that in the analysis migration data used from CZSO (Figure 7.6 to Figure 7.13) must be analyzed with caution due to changes in legislation and definition that took place in 2004 (CZSO 2019).

The changes in the age structure are irreversible (Chapter 7.1.3). The working-age population is shrinking. In addition, the proportion of elderly is increasing fast. This is accelerated by the large generations from the post-WWII baby boom that are entering old-age (Mašková and Stašová 2000) (Figure 7.1). Czechia is ageing from the base/bottom of the pyramid due to low fertility and from the top due to an increase in life expectancy – double ageing. Nevertheless, TFR increased from 1.34 in 2006 to 1.69 in 2017 (EUROSTAT). Life expectancy at age 65 increased from 16.8 years in 2006 to 18.1 in 2017 (EUROSTAT). The EUROSTAT population projections show that the mortality rates will continue decreasing. With the increase of the proportion of elderly, the pressure on the working-age population, health care system and social security system is increasing too. Solutions are required for distribution the resources in an equitable way between the young generation and the elderly (Harper 2016). Nevertheless, the quality of life of the elderly is increasing. For example, in 2006 women had a life expectancy of 79.9 years and in 2017 – 82.2 years (EUROSTAT), in 2006 the healthy life years for women accounted for 59.9 years and in 2017 – 62.4 years (EUROSTAT). In the case of men, life expectancy in 2006 accounted for 73.5 years and in 2017 – 76.1 years. Healthy life years for men in 2006 accounted for 57.9 years and in 2017 – 60.6 years. It is important to note that the old-age-dependency ratio indicator used for the analysis has some limitations. The main limitation is that this measure is a headcount ratio. Also, the working age does not mean necessarily 15–64; young people are graduating from university the earliest in their 20s. Moreover, not all people retire at the age of 65. As mentioned above, the healthy life years are increasing, meaning the elderly can spend more time in the labour market (United Nations 2017). Nevertheless, this measure shows the burden of elderly support on the working-age population, and during 1950-2017, the old-age-dependency ratio increased by 124%.

The classification of districts from Chapter 7.2 showed differences in onset and speed of ageing at the regional level. The ageing started early and at a low speed in some districts in Central, South and Eastern Bohemia, and several in Moravia specifically around Brno and its suburbs. The districts with early onset and high speed of ageing are scattered in the Central Bohemia; two are in the Western Bohemia and two in the Central Moravia. The ageing started late and at a low speed in the surroundings of Praha, namely Praha-západ and Praha-východ, Northern and Western Bohemia (but not the districts at the border of the country), Northern and Eastern Moravia, some peripheral districts: Český Krumlov, Znojmo, Břeclav and Jihlava. The districts with late onset and high speed of ageing are located in Northern and some in North-West Bohemia, Praha, Brno-venkov, Brno-město. There were differences among the districts regarding the onset of fertility decline and proportion of population aged 65+, but after 2011 the differences between the districts declined when the increase in the population 65+ became universal.

In 2017, the 3/4 of districts had a proportion of people aged 65+ between 17 and 20%. One-fourth of districts entered the category of super-aged with more than 20% of the elderly (Figure 7.2). The lowest proportion of the population aged 65+ was in the districts surrounding Praha – Praha-západ and Praha-východ. These districts have a younger age structure due to suburbanisation.

An important part of this chapter was to determine the interrelations between ageing and demographic transition using correlation and regression analysis. One of the limitations of this section is that although the districts with a significant change in the ethnic German population between 1930 and 1950 were eliminated from the analysis, it is assumed that the change in age structure occurred throughout the country. This was due to the high mobility of people during WWII. Nevertheless, two correlations showed moderately strong relationships: the onset of demographic transition correlated with the proportion of population aged 65+ at the onset of ageing and the duration of demographic transition correlated with the speed of ageing.

It was revealed that there was a close association of ageing with geographical position. This was confirmed by the classification of districts. The second hypothesis, mentioned in the introduction of Chapter 7, was confirmed partly. The onset of demographic transition (fertility decline) did not correlate with the onset or speed of ageing, but it correlated with the proportion of population aged 65+ at the beginning of the ageing process. The duration of demographic transition did not correlate with the onset of ageing, but only with the speed of ageing. Thus, the later or earlier demographic transition started, the smaller or larger the proportion of the population aged 65+ was at the onset of ageing. And with the increase in the duration of demographic transition, the speed of ageing decreased. Both correlations had moderate strength.

Chapter 8
Conclusions

8.1 Main findings and discussion

The major result of this research is the original recalculation methodology of long historical data series going across multiple administrative division reforms of the country. This step was preceded by reconstruction of digital versions of historical maps (1869-1910), which were not available. The data recalculation methodology led to the creation of time series data for approximately 150 years. Thus, the mortality levels and fertility levels can be compared over time. However, the main limitation is the indicators that can be compared, mostly being crude rates. This is connected to the availability of historical data.

Chapter 6 provided a comprehensive description of the demographic transition at the district level for both historical districts and current districts (2011 administrative division). The historical data was used for an exact depiction of the processes. Nevertheless, the recalculated data for current districts is usually similar to the historical one, but more generalized. One possible explanation is the number of historical and current districts. There were 150 political districts in the period 1868–1913 compared to only 77 districts used in this research. Overall, the demographic transition in the Czech lands followed the classical model of demographic transition with moderately high mortality and fertility during the pre-transition period, followed by a decline in mortality in the second stage and fertility decline in the third stage, and it ended with a natural increase close to zero or even negative natural increase.

The main finding during the pre-transition period in the Czech lands is the high fertility for main urban centres (Praha and Brno). The finding contradicts the previous works of some scholars (De Vries 1990; Dyson 2010). One possible explanation of these fertility trends is that the proportion of illegitimate births was significantly high in urban areas (Praha and Brno in our case).

In the phase of mortality decline, the districts were heterogeneous. In rural areas, the CDR was lower than in the urban areas. Moreover, the CDR, and also IMR slightly increased in the urban areas during industrialization. This was a normal phenomenon; cities were also called demographic sinks (Dyson 2010). During this stage, the CBR was higher than CDR in the rural areas. Thus, population growth was generated. This excess of the population was an important source of urban growth due to high out-migration from rural areas (Dyson 2010; Bocquier and Costa 2015). The rural-urban migration is considered in some studies (Davis 1955; Davis 1963) as a cause for delayed fertility decline; the migration was decreasing the effects of high fertility. There is a link between the decline in IMR and in CDR, and several authors mentioned that the decline in mortality started among infants (Notestein 1945; Vishnevskii 1976; Lipovski 2007). At the start of mortality decline, almost half of the deaths were occurring among children aged 0 to 4.

The fertility decline hasn't started simultaneously in all the districts. A similar degree of heterogeneity was observed among districts as in the case of mortality decline. The analysis of fertility decline showed higher natality at the peripheries of the country, this being related to the disconnection from the main centres of change – the cities and the capital. This finding is similar to France during the demographic transition (Diebolt and Perrin 2017). A higher proportion of births out of wedlock is observed in several districts located mostly in North-Western Bohemia and South-Western Bohemia. This is associated with nationality (Fialová 1991). The districts with the highest proportion of illegitimate births had a high proportion of ethnic Germans and were located near the regions in Germany with the highest proportion of illegitimate births – South-Eastern Germany, Thüringen and Saxony (Knodel 1974).

It is important to note that at the end of demographic transition, the districts became more homogeneous concerning CBR and CDR, a converging trend was observed.

The results of the classification of districts by the onset and duration (speed) of demographic transition showed that the forerunners of fertility decline were located in Northern Bohemia and a majority of districts from Central, Southern and Eastern Bohemia. Last districts to enter the demographic transition were from Western Bohemia and a majority from Moravia and Silesia. However, some of these findings are not supported by previous research (Fialová, Pavlík and Vereš 1990; Fialová 1991). The cause of the inconsistencies lies in the different methodology and different measures used in this research. This was also mentioned in the limitations of the research in Chapter 1.

The age structure changed substantially during the demographic transition. The direct consequence of this process is the population ageing. Migration also has its impact, especially in the case of Czechia. The transfer of the ethnic German population after WWII had a considerable impact on the age structure, especially in the districts that had a high proportion of ethnic Germans. This led to ageing "postponement" in the districts previously inhabited preponderantly by ethnic Germans and in the same time "premature" ageing in the districts that faced out-migration. The classification of districts by the onset and speed of ageing showed that the districts where the change in the ethnic German population was of approximately 50% the ageing did start later. A possible explanation of the differences in the speed of ageing is the internal migration triggered by economic opportunities. For example, during the communist regime, people were moving where the jobs opportunities were available, specifically, in coal mining and heavy industry. Nevertheless, we should acknowledge the temporary impact of migration on ageing (Katus et al. 2000; Demeny, McNicoll and Hodgson 2003).

The population of Czechia is double ageing. The fertility is under replacement level, although, it is increasing lately. TFR increased from 1.34 children per woman in 2006 to 1.69 children per woman in 2017 (EUROSTAT). Mortality is still decreasing for older ages. Life expectancy at age 65 increased from 16.8 years in 2006 to 18.1 in 2017 (EUROSTAT). The proportion of the population aged 65+ continues to increase. The upward trend is accelerated by the large baby boom generations from the post-WWII that are entering old-age (Mašková and Stašová 2000). In 2017, the proportion of the population aged 65+ was between 17 and 20% in the majority of districts. One-fourth of the districts entered the super-aged category with a population aged 65+ of 20% and over. The increase in the elderly population increases the pressure on health care and social security system. It is important to mention that the old-age-dependency ratio increased by 124% during 1950-2017.

An important objective of the research was to determine the interrelations between demographic transition and ageing. Several correlations were tested. The results showed that the onset of demographic transition does not correlate with the onset or speed of ageing, but it correlates with the proportion of the population aged 65+ at the beginning of the ageing process. The duration of demographic transition does not correlate with the onset of ageing, but only with the speed of ageing. Thus, the proportion of the population aged 65+ at the onset of ageing depends on the timing of the demographic transition. For example, if the demographic transition starts earlier, the larger is the proportion of the population aged 65+ at the onset of ageing, and vice-versa. The duration of demographic transition correlates with the speed of ageing: the longer the duration of demographic transition, the lower is the speed of ageing, and vice-versa. It is important to mention that the relationships between the independent and dependent variables had a moderate strength in both cases. For the determination of interrelations between demographic transition and ageing, only 47 districts (Table.7.1) were chosen. The districts with the most significant change in the proportion of ethnic German population between 1930 and 1950 were not included in the analysis, because we assumed that their age structure was affected the most after the WWII.

8.2 Implications and recommendations

One of the objectives of this study was the recalculation of historical data to the 2011 administrative division. As a result, time series data were created for a period of about 150 years. The comparison of the historical data with the recalculated data shows that the recalculation methodology is reliable.

The methodology for data recalculation can be applied in all the countries that faced multiple reforms in the administrative division during the demographic transition, irrespective of the onset or duration. Thus, comparable time series at the regional level can be created for describing and following the evolution of mortality and fertility levels during demographic transition or other indicators based on the availability of data.

This research focused on creating a link between the past and present, historical, and current data. Further analysis can be done by linking the historical data with the future, with population projections. Also, more indicators can be calculated. There are more available data for the Czech lands that were not used in this study, e.g. mortality by causes of death, child mortality, marriages, the legitimation of children. Specifically, an analysis of nuptiality would bring more insights on the determinants of fertility decline.

Data recalculation can also be done at the ORP (municipality with extended powers) level (206) or at the region level (14 regions) and compared to both historical data and to the results presented in this study.

The classification of demographic transition used in this study should be replicated with caution because of the definitions of the classification criteria. The limitations are already mentioned in the Discussion and conclusions section of Chapter 6. However, other definitions can be used (e.g. Reher 2004) and compared to the results of this study.

The purpose of this work was not to find solutions or recommendations for ageing, because ageing is irreversible, and although the districts are at different stages of ageing there are no specific policies regarding ageing at their level or pensions are not calculated differently (according to the proportion of the working-age population for example). Moreover, in most of the literature, it is considered a general truth that ageing is a consequence of demographic transition, and there are few attempts to show how these two processes interrelate. And this was one of the main goals of this work. We attempted to find the correlations of ageing with the demographic transition. However, further analysis of the interrelations can be done, also with the implications of socio-economic factors.

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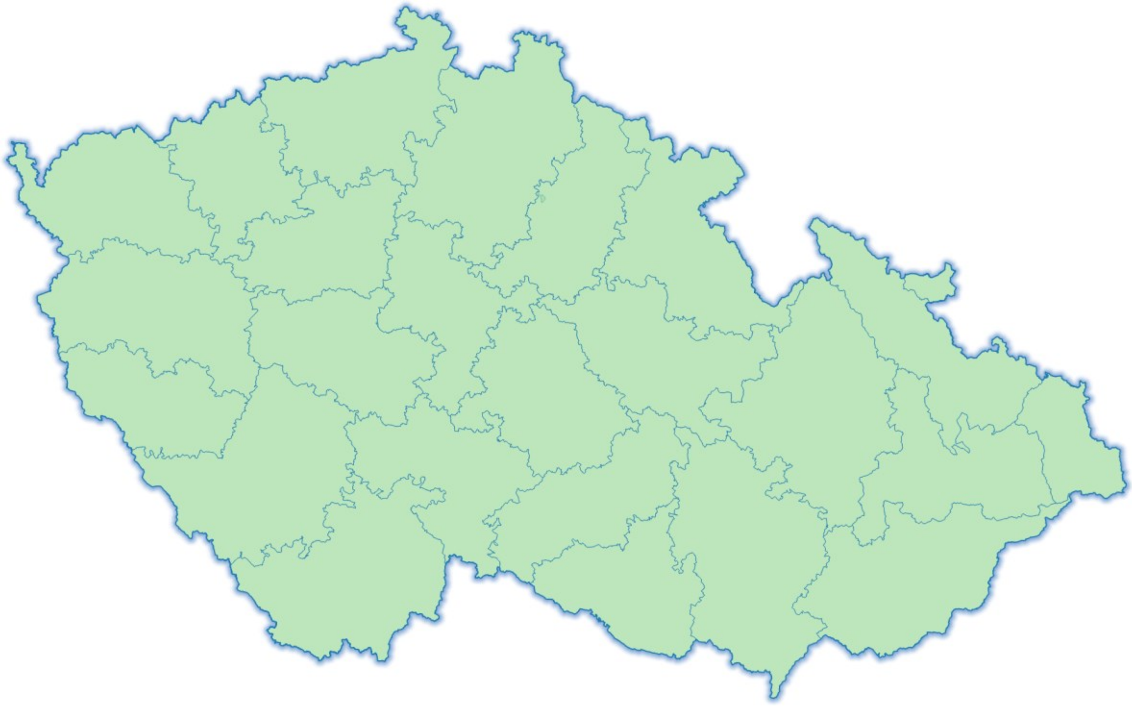
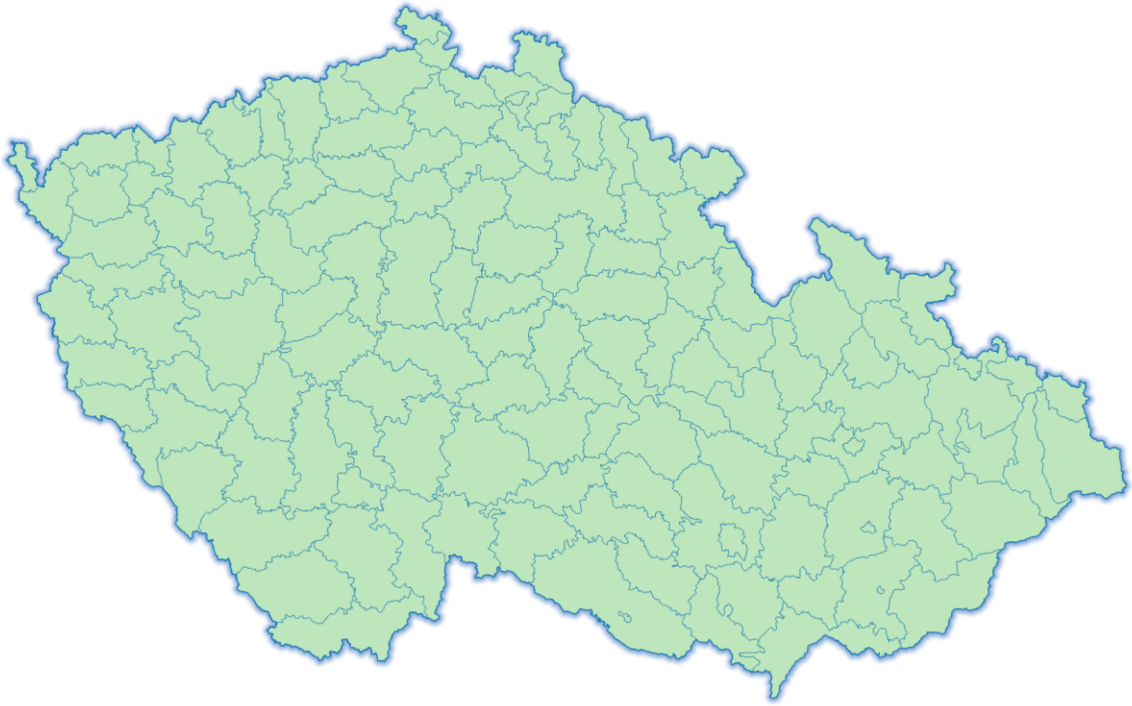
APPENDICES

Appendix 5.1 – Regions, Czech lands, 1831–1848



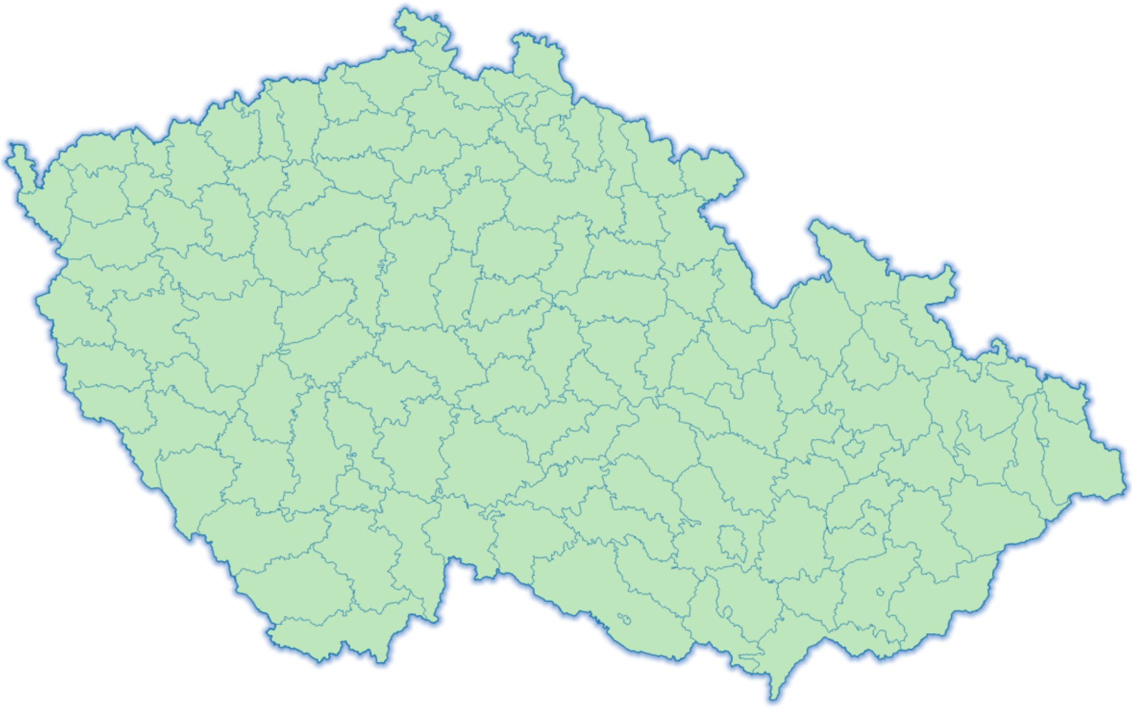
Source: Author's calculations based on data from Burda (2016) and Austrian Statistics.

Appendix 5.2 – Political districts, Czech lands, 1869



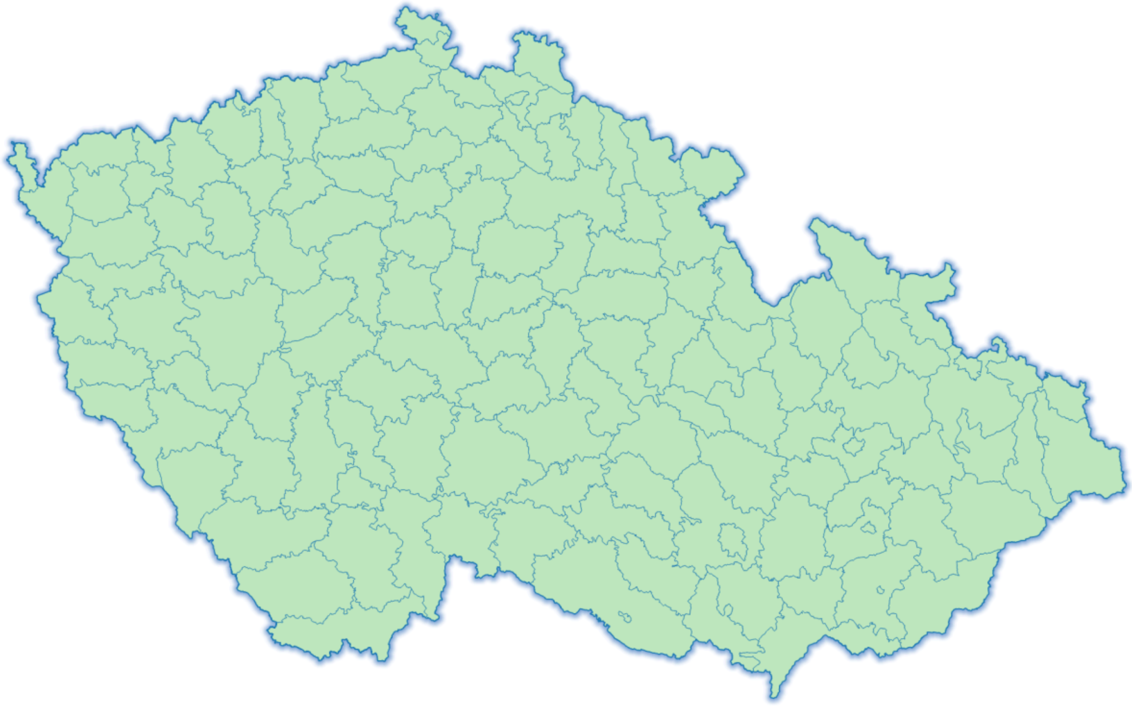
Source: Author's calculations based on data from CZSO and Historický GIS.

Appendix 5.3 – Political districts, Czech lands, 1880



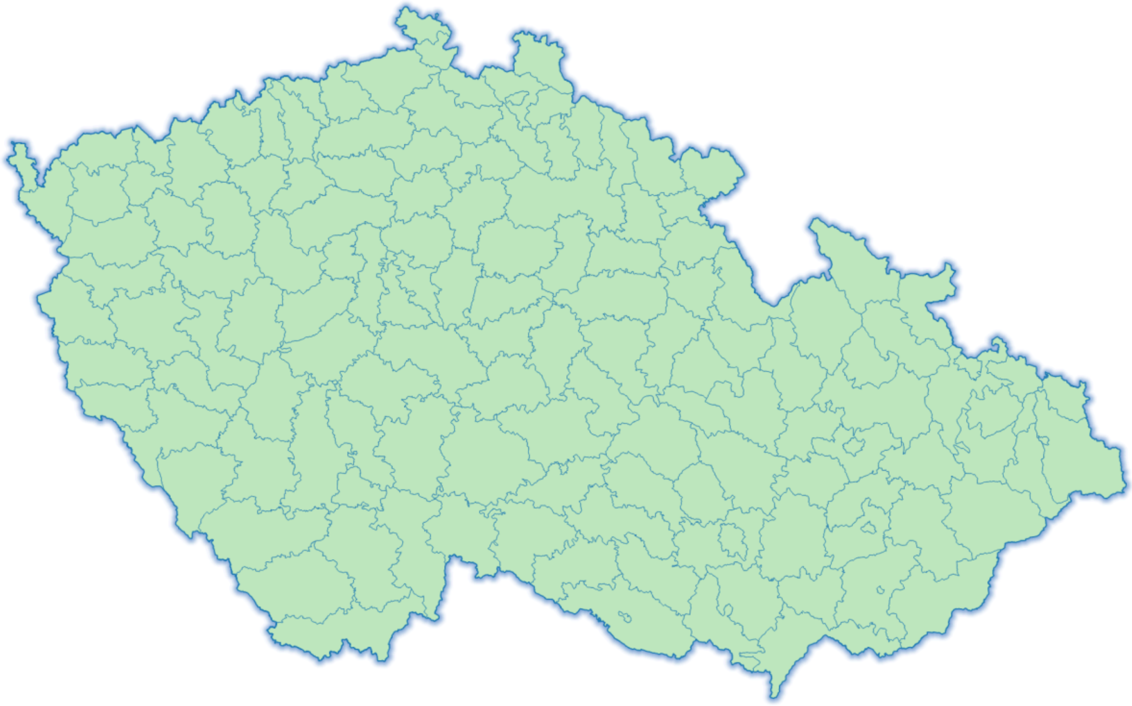
Source: Author's calculations based on data from CZSO and Historický GIS.

Appendix 5.4 – Political districts, Czech lands, 1890



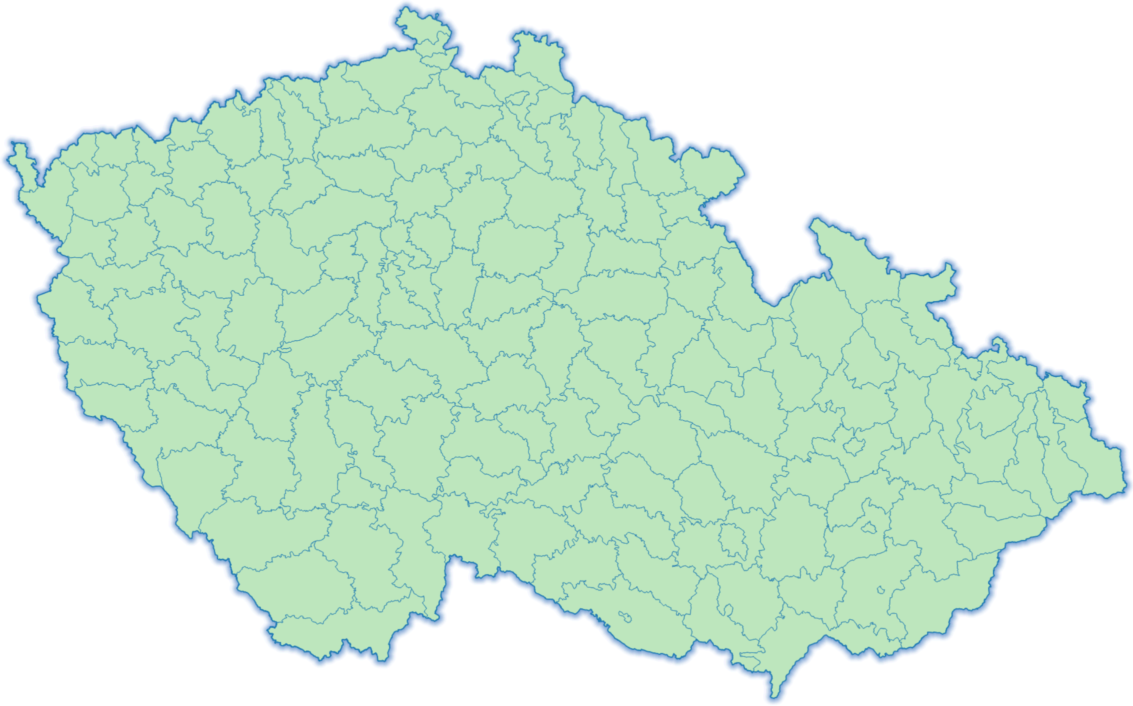
Source: Author's calculations based on data from CZSO and Historický GIS.

Appendix 5.5 – Political districts, Czech lands, 1900



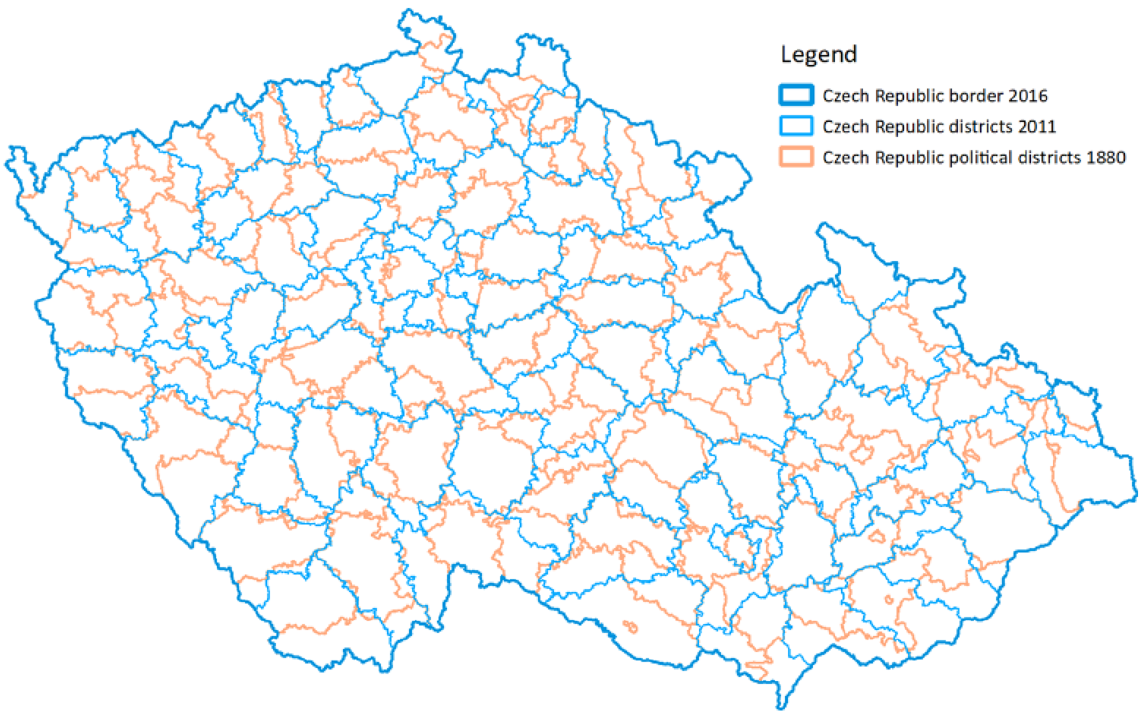
Source: Author's calculations based on data from CZSO and Historický GIS.

Appendix 5.6 – Political districts, Czech lands, 1910



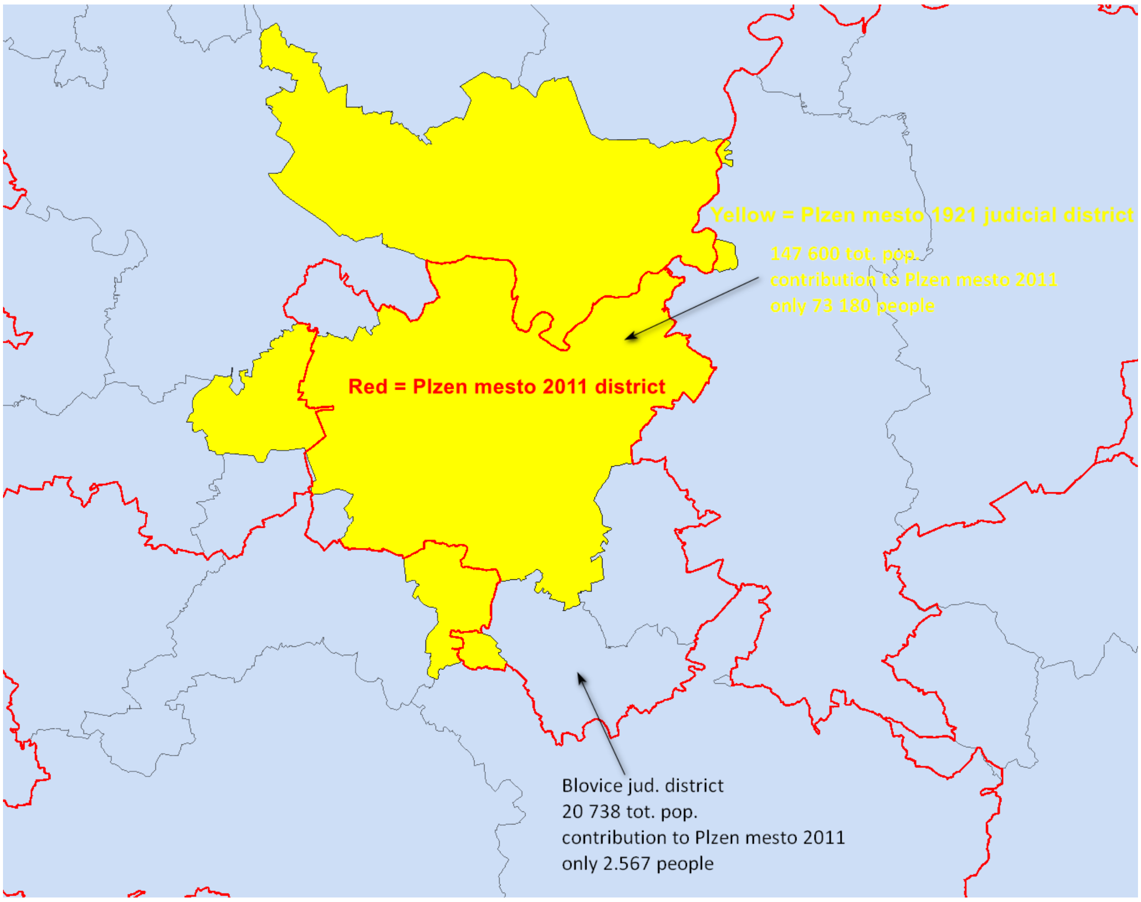
Source: Author's calculations based on data from CZSO and Historický GIS.

Appendix 5.7 – Layers used for spatial overlay (example of 1880 layer)



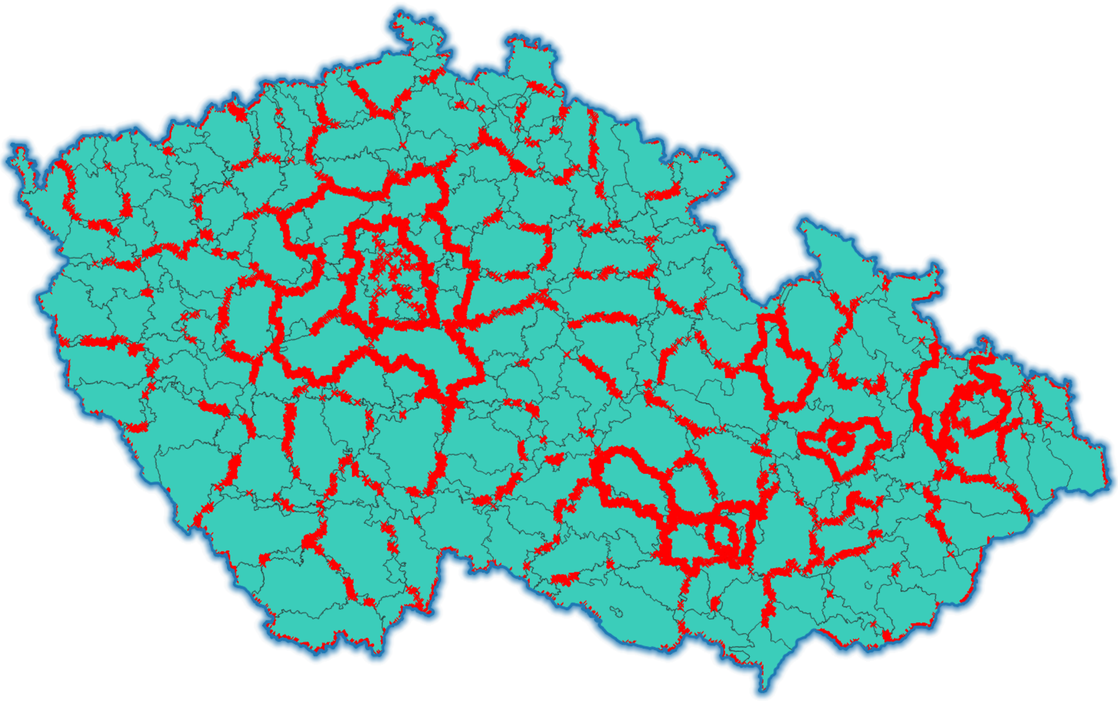
Source: Author's calculations based on data from CZSO and Historický GIS.

Appendix 5.8 – Example of variance in reliability of recalculated data (1921–2011)



Source: Author's calculations based on data from CZSO and Historický GIS.

Appendix 5.9 – Example of variance in reliability of recalculated data (1921–2011)



Source: Author's calculations based on data from CZSO.

Appendix 6.1 – Change in crude death rates 1869–1937

Code LAU	District name	1869	1881	1890	1900	1910	1921	1930	1937	C1	C2	C3	C4	C5	C6	C7	C8
CZ0100	Praha	39.1	35.6	29.6	25.7	21.7	15.1	11.0	10.7	-9	-17	-13	-16	-30	-28	-2	-70
CZ0201	Benešov	27.3	28.8	25.8	22.4	19.1	16.3	15.7	15.3	5	-10	-13	-15	-15	-4	-3	-47
CZ0202	Beroun	25.0	26.9	26.5	20.2	18.1	14.2	13.5	12.6	7	-1	-24	-10	-22	-4	-7	-53
CZ0203	Kladno	27.1	29.9	28.6	23.5	18.9	15.9	14.2	13.3	10	-4	-18	-19	-16	-11	-6	-55
CZ0204	Kolín	29.6	31.5	30.2	22.7	18.5	14.4	14.8	13.6	6	-4	-25	-18	-22	3	-8	-57
CZ0205	Kutná Hora	29.3	32.0	29.9	25.5	19.1	15.0	14.1	14.9	9	-7	-15	-25	-22	-6	6	-53
CZ0206	Mělník	28.4	29.7	25.4	24.1	19.3	16.0	14.1	13.8	4	-14	-5	-20	-17	-12	-2	-54
CZ0207	Mladá Boleslav	26.7	28.6	27.3	24.9	19.5	17.6	14.1	12.7	7	-5	-9	-22	-10	-20	-10	-56
CZ0208	Nymburk	28.8	31.1	29.2	24.0	19.2	15.2	14.3	13.6	8	-6	-18	-20	-21	-6	-5	-56
CZ0209	Praha-východ	26.5	28.8	20.3	19.5	15.2	13.5	13.4	11.6	9	-29	-4	-22	-11	-1	-14	-60
CZ020A	Praha-západ	26.1	28.5	25.5	17.2	15.7	13.6	13.4	11.2	9	-10	-32	-9	-13	-1	-17	-61
CZ020B	Příbram	27.6	26.4	26.5	22.5	21.0	16.3	15.7	15.8	-4	0	-15	-7	-22	-4	1	-40
CZ020C	Rakovník	26.2	27.5	28.6	21.9	18.1	15.3	14.5	13.5	5	4	-24	-17	-15	-6	-7	-51
CZ0311	České Budějovice	29.3	25.6	25.4	22.4	19.6	15.6	13.5	14.0	-13	-1	-12	-13	-21	-13	4	-45
CZ0312	Český Krumlov	25.6	26.1	28.2	22.0	19.7	18.1	16.4	14.8	2	8	-22	-11	-8	-10	-9	-43
CZ0313	Jindřichův Hradec	28.1	27.7	27.3	21.4	18.5	15.0	13.6	15.3	-1	-2	-21	-14	-19	-9	12	-45
CZ0314	Písek	24.5	24.3	25.6	21.4	18.9	15.1	14.6	14.9	-1	5	-16	-12	-20	-3	2	-39
CZ0315	Prachatice	25.1	27.2	24.7	22.2	20.6	18.6	16.2	16.0	8	-9	-10	-7	-9	-13	-2	-41
CZ0316	Strakonice	24.7	26.6	24.7	21.3	18.6	16.4	14.8	16.0	8	-7	-14	-12	-12	-10	8	-40
CZ0317	Tábor	28.3	30.2	30.7	25.9	19.2	14.9	15.1	15.7	7	2	-15	-26	-22	1	4	-48
CZ0321	Domažlice	29.1	30.3	29.4	23.3	19.3	17.9	14.8	14.0	4	-3	-21	-17	-7	-17	-6	-54
CZ0322	Klatovy	26.6	31.0	26.7	22.0	20.0	17.0	14.4	14.3	16	-14	-18	-9	-15	-15	-1	-54
CZ0323	Plzeň-město	27.8	25.4	26.0	18.0	16.8	13.6	12.0	11.1	-9	3	-31	-7	-19	-12	-7	-56
CZ0324	Plzeň-jih	27.4	26.1	25.8	19.0	17.1	16.2	13.2	12.5	-5	-1	-26	-10	-6	-19	-5	-52
CZ0325	Plzeň-sever	29.7	26.9	26.3	19.9	17.2	14.7	12.9	12.2	-9	-2	-24	-14	-14	-12	-6	-55
CZ0326	Rokycany	26.4	25.9	26.2	24.9	18.3	13.9	14.5	13.6	-2	1	-5	-27	-24	4	-6	-48
CZ0327	Tachov	28.8	26.6	25.9	22.2	17.5	16.6	13.8	14.0	-8	-3	-14	-21	-5	-17	2	-47

Code LAU	District name	1869	1881	1890	1900	1910	1921	1930	1937	C1	C2	C3	C4	C5	C6	C7	C8
CZ0411	Cheb	29.4	28.8	26.7	21.2	17.9	15.3	12.5	11.7	-2	-7	-21	-15	-15	-19	-6	-59
CZ0412	Karlovy Vary	30.7	28.9	31.2	26.7	18.2	18.3	13.8	12.6	-6	8	-14	-32	1	-25	-9	-57
CZ0413	Sokolov	31.7	28.7	31.9	26.4	18.1	17.4	12.6	12.0	-10	11	-17	-31	-4	-28	-5	-58
CZ0421	Děčín	28.5	32.0	31.1	25.7	17.5	15.9	13.3	12.8	13	-3	-17	-32	-9	-17	-3	-60
CZ0422	Chomutov	30.8	29.9	31.7	25.5	18.7	18.0	13.8	11.6	-3	6	-20	-27	-4	-24	-16	-61
CZ0423	Litoměřice	27.6	27.7	28.8	24.9	20.4	17.4	14.4	13.1	1	4	-13	-18	-15	-17	-9	-53
CZ0424	Louny	30.3	30.2	31.2	26.7	19.8	17.6	14.8	13.8	0	3	-14	-26	-11	-16	-7	-54
CZ0425	Most	31.6	34.7	32.7	27.8	19.5	16.8	12.3	12.3	10	-6	-15	-30	-14	-27	0	-65
CZ0426	Teplice	29.8	35.3	33.4	20.7	18.8	16.8	12.8	12.4	18	-5	-38	-9	-11	-24	-3	-65
CZ0427	Ústí nad Labem	28.8	32.8	32.1	24.0	17.7	14.9	11.9	11.4	14	-2	-25	-26	-16	-20	-4	-65
CZ0511	Česká Lípa	29.3	30.4	31.7	26.2	21.0	17.8	13.8	14.1	4	4	-17	-20	-15	-23	2	-54
CZ0512	Jablonec nad Nisou	30.2	32.7	33.3	26.4	17.7	13.6	11.8	11.4	8	2	-21	-33	-23	-13	-3	-65
CZ0513	Liberec	31.0	32.8	32.3	27.4	18.7	15.3	12.8	12.9	6	-1	-15	-32	-19	-16	1	-61
CZ0514	Semily	26.4	26.5	28.6	27.5	20.7	15.4	14.3	13.6	1	8	-4	-25	-25	-8	-5	-49
CZ0521	Hradec Králové	28.2	27.5	27.3	23.1	17.7	15.2	13.7	12.3	-2	-1	-15	-23	-14	-10	-10	-55
CZ0522	Jičín	26.9	27.4	27.6	25.2	18.4	16.5	15.0	15.0	2	1	-9	-27	-10	-9	0	-45
CZ0523	Náchod	29.8	28.4	28.3	25.3	21.1	16.4	14.9	13.3	-5	0	-10	-17	-22	-9	-11	-53
CZ0524	Rychnov nad Kněžnou	27.4	25.5	27.1	19.8	19.6	16.7	14.9	14.0	-7	6	-27	-1	-15	-11	-6	-45
CZ0525	Trutnov	30.3	29.7	30.3	28.0	21.0	15.4	13.7	13.2	-2	2	-8	-25	-27	-11	-3	-55
CZ0531	Chrudim	27.4	28.7	28.2	21.4	18.7	15.1	13.6	13.2	5	-1	-24	-13	-19	-10	-3	-54
CZ0532	Pardubice	28.0	27.2	27.9	22.2	19.1	14.9	13.5	12.5	-3	3	-20	-14	-22	-9	-7	-54
CZ0533	Svitavy	25.2	27.2	30.5	25.8	21.6	18.6	14.8	13.8	8	12	-15	-17	-14	-20	-6	-49
CZ0534	Ústí nad Orlicí	25.3	27.8	27.9	24.5	20.0	16.1	14.1	13.9	10	0	-12	-18	-20	-12	-1	-50
CZ0631	Havlíčkův Brod	26.1	29.2	28.0	23.9	17.2	16.5	13.9	14.6	12	-4	-14	-28	-4	-15	4	-50
CZ0632	Jihlava	30.7	30.3	28.4	23.5	18.8	15.7	13.3	13.2	-1	-6	-17	-20	-16	-15	-1	-56
CZ0633	Pelhřimov	29.2	28.8	28.6	26.8	17.5	15.2	15.4	14.9	-1	-1	-7	-35	-14	1	-3	-48
CZ0634	Třebíč	28.8	27.4	27.5	21.0	17.3	14.6	13.0	12.0	-5	0	-24	-18	-15	-11	-7	-56
CZ0635	Žďár nad Sázavou	28.4	30.6	29.3	22.0	18.6	15.4	13.9	13.9	8	-4	-25	-15	-17	-9	0	-55

Code LAU	District name	1869	1881	1890	1900	1910	1921	1930	1937	C1	C2	C3	C4	C5	C6	C7	C8
CZ0641	Blansko	24.7	26.4	29.9	23.4	19.4	15.8	13.2	12.0	7	13	-22	-17	-18	-17	-9	-55
CZ0642	Brno-město	38.1	34.4	35.0	24.8	20.4	16.9	10.7	10.6	-10	2	-29	-18	-17	-37	0	-69
CZ0643	Brno-venkov	28.1	30.4	31.8	23.2	18.7	14.3	11.9	10.7	8	5	-27	-20	-24	-17	-10	-65
CZ0644	Břeclav	28.7	31.4	30.0	25.2	18.8	16.9	13.4	12.8	10	-4	-16	-25	-10	-21	-5	-59
CZ0645	Hodonín	31.4	33.6	30.8	26.1	18.7	16.3	14.6	12.5	7	-8	-15	-28	-13	-10	-15	-63
CZ0646	Vyškov	28.3	29.8	30.6	24.0	18.9	15.6	13.0	12.8	5	3	-22	-21	-17	-16	-2	-57
CZ0647	Znojmo	27.4	25.5	25.7	23.4	18.3	16.9	13.6	12.4	-7	1	-9	-22	-8	-19	-9	-51
CZ0711	Jeseník	24.8	27.9	26.6	26.2	22.6	18.9	14.4	12.8	13	-4	-2	-14	-16	-24	-11	-54
CZ0712	Olomouc	28.6	28.7	30.3	25.5	19.7	17.6	13.1	12.4	0	6	-16	-23	-11	-26	-5	-57
CZ0713	Prostějov	27.8	30.3	30.9	24.7	19.4	16.6	14.4	13.0	9	2	-20	-21	-15	-13	-9	-57
CZ0714	Přerov	26.9	32.6	28.6	25.1	21.7	16.1	14.5	12.8	21	-12	-12	-13	-26	-10	-11	-61
CZ0715	Šumperk	25.5	30.0	29.6	26.8	23.0	18.2	13.7	13.5	18	-1	-10	-14	-21	-25	-1	-55
CZ0721	Kroměříž	26.6	35.0	29.1	24.6	20.9	18.2	13.8	13.0	32	-17	-15	-15	-13	-24	-6	-63
CZ0722	Uherské Hradiště	29.1	36.8	34.2	26.4	20.0	16.8	13.9	13.0	27	-7	-23	-24	-16	-17	-7	-65
CZ0723	Vsetín	32.8	33.1	33.2	28.8	18.6	18.1	16.1	14.3	1	0	-13	-35	-3	-11	-12	-57
CZ0724	Zlín	28.4	37.4	32.8	26.1	20.7	16.5	13.3	10.9	32	-12	-21	-20	-21	-19	-18	-71
CZ0801	Bruntál	26.8	27.0	29.7	26.7	20.6	18.4	14.2	13.7	1	10	-10	-23	-11	-23	-4	-49
CZ0802	Frýdek-Místek	30.7	29.1	31.9	26.4	21.1	18.0	12.9	11.3	-5	10	-17	-20	-14	-29	-12	-61
CZ0803	Karviná	30.1	28.4	29.9	26.6	19.2	14.8	10.7	10.0	-6	5	-11	-28	-23	-27	-7	-65
CZ0804	Nový Jičín	28.2	28.4	28.3	23.9	20.4	15.4	13.4	12.4	1	0	-15	-15	-25	-13	-8	-57
CZ0805	Opava	30.2	29.2	28.4	24.5	21.8	17.8	13.4	13.1	-4	-3	-14	-11	-19	-24	-2	-55
CZ0806	Ostrava-město	30.7	29.2	30.1	26.9	20.3	13.4	10.5	9.6	-5	3	-11	-25	-34	-21	-9	-67

Notes: C1 – Change between 1869-1881(%), C2 – Change between 1881 - 1890 (%), C3 – Change between 1890 - 1900 (%), C4 – Change between 1900 - 1910 (%), C5 – Change between 1910 - 1921 (%), C6 – Change between 1921 - 1930 (%), C7 – Change between 1930 - 1937 (%), C8 – Change between 1869 - 1937 (%).

Source: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

Appendix 6.2 – Change in infant mortality rates 1869–1937

Code LAU	District name	1881	1890	1900	1910	1921	1930	1937	C1	C2	C3	C4	C5	C6	C7
CZ0100	Praha	233	211	175	165	150	97	92	-9	-17	-6	-9	-36	-5	-60
CZ0201	Benešov	295	287	260	188	173	154	127	-3	-9	-28	-8	-11	-18	-57
CZ0202	Beroun	246	251	218	190	171	125	89	2	-13	-13	-10	-27	-29	-64
CZ0203	Kladno	272	285	234	191	187	142	108	5	-18	-19	-2	-24	-24	-60
CZ0204	Kolín	320	311	246	181	152	124	110	-3	-21	-26	-16	-18	-11	-66
CZ0205	Kutná Hora	296	317	271	188	124	118	121	7	-15	-31	-34	-5	3	-59
CZ0206	Mělník	271	277	258	184	170	121	99	2	-7	-29	-8	-29	-18	-63
CZ0207	Mladá Boleslav	275	283	244	170	177	132	104	3	-14	-30	4	-25	-21	-62
CZ0208	Nymburk	316	284	247	173	166	123	106	-10	-13	-30	-4	-26	-14	-67
CZ0209	Praha-východ	299	278	223	185	154	137	101	-7	-20	-17	-16	-11	-26	-66
CZ020A	Praha-západ	276	258	221	183	172	133	104	-7	-14	-17	-6	-23	-22	-62
CZ020B	Příbram	241	244	217	207	157	127	127	1	-11	-5	-24	-19	0	-47
CZ020C	Rakovník	263	304	216	174	175	120	117	15	-29	-19	0	-31	-3	-56
CZ0311	České Budějovice	243	254	236	207	176	126	110	4	-7	-12	-15	-28	-13	-55
CZ0312	Český Krumlov	253	256	230	204	208	180	122	1	-10	-11	2	-13	-32	-52
CZ0313	Jindřichův Hradec	256	255	224	180	134	117	115	0	-12	-20	-25	-13	-1	-55
CZ0314	Písek	222	267	215	179	140	135	97	20	-20	-17	-22	-3	-28	-56
CZ0315	Prachatice	262	239	227	210	193	154	151	-9	-5	-8	-8	-20	-2	-43
CZ0316	Strakonice	245	232	196	171	179	137	125	-5	-15	-13	5	-24	-9	-49
CZ0317	Tábor	313	359	324	195	153	138	131	15	-10	-40	-21	-10	-5	-58
CZ0321	Domažlice	297	290	228	198	198	161	116	-2	-21	-13	0	-19	-28	-61
CZ0322	Klatovy	264	248	201	195	175	134	119	-6	-19	-3	-10	-24	-11	-55
CZ0323	Plzeň-město	239	232	204	188	151	118	88	-3	-12	-8	-20	-21	-25	-63
CZ0324	Plzeň-jih	245	242	200	181	171	128	105	-1	-18	-9	-6	-25	-18	-57
CZ0325	Plzeň-sever	264	261	198	183	174	127	98	-1	-24	-8	-5	-27	-23	-63
CZ0326	Rokycany	239	237	190	162	135	123	99	-1	-20	-15	-17	-9	-20	-59
CZ0327	Tachov	262	242	213	186	182	133	102	-8	-12	-12	-2	-27	-23	-61

Code LAU	District name	1881	1890	1900	1910	1921	1930	1937	C1	C2	C3	C4	C5	C6	C7
CZ0411	Cheb	266	234	201	187	159	118	85	-12	-14	-7	-15	-25	-28	-68
CZ0412	Karlovy Vary	269	287	260	223	209	144	91	7	-9	-14	-7	-31	-37	-66
CZ0413	Sokolov	259	270	252	200	199	129	92	5	-7	-21	-1	-35	-29	-65
CZ0421	Děčín	362	369	291	210	186	100	82	2	-21	-28	-12	-46	-18	-77
CZ0422	Chomutov	295	338	268	228	215	157	107	15	-21	-15	-6	-27	-32	-64
CZ0423	Litoměřice	286	317	265	207	191	131	90	11	-16	-22	-8	-31	-32	-68
CZ0424	Louny	313	348	270	213	195	162	131	11	-22	-21	-8	-17	-19	-58
CZ0425	Most	347	333	285	220	211	146	138	-4	-14	-23	-4	-31	-6	-60
CZ0426	Teplice	348	341	277	213	217	128	103	-2	-19	-23	2	-41	-20	-70
CZ0427	Ústí nad Labem	341	330	260	226	188	110	81	-3	-21	-13	-17	-42	-26	-76
CZ0511	Česká Lípa	325	348	300	230	183	126	102	7	-14	-23	-20	-31	-19	-68
CZ0512	Jablonec nad Nisou	337	340	286	189	128	83	69	1	-16	-34	-32	-35	-17	-79
CZ0513	Liberec	362	350	291	210	163	99	72	-3	-17	-28	-22	-40	-27	-80
CZ0514	Semily	259	259	265	175	140	100	80	0	2	-34	-20	-28	-20	-69
CZ0521	Hradec Králové	266	262	220	168	145	101	91	-2	-16	-24	-14	-30	-11	-66
CZ0522	Jičín	264	266	246	187	155	122	102	0	-7	-24	-17	-21	-17	-62
CZ0523	Náchod	293	290	262	199	158	117	79	-1	-10	-24	-21	-26	-33	-73
CZ0524	Rychnov nad Kněžnou	223	246	205	143	143	99	76	10	-17	-30	0	-31	-23	-66
CZ0525	Trutnov	306	326	300	204	175	110	84	6	-8	-32	-14	-37	-24	-72
CZ0531	Chrudim	240	245	192	143	133	109	94	2	-22	-25	-7	-18	-14	-61
CZ0532	Pardubice	243	256	211	162	146	120	98	5	-18	-23	-10	-18	-18	-60
CZ0533	Svitavy	242	269	278	221	175	115	94	11	3	-20	-21	-35	-18	-61
CZ0534	Ústí nad Orlicí	239	252	234	184	145	110	87	5	-7	-21	-21	-24	-21	-64
CZ0631	Havlíčkův Brod	239	268	232	154	149	115	116	12	-14	-34	-3	-23	1	-52
CZ0632	Jihlava	270	259	248	169	140	116	98	-4	-4	-32	-18	-17	-16	-64
CZ0633	Pelhřimov	245	271	295	193	140	146	120	10	9	-35	-27	4	-18	-51
CZ0634	Třebíč	227	245	194	147	126	107	89	8	-21	-24	-15	-15	-17	-61
CZ0635	Žďár nad Sázavou	267	245	184	171	144	115	96	-8	-25	-7	-15	-21	-16	-64

Code LAU	District name	1881	1890	1900	1910	1921	1930	1937	C1	C2	C3	C4	C5	C6	C7
CZ0641	Blansko	212	265	220	184	145	100	84	25	-17	-16	-21	-31	-16	-60
CZ0642	Brno-město	288	292	211	149	124	96	68	1	-28	-29	-17	-23	-29	-76
CZ0643	Brno-venkov	275	306	246	194	153	108	83	11	-20	-21	-21	-29	-23	-70
CZ0644	Břeclav	265	277	245	179	190	118	106	5	-12	-27	6	-38	-10	-60
CZ0645	Hodonín	277	275	242	165	164	127	98	-1	-12	-32	0	-23	-23	-65
CZ0646	Vyškov	274	300	233	169	174	95	84	9	-22	-27	3	-45	-12	-69
CZ0647	Znojmo	239	262	245	185	182	124	103	9	-6	-25	-2	-32	-17	-57
CZ0711	Jeseník	235	247	216	191	185	116	82	5	-13	-12	-3	-37	-30	-65
CZ0712	Olomouc	275	303	250	180	173	114	87	11	-18	-28	-4	-34	-23	-68
CZ0713	Prostějov	267	299	240	181	162	117	106	12	-20	-25	-11	-28	-10	-60
CZ0714	Přerov	256	274	218	186	160	144	85	7	-20	-15	-14	-10	-41	-67
CZ0715	Šumperk	275	292	279	228	170	124	92	6	-4	-18	-26	-27	-26	-67
CZ0721	Kroměříž	288	257	240	169	153	105	103	-11	-7	-29	-10	-32	-1	-64
CZ0722	Uherské Hradiště	281	294	231	176	171	128	109	4	-21	-24	-3	-25	-15	-61
CZ0723	Vsetín	223	253	233	197	168	144	133	13	-8	-16	-15	-14	-8	-41
CZ0724	Zlín	271	277	232	187	166	123	101	2	-16	-20	-11	-26	-18	-63
CZ0801	Bruntál	253	284	269	219	170	119	99	12	-5	-19	-22	-30	-17	-61
CZ0802	Frýdek-Místek	215	261	232	207	167	117	102	21	-11	-11	-19	-30	-12	-53
CZ0803	Karviná	205	227	200	197	177	116	102	10	-12	-2	-10	-34	-13	-50
CZ0804	Nový Jičín	216	263	206	184	145	125	85	22	-22	-11	-21	-14	-32	-61
CZ0805	Opava	230	250	235	201	177	131	100	9	-6	-15	-12	-26	-24	-57
CZ0806	Ostrava-město	216	251	209	193	146	107	90	16	-17	-8	-24	-27	-16	-59

Notes: C1 – Change between 1881 - 1890 (%), C2 – Change between 1890 - 1900 (%), C3 – Change between 1900 - 1910 (%), C4 – Change between 1910 - 1921 (%), C5 – Change between 1921 - 1930 (%), C6 – Change between 1930 - 1937 (%), C7 – Change between 1869 - 1937 (%).

Source: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

Appendix 6.3 – Change in crude birth rates 1869–1937

Code LAU	District name	1869	1881	1890	1900	1910	1921	1930	1937	C1	C2	C3	C4	C5	C6	C7	C8
CZ0100	Praha	42.1	41.2	34.8	31.5	25.0	19.1	13.1	10.3	-1	-15	-10	-21	-24	-31	-22	-76
CZ0201	Benešov	39.2	36.4	33.0	31.3	26.4	25.0	21.6	17.2	-3	-10	-5	-16	-5	-13	-21	-56
CZ0202	Beroun	40.9	38.4	36.4	33.6	30.8	25.4	20.7	13.6	-2	-5	-8	-8	-18	-19	-34	-67
CZ0203	Kladno	41.7	42.0	39.2	40.5	32.1	25.8	19.5	12.5	0	-7	3	-21	-20	-25	-36	-70
CZ0204	Kolín	42.1	41.2	35.5	33.0	28.1	22.5	19.6	13.8	-1	-14	-7	-15	-20	-13	-30	-67
CZ0205	Kutná Hora	41.1	38.5	34.5	34.5	27.2	22.4	18.3	15.2	-3	-10	0	-21	-18	-18	-17	-63
CZ0206	Mělník	37.1	39.0	32.1	34.2	29.7	25.2	20.7	14.5	2	-18	7	-13	-15	-18	-30	-61
CZ0207	Mladá Boleslav	38.0	35.7	31.3	32.8	28.2	24.0	20.2	12.9	-2	-12	5	-14	-15	-16	-36	-66
CZ0208	Nymburk	42.1	40.5	36.0	33.8	29.5	23.3	20.0	13.9	-2	-11	-6	-13	-21	-14	-31	-67
CZ0209	Praha-východ	39.2	41.4	26.9	31.6	24.1	23.8	23.4	14.0	2	-35	18	-24	-1	-1	-40	-64
CZ020A	Praha-západ	41.1	41.7	37.7	28.9	25.3	26.1	24.1	13.6	1	-10	-23	-13	3	-8	-43	-67
CZ020B	Příbram	38.1	37.5	34.3	33.6	27.1	23.7	20.8	15.8	-1	-8	-2	-19	-12	-12	-24	-59
CZ020C	Rakovník	40.1	40.5	36.6	37.2	30.6	24.8	21.8	14.6	0	-10	2	-18	-19	-12	-33	-64
CZ0311	České Budějovice	34.5	33.6	32.7	33.8	28.8	24.6	18.2	14.1	-1	-3	3	-15	-15	-26	-22	-59
CZ0312	Český Krumlov	31.9	31.8	31.2	34.4	29.3	28.8	25.0	20.1	0	-2	10	-15	-2	-13	-20	-37
CZ0313	Jindřichův Hradec	34.7	31.6	31.6	30.8	26.5	24.6	19.8	15.8	-3	0	-3	-14	-7	-20	-20	-54
CZ0314	Písek	35.9	34.7	30.5	32.9	28.0	23.0	18.4	16.5	-1	-12	8	-15	-18	-20	-10	-54
CZ0315	Prachatice	34.5	33.7	33.1	33.7	29.4	30.7	24.1	21.2	-1	-2	2	-13	4	-22	-12	-39
CZ0316	Strakonice	37.8	36.8	32.7	33.8	28.4	23.4	20.7	16.5	-1	-11	3	-16	-18	-11	-20	-56
CZ0317	Tábor	35.9	34.5	31.6	32.8	27.9	23.7	20.5	16.5	-1	-8	4	-15	-15	-14	-19	-54
CZ0321	Domažlice	40.5	40.7	35.4	36.9	32.6	29.1	21.9	16.5	0	-13	4	-12	-11	-25	-25	-59
CZ0322	Klatovy	39.3	38.1	35.4	36.1	32.2	28.2	22.1	16.5	-1	-7	2	-11	-13	-21	-25	-58
CZ0323	Plzeň-město	41.5	40.7	37.5	32.3	27.1	20.1	16.8	11.6	-1	-8	-14	-16	-26	-17	-31	-72
CZ0324	Plzeň-jih	40.5	40.8	36.2	33.6	28.8	26.0	22.0	15.1	0	-11	-7	-14	-10	-16	-31	-63
CZ0325	Plzeň-sever	40.0	39.6	36.1	33.0	28.7	22.3	19.1	13.7	0	-9	-8	-13	-22	-14	-28	-66
CZ0326	Rokycany	41.1	39.2	36.7	40.0	28.9	24.6	21.1	14.3	-2	-7	9	-28	-15	-14	-32	-65
CZ0327	Tachov	37.1	37.7	34.4	34.1	29.1	26.8	22.2	17.2	1	-9	-1	-15	-8	-17	-23	-54

Code LAU	District name	1869	1881	1890	1900	1910	1921	1930	1937	C1	C2	C3	C4	C5	C6	C7	C8
CZ0411	Cheb	37.3	35.1	34.8	34.3	27.2	24.6	18.6	12.6	-2	-1	-2	-20	-10	-24	-33	-66
CZ0412	Karlovy Vary	40.6	40.0	39.7	39.6	27.3	28.9	19.3	12.1	-1	-1	0	-31	6	-33	-37	-70
CZ0413	Sokolov	42.0	40.9	42.5	41.8	32.3	34.1	20.2	13.2	-1	4	-2	-23	6	-41	-35	-69
CZ0421	Děčín	34.6	32.9	33.4	32.9	23.2	23.2	15.0	11.5	-2	1	-1	-30	0	-35	-23	-67
CZ0422	Chomutov	40.2	40.5	38.9	39.1	30.4	30.0	19.9	13.0	0	-4	1	-22	-1	-34	-35	-68
CZ0423	Litoměřice	34.0	34.7	31.9	33.3	28.6	24.7	20.1	14.0	1	-8	5	-14	-14	-18	-31	-59
CZ0424	Louny	39.0	40.5	37.4	41.9	29.6	26.5	21.2	14.7	1	-7	12	-29	-10	-20	-30	-62
CZ0425	Most	38.3	43.1	43.4	46.6	36.3	31.6	18.1	11.7	5	1	7	-22	-13	-43	-35	-69
CZ0426	Teplice	37.2	42.7	41.4	33.4	31.8	28.2	17.2	11.1	5	-3	-19	-5	-11	-39	-35	-70
CZ0427	Ústí nad Labem	36.6	38.4	40.9	38.6	27.6	24.0	15.3	11.2	2	6	-6	-29	-13	-36	-27	-69
CZ0511	Česká Lípa	35.9	33.4	31.6	31.2	26.5	25.8	18.5	13.3	-2	-5	-1	-15	-3	-28	-28	-63
CZ0512	Jablonec nad Nisou	44.9	37.0	37.6	34.3	23.9	20.6	13.8	9.6	-8	1	-9	-30	-14	-33	-31	-79
CZ0513	Liberec	41.2	35.5	35.0	34.9	23.4	19.2	13.2	9.9	-6	-2	0	-33	-18	-31	-25	-76
CZ0514	Semily	40.6	33.6	32.7	33.2	28.1	21.7	18.2	12.8	-7	-3	2	-15	-23	-16	-29	-68
CZ0521	Hradec Králové	38.3	35.2	32.4	31.5	24.7	22.2	19.0	12.2	-3	-8	-3	-22	-10	-15	-35	-68
CZ0522	Jičín	37.9	35.3	31.8	31.9	23.6	21.0	18.2	13.1	-3	-10	0	-26	-11	-14	-28	-65
CZ0523	Náchod	40.0	32.6	32.5	32.3	28.0	21.3	17.0	12.2	-7	0	-1	-13	-24	-20	-28	-69
CZ0524	Rychnov nad Kněžnou	38.8	31.4	31.6	26.0	26.8	22.4	19.1	14.4	-7	1	-18	3	-16	-15	-25	-63
CZ0525	Trutnov	40.6	34.5	34.1	35.1	28.6	22.7	16.9	13.6	-6	-1	3	-19	-20	-26	-19	-66
CZ0531	Chrudim	36.4	34.5	33.9	32.5	28.0	24.8	20.2	14.3	-2	-2	-4	-14	-12	-18	-29	-61
CZ0532	Pardubice	39.9	36.6	36.1	33.0	29.1	22.1	19.3	14.0	-3	-1	-9	-12	-24	-13	-27	-65
CZ0533	Svitavy	37.1	32.6	33.2	33.7	28.8	25.3	21.1	17.5	-5	2	1	-15	-12	-16	-17	-53
CZ0534	Ústí nad Orlicí	37.2	33.0	32.6	32.4	28.0	24.7	20.1	14.8	-4	-1	0	-14	-12	-19	-26	-60
CZ0631	Havlíčkův Brod	38.1	36.7	34.6	34.8	27.8	26.6	21.4	17.2	-1	-6	1	-20	-4	-19	-20	-55
CZ0632	Jihlava	36.1	34.2	33.7	31.5	27.3	27.0	20.7	15.9	-2	-1	-7	-13	-1	-23	-23	-56
CZ0633	Pelhřimov	37.4	36.4	35.4	34.4	25.8	24.9	21.8	18.2	-1	-3	-3	-25	-4	-12	-17	-51
CZ0634	Třebíč	39.3	36.5	35.1	35.6	30.2	28.1	22.3	18.2	-3	-4	1	-15	-7	-20	-18	-54
CZ0635	Žďár nad Sázavou	37.5	35.0	33.3	34.6	29.8	26.8	22.5	19.3	-2	-5	4	-14	-10	-16	-14	-49

Code LAU	District name	1869	1881	1890	1900	1910	1921	1930	1937	C1	C2	C3	C4	C5	C6	C7	C8
CZ0641	Blansko	39.0	36.0	35.1	37.1	32.9	29.0	22.5	17.7	-3	-2	6	-11	-12	-22	-22	-55
CZ0642	Brno-město	43.8	33.6	32.8	32.2	27.2	22.8	11.8	10.4	-10	-2	-2	-15	-16	-48	-11	-76
CZ0643	Brno-venkov	43.9	40.8	37.7	37.5	32.7	28.1	21.1	14.9	-3	-8	0	-13	-14	-25	-29	-66
CZ0644	Břeclav	43.1	41.6	37.3	37.4	33.0	31.0	22.2	17.7	-2	-10	0	-12	-6	-28	-20	-59
CZ0645	Hodonín	46.8	43.3	38.9	39.9	34.2	30.2	23.6	19.2	-4	-10	2	-14	-12	-22	-19	-59
CZ0646	Vyškov	42.3	40.4	35.6	37.8	33.6	26.9	22.3	18.3	-2	-12	6	-11	-20	-17	-18	-57
CZ0647	Znojmo	36.7	35.5	33.5	34.2	28.5	28.3	22.3	16.6	-1	-6	2	-17	-1	-21	-26	-55
CZ0711	Jeseník	32.8	33.4	32.6	34.7	29.9	28.9	23.9	17.4	1	-2	6	-14	-3	-17	-27	-47
CZ0712	Olomouc	39.2	33.5	33.2	33.9	28.7	26.3	19.3	14.3	-6	-1	2	-15	-9	-26	-26	-63
CZ0713	Prostějov	40.2	38.3	35.2	36.5	31.2	25.4	20.6	16.5	-2	-8	4	-14	-19	-19	-20	-59
CZ0714	Přerov	37.5	37.3	33.3	34.9	33.1	27.3	21.1	15.7	0	-11	5	-5	-18	-23	-26	-58
CZ0715	Šumperk	37.8	32.9	33.1	34.2	29.4	27.9	19.8	15.6	-5	1	3	-14	-5	-29	-21	-59
CZ0721	Kroměříž	38.5	36.5	34.0	34.4	31.4	26.9	21.5	16.7	-2	-7	1	-9	-14	-20	-22	-57
CZ0722	Uherské Hradiště	41.6	40.1	37.3	40.6	35.2	32.8	25.9	22.1	-1	-7	9	-13	-7	-21	-15	-47
CZ0723	Vsetín	42.9	37.9	38.5	41.4	29.8	35.7	29.7	23.8	-5	1	8	-28	20	-17	-20	-44
CZ0724	Zlín	40.2	38.7	36.8	39.7	35.3	31.9	28.0	23.7	-1	-5	8	-11	-10	-12	-15	-41
CZ0801	Bruntál	37.7	33.4	33.1	33.9	28.0	28.6	20.6	15.8	-4	-1	2	-18	2	-28	-23	-58
CZ0802	Frýdek-Místek	41.9	35.7	40.6	34.9	32.1	33.6	25.1	15.8	-6	14	-14	-8	5	-25	-37	-62
CZ0803	Karviná	45.3	39.6	45.3	51.6	31.9	32.6	21.7	12.3	-6	14	14	-38	2	-34	-43	-73
CZ0804	Nový Jičín	38.0	34.2	34.5	35.3	31.3	27.1	21.2	16.4	-4	1	2	-11	-13	-22	-22	-57
CZ0805	Opava	40.4	35.6	37.1	38.2	33.4	31.1	22.9	17.7	-5	4	3	-13	-7	-26	-23	-56
CZ0806	Ostrava-město	41.7	36.8	40.5	47.7	35.8	27.5	16.7	11.0	-5	10	18	-25	-23	-39	-34	-74

Notes: C1 – Change between 1869-1881(%), C2 – Change between 1881 - 1890 (%), C3 – Change between 1890 - 1900 (%), C4 – Change between 1900 - 1910 (%), C5 – Change between 1910 - 1921 (%), C6 – Change between 1921 - 1930 (%), C7 – Change between 1930 - 1937 (%), C8 – Change between 1869 - 1937 (%).

Source: Author's calculations based on data from Austrian Statistics, CZSO and Historický GIS.

Appendix 6.4 – Detailed data, classification by the onset and duration of demographic transition

LAU code	District name	Onset	End	Duration (years)	Type
CZ0100	Praha	1898	1923	25	2
CZ0201	Benešov	1889	1931	42	1
CZ0202	Beroun	1903	1931	28	3
CZ0203	Kladno	1907	1927	20	4
CZ0204	Kolín	1896	1929	33	1
CZ0205	Kutná Hora	1895	1926	31	1
CZ0206	Mělník	1897	1931	34	1
CZ0207	Mladá Boleslav	1891	1931	40	1
CZ0208	Nymburk	1899	1931	32	1
CZ0209	Praha-východ	1898	1934	36	1
CZ020A	Praha-západ	1899	1934	35	1
CZ020B	Příbram	1896	1930	34	1
CZ020C	Rakovník	1901	1932	31	3
CZ0311	České Budějovice	1896	1930	34	1
CZ0312	Český Krumlov	1896	1937	41	1
CZ0313	Jindřichův Hradec	1893	1932	39	1
CZ0314	Písek	1886	1927	41	1
CZ0315	Prachatice	1896	1937	41	1
CZ0316	Strakonice	1893	1930	37	1
CZ0317	Tábor	1891	1931	40	1
CZ0321	Domažlice	1906	1934	28	3
CZ0322	Klatovy	1904	1935	31	3
CZ0323	Plzeň-město	1902	1925	23	4
CZ0324	Plzeň-jih	1903	1933	30	3
CZ0325	Plzeň-sever	1902	1931	29	3
CZ0326	Rokycany	1904	1932	28	3
CZ0327	Tachov	1893	1934	41	1
CZ0411	Cheb	1899	1931	32	1
CZ0412	Karlovy Vary	1907	1927	20	4
CZ0413	Sokolov	1911	1932	21	4
CZ0421	Děčín	1894	1924	30	1
CZ0422	Chomutov	1907	1931	24	4
CZ0423	Litoměřice	1886	1931	45	1
CZ0424	Louny	1906	1931	25	4
CZ0425	Most	1910	1931	21	4
CZ0426	Teplice	1908	1930	22	4
CZ0427	Ústí nad Labem	1906	1926	20	4
CZ0511	Česká Lípa	1884	1924	40	1
CZ0512	Jablonec nad Nisou	1898	1924	26	1
CZ0513	Liberec	1900	1910	10	2
CZ0514	Semily	1896	1926	30	1
CZ0521	Hradec Králové	1885	1927	42	1
CZ0522	Jičín	1885	1924	39	1
CZ0523	Náchod	1896	1912	16	2

LAU code	District name	Onset	End	Duration (years)	Type
CZ0524	Rychnov nad Kněžnou	1882	1926	44	1
CZ0525	Trutnov	1900	1925	25	2
CZ0531	Chrudim	1895	1933	38	1
CZ0532	Pardubice	1896	1931	35	1
CZ0533	Svitavy	1893	1935	42	1
CZ0534	Ústí nad Orlicí	1896	1931	35	1
CZ0631	Havlíčkův Brod	1900	1934	34	1
CZ0632	Jihlava	1895	1932	37	1
CZ0633	Pelhřimov	1896	1933	37	1
CZ0634	Třebíč	1902	1937	35	3
CZ0635	Žďár nad Sázavou	1902	1937	35	3
CZ0641	Blansko	1908	1937	29	3
CZ0642	Brno-město	1897	1924	27	1
CZ0643	Brno-venkov	1908	1935	27	3
CZ0644	Břeclav	1908	1935	27	3
CZ0645	Hodonín	1909	1937	28	3
CZ0646	Vyškov	1909	1935	26	3
CZ0647	Znojmo	1902	1935	33	3
CZ0711	Jeseník	1902	1935	33	3
CZ0712	Olomouc	1902	1932	30	3
CZ0713	Prostějov	1907	1933	26	3
CZ0714	Přerov	1902	1933	31	3
CZ0715	Šumperk	1902	1931	29	3
CZ0721	Kroměříž	1902	1933	31	3
CZ0722	Uherské Hradiště	1910	1937	27	3
CZ0723	Vsetín	1911	1937	26	3
CZ0724	Zlín	1910	1937	27	3
CZ0801	Bruntál	1901	1931	30	3
CZ0802	Frýdek-Místek	1911	1935	24	4
CZ0803	Karviná	1913	1934	21	4
CZ0804	Nový Jičín	1904	1933	29	3
CZ0805	Opava	1909	1935	26	3
CZ0806	Ostrava-město	1910	1932	22	4

Source: Author’s calculations based on data from Austrian Statistics, CZSO and Historický GIS.

Appendix 7.1 – Results of the classification of districts by onset and speed of ageing

LAU code	District name	Ageing	P65+	Onset	Aged	Duration	Speed	Type
CZ0100	Praha	1950	8	late	1970	20	0.34	4
CZ0201	Benešov	1950	11	early	1970	20	0.21	2
CZ0202	Beroun	1950	10	early	1970	20	0.23	2
CZ0203	Kladno	1950	10	early	2001	51	0.09	1
CZ0204	Kolín	1950	11	early	1970	20	0.24	2
CZ0205	Kutná Hora	1950	12	early	1970	20	0.20	2
CZ0206	Mělník	1950	10	early	2011	61	0.07	1
CZ0207	Mladá Boleslav	1950	11	early	2011	61	0.06	1
CZ0208	Nymburk	1950	11	early	1970	20	0.25	2
CZ0209	Praha-východ	1950	9	late	2013	63	0.07	3
CZ020A	Praha-západ	1950	9	late	2013	63	0.08	3
CZ020B	Příbram	1950	12	early	2001	51	0.04	1
CZ020C	Rakovník	1950	10	early	1970	20	0.28	2
CZ0311	České Budějovice	1950	10	early	2011	61	0.08	1
CZ0312	Český Krumlov	1970	8	late	2012	42	0.15	3
CZ0313	Jindřichův Hradec	1950	11	early	2001	51	0.06	1
CZ0314	Písek	1950	12	early	1970	20	0.15	1
CZ0315	Prachatice	1950	10	early	2011	61	0.09	1
CZ0316	Strakonice	1950	11	early	2001	51	0.06	1
CZ0317	Tábor	1950	11	early	2001	51	0.08	1
CZ0321	Domažlice	1950	8	late	2011	61	0.11	3
CZ0322	Klatovy	1950	10	early	1970	20	0.18	2
CZ0323	Plzeň-město	1950	9	late	2001	51	0.13	3
CZ0324	Plzeň-jih	1950	10	early	1970	20	0.22	2
CZ0325	Plzeň-sever	1950	9	late	2001	51	0.10	3
CZ0326	Rokycany	1950	11	early	1970	20	0.23	2
CZ0327	Tachov	1980	8	late	2012	32	0.18	3
CZ0411	Cheb	1980	9	late	2011	31	0.19	4
CZ0412	Karlovy Vary	1980	9	late	2011	31	0.23	4
CZ0413	Sokolov	1980	7	late	2011	31	0.24	4
CZ0421	Děčín	1970	8	late	2011	41	0.16	4
CZ0422	Chomutov	1970	7	late	2012	42	0.18	4
CZ0423	Litoměřice	1950	8	late	2011	61	0.12	3
CZ0424	Louny	1950	8	late	2011	61	0.10	3
CZ0425	Most	1970	7	late	2011	41	0.18	4
CZ0426	Teplice	1961	7	late	2011	50	0.16	4
CZ0427	Ústí nad Labem	1970	8	late	2011	41	0.17	4
CZ0511	Česká Lípa	1970	9	late	2012	42	0.14	3
CZ0512	Jablonec nad Nisou	1950	8	late	2011	61	0.13	3
CZ0513	Liberec	1961	7	late	2011	50	0.15	3
CZ0514	Semily	1950	13	early	1961	11	0.13	1
CZ0521	Hradec Králové	1950	10	early	2001	51	0.10	1

LAU code	District name	Ageing	P65+	Onset	Aged	Duration	Speed	Type
CZ0522	Jičín	1950	13	early	1961	11	0.15	1
CZ0523	Náchod	1950	10	early	2001	51	0.08	1
CZ0524	Rychnov nad Kněžnou	1950	11	early	2001	51	0.07	1
CZ0525	Trutnov	1961	8	late	2011	50	0.18	4
CZ0531	Chrudim	1950	11	early	2001	51	0.07	1
CZ0532	Pardubice	1950	10	early	2001	51	0.10	1
CZ0533	Svitavy	1950	8	late	2011	61	0.12	3
CZ0534	Ústí nad Orlicí	1950	9	late	2011	61	0.11	3
CZ0631	Havlíčkův Brod	1950	10	early	2001	51	0.08	1
CZ0632	Jihlava	1950	9	late	2001	51	0.09	3
CZ0633	Pelhřimov	1950	11	early	1970	20	0.16	2
CZ0634	Třebíč	1950	11	early	2001	51	0.06	1
CZ0635	Žďár nad Sázavou	1950	11	early	2011	61	0.09	1
CZ0641	Blansko	1950	10	early	2001	51	0.08	1
CZ0642	Brno-město	1950	7	late	1980	30	0.24	4
CZ0643	Brno-venkov	1950	9	late	1980	30	0.17	4
CZ0644	Břeclav	1950	8	late	2011	61	0.12	3
CZ0645	Hodonín	1950	10	early	2011	61	0.10	1
CZ0646	Vyškov	1950	11	early	1970	20	0.19	2
CZ0647	Znojmo	1950	7	late	2011	61	0.12	3
CZ0711	Jeseník	1961	7	late	2011	50	0.18	4
CZ0712	Olomouc	1950	8	late	2001	51	0.12	3
CZ0713	Prostějov	1950	10	early	1970	20	0.22	2
CZ0714	Přerov	1950	9	late	2001	51	0.09	3
CZ0715	Šumperk	1950	7	late	2011	61	0.15	3
CZ0721	Kroměříž	1950	10	early	2001	51	0.08	1
CZ0722	Uherské Hradiště	1950	9	late	1980	30	0.16	4
CZ0723	Vsetín	1950	7	late	2011	61	0.15	3
CZ0724	Zlín	1961	7	late	2001	40	0.19	4
CZ0801	Bruntál	1980	8	late	2011	31	0.21	4
CZ0802	Frýdek-Místek	1950	8	late	2011	61	0.13	3
CZ0803	Karviná	1950	7	late	2011	61	0.15	3
CZ0804	Nový Jičín	1950	7	late	2011	61	0.14	3
CZ0805	Opava	1950	7	late	2011	61	0.14	3
CZ0806	Ostrava-město	1961	7	late	2011	50	0.18	4

Note: P65+ means the proportion of people aged 65+ at the onset of ageing.

Source: Author's calculations based on data from CZSO and Historický GIS.