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Demographic change and unemployment in East Germany: how close are the ties?

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Demographic change and unemployment in East Germany: how close are the ties?

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– Preliminary Version - do not quote –

Abstract

We analyze the relationship between population aging and unemployment change in East Germany for the period from 1993 to 2012. Using data from official population and labor-market statistics, we calculate both a direct and an indirect effect of aging on unemployment. For the direct effect we decompose the East German unemployment rate in three components. We find that not changes in the age structure of the population but rather labor-market effects had the greatest impact on the decrease in unemployment. For the econometric analysis of the indirect effect, we use information on the small-scale regional level and resort to spatial panel methods. The results yield a strong relation between the youth as well as the old-age dependency ratio and the unemployment ratio. A decline in the youth dependency ratio of one per cent comes along with a decline of the unemployment ratio of 0.489 per cent. Likewise, an increase of the old-age dependency ratio of one per cent is accompanied by a fall of the unemployment ratio of 0.470 per cent. Overall, our results provide evidence that the declining unemployment rate in East Germany is indeed affected by aging. Thus, a reversed cohort crowding effect has been taking place at the East German labor market.

Keywords: Demographic change, Unemployment, East Germany, Spatial panel methods

JEL classification: C21, J21, J82, R23

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1 Introduction

In East Germany a profound demographic change has been taking place that manifests itself in the shrinkage and the aging of the population. The number of inhabitants of working age, i. e. between 15 and 64 years, declined from 12.045 million in the year 1993 to 10.683 million in 2012. This implies a decrease of 11.3%, while at the same time this figure increased in West Germany by 1.0%. One major reason for this marked development in the Eastern part of the country can be attributed to the drop in the East German fertility rates by about half directly after the reunification of Germany in 1990. In no other countries of the former Eastern Bloc, this process was so drastic and abrupt as in East Germany (Goldstein/Kreyenfeld, 2011). Consequently, the youth dependency ratio, i. e. the population aged 15 to 24 years divided by the population aged 15 to 64 years, dropped from 18.9% in 2004 to 14.0% in 2011. A high degree of net out-migration mainly to West Germany further aggravated these demographic developments.

Around the year 2007, these sparsely filled after-reunification cohorts started to enter the East German labor market that had been characterized for many years by high unemployment and declining employment. Starting in 2005, however, a reversed trend could be observed. Between 2005 and 2012, the unemployment rate in East Germany declined from 18.9% to 7.1%, and the labor force increased by 6.2%. At the same time, substantial labor market reforms were started in Germany that have (additionally) spurred employment (Klinger/Rothe, 2012). Given these developments, the question arises if and to what extent the labor market entry of the young and smaller cohorts has affected the declining unemployment rate in East Germany.

This paper aims at providing an answer to the question of the ties between demography and unemployment in East Germany and to this end draws on the concepts of the cohort crowding literature. As to the central cohort crowding hypothesis, Easterlin (1961) argues that workers are worse off on the labor market if they belong to larger cohorts. It is hereby assumed that labor demand reacts less elastically than labor supply. Shimer (2001), on the other hand, makes an argument against this mechanism by modelling how enterprises have an incentive to create even more jobs in regions with large labor market entry cohorts. The empirical findings are not clear on the relationship between demography and unemployment, either (see, e.g. Skans, 2005 or Foote, 2007).

Transferring Easterlin's cohort crowding hypothesis to the case of East Germany would imply that shrinking cohort sizes lead to a decrease in unemployment. We scrutinize this relationship by analyzing both a direct and an indirect effect of population aging on unemployment changes. The direct effect stems from a decomposition of the age-specific unemployment rate into several components denoting, among others, the effect of population changes (Perry, 1970, Flaim, 1979, Shimer, 1999). The indirect effect, on the other hand, is econometrically identified by regressing demographic indicators on unemployment (Shimer, 2001). Data for the

calculation of the direct effect comes from the German Microcensus and covers the whole of East Germany for the years from 1993 to 2012. The indirect effect is estimated with data from the Federal Statistical Office and the Federal Employment Agency. It covers the East German NUTS 3-regions for 1996 to 2011.

Our analysis adds to the existing literature on cohort crowding in several ways. First, to our knowledge this is the first comprehensive study on demography and unemployment in East Germany. Studies on Germany have so far mainly dealt with West Germany (Zimmermann, 1991, GarloffPohl/Schanne, 2013) or focused on single Federal States within Germany (*Bundesländer*) for the calculation of the direct effect (Fuchs et al., 2013b, Fuchs et al., 2013a, Fuchs et al., 2013c). East Germany, however, is especially intriguing to look at, because the enormous structural breaks due to the fall of Communism affected West Germany only marginally. Since East Germany can be directly compared to West Germany because of the same legal and political institutions, a comparison of both parts of the country can prove very insightful as to the role of demography for the labor market. Precise figures on this question, for example, are of special relevance for policy-makers in charge of labor-market issues. Second, for the estimation of the indirect effect we focus on a spatial panel model with fixed region-specific effects in order to take account for spatiotemporal spillovers. In compliance with GarloffPohl/Schanne (2013) we estimate the relationship between the youth dependency ratio. In addition, we also scrutinize the role of aging by means of the old-age dependency ratio (population aged 50 to 64 years divided by the population aged 15 to 64 years). With this measure we explicitly take into account the large increase of elder workers on the labor market. Since the two age groups are not directly counterparts of each other, the results on the youth dependency ratio cannot directly be transferred to the old-age working population.

The remainder of the paper is structured as follows. Chapter 2 gives an overview over theoretical approaches on the influence of demographic change on unemployment and summarizes central empirical findings. In chapter 3, the data sets used for the empirical analyses are presented. The calculation of the direct effect of aging on unemployment in East Germany is at the center of chapter 4. We discuss the regression results on the indirect effect in chapter 5, and chapter 6 concludes.

2 Theoretical considerations

The research design we apply for analyzing the ties between demography and unemployment rests on the literature that deals with the impact of changing age cohorts on the labor market. The so-called cohort crowding literature going back to Easterlin (1961), Perry (1970) or Flaim (1979) argues that workers are worse off on the labor market if they belong to bigger cohorts.¹

¹Other approaches to this question include, for example, general equilibrium models. LisenkovaMerette/Wright (2013) evaluate the effects of labour force decline and labour force ageing on key macro-economic

According to the underlying hypothesis (Easterlin, 1961), the workers belonging to big cohorts are confronted with more competitors for jobs on the labor market due to the larger labor supply. If labor demand does not rise at the same magnitude, unemployment should rise. In the case of East Germany, the argument reverses: if small cohorts enter the labor market, according to the hypothesis of Easterlin unemployment should decrease as well.

For the examination of the cohort crowding hypothesis two complementary approaches have been developed over time that either focus on a direct or an indirect effect of demography on unemployment. The central research question for the calculation of the direct effect is how the unemployment rate changes if the age structure, the labor market participation and the age-specific unemployment rate change. Hence, this effect stems from a pure statistical decomposition of the unemployment rate into age-specific unemployment rates weighted with the share of the age-specific population. The decomposition of the unemployment rate in several components was undertaken for the USA already in the 1970ies (Flaim, 1979, Perry, 1970, Flaim, 1990). Shimer (1999) also computes counterfactual unemployment rates to demonstrate the influence of demography and changes in the labor market participation on unemployment. For Germany, to our knowledge there is so far only one study by GarloffPohl/Schanne (2013) on the direct effect. They consider the Western part of Germany for the period from 1991 to 2009, where the unemployment rate rose from initially 4.7% to 11.3% in 2005 and then declined again to 7.8%. Their results show that demographic change in West Germany results in a low but still negative direct effect on the overall unemployment. The direct effect shows that the unemployment rate would have been higher after 2000 if the age structure of the population had been the same as in 1991. GarloffPohl/Schanne (2013) interpret this finding as first evidence for a positive relationship between declining cohort sizes and a lower unemployment rate.

In addition to the direct effect, more recent studies have looked at the indirect effect of demography on unemployment (see Korenman/Neumark, 2000 for an overview). Broadly, the indirect effect is identified by analyzing the relationship between demographic indicators and the labor market over time. The empirical literature comes to ambiguous results. In a study on the USA, Shimer (2001) estimates the response of the unemployment rate and labor force participation rate to changes in the youth share of the working age population from 1978 to 1996. He considers both the young and the prime-aged workers and finds that a one percent increase in the youth share reduces the unemployment rate of young workers by more than one percent and of older workers by more than two percent. Shimer (2001) explains these results with increasing returns to scale in the labor market. Young workers are frequently mismatched in their employment, and firms create jobs to take advantage of this mismatch. Under certain parameter assumptions, the amount of new jobs created overcompensates the initial increase in labor supply. Hence, according to the results of Shimer (2001), when youth shares increase,

variables for Scotland. Michaelis/Debus (2011) show that an increase in the relative number of older workers has no effect on young and old unemployment.

overall unemployment declines, implying a negative correlation between the two indicators. Similar findings are presented by Skans (2005) for the Swedish labor market. By explicitly controlling for spatial autocorrelation and by extending the observation period from 1996 to 2005, Foote (2007) contrasts the results of Shimer (2001). In line with the cohort crowding hypothesis, he evidences a positive effect of the youth share on unemployment.

For Germany, to our knowledge there are, in addition to GarloffPohl/Schanne (2013), two further studies that estimate the indirect effect of a cohort entering the labor market on unemployment respectively employment. Zimmermann (1991) analyzes the relationship for the period from 1967 and 1987 and finds in the long run no adverse effects for large labor market entry cohorts. Ochsen (2009) conducts his analysis on the level of all NUTS 3-regions using monthly data for 2000 and 2001. He concludes that especially for the East German regions regional unemployment rates rise if the share of the younger population declines. Hence, he refutes the hypothesis of Easterlin, which might be connected with the short period under observation and the fact that in the period under consideration the small after-reunification cohorts had not entered the East German labor market yet. GarloffPohl/Schanne (2013), in contrast, consider for the indirect effect a long time span from 1978 to 2009, but confine themselves on labor market regions in West Germany. Their results confirm Easterlin (1961) in that the labor market entry of small cohorts leads to a reduction of unemployment.

Empirical literature that focuses explicitly on East Germany is scarce. This is surprising in view of the tremendous changes in demography as well as the labor market since German re-unification in 1991. The present paper aims at filling this research gap in several ways. First, so far the direct effect has only been calculated for West Germany. Although it was scrutinized for single East German *Bundesländer* (NUTS2-regions) by Fuchs et al. (2013b), Fuchs et al. (2013a) and Fuchs et al. (2013c), a thorough analysis for East Germany is still missing and provided here. Second, we estimate the indirect effect of changes in the age structure of the population on unemployment for East Germany at the small-scale regional level by resorting to spatial panel models and by considering both the youth and the old-age dependency ratios.

3 Data

Our empirical analysis is based on various data sets. For the calculation of the direct effect that aging might exert on unemployment, we resort to data from the Microcensus provided by the Federal Statistical Office.² It provides official representative statistics of the population and the labor market in Germany and consists of a one-percent random representative sample of the population in Germany, where each year about 830,000 persons from 370,000 households are questioned on a variety of subjects. From this data source we utilize information on the

²See https://www.destatis.de/EN/Meta/abisz/Mikrozensus_e.html for further details.

activity status that is based on the labor force concept of the International Labour Organization (ILO). We restrict ourselves to persons between 15 and 64 years living in East Germany and the years from 1993 to 2012. In addition, the Labour Force Survey of the European Union (EU Labour Force Survey) which is harmonised in all EU member states is integrated into the Microcensus, thus allowing comparisons to be drawn on issues of labour force participation and unemployment. The majority of the variables covered by the Labour Force Survey are also Microcensus variables.

For reasons of data privacy protection, the original data of the Microcensus are anonymized. In the form of scientific use files that are factually anonymized 70 per cent samples of the original files, they are made available to independent domestic research institutions for their analyses. Until the year 2009, we construct our variables from these scientific use files, because the data was not available from the statistical offices for the fine age groups we need for our analysis. For 2010, 2011 and 2012, we use the original data from the Microcensus made available from the Federal Statistical Office upon request.

For the estimation of the indirect effect of aging on unemployment we take data on the number of unemployed from the Federal Employment Agency for the years from 1996 to 2011. Due to restrictions in the unemployment data when conducting analyses at a small regional level, we cannot use the years prior to 1996. Population data for the 76 districts³ (NUTS 3-regions) comes from the Federal Statistical Office. A detailed description of the variables used as well as descriptive statistics are given in chapter 4.1 for the direct effect and in chapter 5.1 for the indirect effect.

4 Direct effect

In this chapter, we analyze the direct effect of aging on unemployment, i. e. the relationship between changes in both the age structure as well as in the labor participation of the East German population and changes in the unemployment rate. To this end we statistically decompose the unemployment rate into three components. Holding one or two components fixed enables us to compute various counterfactual unemployment rates. In comparison with the actual development it can be identified which part of the changes can be attributed to the respective component. Before we present the decomposition results, we provide an overview of the variables used, some descriptive statistics and the precise decomposition formula used.

³Because of reforms of the regional demarcations in the *Bundesland* of Mecklenburg-Vorpommern and subsequent inconsistencies, we had to aggregate two districts.

4.1 Variables and descriptives

For the calculation of the direct effect we need information on the labor-market participation in East Germany for single age groups. For the purposes followed here we use yearly data on ten age groups of the population between 15 and 64 years from the Microcensus (see chapter 3). We distinguish between the economically active and non-active population. The former comprises the labor force that includes all persons working as employees or self-employed as well as the unemployed. Table 1 provides an overview on the variables used and their definitions.

Table 1: Variables used for the calculation of the direct effect

Variable	Abbreviation	Definition
population	<i>POP</i>	number of inhabitants between 15 and 64 years
economically active population	<i>EAP</i>	Labor force plus unemployed
economically non-active population	<i>EnAP</i>	<i>POP</i> minus <i>EAP</i>
labor force	<i>LF</i>	Each person working against payment or independently
unemployed	<i>U</i>	Each person not working and having looked for a job in the last four weeks before the survey
unemployment rate	<i>UR</i>	U / POP
activity rate	<i>AR</i>	EAP / POP

Since reunification in 1990, the population in East Germany has been shrinking and changing in its age structure (see table A.1 in the appendix for detailed descriptive statistics on East and West Germany). According to the Microcensus, the number of inhabitants between 15 and 64 years in East Germany declined from 12,091 million in 1991 to 10,683 in 2012. This does not necessarily imply, however, that the economically active population has decreased as well. As figure 1 shows, several trends in the labor market participation have helped offsetting the overall population decline. Most notably, the number of unemployed has decreased continuously since 2004. Additionally, since 2002 the economically non-active population has declined constantly as well. As a result, the labor force has increased in the last years in spite of the shrinking of the total population. This development can also be seen in the relative compositional changes of the population. The labor force participation rate rose from 60.8 per cent in 2003 to 71.8 per cent in 2012, and, inversely, the unemployment rate decreased from 14.7 per cent in 2004 to 7.1 per cent in 2012. The activity rate as the share of both labor force and unemployed on the population rose from a trough of 72.1 per cent in 2002 to 78.9 per cent in 2012.

A detailed look behind the aggregate activity and unemployment rates reveals fundamental changes in the labor market participation of the single age groups (see table 2). Overall, the activity rate rose between 1993 and 2012. Among the younger cohorts, however, the activity rate declined, which is mainly due to a longer continuance in the educational system. Among the persons over 55 years of age, on the other side, the activity rate increased considerably. Reasons therefor are the disposition to work longer, better health conditions or the wish to improve the retirement pension. Also, the labor market reforms undertaken in the years 2002

to 2005 brought with them a tighter handling of regulations on early retirement. While changes in the unemployment rate were rather small between 1993 and 2003, it dropped sharply until 2012 in almost all age groups. Remarkably, the unemployment rate among the 15- to 20 year old took the opposite development.

Figure 1: Labor-market participation of the East German population (15-64 years)

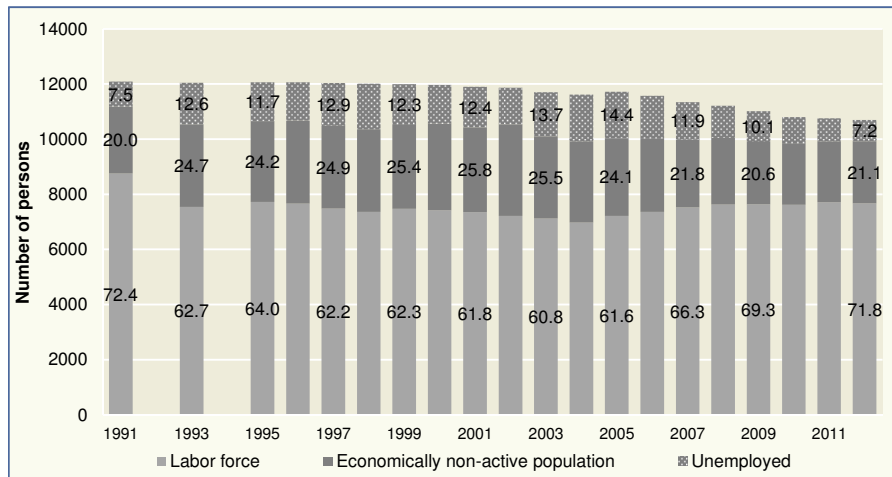
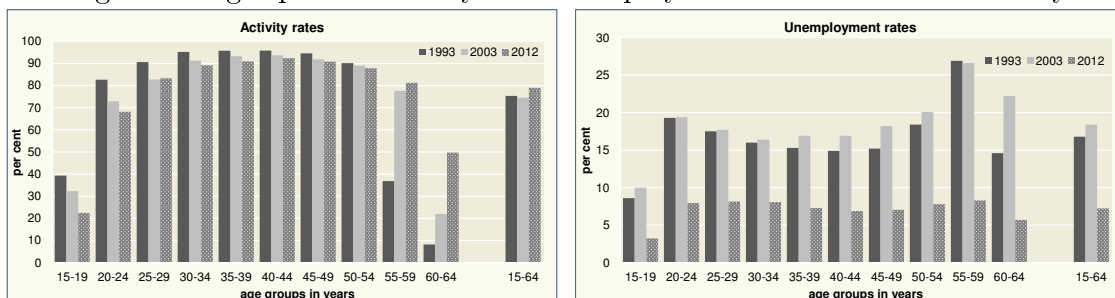


Figure 2: Age-specific activity and unemployment rates in East Germany



4.2 Method

We calculate the direct effect that the aging of the East German population exerts on unemployment by applying a statistical decomposition method. The aggregate unemployment rate can be decomposed into three components, each containing information on ten age groups (*age*) that comprise the 15- to 64 year-old in 5-year steps:

$$UR_t = \sum_{age=1}^{10} \frac{pop_{age,t}}{pop_t} * \frac{AR_{age,t}}{AR_t} * \frac{U_{age,t}}{EAP_{age,t}}, \quad (1)$$

where UR_t is the overall unemployment rate at time t , $\frac{pop_{age,t}}{pop_t}$ denotes the age-specific population (*pop*) shares, and $\frac{AR_{age,t}}{AR_t}$ stands for the relative age-specific activity rate (*AR*).

$\frac{U_{age,t}}{EAP_{age,t}}$ is the age-specific unemployment rate, with U the number of unemployed and EAP the number of the economically active persons.

If one or two of the three components are held constant at the level of a certain base year and for the second or third component the actual values are used, it is possible to calculate how high the unemployment rate would have been if those components held constant had actually not changed over time. This counterfactual unemployment rate reflects a situation in which there would have been no changes in either the demographic development, the age-specific labor participation or in the age-specific unemployment rate. A comparison with the actually realized unemployment rate answers then the question which part of the changes in the unemployment rate can be attributed towards the components held constant over time.

4.3 Results

In order to quantify the impact of changes in the age structure of the population on changes in the unemployment rate, in a first step we calculate two counterfactual unemployment rates. In column (A) of table 2, the actual unemployment rates are represented. In order to facilitate the following decomposition, in column (B) the unemployment rates of the base year 1993 are depicted. Column (C) contains the counterfactual unemployment rates with constant age-specific economically active population (EAP), i. e. constant age-specific activity rates and constant age structure of the population. The rate for 1999, for example, illustrates how high the unemployment rate would have been if the labor participation of the single age groups as well as the age structure of the population had corresponded to those in 1993. The second counterfactual unemployment rate in column (D) is computed holding only the age structure of the population constant at the levels of 1993.

The results on the two counterfactual rates reveal only slight differences towards the actual unemployment rates. The largest deviations up to 3.1 percentage points become evident for the year 2002. This implies that changes in the age-specific labor participation as well as the age composition of the population only had a slight impact on the development of the overall unemployment rate.

Based on the two counterfactual unemployment rates in table 2 it is now possible to decompose unemployment into three components. Table 3 shows how the changes in total unemployment (column A - column B in table 2) can be divided into an

- effect of population changes that is due to changes in the age composition of the population,
- effect of participation changes that goes back to changes in the labor participation of the single age groups,
- effect of labor market changes based on changes in the age-specific unemployment rates.

Table 2: Results for the counterfactual unemployment rates in East Germany

Year	Unemployment rate		Counterfactual unemployment rate with constant...	
	actual	base year	age-specific EAP	age structure of the population
	A	B	C	D
1993	16.8	16.8	16.8	16.8
1995	15.5	16.8	15.2	15.7
1996	15.4	16.8	14.7	15.6
1997	17.2	16.8	16.3	17.5
1998	18.4	16.8	17.5	18.8
1999	16.5	16.8	15.7	17.1
2000	16.0	16.8	15.2	16.5
2001	16.7	16.8	16.2	17.4
2002	15.6	16.8	17.1	18.7
2003	18.4	16.8	18.0	19.2
2004	19.7	16.8	19.4	20.4
2005	18.9	16.8	18.7	19.4
2006	17.5	16.8	17.3	17.3
2007	15.2	16.8	15.0	15.3
2008	13.3	16.8	13.2	13.3
2009	12.8	16.8	12.7	12.7
2010	11.3	16.8	11.2	11.2
2011	9.9	16.8	9.8	9.8
2012	7.1	16.8	7.5	7.3

Source: Federal Statistical Office of Germany, own calculations

Among these three components, the effect of population changes pictures the direct impact of aging on unemployment. The decomposition in table 3 highlights the effect of labor market changes as the most eminent factor. Between 1993 and 2012, the unemployment rate in East Germany dropped by 9.7 percentage points. 9.3 percentage points of this decline can be attributed to the labor market effect. One possible explanation can be seen in the improved labor-market situation in the last years. This result confirms the large impact of the decline of the age-specific unemployment rates (see figure 2) on the total effect.⁴ The other two effects, in contrast, are of rather low importance. The slightly positive values of the effect of population changes between 2008 and 2011 provide evidence that the changes in the age structure have even counteracted the decline in unemployment.

To sum up, the direct effect of demography defined as aging of the population on unemployment can be regarded as rather low. Changes in the participation rates are only slightly more influential. The most important effect comes from changes in the age-specific unemployment rates that are due to the improved labor-market situation.

⁴A recent study by Klinger/Rothe (2012) supports the large impact of the labor market effect. The authors show that the labor-market reforms have supported the decline of long-term unemployment in Germany.

Table 3: Decomposition of the change in the unemployment rate in East Germany

Year	Total effect	Decomposition of the change in the unemployment rate		
	(A - B)	effect of population changes (A - D)	effect of participation changes (D - C)	effect of labor market changes (C - B)
1993	0.0	0.0	0.0	0.0
1995	-1.3	-0.2	0.5	-1.6
1996	-1.4	-0.2	0.8	-2.1
1997	0.4	-0.3	1.1	-0.5
1998	1.6	-0.4	1.3	0.7
1999	-0.3	-0.6	1.3	-1.1
2000	-0.8	-0.5	1.3	-1.6
2001	-0.1	-0.7	1.3	-0.6
2002	-1.2	-3.1	1.6	0.3
2003	1.6	-0.8	1.2	1.2
2004	2.9	-0.7	1.1	2.6
2005	2.1	-0.5	0.7	1.9
2006	0.7	0.2	0.0	0.5
2007	-1.6	-0.1	0.3	-1.8
2008	-3.5	0.0	0.1	-3.6
2009	-4.0	0.1	0.0	-4.1
2010	-5.5	0.1	0.0	-5.6
2011	-6.9	0.1	0.0	-7.0
2012	-9.7	-0.2	-0.2	-9.3

Source: Federal Statistical Office of Germany, own calculations

5 Indirect effect

We now turn to the estimation of the indirect effect. Here, the central research question is how the entry of small cohort sizes into the labor market affects unemployment. If labor demand does not decline to the same extent as labor supply, according to the central hypothesis of Easterlin (1961) unemployment should fall. One reason could be that enterprises will have to increasingly recruit among the unemployed in order to meet their labor demand. Another adjustment mechanism could work through the higher labor participation of the elder cohorts, whose share on the total population has moreover risen (see figure 2 and table A.1 in the appendix). In order to capture both causes of the population aging, we not only consider the relationship between the youth dependency ratio and unemployment as usually done in the previous literature (Shimer, 2001 or GarloffPohl/Schanne, 2013), but also the link between the old-age dependency ratio and unemployment.

Since in analyses at a small-scale regional level it should be controlled for spatial autocorrelation (Anselin, 1988), we focus on the estimation of a spatial panel model. A general overview on recent developments in econometric specification and estimation of spatial panel data models is given by fei Lee/Yu (2010). The importance of taking into account of spatial correlation when estimating the indirect effect is also emphasized by Foote (2007). The effects of aging do not need to be confined to the region the process is observed, but might well in-

fluence unemployment in the adjacent areas as well, e. g. via changes in commuting flows. If such a spatial dependence exists in the sense that observations that are closer to each other are also similar in their characteristics than observations that are more distant from each other, spatial autocorrelation is existent.

5.1 Variables and descriptives

For the calculation of the variables that are needed for the indirect effect we use data on the number of unemployed and on the population for the East German NUTS 3-regions. A common approach in the related empirical literature is to regress the youth dependency ratio on unemployment. We follow this approach in a first step. In a second step, however, we also scrutinize the impact of the old-age dependency share in order to explicitly consider both the relative decline of the young and the relative rise of the old on the labor market.

Our dependent variable is the unemployment ratio calculated as follows:

$$\textit{share unemployed} = \textit{unemployed} / \textit{population (15-64)}$$

We measure the youth dependency ratio (*share_young*) as the share of the population between 15 and 24 years on total population between 15 and 64:

$$\textit{share young} = \textit{population (15-24)} / \textit{population (15-64)}$$

Likewise, the old-age dependency ratio (*share_old*) relates the share of the population between 50 and 64 years on total population between 15 and 64:

$$\textit{share old} = \textit{population (50-64)} / \textit{population (15-64)}$$

Figure 3 depicts the development of the unemployment share in East Germany as compared to the Western part of the country. Although still large differences exist between the two regions, they have decreased in the last years due to the much larger decline of the unemployment share in the East. As concerns the youth dependency ratio, the effects of the plummeting fertility rates in East Germany at the beginning of the 1990ies can be clearly seen in the decline starting in 2005 (figure 4). In relation to this stands the increase of the old-age dependency ratio (figure 5) by about five percentage points between 2005 and 2011.

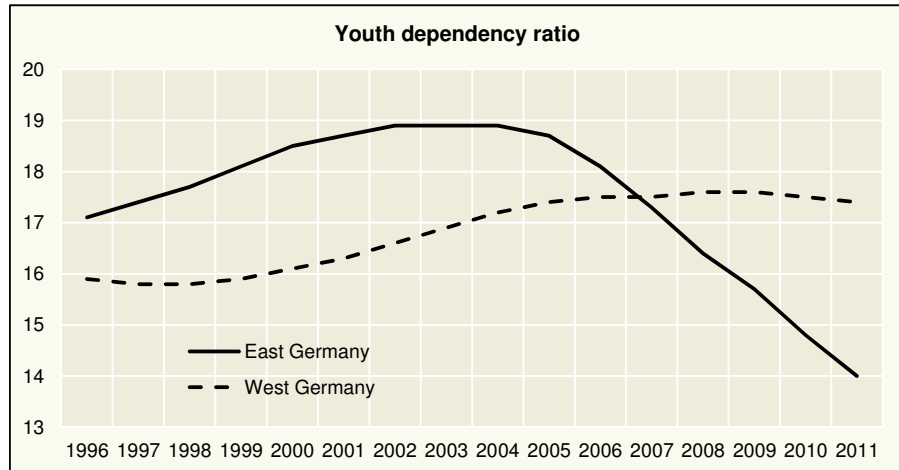
In small-scale regional data such as in our case spatial autocorrelation is very likely to occur. It can broadly be defined as the phenomenon that occurs when the spatial distribution of the independent variable shows a systematic pattern (Cliff/Ord, 1981). A graphic visualization of the three central variables in figures 6 to 8 in the appendix illustrates distinctive spatial

Figure 3: Unemployment ratio in East and West Germany



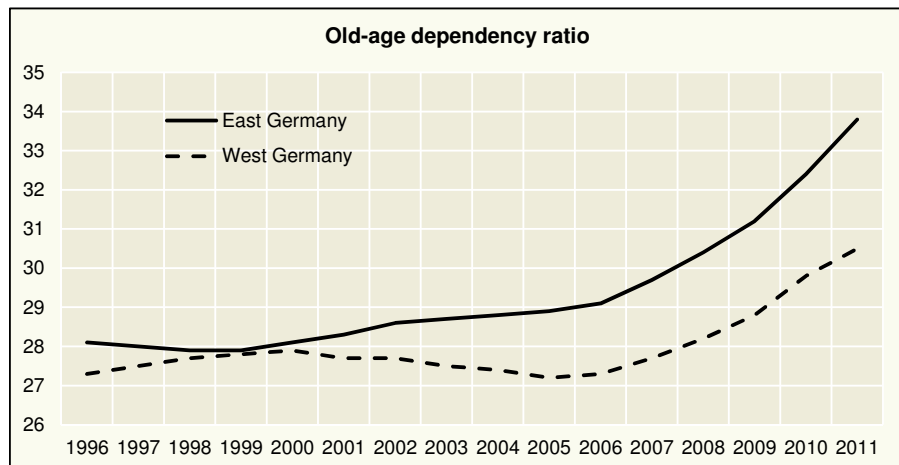
share.pdf

Figure 4: Youth dependency ratio in East and West Germany



dependency ratio.pdf

Figure 5: Old-age dependency ratio in East and West Germany



dependency ratio.pdf

patterns.

In order to test against spatial autocorrelation in all three variables, we apply the Moran's I statistic for spatial autocorrelation, popularized in the work of Cliff/Ord (1981). Table 5.1 depicts the test statistics for our three variables, for which all observations are pooled over time. The test statistics confirm statistically the existence of spatial autocorrelation. In all three cases, Moran's I is positive and highly significant.

Table 4: Measuring spatial autocorrelation: Moran's I (average 1996-2011)

	Moran's I
share unemployed	0.242***
share young	0.181***
share old	0.335***

Levels of significance: *** 1 %, ** 5 %, * 10 %.

Source: Federal Statistical Office of Germany, own calculations .

5.2 Method

For the econometric analysis of the indirect effect we proceed in three steps.⁵ The regression estimation we carry out takes the following basic form:

$$y = \alpha + \beta x + \eta, \quad (2)$$

with y standing for the unemployment ratio and x for the youth or the old-age dependency ratio, respectively. In the first step we estimate equation 2 with standard pooled OLS as a basic consistency check. In all estimations, the Huber-White-Sandwich procedure is applied in order to obtain heteroskedasticity-robust standard errors (White, 1980). In addition, each observation is weighted with the fraction of the region's working-age population on the total working-age population in East Germany in order to correct for biases in the impact of large and small regions. Furthermore, we check for possible endogeneity by regressing the exogenous variables lagged one and five years ($x_t - 1, x_t - 5$). We also include year and region dummies.

In a second step, we make use of the panel character of our data and estimate explicitly panel data models with both fixed and random effects. The regression takes the following basic form:

$$y_{it} = \alpha_i + \beta x_{it} + \epsilon_{it}, \quad (3)$$

with i denoting the region ($i=1, \dots, 76$) and t the year under consideration ($t=1996, \dots, 2011$). A common Hausman test is performed to decide whether a fixed effects (FE) or random effects (RE) model is appropriate (Hausman, 1978). In the third step we focus on a spatial panel

⁵All calculations and regressions were executed in Stata12.

model with fixed region-specific effects in order to take account for spatiotemporal spillovers. In general, spatial dependence can be incorporated into the standard linear regression model in two distinct ways, depending on how spatial correlation is modelled (Anselin, 1988): First, spatial lag dependence pertains to spatial correlation in the dependent variable, which is accounted for in the regression via a function of the dependent variable observed at the other locations on the right hand side. In general, this function is simplified by using a spatial weights matrix \mathbf{W} . The $N \times N$ matrix \mathbf{W} has non-zero elements $w_{i,j}$ in each row i for those columns j that are "neighbours" of region i .⁶ Our spatial autoregressive model takes on the general form:

$$y_{it} = \alpha + \rho \sum_{j=1}^{75} \mathbf{W}_{ij} y_{jt} + \beta x_{it} + \nu_{it}, \quad (4)$$

with

$$\nu_{it} = \lambda \sum_{j=1}^{75} m_{ij} \nu_{jt} \epsilon_{it}. \quad (5)$$

\mathbf{W} denotes the spatial weights matrix for which we use a binary contiguity matrix. The spatial coefficient ρ in the spatial lag estimation shows whether the dependent variable in a model (in our case the unemployment ratio) is dependent on neighbouring values of the same dependent variables. If so, conclusions can be reached on the significance and magnitude of this spatial dependence. Alternatively, spatial error models incorporate spatial dependence not explicitly as an additional variable, but instead in the error term of the regression, thus affecting the covariance structure of the random disturbance terms. The typical motivation for this is that non-modelled effects spill over across units of observation and hence result in spatially correlated errors such as the above mentioned commuting activities. Spatial error autocorrelation is a special case of a non-spherical error covariance matrix, in which the off-diagonal elements are non-zero, i.e., $E[\epsilon_i \epsilon_j] \neq 0$, or, in matrix notation, $E[\epsilon \epsilon'] = \Sigma$.

For estimation purposes, we use a new Stata command by Belotti/Hughes/Mortari (2013) which fits FE and RE spatial models for balanced panel data for a wide range of specifications. Since in empirical practice there are often no strong a priori reasons to consider a spatial lag or a spatial error model (Anselin et al., 1996), we estimate a spatial error (SEM) model, a spatial autoregressive (SAR) model, and a spatial autocorrelation (SAC) model.

5.3 Results

Tables 5 and 6 present the estimation results for the effect of the youth and the old-age dependency ratios on the unemployment ratio in East Germany. In the first column the results of the standard pooled OLS estimations are contained. The second column shows the panel

⁶There are various specifications possible of the contiguity matrix \mathbf{W} , but it is often shown that the results of the models are very similar.

results. Applying the Hausman test to differentiate between the FE and RE model favors the FE model, whose results are depicted here. In the third step of our approach, we first test the OLS results on spatial autocorrelation. According to the test statistics of the spatial model diagnostics, the spatial error model is to be preferred for the models with both the youth and the old-age dependency ratio. This implies that spatial correlation in the error term needs to be accounted for. The results in tables 5 and 6 adhere to the FE SEM model.⁷

Table 5: The effect of the youth dependency ratio on the unemployment ratio

	OLS	panel (FE)	spatial panel (FE SEM)
Youth dependency ratio	0.459***	1.196***	0.489***
spatial error			0.834***
time dummies		yes	
region dummies	yes	yes	
R ²	92.7	24.9	22.0
Number of observations	1,216	1,216	1,216

Levels of significance: *** 1 %, ** 5 %, * 10 %.

Source: Federal Statistical Office of Germany, own calculations

Table 6: The effect of the old-age dependency ratio on the unemployment ratio

	OLS	panel (FE)	spatial panel (FE SEM)
Old-age dependency ratio	-0.439***	-1.228***	-0.470***
spatial error			0.857***
time dummies		yes	
region dummies	yes	yes	
R ²	92.7	5.5	2.1
Number of observations	1,216	1,216	1,216

Levels of significance: *** 1 %, ** 5 %, * 10 %.

Source: Federal Statistical Office of Germany, own calculations

We find a positive and highly significant relation between the youth dependency ratio and the unemployment ratio. Because of the specification in logs, the coefficients can be interpreted as elasticities. As indicated by our preferred FE SEM model, a decline of the youth dependency ratio of one per cent comes along with a decline of the unemployment ratio of 0.489 per cent. This result confirms the reversed cohort crowding hypothesis in that a smaller cohort entering the labor market indeed improves the conditions on the labor market for the unemployed. Furthermore, a comparison of the OLS results with those of GarloffPohl/Schanne (2013) hints towards a similar magnitude of the effect. The authors present for West Germany an elasticity of 0.3961. For the old-age dependency ratio we find a highly significant and negative relation. An increase of one per cent is accompanied with a decrease of the unemployment ratio of 0.470

⁷Results for the SAR and SAC models as well as the models with the lagged variables can be obtained from the authors upon request.

per cent. In both models the spatial error has a positive and significant impact, highlighting the importance of spatial dependence between the districts. Also, the regression results are very stable regardless of the econometric method used. This is also the case when regressing the lagged values of the youth and old-age dependency ratio on the unemployment rate. Further robustness tests with different time periods or control regressions for West Germany emphasize this stability of the results and also highlight stronger relations for the Eastern part of the country.

6 Conclusions

In this paper, we asked how strong the relationship between population aging and unemployment decline was in East Germany for the period from 1993 to 2012. Because of the entry of the small after-reunification birth cohorts into the East German labor market at around the same time when unemployment started declining and employment rising, an answer to this question is of high relevance not only for science but also for politics.

Resting on the concepts of the cohort crowding literature and using data from official population and labor-market statistics, we calculate both the direct and indirect effect of aging on unemployment. For the computation of the direct effect, we decompose changes in the unemployment rate into effects of changes in the age structure of the population, in participation rates and in the labour-market situation. The results clearly show that the direct effect of demography on unemployment as evidenced by changes in the age structure can be regarded as very low. During the last years of our observation period, the aging of the population has even counteracted the decline in unemployment. The largest effect comes from changes in the age-specific unemployment rates that are due to the improved labor-market situation. Almost the whole decline of the unemployment rate of 9.7% between 1993 and 2012 can be attributed to the effect of labor market changes.

The impact of demography on unemployment rate is rather of indirect nature, as our regression results on the indirect effect show. We find close ties between the youth as well as the old-share dependency ratio and the unemployment ratio. A decline in the youth dependency ratio of one per cent comes along with a decline of the unemployment ratio of 0.489 per cent. Likewise, an increase of the old-age share of one per cent is accompanied by a fall of the unemployment ratio of 0.470 per cent. The regression results are very stable with regard to various robustness checks. They furthermore emphasize the need to control for spatial autocorrelation when analyzing the indirect effect at a small-scale regional level.

Overall, our results provide indeed evidence that the declining unemployment rate in East Germany is affected by the demographic change as evidenced by the relative decline of the young and the relative increase of the elder population cohorts. Thus, a reversed cohort

crowding process has not been taking place on the labour market in West Germany, but also in East Germany. We have to limit our conclusions insofar, however, as there is no complete answer to the question which part of the decreasing unemployment rate can be traced back on demographic change. There might still remain unobserved and non-quantifiable impacts that do not relate to demographic change only. Hence, especially with respect to recommendations for policy makers it is very difficult to exactly quantify which part of the demographic change (shrinking or aging) is responsible for the decreasing unemployment ratio, and to what extent it works. These aspects remain open for future research.

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A Appendix

Table A.1: Descriptive statistics for age groups in East and West Germany

Year	age group										
	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	50-64	15-64
Population in East Germany (in million)											
1993	0.978	1.059	1.353	1.444	1.325	1.272	0.962	1.414	1.245	0.945	12.045
2003	1.144	1.097	0.861	1.055	1.316	1.430	1.310	1.236	0.925	1.330	11.703
2012	0.556	0.918	1.079	1.003	0.905	1.188	1.362	1.343	1.243	1.086	10.683
Population in West Germany (in million)											
1993	3.201	4.304	5.346	4.985	4.471	4.330	3.777	4.843	4.321	3.465	43.043
2003	3.511	3.570	3.516	4.549	5.525	5.239	4.570	4.382	3.682	4.568	43.112
2012	3.568	3.970	3.920	3.993	3.840	5.083	5.601	5.125	4.391	3.985	43.476
Population in East Germany (age-group shares in %)											
1993	8.1	8.8	11.2	12.0	11.0	10.6	8.0	11.7	10.3	8.3	100.0
2003	9.8	9.4	7.4	9.0	11.2	12.2	11.2	10.6	7.9	11.4	100.0
2012	8.2	9.1	9.0	9.2	8.8	11.7	12.9	11.8	10.1	9.2	100.0
Population in West Germany (age-group shares in %)											
1993	7.4	10.0	12.4	11.6	10.4	10.1	8.8	11.3	10.0	8.1	100.0
2003	9.8	9.4	7.4	9.0	11.2	12.2	11.2	10.6	7.9	11.4	100.0
2012	5.2	8.6	10.1	9.4	8.5	11.1	12.7	12.6	11.6	10.2	100.0
Activity rates in East Germany (in %)											
1993	39.3	82.6	90.6	95.2	95.7	95.8	94.5	90.1	36.8	8.2	75.3
2003	32.3	72.9	82.7	91.2	93.2	93.6	91.8	89.0	77.6	22.0	74.5
2012	22.2	68.2	83.3	89.1	90.9	92.3	90.8	87.9	81.3	49.7	78.9
Activity rates in West Germany (in %)											
1993	36.2	37.8	79.0	81.8	83.3	85.0	82.6	77.3	62.4	22.6	70.6
2003	29.5	70.5	80.1	86.1	86.9	88.0	87.1	81.5	68.2	27.8	72.0
2012	29.0	69.5	82.6	86.3	87.3	89.3	89.1	86.1	78.4	49.6	76.4
Unemployment rates in East Germany (in %)											
1993	8.6	19.3	17.5	16.0	15.3	14.9	15.2	18.4	26.9	14.6	16.8
2003	10.0	19.4	17.7	16.4	16.9	16.9	18.2	20.1	26.6	22.2	18.4
2012	1.1	8.0	8.2	8.1	7.3	6.9	7.0	7.8	8.3	5.7	7.1
Unemployment rates in West Germany (in %)											
1993	7.1	7.1	6.9	6.5	5.8	5.4	4.5	5.4	9.7	7.1	6.4
2003	9.5	9.9	8.5	7.5	6.9	6.6	6.6	7.5	10.4	8.4	7.8
2012	2.4	4.7	4.4	3.8	4.0	3.2	3.0	3.1	3.2	2.3	3.4

Source: Federal Statistical Office of Germany, own calculations

Figure 6: Unemployment ratio in the East German regions

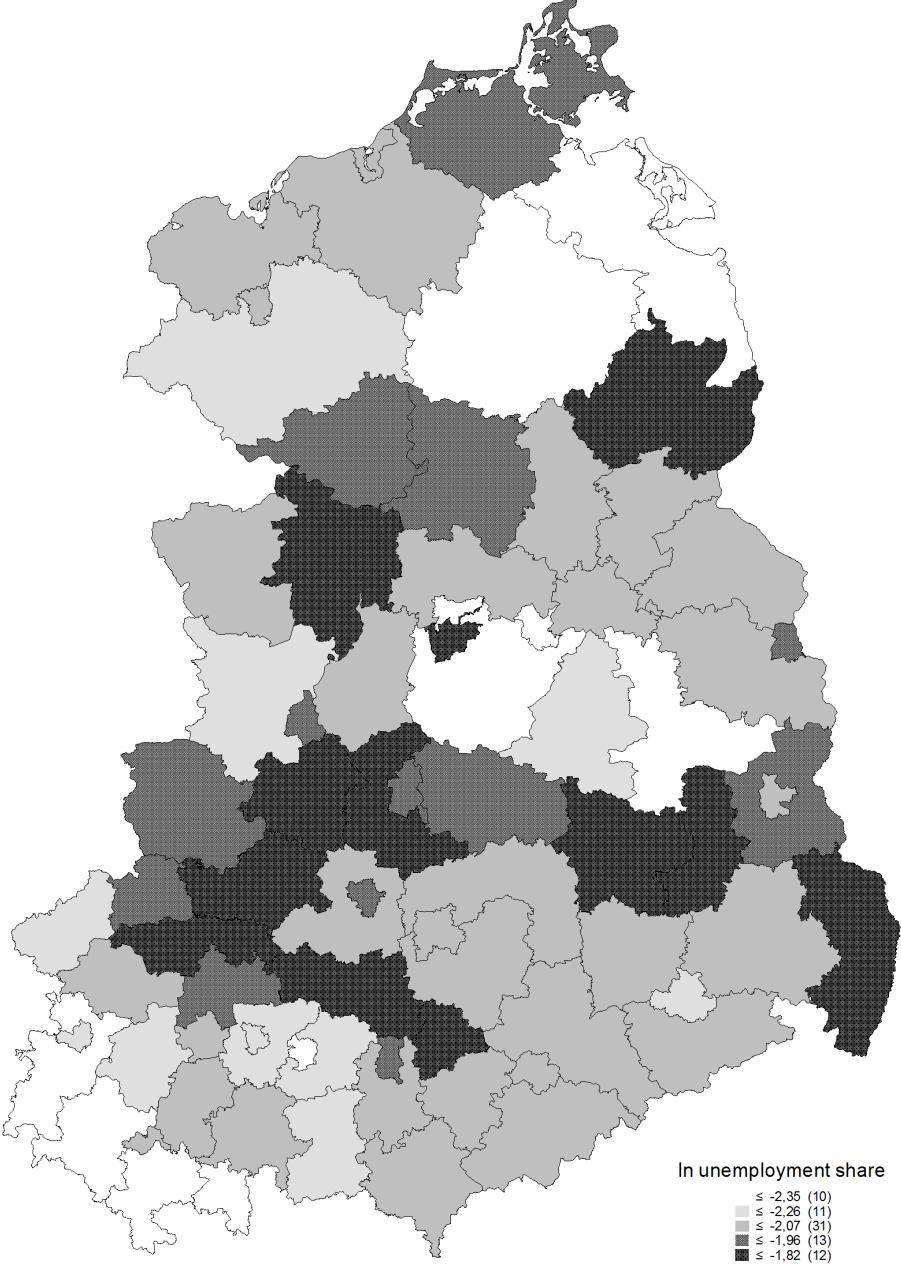


Figure 7: Youth dependency ratio in the East German regions

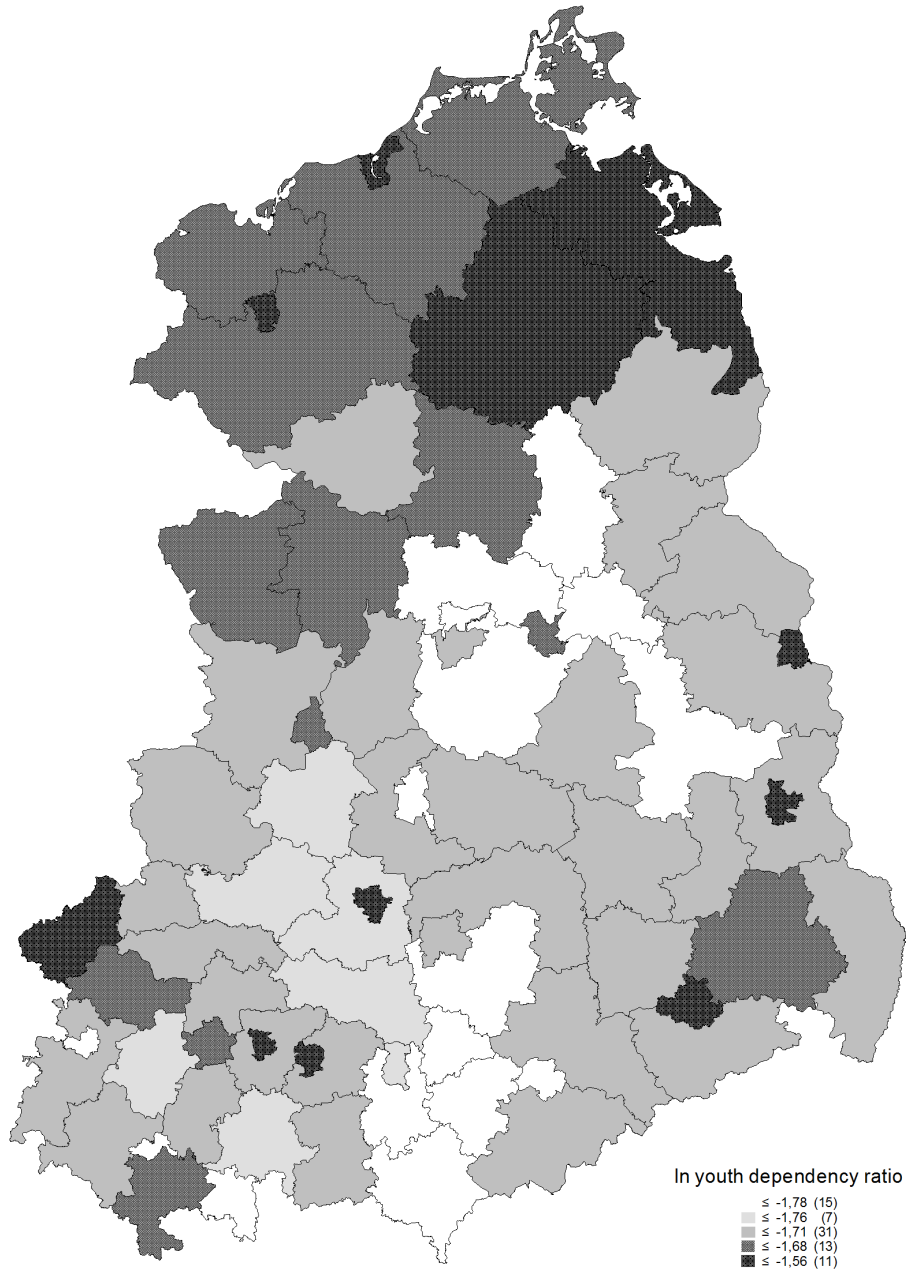


Figure 8: Old-age dependency ratio in the East German regions

