BiB WORKING PAPER 03|2024

Future subnational population change in Germany: The role of internal and international migration

Laura Cilek, Elke Loichinger, Frank Swiaczny, Claus Schlömer, Jana Hoymann, Steffen Maretzke

BiB Bundesinstitut für Bevölkerungsforschung

Future subnational population change in Germany: The role of internal and international migration

Cilek, Laura [1]; Loichinger, Elke [1]; Swiaczny, Frank [1]; Schlömer, Claus [2]; Hoymann, Jana [2]; Maretzke, Steffen [2]

[1] BiB, [2] BBSR

LauraAnn.Cilek@bib.bund.de

December 6, 2023

Keywords: Population Projections, Internal Migration, International Migration, Sub-regional population development

Contents

Abstract

Population change in Germany at the sub-national level is particularly driven by changes in net international migration and overall internal migration patterns, namely between urbanization, suburbanization and counter-urbanization. Official population projections at the county level only consist of one scenario, thereby omitting uncertainty that arises from changing patterns in the assumed components of demographic change. We use a cohort-component model that incorporates the spatial distribution of a net number of international migrants and internal migration matrices to provide population projections for 401 counties in Germany until 2070, encompassing a range of nine international and internal migration scenarios. Our results highlight the variability in possible population change in terms of population structure, size, and spatial distribution. According to our scenarios, the total projected population of Germany is expected to range between 74.25 to 86.84 million people. There are considerable differences in expected population change both spatially (e.g. between urban and rural areas) and concerning county population age structure, depending on the assumed absolute level of net international migration as well as the direction of internal migratory patterns. Our results highlight the large role internal and international migration patterns will play in future population development in Germany at the county level. We also discuss what our results and the uncertainty of future population change at the regional level mean for local policy making and planning.

1 Introduction

Since the early 1970s, the natural population balance of Germany has been negative (Findlay & White, 2023; Swiaczny et al., 2008). Although life expectancy has experienced large increases, this negative balance is largely the result of stagnated low fertility, which fell below the replacement rate of 2.1 children per woman in 1970 for the first time since WW II, and has since remained below this level (Luy & Pötzsch, 2011). Thus, without a net positive international migration balance in the last 50 years, the overall population would have started to decline in the 1970s. Germany is not unique–in other countries with similar demographic structures and sustained sub replacement fertility, the importance of international migration on national and subnational population development has also been recognized (for example, (Benassi et al., 2023; A. G. Champion, 1994; Livi Bacci, 2017; Parr, 2023). In fact, much work has been completed to identify how differing migration scenarios may impact projected population growth at the national level (Cafaro & Dérer, 2019; Marois et al., 2020; United Nations Department for Economic and Social Affairs, 2023; United Nations Population Division, 2000). Within Europe, in particular, levels of international migration impact the ongoing process of demographic change and determine to which degree a negative balance of deaths over births can be compensated and whether a decline in population (and ageing) can be avoided. At the subnational level, population change also depends on levels and patterns of internal migration. Disparities in regional patterns of population growth and decline, in both Germany and Europe, have been and are expected to remain prevalent (Beer et al., 2010; Rees & Sander, 2019; Rees et al., 2012; Vanella et al., 2023). Many rural regions have experienced large population declines due to out-migration to structurally strong regions with more amenities and greater educational and economic opportunities, especially among young adults and families (Stawarz et al., 2020). Thus, large regional differences in the age structure of the population are also an important factor in regional population development; rural areas in Germany differ greatly in their demographic development depending on their structural strength, and structurally weak rural areas in Germany are particularly affected by population decline (Maretzke, 2016).

The understanding of future sub-national population trends in Germany is important for several reasons (Gans & Schlömer, 2014). By anticipating future growth or shrinkage of an area and the progress of ageing, local plans and targeted investments can address needs for e.g. new infrastructure such as housing, transportation, and schools. It can also improve resource allocation for public services such as health and elderly care and recruitment and training for anticipated needs of specific labor market segments. To provide policy makers and other local stakeholders with country-wide information for Germany at the local scale, the Federal Institute for Research on Building, Urban Affairs and Spatial Development (Bundesinstitut für Bau-, Stadt- und Raumforschung, BBSR) regularly conducts and publishes population projections at the level of German counties – equal to the NUTS-3 classification level (Maretzke et al., 2021).[1]

For its official projections, the BBSR uses a cohort component model, where future inputs for fertility, mortality, and migration are modelled by clustering and extrapolating average county rates from observed trends in the past. These assumptions render a distinct scenario for each county based on a unique combination of future age- and sex- specific mortality, fertility, and internal and international migration rates. While anticipated changes in mortality and fertility, based on recent trends, are modest, especially international but also internal migration in Germany has fluctuated greatly in the past, and future trajectories are difficult to anticipate. Additional projections of future migration flows at the NUTS-3 level in Germany exist, but generally only one projected scenario of regional population development is presented (Vanella et al., 2023). Given the overall variability in migration patterns across both time and space, in the present analysis, we specify a combination of distinct internal and international migration scenarios. This allows us to present an outcome range within which the population is likely to fall at the sub-national level. The approach adds to the understanding of how future county-level population numbers may differ in the context of various migration trends.

Our results show that there is considerable variation in the expected future population size between different regions. The most rural counties, especially in eastern Germany, are likely to experience significant population decline. However, our findings are more ambiguous in the most urban and structurally strong regions—in these areas, patterns of internal migration will play a role in shaping future population trends between extremes of continuing growth and only slightly shrinking populations. We present our findings according to an official BBSR classification of four county types along the rural-urban continuum (Bundesinstitut für Bau-, Stadt- und Raumforschung [BBSR], 2021). The official names and English translations of these county groups are presented in Table 1, but will henceforth be referred to as Type 1 to Type 4, where Type 1 generally refers to large cities of unitary authority (independently governed large cities with more than 100,000 inhabitants), and Type 4 refers

[1] As of 2023, there are 400 German counties, but this paper projects the population for 401 individual counties, the official number in 2021.

to the most sparsely populated counties.[1] Figure 1 also shows the spatial distribution of these county types.

Table 1: *County typologies and distribution in 2021. Data: BBSR, 2021; own calculation.*

Official German	English translation	In Paper	Number of counties (%)	2021 Population in millions (%)
Kreisfreie Großstädte	Unitarity authority cities	Type 1	66 (16.5)	24.4 (29)
städtische Kreise	Urban counties	Type 2	137 (34.2)	32.3 (40)
Ländliche Räume mit Verdichtungsansätzen	Rural counties with incipient urbanization	Type 3	102 (25.4)	14.3 (17)
Dünn besiedelte ländliche Räume	Sparsely populated rural counties	Type 4	96 (23.9)	12.2 (14)

2 Background

2.1 Subnational development as a result of aggregate internal migration patterns in Germany

Longitudinal patterns of internal migration to and from urban and rural areas in Germany have often been characterized as a helix pattern (Bundesinstitut für Bevölkerungsforschung [BiB], 2023). As shown in Figure 2, internal migration is marked first by suburbanization patterns in the 1990s following the reunification of Germany (Gans, 2000; Leibert et al., 2022; Maretzke, 2010) – driven partly by catching up of eastern Germany where suburbanization had previously been discouraged by the state. This period is followed by a shift to re-urbanization with rising migration to large cities in the first decade of the 2000s—peaking between roughly 2005 and 2011. A return to suburbanization (and to a smaller degree counter-urbanization) followed—after 2011, net moves out of large cities first declined, then turned increasingly negative, a pattern continuing through today. In 2020, during the COVID-19 pandemic, the total level of migration dropped, but the overall patterns of out-migration from large cities to other regions remained (Stawarz et al., 2022; Stawarz & Sander, 2020; Stawarz et al., 2021). This pattern has been consistent, in general, with the so-called "Concept of Differential Urbanization," which postulates that cities of differing size experience continuous cycles of net growth due to varying migration patterns over time (Geyer & Kontuly, 1993).

[1] The classification across the urban-rural spectrum is based on counties and subject to MAUP issues Openshaw (1984)– the analysis is scale dependent. However, due to data limitations, projections on the municipality level are beyond the scope of this paper. Some medium sized cities of similar population size, for example, are either independent city counties of unitary authority (comprising only the area of the city) or part of larger counties, where the population density ranges from urban to suburban and different degrees of rural.

Nonetheless, the cyclical "urban-rural" helix narrative and the role it plays in the redistribution of population at a local level remains decidedly complex. Not all cities continuously gain population during periods of urbanization, and migration patterns remain unique within and between rural regions and individual labor markets, which is especially influenced by the structural capacity of a region (Busch, 2016; Maretzke, 2016; Stawarz & Sander, 2020). While the specific dynamics that have contributed to the development of regional migration patterns in Germany are less studied (Kemper, 2004), they are important to understanding the potential future of internal patterns of migration in Germany, even if some of these factors themselves cannot be predicted given the lack of disaggregated spatial data in Germany.

Between 1995 and 2010, the overall intensity of inter-county migration remained quite stable, but there were nevertheless large increases in intensity of migration in the age groups 18-24 and 25-29, associated with educational and early career moves (Shuttleworth & Champion, 2021). Additionally, increased housing costs are found to have been positively correlated to net outmigration out of urban areas in Germany since at least 2004. In other European countries, similar suburbanization/re-urbanization processes have been recognized (Dembski et al., 2021; Karsten, 2020).

In the 1990s, young adults and families, i.e. those age groups with the highest propensity to migrate, were responsible for a large amount of the suburbanization occurring in Germany, specifically from urban centers to their hinterland (Stawarz & Sander, 2020). This process was driven by an unprecedented number of households, and therefore demand for housing with good access to vital infrastructure, such as schools and other local amenities, that were more affordable in suburban areas (Buch et al., 2014). In fact, outside of the periods of high east-to-west migration, the average distance moved between counties is not very high. This implies that decisions for these internal movements are not determined predominantly by search for employment but rather by the perceived advantages of living in one type of area over another, within a region defined by convenient commuting distances to existing jobs (Busch, 2016; Stawarz & Sander, 2020).

The age distribution of internal migration described above can have an additional impact on population change at a sub-regional level. In areas that gain from migration, a higher number of women in childbearing age can result in a larger number of children born, even if fertility rates remain low. Thus, the variation in internal migration patterns, specifically among younger ages, are especially important as a factor in setting assumptions for population projections. In addition, the COVID-19 pandemic and the establishment of widespread telecommuting possibilities has also been found to play a role in both the total level of internal migration and migration out of large cities in 2020 (Stawarz et al., 2022) .

Moreover, distinct patterns of migration between former East and West Germany also contribute to the overall picture of internal migration. After an exceptionally high inflow of East Germans to the west directly following German reunification in 1990, east to west migration patterns gradually declined but remained high (Stawarz et al., 2020). This level again peaked in 2002 during a period of economic stagnation in eastern Germany, before slowly declined to its current level. Conversely, relatively low migration persisted from west to east until 2017, when for the first-time, migrants from the west to the east (including former West Berlin) exceeded those from east to west.

Many aspects of East-west migration have a larger influence on overall migration patterns. While push and pull factors related to age, sex, and education, such as employment opportunities, play a role in the individual decision to migrate, the aggregation of these individual migration decisions plays a significant role in subnational population change. East Germans with higher educational levels, existing networks in the west, and interest in employment opportunities with better wages more often migrated westward than others – and were on average younger than the mean age of their population of origin (Glorius, 2010). The effect of these internal patterns on population decline in East Germany was large and widespread. Due to demographic momentum, not only did ageing accelerate in former East German counties, both rural areas and large industrial cities lost large quantities of inhabitants both directly after reunification and in the decades following (Schlömer, 2010). However, since 2017 net positive outmigration from former East Germany ceased, driven by internal immigration to cities, such as Dresden, Leipzig, and Potsdam – which have experienced a period of economic and demographic rejuvenation. Moreover, Berlin and surrounding counties also experience net internal gains from throughout Germany. This reversal in east-west migration is, nonetheless, heavily weighted towards a relatively small number of thriving areas. The majority of rural counties and lesser urban centers continue to witness a 30-year paradigm of outmigration, population loss and a vicious circle of shrinking (Stawarz et al., 2020).

2.2 International migration patterns in Germany

Generally speaking, international migration in Germany since reunification can be characterized as net positive, mostly directed towards structurally strong agglomerations and large cities, and with periodic surges due to international conflicts. The countries of origin of migrants and the circumstances under which their migration to Germany has taken place have evolved over time. Immigration increased and became more heterogeneous. New forms of migration, such as family unification, supplemented and later replaced the immigration of "guest workers" that dominated immigration from the late 1950s to the "oil crisis" in the early 1970s (Milewski & Swiaczny, 2012). In the late 1980s and especially following the reunification of Germany in 1990, immigration was initially characterized by resettled ethnic Germans, or "(Spät) Aussiedler", and asylum seekers and refugees, for example from former Yugoslavia (Heider et al., 2020).

While migration overall declined during the second half of the 1990s and remained relatively low until about 2010, the share of migrants coming from member states of the enlarged European Union (EU) started to increase. From 2010, immigration increased again. This migration under new EU freedom of movement comprised in particular persons from southern and eastern European countries. The number of international students attracted to university cities also increased in recent decades.

At the same time, Germany was the destination of a rising number of asylum seekers and refugees during the last decade. In 2015, net migration peaked at 1.1 million persons – the net balance of 2.1 million immigrants and 1 million emigrants – most of them refugees from countries such as Syria and Afghanistan. Most recently, between Russia's invasion of Ukraine on February 24 2022 and March 2023, more than one million refugees from Ukraine were registered in Germany (Sauer et al., 2023). These trends demonstrate that Germany has been a country of immigration for decades. With migrants coming to Germany from a wide range of countries of origin, Germany has gained demographically – not only did immigration compensate partly for the consequences of low fertility, the population is now also more diverse than it was in the past (A. G. Champion, 1994; Deschermeier, 2016; Heider et al., 2020).

Nonetheless, the extent to which international migration contributes to the population dynamics at the subnational level varies widely by region (Heider et al., 2020; Körner-Blätgen & Sturm, 2015) and is generally based on the background and preferences of international migrants (Heidland et al., 2021). Despite variation in the age, educational level, country of origin, and other background factors of migrants, especially large cities throughout Germany and structurally strong counties, particularly in the south and west of the country, have attracted a larger number of immigrants in the recent past as an initial location within Germany and continue to do so today, despite tight housing markets (Gans, 2017; Tanis, 2020). The reasons for the choice of destination is not necessarily due to sheer population size of the destination region itself but is also associated with the specific features of these cities and counties, namely traditional pull factors such as previously existing contact networks ("network migration") and economic and social opportunities, such as education and jobs (Haas, 2010; Lehmann & Nagl, 2019; Tanis, 2020).

However, not all immigrants are free to decide on their place of residence. In years of high refugee migration, the spatial distribution of incoming migrants varies from the normal patterns because incoming asylum seekers and refugees – in contrast to other forms of immigration - are initially distributed proportionally across the German states according to the “Königstein Key” via the “EASY” system (“Initial Distribution of asylum seekers” (EASY)), and the states can then reallocate asylum seekers and refugees to a place of residence within the respective state where they must stay while their application is processed (Deutscher Bundestag, 2015).[1] Thus, during years of high inflow of asylum seekers and refugees, the relocation from the place of initial immigration to the assigned place of residence creates additional cases of internal migration, which are reflected in inflated internal migration flows. Subsequent internal migration after receiving a residence permit that includes freedom of movement is again directed towards cities and other preferred counties of internal migration. Of note, Ukrainian migrants entering Germany due to the Russian invasion beginning in 2022 are not subjected to these same regulations and are free to move within the country as desired (Sauer et al., 2023). The population projections in this paper must reflect these complex and volatile internal migration processes.

3 Data and methods

3.1 Data and model

The projections in this paper are calculated using a cohort component model with single year sex- and age- groups based on unique fertility, mortality, and migration assumptions for all 401 counties (Preston et al., 2001). The base year of the model is 2021, and the projection horizon is 2070.

The input data for our model primarily comes from the input data used in the BBSR projections to be published in 2024.[2] County level mortality and fertility assumptions are based on past trends from data collected by the German Federal Statistical Office. Age-specific fertility rates for each county were calculated by the BBSR, based on a clustering-analyses to group similar counties and extrapolate rates based on differences between and within the identified clusters until 2032, where they remain constant at around 1.6 children per woman until 2070 (2040 in the official BBSR projections). For more information, the specific calculation of input data is found in the BBSR technical report (Maretzke et

[1] https://www.bamf.de/EN/Themen/AsylFluechtlingsschutz/AblaufAsylverfahrens/Erstverteilung/erstverteilung-node.html
[2] Official projections by the BBSR are made using the SIKURS program. Projections made for this paper are made using an R script that replicates the results computed with SIKURS.

al., 2021). Mortality rates decline modestly until 2051, where life expectancy ranges between 81.1 (males) and 84.9 (females), then are held constant until 2070, in accordance with the BBSR assumptions. Within our projection model, international emigration is calculated as an age specific percentage of the current county population, which is then summed and added to a yearly net international migration number to get the total number of projected immigrants. The net number of expected immigrants are first allocated to counties, where they are then distributed by age according to the county-specific age profile. For example, university cities receive a different age distribution of immigrants than other counties with high immigration due to other processes. Internal migration flows between each pair of counties is calculated according to a 401 by 401 probability matrix of the expected proportion of the age- and sex-specific population in county *i* assumed to migrate to county *j*.

While each county's trajectory in each scenario is unique, we aggregate 401 county level results to the four distinct county types based on the common BBSR classification (see Table 1 and Figure 1) in order to better contextualize projected differences along the urban-rural continuum.

3.2 Migration scenarios

In order to understand the possible future evolution and spatial distribution of the German population and given the variability of migration patterns over time, we consider three unique future scenarios for both international and internal migration patterns and present the results of nine unique combinations of these scenarios.

The assumptions for the internal migration scenarios are based on past trends for the four county types and attempt to capture the different phases of the internal migration helix described in section 2.2, namely the urbanization observed in the early 2000s and the suburbanization trends occurring in the 1990s and again in recent years (left Panel in Figure 2). These scenarios are constructed by using the smoothed average proportion of county *i* that migrates to county *j* each year during the periods of 2006-2011 for the urbanization scenario and 2017-2021 for the suburbanization scenario. The period 2015-2016 has been excluded because of the distortion created by the exceptional immigration of refugees. The "baseline" internal migration scenario uses the average of the years 2006-11 and 2017-21, which captures an average of past suburbanization and urbanization trends (left panel in Figure 2).

We also incorporate three scenarios of international migration by varying the level of net immigrants consistent with the high, medium, and low variants of the official "15th Coordinated Population Projection of Germany" (Statistisches Bundesamt [Destatis], 2022a). Each of these variants considers the large influx of Ukrainian migrants in 2022. The peak observed level of migration in 2022 is modeled to steadily decline until 2032, when the numbers are held constant until 2070 at 150,000; 250,000; and 350,000 net migrants per annum for the low, medium, and high scenarios respectively.

Note on war in Ukraine**:** In our projections, we take special care when distributing the more than one million Ukrainian migrants to Germany in 2022 due to the onset of the Ukrainian war. Before the outbreak of the war, the distribution of Ukrainians throughout Germany was different compared to other non-German populations, and the distribution of Ukrainian refugees also differed from the expected overall distribution of international in-migrants in the model, as Ukrainian refugees were allowed to freely migrate to and within Germany (Heider et al., 2020; Kosyakova, 2022). To factor these migrants into our projections, we allocate them according to their unique age and sex distribution, as well as by the relative distribution of registered Ukrainian refugees at the county level in 2022 using data from the German Central Register of Foreign Nationals (BAMF-Forschungsdatenzentrum, 2023).

4 Results

Table 2: Characteristics of projected population development by County Type and migration scenario combination, in 2021, 2040 and 2070

County Type	Migration Scenarios: Interna-tional	Migration Scenarios: Internal	Total Population in 1000s: 2010	2021	2040	2070	Mean Age: 2010	2021	2040	2070	Mean County Population in 1000s (sd): 2021	2040	2070	Mean County Percent Change from 2021 (sd): 2040	2070
Type 1 (n=67)	Low	Suburbanization	23368	24445	24103	22259	42.6	42.4	42.8	43.0	364.85 (511.57)	359.75 (519.32)	332.22 (490.19)	-2.35 (4.03)	-10.51 (5.63)
Type 2 (n=132)			31796	32299	31932	29025	43.0	44.4	45.5	45.3	244.69 (151.76)	241.91 (149.8)	219.89 (137.28)	-1.19 (5.01)	-10.31 (7.46)
Type 3 (n=100)			14232	14258	13860	12444	43.8	45.3	46.8	46.4	142.58 (66.05)	138.6 (63.75)	124.44 (58.03)	-2.68 (7.13)	-12.51 (10.84)
Type 4 (n=102)			12355	12236	11791	10526	44.3	46.0	47.5	47.1	119.96 (56.03)	115.6 (56.89)	103.19 (53.38)	-4.59 (7.75)	-15.39 (11.78)
Type 1 (n=67)		Baseline			24678	23093			42.8	43.2		368.33 (537.27)	344.67 (516.95)	-0.85 (4.43)	-8.43 (6.4)
Type 2 (n=132)					31874	29022			45.5	45.2		241.47 (150.8)	219.87 (139.22)	-1.5 (5.28)	-10.51 (8.23)
Type 3 (n=100)					13649	12129			46.8	46.3		136.49 (63.26)	121.29 (57.48)	-4.13 (7.37)	-14.67 (11.44)
Type 4 (n=102)					11498	10067			47.7	47.0		112.73 (54.63)	98.7 (50.01)	-6.6 (7.12)	-18.59 (11.17)
Type 1 (n=67)		Urbanization			25180	23835			42.8	43.3		375.82 (552.51)	355.74 (540.03)	0.52 (6.74)	-6.47 (9.58)
Type 2 (n=132)					31813	28994			45.5	45.2		241.01 (151.89)	219.65 (141.58)	-1.81 (6.45)	-10.79 (10.25)
Type 3 (n=100)					13462	11846			46.9	46.2		134.62 (63.02)	118.46 (57.54)	-5.42 (8.11)	-16.65 (12.71)
Type 4 (n=102)					11257	9690			47.8	47.0		110.36 (52.89)	95 (47.69)	-8.17 (7.95)	-21.09 (12.35)
Type 1 (n=67)	Medium	Suburbanization			24972	24285			42.5	42.7		372.71 (540.18)	362.46 (537.76)	0.98 (4.35)	-2.6 (6.34)
Type 2 (n=132)					32855	31439			45.2	45.0		248.9 (154.08)	238.17 (148.53)	1.66 (5.44)	-2.83 (8.42)
Type 3 (n=100)					14226	13430			46.5	46.1		142.26 (65.35)	134.3 (62.55)	-0.06 (7.69)	-5.5 (12.11)
Type 4 (n=102)					12078	11331			47.2	46.8		118.41 (58.32)	111.09 (57.52)	-2.24 (8.19)	-8.88 (12.98)
Type 1 (n=67)		Baseline			25562	25178			42.5	42.8		381.52 (558.54)	375.79 (566.28)	2.53 (5.12)	-0.36 (7.59)
Type 2 (n=132)					32793	31429			45.2	44.9		248.43 (155.13)	238.09 (150.67)	1.34 (5.88)	-3.07 (9.43)
Type 3 (n=100)					14010	13094			46.5	46.0		140.1 (64.87)	130.94 (62.03)	-1.54 (8.01)	-7.81 (12.82)
Type 4 (n=102)					11780	10844			47.4	46.7		115.49 (56.04)	106.32 (54.01)	-4.29 (7.66)	-12.26 (12.45)
Type 1 (n=67)		Urbanization			26077	25972			42.5	43.0		389.22 (574.14)	387.64 (590.88)	3.95 (7.6)	1.76 (11.1)
Type 2 (n=132)					32728	31393			45.2	44.9		247.94 (156.27)	237.82 (153.24)	1.02 (7.14)	-3.39 (11.67)
Type 3 (n=100)					13817	12791			46.6	45.9		138.17 (64.65)	127.91 (62.16)	-2.87 (8.78)	-9.93 (14.19)
Type 4 (n=102)					11533	10444			47.5	46.6		113.07 (54.3)	102.39 (51.62)	-5.88 (8.69)	-14.91 (13.92)
Type 1 (n=67)	High	Suburbanization			25840	26312			42.2	42.4		385.68 (561.08)	392.71 (585.38)	4.32 (4.79)	5.31 (7.18)
Type 2 (n=132)					33778	33853			44.9	44.7		255.89 (158.38)	256.47 (159.82)	4.52 (5.92)	4.65 (9.44)
Type 3 (n=100)					14592	14417			46.2	45.8		145.92 (66.96)	144.17 (67.1)	2.56 (8.31)	1.51 (13.44)
Type 4 (n=102)					12365	12136			47.0	46.5		121.23 (59.77)	118.98 (61.68)	0.11 (8.66)	-2.35 (14.21)
Type 1 (n=67)		Baseline			26447	27264			42.2	42.6		394.73 (579.85)	406.92 (615.66)	5.91 (5.87)	7.72 (8.84)
Type 2 (n=132)					33712	33836			44.9	44.7		255.39 (159.48)	256.33 (162.15)	4.18 (6.5)	4.37 (10.68)
Type 3 (n=100)					14370	14060			46.2	45.7		143.7 (66.51)	140.6 (66.63)	1.04 (8.68)	-0.95 (14.25)
Type 4 (n=102)					12061	11622			47.1	46.4		118.24 (57.47)	113.94 (58.03)	-1.97 (8.24)	-5.93 (13.76)
Type 1 (n=67)		Urbanization			26976	28110			42.2	42.7		402.62 (595.8)	419.55 (641.78)	7.39 (8.5)	9.99 (12.66)
Type 2 (n=132)					33644	33792			44.9	44.6		254.88 (160.68)	256 (164.93)	3.84 (7.85)	4.01 (13.1)
Type 3 (n=100)					14173	13737			46.3	45.6		141.73 (66.31)	137.37 (66.81)	-0.32 (9.49)	-3.21 (15.71)
Type 4 (n=102)					11809	11198			47.2	46.3		115.78 (55.73)	109.79 (55.57)	-3.59 (9.46)	-8.72 (15.51)

Across all nine migration scenario combinations, the projected total population for Germany in 2070 ranges between 74.25 million (suburbanization internal and low international) and 86.84 million inhabitants (urbanization internal and high international). Our projections show that overall the population of Germany is expected to decline in the future, but the level to which this occurs is dependent on the amount of international migration, which is in line with results from other national-level projections (Deschermeier, 2016; Fuchs et al., 2021; Destatis, 2022a). For example, the official "15th Coordinated Population Projection of Germany" projects between 74.5 (low international migration) and 89.8 (high international migration) million inhabitants. Our projections likely differ from these official ones due to the dynamism of our internal migration matrix and slightly different assumptions regarding mortality and fertility. The results in Figure 3 index the impact of varying internal and international migration scenarios in each of the four county types to the 2021 base population – a value higher than 1 is equal to a gain in that county type's population in the given scenario and year relative to the 2021 population, and a value lower than 1 is equal to a loss. In each inset, the distribution of the total expected loss/gain percentage in 2040 for each scenario of every county in the subgroup shows the variation in individual county projected population dynamics.

The expected growth of Type 1 counties varies widely according to both international and internal scenarios, but at the end of the horizon period, a gradient from most projected growth (15%) to loss (-9%) exists from high to low net international migration, and from urbanization to suburbanization internal migration scenarios. In nearly all projected high and middle international scenarios, the total population of Type 1 counties is expected to be higher in 2070 than in 2021. The population in the middle international migration scenario will peak before the end of the projection period. Overall, for Type 1 counties, the level of international migration will play the largest role in the extent of population gain or loss, as international migrants often settle in the largest cities (Heider et al., 2020). However, the difference between projected Type 1 county population in the highest and lowest internal migration scenarios is between 6.4 (International low) and 7.4% (International high), meaning that the amount of population gain or loss in Type 1 counties also depends on internal migration patterns. Contrary to the important role of internal migration in Type 1, 3, and 4 counties, the projected change of population in Type 2 counties is scarcely affected by the assumed internal migration scenario. Instead, the migration matrices in all scenarios, show remarkable stable internal flows to and from Type 2 counties, and thus the expected population change, ranging between 5% growth and 10% loss, is projected to depend nearly entirely on the level of international migration.

The projected population change of Type 3 counties by scenario is similar to that of Type 1 counties with two obvious differences. The expected total gain or loss of the population between the base year and 2070 in Type 3 counties is much lower than in Type 1 counties. Type 3 counties are only projected to experience a small increase of less than 1% compared to 2021 in the high international/suburbanization scenario. These counties are projected to experience a loss of up to 2.4 million, roughly 17% of the 2021 population, in other scenarios. Additionally, the internal migration gradient among Type 3 counties is opposite to that of Type 1 counties, as suburbanization scenarios would mitigate some of the expected loss, while Type 1 counties obviously profit demographically from urbanization scenarios. In no combination of international and internal scenarios does the total projected population of Type 4 counties grow, and in fact, a scenario of internal urbanization and low international migration suggests a loss of more than 20% of the total population by 2070. Nonetheless, the distribution of growth in individual Type 4 counties also reveals a bimodal peak in most scenarios; not all Type 4 counties are expected to lose population relative to 2021 in 2040, despite overall projected loss, highlighting the major differences between structurally strong and weak regions in rural areas (Maretzke, 2016).

Table 3: Components of population change per 1000 inhabitants, by county type and migration scenario combination, in 2040 and 2070

County Type	Migration scenario combination		Deaths		Births		Net internat. migration		Net internal migration	
	International	Internal	2040	2070	2040	2070	2040	2070	2040	2070
Type 1	Low	Baseline	-11,20	-10,96	9,92	9,24	2,42	2,24	-2,44	-2,76
		Suburbanization	-11,37	-10,59	10,05	9,11	2,79	2,61	-3,54	-3,46
		Urbanization	-11,05	-11,29	9,81	9,35	2,10	1,91	-1,50	-2,12
	Medium	Baseline	-10,84	-11,41	9,99	10,11	3,85	3,78	-2,65	-3,22
		Suburbanization	-11,00	-11,03	10,12	9,97	4,26	4,19	-3,78	-4,01
		Urbanization	-10,70	-11,75	9,88	10,23	3,51	3,42	-1,69	-2,50
	High	Baseline	-10,50	-11,86	10,06	10,99	5,18	5,32	-2,85	-3,67
		Suburbanization	-10,66	-11,46	10,18	10,84	5,62	5,75	-3,99	-4,55
		Urbanization	-10,37	-12,21	9,95	11,11	4,81	4,93	-1,87	-2,87
Type 2	Low	Baseline	-13,45	-12,38	8,67	7,95	1,50	1,47	0,65	0,63
		Suburbanization	-13,42	-12,37	8,63	7,91	1,43	1,41	0,71	0,66
		Urbanization	-13,48	-12,37	8,71	7,99	1,57	1,53	0,58	0,58
	Medium	Baseline	-13,08	-12,84	8,75	8,68	2,54	2,55	0,75	0,77
		Suburbanization	-13,05	-12,84	8,71	8,63	2,47	2,48	0,81	0,81
		Urbanization	-13,11	-12,84	8,79	8,71	2,62	2,62	0,67	0,71
	High	Baseline	-12,73	-13,31	8,82	9,40	3,52	3,62	0,84	0,91
		Suburbanization	-12,70	-13,31	8,78	9,35	3,45	3,55	0,90	0,96
		Urbanization	-12,76	-13,30	8,86	9,35	3,60	3,70	0,75	0,84
Type 3	Low	Baseline	-15,00	-12,94	8,08	9,35	1,72	1,72	1,34	1,51
		Suburbanization	-14,84	-13,23	8,02	9,35	1,51	1,48	2,02	2,00
		Urbanization	-15,15	-12,68	8,13	9,35	1,92	1,94	0,69	1,07
	Medium	Baseline	-14,61	-13,39	8,15	9,35	2,68	2,71	1,44	1,74
		Suburbanization	-14,46	-13,69	8,09	9,35	2,45	2,46	2,14	2,28
		Urbanization	-14,76	-13,13	8,21	9,35	2,90	2,95	0,78	1,24
	High	Baseline	-14,25	-13,84	8,22	9,35	3,58	3,70	1,53	1,96
		Suburbanization	-14,09	-14,15	8,16	9,35	3,33	3,42	2,25	2,55
		Urbanization	-14,39	-13,57	8,28	9,35	3,81	3,95	0,86	1,41
Type 4	Low	Baseline	-16,04	-13,24	7,72	9,35	1,77	1,76	1,88	2,16
		Suburbanization	-15,77	-13,74	7,68	9,35	1,49	1,45	2,98	2,89
		Urbanization	-16,27	-12,80	7,76	9,35	2,01	2,01	0,92	1,53
	Medium	Baseline	-15,65	-13,68	7,78	9,35	2,66	2,68	2,01	2,46
		Suburbanization	-15,39	-14,20	7,74	9,35	2,35	2,35	3,13	3,28
		Urbanization	-15,88	-13,24	7,82	9,35	2,92	2,95	1,04	1,76
	High	Baseline	-15,28	-14,13	7,85	9,35	3,50	3,59	2,14	2,76
		Suburbanization	-15,03	-14,66	7,80	9,35	3,17	3,24	3,27	3,67
		Urbanization	-15,50	-13,67	7,89	9,35	3,78	3,88	1,15	1,99

4.1 Spatial distribution of population change over time

At the county level, noticeable regional trends can be discerned. Figure 4 illustrates the number of our migration scenarios (out of 9) in which the population of counties grows from 2021 to 2040 (left) and to 2070 (right) respectively. The inset bar graphs show the distribution of this 0-9 gradient by county type. Thus, the white counties are projected to gain population in no scenario, while the black counties are projected to experience population growth in all scenarios. The colors in between show the relative uncertainty in population dynamics (loss or gain) depending on the assumed migration patterns. Given that the expected initial growth of the population in Germany is projected to slow down over time, it is unsurprising that in 2070, many more counties are expected to lose population under all scenarios, relative to the situation in 2040.

Despite the variation of projected patterns across all scenarios, there are still some counties expected to gain population in all nine scenarios in 2070, and they are not all Type 1 counties. The counties expected to gain include Berlin, other big cities, such as Frankfurt and Hamburg, and some areas in southeast Bavaria. Conversely, we project many counties to experience population loss under all scenarios, in both 2040 and 2070. These are concentrated in much of eastern Germany, parts of northern Bavaria, and rural areas with older populations, such as the Saarland. Of note, the counties that are projected to already lose population by 2040 do not change their path and gain population again in the decades after 2040. This confirms that demographic momentum of population processes holds true for regional population dynamics as well; without extreme shifts in the level and trajectory of migration patterns, a path of growth or shrinking perpetuates itself into the future. Structurally weak areas with an unfavorable age structure and low fertility will be unable to compensate for their relatively high death surpluses—for many counties, the overall trajectories of their demographic future are decided.

4.2 Ageing as a component of projected population change

While we project individual population numbers of counties by varied internal and international scenarios, population change also entails distinct shifts in the age structure and its change over time. Ageing patterns of counties also differ according to their classification along the rural to urban spectrum. We use projected dependency ratios (population 0-17 and 65+ divided by the population 18-64) in Figure 5 as an indicator of demographic ageing. As has been a trend in the last 10 years, all counties are expected to experience tremendous and rapid increases in the dependency ratio until at least 2035, due to the large baby boomer population entering retirement age. From most urban (younger) to rural (older) county types, a noticeable gradient in both the absolute value of this measure as well as the extent of expected increase exists.

While aging in Germany is primarily a result of low fertility, the differences in county age structure are a result of past and projected age-specific migration which continue to affect the rate of aging in individual counties. For large cities, intensive in-migration through internal migration is driven by education and employment in young age groups (18 to 29 years), while cities net-lose a population of younger families (under 18 and 30 to 50 years) to areas with larger or more affordable housing in suburban counties (i.e. Type 2). In contrast, in rural areas, the age structure is much older due to outmigration of younger cohorts in the past and present, and is expected to remain so. Type 1 counties, which have a younger population than others – 42.4 mean age in 2021 versus 46.0 in Type 4 counties – will see an increase from a dependency ratio of 0.57 to between roughly 0.62-0.65 by the first peak in 2035, but Type 4 counties are expected to rise from a current level of around 0.69, already higher than the highest projected ratio in Type 1 counties, to more than 0.85 in 2035, a much larger increase of 0.14-0.19.

Between the different internal migration scenarios, few differences in projected dependency ratios occur, and high net international migration lowers the overall level of dependency ratio, as international migrants are usually younger than the average population. With the expected death of the baby boomer cohorts, the dependency ratio begins to decline in 2036. Towards the end of the projection period, the dependency ratio tends to stabilize, though the extent to which this happens is dependent on the county type. Resulting from the assumption that fertility will remain stable after 2032 and life expectancy will only moderately increase, the projected age structure will become more stable, meaning that the shape of the population diagram is no longer changing. While, the overall values remain much higher at the end of the projections period, some slight differences between the two most rural and two most urban county types exist due to the effect of age-specific migration. Following its peak, although the dependency ratio flattens or begins to slightly decline in Type 3 and 4 counties, urban areas witness another slight increase over time.

Additionally, Table 3 shows each population component of change: deaths, births, internal and international migration as a rate per 1000 residents in 2040 and 2070. Deaths and births constitute the largest drivers of population change. Implicative of the age structures in each county type, the contribution of deaths characterizes a much larger percentage of population change as the county types shift from urban to rural. Due to Germany's persistently low birth rates, the percentage of births as a component of change is lower than deaths, yet there is also a low to high gradient from rural to urban in the number of births as a percentage of the population due to the younger populations in Type 1 and 2 counties. Net internal migration contributes the least to population change in nearly all county types across years and scenarios, with the exception of Type 4 counties during suburbanization scenarios. Net internal migration in Type 2 counties is low (.58-.96 per 1000 residents) compared to international migration (1.41-3.7 per 1000 residents), implicative of the observed reciprocal internal migration trends in and out of Type 2 counties (Rowe et al., 2019). Despite the small value of net migration, internal trends in Type 2 counties are not only stable but also large; total volume of internal migration in each scenario (the sum of in- and out-goers) is higher in Type 2 than in Type 3 or 4 counties.

5 Discussion and conclusion

International migration will continue to be the primary driver of population change in Germany, both for the country and across county types. Yet while the level of change in the future is dependent on the number of immigrants, even the highest level of net international migration does not prevent projected population loss in some counties. The dynamics of the changing population in Germany vary across county types, but the largest span between growth and decline over the projected period is expected for urban Type 1 and 2 counties. Large cities, for example, are expected to experience an initial increase in population, even under a suburbanization scenario that favors rural population growth. However, over the projection horizon, this begins to stagnate. In contrast, most of the rural Type 3 and 4 counties are expected to begin or continue to decline in population, irrespective of the level of international migration.

The analysis performed for our projections showed that it is challenging to anticipate how internal patterns of migration will evolve over time. Overall, projected population change at the subnational level is highly variable, which we tried to capture in our internal migration assumptions. As the observed cyclical helix-shaped trend of internal migration flows over the past 30 years may or may not continue in the future, we cover the extremes of the expected outcome space by defining scenarios based on past periods with high urbanization and suburbanization, in addition to a baseline scenario.

Moreover, the extent to which internal patterns may or may not change is also likely to vary between and within individual metropolitan regions. This overall uncertainty is related to the underlying mechanisms that have driven this trend in the past; it is unclear neither to what extent cohort-specific effects may have played on sub-regional population dynamics, nor the future role that technology may play in reducing the need for certain professions to live close to one's place of employment.

Historically, suburbanization has been driven by factors such as housing constraints (supply and affordability) and access to desired amenities, such as schools and other infrastructure via public and especially private transportation. These particular factors have not been associated with a move to remote rural areas but instead led to the development of suburban areas close to the urban core (Mitchell, 2004). However, if population is expected to decline overall, push and pull factors that played a role in the past may have less impact on the desirability or necessity to migrate in the future. There has nevertheless been a recent trend towards suburbanization, which began even before the COVID-19 pandemic created more opportunities for remote work. Most likely, the increasing cost and shortness of housing observed in many cities contributed to this process (Dembski et al., 2021). The current trend of a net loss of population from cities to other regions also includes rising positive net migration rates to the two most rural county types (counter-urbanization), meaning that the current internal migration patterns cannot directly be explained entirely by the dynamics of out-migration from an urban core to the suburban hinterland (Karsten, 2020; Mitchell, 2004).

Our projections show that the population size of independent cities (Type 1 counties) is particularly variable in the future. As international migrants often initially settle into large cities before subsequent migration within Germany may take place, a robust level of international migration contributes to growth in cities, even when later on, suburbanization patterns of internal migration prevail. In this situation, while internal migrants, including those international migrants who originally came to German cities, move over the life course from Type 1 counties to Type 2, 3, or 4 counties, this out-migration from cities is normally replenished by new immigrants from abroad (and smaller younger cohorts in search for education and early career positions). Nonetheless, subsequent periods of urbanization as well as suburbanization in Germany have caused a relative concentration of the population, resulting in additional development around urban cores (Sander, 2017).

The change in age structure also plays a crucial role in the future population structure of Germany at the subnational level. Urban cores, predominately Type 1 but also to some extent, Type 2 counties, have a younger age structure than Type 3 and 4 counties. In this regard, the larger proportion of females of childbearing age in Type 1 cities – due to past and present migration of young adults to cities – results in relatively more births in urban areas than in rural ones, even if the fertility rate remains universally low. Concurrently, the older age structure in the Type 3 and 4 counties, in combination with higher death rates in older ages, results in more deaths relative to the population, thus contributing to high levels of negative natural population growth. Moreover, the projected level of international migration also contributes to the younger age structure in Type 1 counties, because of the young age composition of international migrants to the cities (Körner-Blätgen & Sturm, 2015).

The population of Germany exceeded 84 million in 2022 due to the influx of refugees from Ukraine, a new absolute record of total population (Destatis, 2022b). The spatial distribution of Ukrainian refugees in Germany differs from the spatial distribution of other immigrants, with substantial numbers having settled in areas with existing Ukrainian population and social networks, including both major cities and counties in eastern Germany. Among the latter are in particular counties that were already experiencing or projected to undergo population decline shortly. The long-term impact these migrants may have on the mitigation of population decline in the receiving areas is unknown; in the future, these refugees may remain in these counties, but they may also migrate internally for economic opportunities, return to Ukraine, or even move to a third country. However, in the first year of the war, very few registered Ukrainian refugees left Germany, and of those that moved within Germany, they generally moved within the same city (Beer et al., 2010; Glorius, 2010; Sauer et al., 2023). While the projections consider the initial distribution of Ukrainian refugees, the potential change of population at the county level, especially while Ukrainians currently comprise approximately 1% of the total German population, is highly contingent on the outcome and consequences of the war.

Regional population projections are subject to uncertainty and depend on assumptions of components of demographic change that are complex to model--the smaller the level of scale, the greater the challenges in accurately estimating and projecting rates. While fertility and mortality rates have been relatively stable in recent decades and it is reasonable to expect that they remain so, migration patterns are largely inconsistent, and it is therefore difficult to develop plausible future scenarios of movement. We have shown that internal—and to an even greater extent international — migration patterns are not only a source of uncertainty in projections but when altered, can lead to a wide span of potential outcomes, which range from continuous growth with moderate ageing to steep decline and intense ageing. In contrast to different degrees of growth, a shrinking population is often part of and can reinforce a vicious circle of economic downturn and loss of employment, trigger additional selective out-migration and ageing as well as disinvestment in housing, infrastructure etc. Such depopulation processes often start and are concentrated in peripheral rural areas or urban areas in economic crisis, where living conditions and quality of life are under threat, and socioeconomic inequality and spatial disparities are increasing. Furthermore, in sparsely populated areas, population decline has more severe implications for policy making and spatial planning. Despite the challenges associated with population loss, such as reduced carrying capacity for infrastructure and vital services when cities shrink, they nonetheless continue to serve their respective hinterlands. However, shrinking rural settlements must adapt to a loss of function with regard to the central place hierarchy, which often entails losing critical services.

Regional population projections, as a basis for policy making and spatial planning, are part of a complex discourse and results can be misused to manipulate decisions. Under such circumstances, predicting regional population decline impacts investment in future development of regions and migration decisions of households and individuals, which can impede private and public investments, thereby creating a self-fulfilling prophecy of a vicious circle of decline. Uncertainty in regional projection outcomes for policy making and spatial planning increases when various scenarios and large prediction intervals indicate both potential growth and decline, which each present different challenges. Given the role that regional projections play, the process in which assumptions are decided should anticipate (negative) impacts of results and be transparent and communicated accordingly to the public, focusing on the role of uncertainty in decision making.

UNECE (Europe, 2019) recommends that projections additionally provide analysis of uncertainty and sensitivity and prepare a range of plausible alternative scenarios and projection variants that are relevant to stakeholders and policy makers. Using Germany as an example, we have shown that even in a traditional cohort-component framework, scenarios for assumptions of internal and international migration are important factors in potential spatial population change. Our scenarios account for a range of potential international and internal migration patterns and thus indicate there is great uncertainty in future spatial population change in Germany.

References

BAMF-Forschungsdatenzentrum. (2023). *AZR-Forschungsdatensatz 2021*. BAMF-Forschungsdatenzentrum. https://www.bamf.de/DE/Themen/Forschung/Forschungsdatenzentrum/DatenAZR/daten-azr-node.html

Beer, J. de [J.A.A.], van der Gaag, N. L., van der Erf, R. F., R. Bauer, H. Fassmann, D. Kupiszewska, M. Kupiszewski, P.H. Rees, P. Boden, A. Dennett, M. Jasinska, J. Stillwell, P. Wohland, & Jong, A. de. (2010). *Demographic and migratory flows affecting European regions and cities: final report DEMIFER*. European Spatial Planning Observation Network (ESPON).

Benassi, F., Busetta, A., Gallo, G., & Stranges, M. (2023). Neighbourhood effects and determinants of population changes in Italy: A spatial perspective. *Vienna Yearbook of Population Research*, *21.* https://doi.org/10.1553/p-5dfz-c44a

Buch, T., Hamann, S., Niebuhr, A., & Rossen, A. (2014). What Makes Cities Attractive? The Determinants of Urban Labour Migration in Germany. *Urban Studies*, *51*(9), 1960–1978. https://doi.org/10.1177/0042098013499796

Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR). (2021). *Siedlungsstruktureller Kreistyp*. https://www.bbsr.bund.de/BBSR/DE/forschung/raumbeobachtung/Raumabgrenzungen/deutschland/kreise/siedlungsstrukturelle-kreistypen/kreistypen.html

Bundesinstitut für Bevölkerungsforschung (BiB). (2023). *Binnenwanderungssaldo der Stadt- und Landkreise nach Kreistypen (1991-2021)*. https://www.bib.bund.de/DE/Fakten/Fakt/M41-Binnenwanderungssaldo-Kreistypen-ab-1991.html

Busch, R. (2016). Inländische Wanderungen in Deutschland – wer gewinnt und wer verliert? *Zeitschrift für Immobilienökonomie*, *2*(2), 81–101. https://doi.org/10.1365/s41056-016-0012-3

Cafaro, P., & Dérer, P. (2019). Policy-based Population Projections for the European Union: A Complementary Approach. *Comparative Population Studies*, *44.* https://doi.org/10.12765/CPoS-2019-14

Champion, A. G. (1994). International Migration and Demographic Change in the Developed World. *Urban Studies*, *31*(4-5), 653–677. https://doi.org/10.1080/00420989420080621

Dembski, S., Sykes, O., Couch, C., Desjardins, X., Evers, D., Osterhage, F., Siedentop, S., & Zimmermann, K. (2021). Reurbanisation and suburbia in Northwest Europe: A comparative perspective on spatial trends and policy approaches. *Progress in Planning*, *150*, 100462. https://doi.org/10.1016/j.progress.2019.100462

Deschermeier, P. (2016). Einfluss der Zuwanderung auf die demografische Entwicklung in Deutschland. *IW-Trends – Vierteljahresschrift Zur Empirischen Wirtschaftsforschung*, *43*(2), 21–38. https://econpapers.repec.org/article/zbwiwktre/157227.htm

Deutscher Bundestag (2015). Asylgesetz: AsylG(Abschnitt 5 §45). https://www.gesetze-im-internet.de/asylvfg_1992/index.html

Europe, E. C. f. (2019). *Recommendations on Communicating Population Projections*. United Nations.

Findlay, A. M., & White, P. E. (2023). *WEST EUROPEAN POPULATION CHANGE*. *Routledge library editions. Demography*. ROUTLEDGE.

Fuchs, J., Söhnlein, D., & Weber, B. (2021). Demografische Entwicklung lässt das Arbeitskräfteangebot stark schrumpfen, *25*(11). https://doku.iab.de/kurzber/2021/kb2021-25.pdf

Gans, P. (2000). Urban Population Change in Large Cities in Germany, 1980-94. *Urban Studies*, *37*(9), 1497–1512. https://doi.org/10.1080/00420980020080231

Gans, P. (2017). Urban Population Development in Germany (2000-2014): The Contribution of Migration by Age and Citizenship to Reurbanisation. *Comparative Population Studies*, *42*. https://doi.org/10.12765/CPoS-2018-01

Gans, P., & Schlömer, C. (2014). Editorial on the special issue "Coping with Local Challenges of Population Decline and Ageing – Case Studies from Germany". Advance online publication. https://doi.org/10.12765/CPoS-2014-08en (3.69 MB / Comparative Population Studies, Vol 39, No 2 (2014): Coping with Local Challenges of Population Decline and Ageing –).

Geyer, H. S., & Kontuly, T. (1993). A Theoretical Foundation for the Concept of Differential Urbanization. *International Regional Science Review*, *15*(2), 157–177. https://doi.org/10.1177/016001769301500202

Glorius, B. (2010). Go west : Internal migration in Germany after reunification. *Belgeo. Revue Belge De Géographie*(3), 281–292. https://doi.org/10.4000/belgeo.6470

Haas, H. de (2010). The Internal Dynamics of Migration Processes: A Theoretical Inquiry. *Journal of Ethnic and Migration Studies*, *36*(10), 1587–1617. https://doi.org/10.1080/1369183X.2010.489361

Heider, B., Stroms, P., Koch, J., & Siedentop, S. (2020). Where do immigrants move in Germany? The role of international migration in regional disparities in population development. *Population, Space and Place*, *26*(8), e2363. https://doi.org/10.1002/psp.2363

Heidland, T., Jannsen, N., Groll, D., Kalweit, R., & Boockmann, B. (2021). *Analyse und Prognose von Migrationsbewegungen*. *Kieler Beiträge zur Wirtschaftspolitik: Vol. 34.*

Karsten, L. (2020). Counterurbanisation: Why settled families move out of the city again. *Journal of Housing and the Built Environment*, *35*(2), 429–442. https://doi.org/10.1007/s10901-020-09739-3

Kemper, F.-J. (2004). Internal Migration in Eastern and Western Germany: Convergence or Divergence of Spatial Trends after Unification? *Regional Studies*, *38*(6), 659–678. https://doi.org/10.1080/003434042000240969

Körner-Blätgen, N., & Sturm, G. (2015). Deutsche Großstädte im Netz internationaler Wanderungen. *Stadtforschung und Statistik : Zeitschrift des Verbandes Deutscher Städtestatistiker*, *28*(2), 2–7.

Kosyakova, Y. (2022). *Regionalstruktur Ukrainischer Communities in Deutschland*. Institut für Arbeitsmarkt- und Berufsforschungvder Bundesagentur für Arbeit. https://doku.iab.de/arbeitsmarktdaten/ADuI_ukrainische_Communities.pdf

Lehmann, R., & Nagl, W. (2019). Explaining spatial patterns of foreign employment in Germany. *Regional Studies*, *53*(7), 991–1003. https://doi.org/10.1080/00343404.2018.1515479

Leibert, T., Wolff, M., & Haase, A. (2022). Shifting spatial patterns in German population trends: local-level hot and cold spots, 1990–2019. *Geographica Helvetica*, *77*(3), 369–387. https://doi.org/10.5194/gh-77-369-2022

Livi Bacci, M. (2017). Does Europe need mass immigration? *Journal of Economic Geography.* Advance online publication. https://doi.org/10.1093/jeg/lbx029

Luy, M., & Pötzsch, O. (2011). Estimates of the Tempo-adjusted Total Fertility Rate in Western and Eastern Germany, 1955-2008. *Comparative Population Studies*, *35*(3). https://doi.org/10.12765/CPoS-2010-14

Maretzke, S. (2010). Der demografische Wandel – eine prägende Begleiterscheinung des ostdeutschen Transformationsprozesses. *Informationen Zur Raumentwicklung*, *11/12*, 787–802.

Maretzke, S. (2016). Demografischer Wandel im ländlichen Raum. So vielfältig wie der Raum, so verschieden die Entwicklung. *Information on Spatial Development*, *2*, 169–187.

Maretzke, S., Hoymann, J., Schlömer, C., & Stelzer, A. (2021). *Raumordnungsprognose 2040 - Bevölkerungsprognose: Ergebnisse und Methodik*. Bonn.

Marois, G., Bélanger, A., & Lutz, W. (2020). Population aging, migration, and productivity in Europe. *Proceedings of the National Academy of Sciences*, *117*(14), 7690–7695. https://doi.org/10.1073/pnas.1918988117

Milewski, N., & Swiaczny, F. (2012). Internationalsierung der Migration und demographischer Wandel. *Schriftenreihe Der Deutschen Gesellschaft Für Demographie*, *5*, 11–41 (Internationalisierung. Die unterschätzte Komponente des demographischen Wandels in Deutschland.).

Mitchell, C. J. (2004). Making sense of counterurbanization. *Journal of Rural Studies*, *20*(1), 15–34. https://doi.org/10.1016/S0743-0167(03)00031-7

Openshaw, S. (1984). *The modifiable areal unit problem*. *CATMO: Vol. 38*. Geo Abstracts Univ. of East Anglia.

Parr, N. (2023). Immigration and the prospects for long-run population decreases in European countries. *Vienna Yearbook of Population Research*, *21.* https://doi.org/10.1553/p-8jf5-7cdc

Preston, S. H., Heuveline, P., & Guillot, M. (2001). *Demography: Measuring and modeling population processes*. Blackwell Publishers.

Rees, P., & Sander, N. (2019). The Role of Internal Migration as a Driver of Regional Population Change in Europe. *Comparative Population Studies*, *44.* https://doi.org/10.12765/CPoS-2020-17

Rees, P., van der Gaag, N., Beer, J. de [Joop], & Heins, F. (2012). European Regional Populations: Current Trends, Future Pathways, and Policy Options. *European Journal of Population / Revue Européenne De Démographie*, *28*(4), 385–416. https://doi.org/10.1007/s10680-012-9268-z

Rowe, F., Bell, M., Bernard, A., Charles-Edwards, E., & Ueffing, P. (2019). Impact of Internal Migration on Population Redistribution in Europe: Urbanisation, Counterurbanisation or Spatial Equilibrium? *Comparative Population Studies*, *44.* https://doi.org/10.12765/CPoS-2019-18

Sander, N. (2017). Germany: Internal migration within a changing nation. In T. Champion, T. Cooke, & I. Shuttleworth (Eds.), *Internal Migration in the Developed World: Are We Becoming Less Mobile?* (1st ed.). ROUTLEDGE.

Sauer, L., Ette, A., Steinhauer, H. W., Siegert, M., & Tanis, K. (2023). Spatial Patterns of Recent Ukrainian Refugees in Germany: Administrative Dispersal and Existing Ethnic Networks. *Comparative Population Studies*, *48.* https://doi.org/10.12765/CPoS-2023-11

Schlömer, C. (2010). Demographic Change in Germany from a spatial point of view: beyond East vs. West. *GeoINova Special Issue*, Article The Evolution of Integration in Europe 20 Years after the fall of the Berlin Wall, 111–129.

Shuttleworth, I., & Champion, T. (2021). Declining internal migration? Patterns, causes and prospects. *Population, Space and Place*, *27*(7), e2501. https://doi.org/10.1002/psp.2501

Statistisches Bundesamt (2022a). 15. koordinierte Bevölkerungsvorausberechnung - Deutschland, Berichtszeitraum 2021 - 2070. https://www.statistischebibliothek.de/mir/receive/DESerie_mods_00007621

Statistisches Bundesamt (Destatis). (2022b). *Germany's population grew strongly in the 1st half of 2022*. https://www.destatis.de/EN/Press/2022/09/PE22_410_12411.html

Stawarz, N., Rosenbaum-Feldbrügge, M., Sander, N., Sulak, H., & Knobloch, V. (2022). The impact of the COVID-19 pandemic on internal migration in Germany: A descriptive analysis. *Population, Space and Place*, *28*(6), e2566. https://doi.org/10.1002/psp.2566

Stawarz, N., & Sander, N. (2020). The Impact of Internal Migration on the Spatial Distribution of Population in Germany over the Period 1991-2017. *Comparative Population Studies*, *44.* https://doi.org/10.12765/CPoS-2020-06

Stawarz, N., Sander, N., & Sulak, H. (2021). Internal migration and housing costs—A panel analysis for Germany. *Population, Space and Place*, *27*(4), e2412. https://doi.org/10.1002/psp.2412

Stawarz, N., Sander, N., Sulak, H., & Rosenbaum-Feldbrügge, M. (2020). The turnaround in internal migration between East and West Germany over the period 1991 to 2018. *Demographic Research*, *43*, 993–1008. https://doi.org/10.4054/DemRes.2020.43.33

Swiaczny, F., Graze, P., & Schlömer, C. (2008). Spatial impacts of demographic change in Germany. *Zeitschrift Für Bevölkerungswissenschaft*, *33*(2), 181–205. https://doi.org/10.1007/s12523-009-0010-9

Tanis, K. (2020). Regional distribution and location choices of immigrants in Germany. *Regional Studies*, *54*(4), 483–494. https://doi.org/10.1080/00343404.2018.1490015

United Nations Department for Economic and Social Affairs. (2023). *World Population Prospects 2022: Summary of results*. United Nations.

United Nations Population Division. (2000). *Replacement migration: is it a solution to declining and ageing populations?* New York.

Vanella, P., Hellwagner, T., & Deschermeier, P. (2023). Parsimonious stochastic forecasting of international and internal migration on the NUTS-3 level – an outlook of regional depopulation trends in Germany. *Vienna Yearbook of Population Research*, *21.* https://doi.org/10.1553/p-5pn2-fmn8

Figures

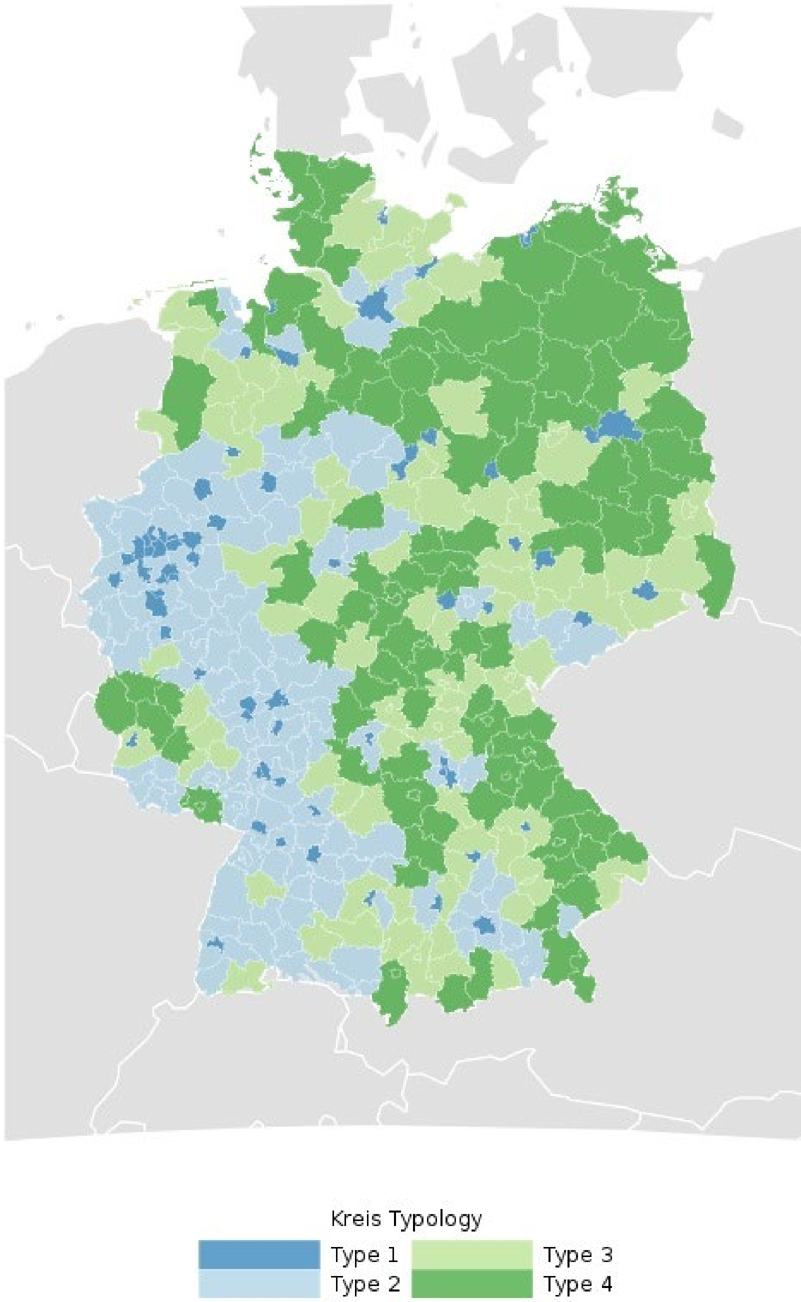

Figure 1: The spatial distribution of the county types as in 2021, where Type 1 is most urban and Type 4 is the most rural. See Table 1 for a description of country types. Source: BBSR.

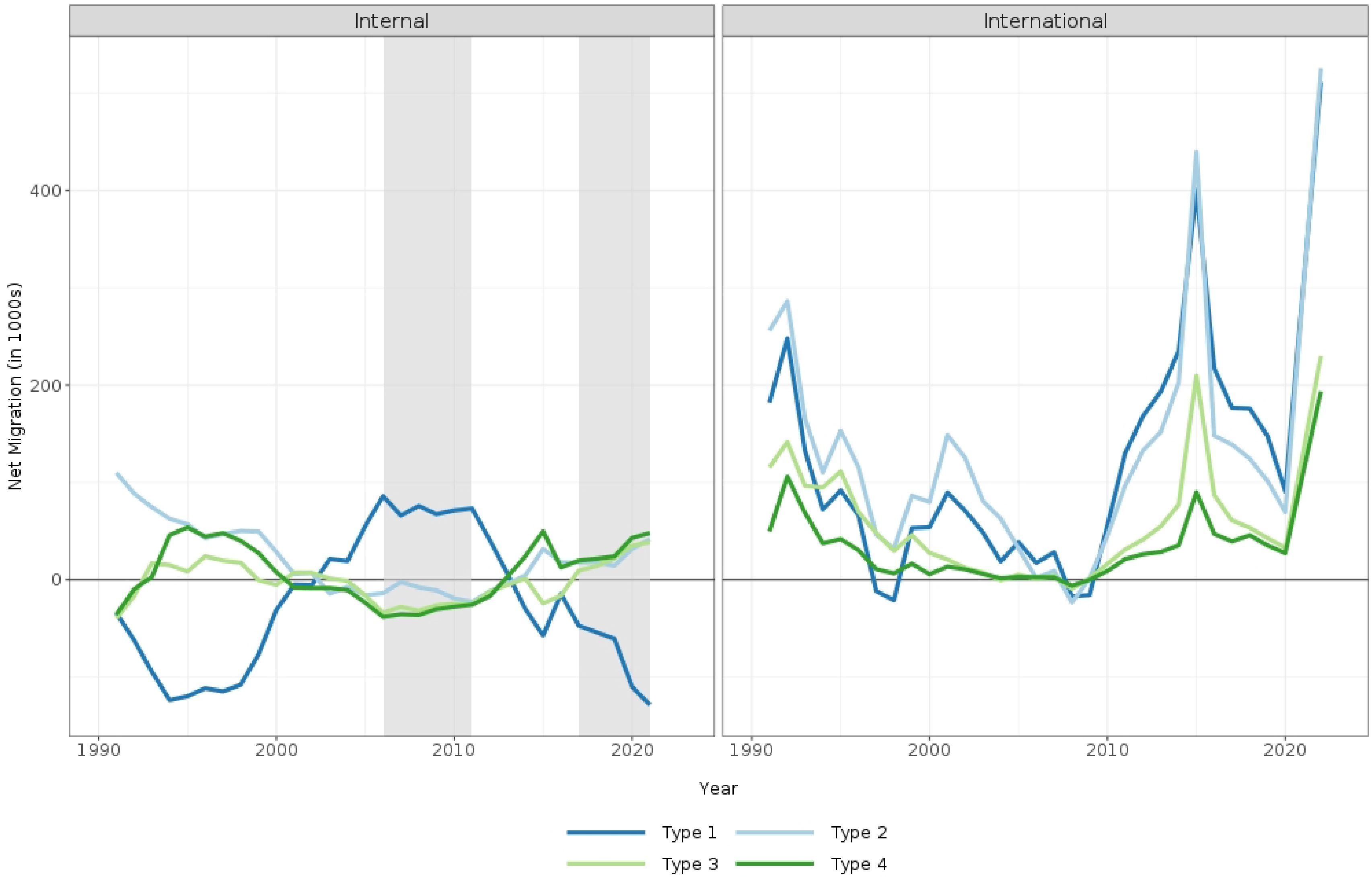

Figure 2: Recent net-internal and net-international migration trends in Germany according to county type. The gray shaded rectangles in the left panel represent the time periods from which the internal scenarios are drawn–the mean values of the left rectangle from 2006-2011 shows the internal migration pattern during the urbanization scenario, the mean values from 2017-2021 in the right panel represent the suburbanization scenario, and the overall average of these two represents our baseline scenario. See Table 1 for a description of country types. Source: INKAR database, based on own calculations

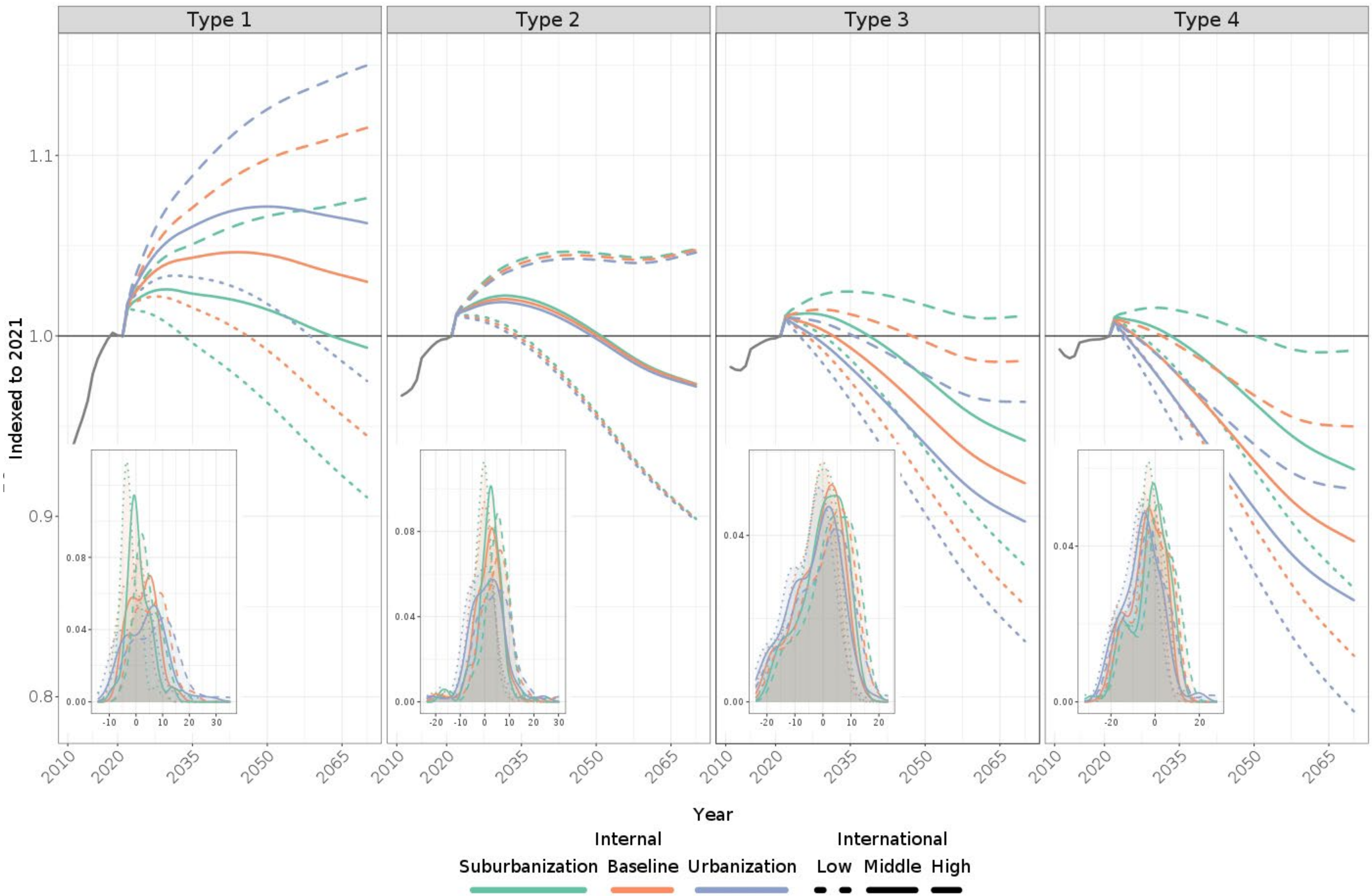

Figure 3: The projected evolution of the total population under nine scenarios for the four county types. Insets show the distribution of individual county trajectories (% projected growth or decline) for each county type in 2040. See Table 1 for a description of country types.

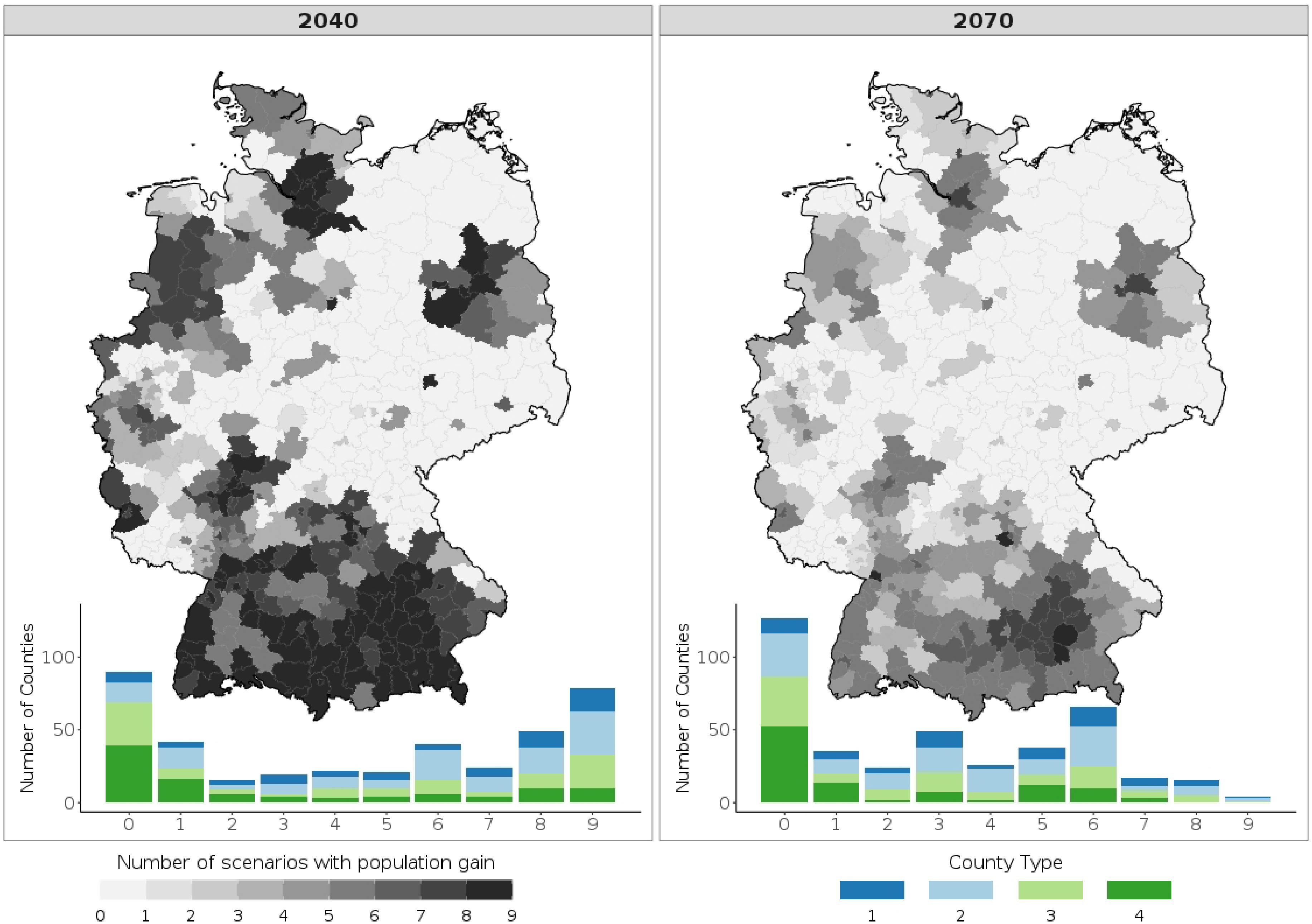

Figure 4: The number of scenarios (out of the nine migration scenarios) in which each county is expected have more population in 2040 and 2070 than the baseline year of 2021. Underneath the maps, this distribution of 0-9 possible scenarios of population growth is shown according to county type. See Table 1 for a description of country types.

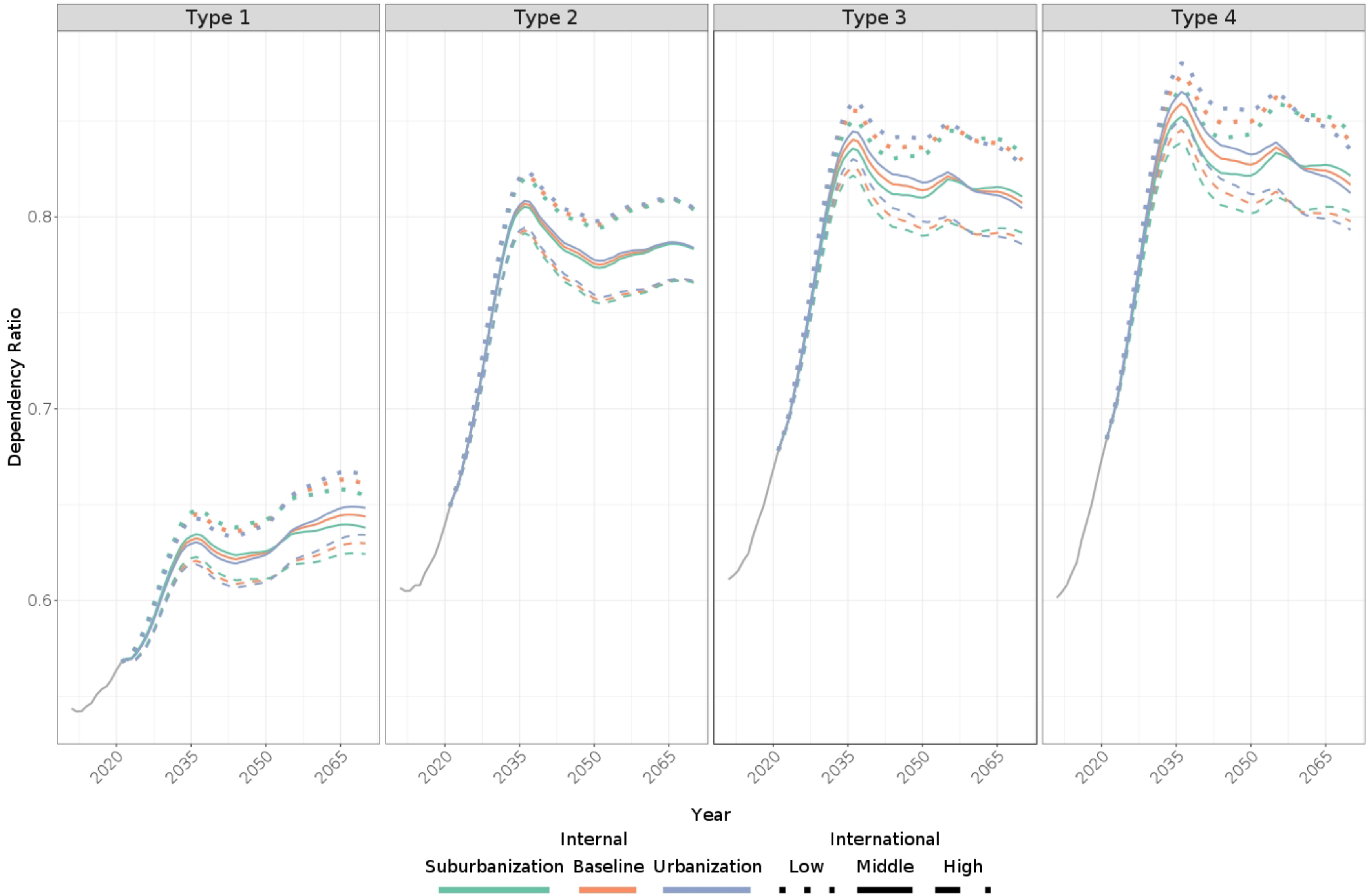

Figure 5: Projected changes in the dependency ratio (population below age 18 and above age 65, in relation to the population aged 18 to 64) until 2070 according to international and internal migration scenarios. See Table 1 for a description of country types.