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Working paper

A Multidimensional Projection of Future Regional Inequalities: Migration and Educational Attainment in Spain 2021–2071

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Abstract

Population projections can be substantially enhanced by incorporating dimensions beyond age and sex. This study presents a multidimensional population projection for Spain by educational attainment, origin, and sub-national region, explicitly accounting for future social heterogeneity. Using data from the Spanish National Statistics Institute (INE) for the period 2017–2023, the baseline population is set in 2021 and projected in five-year intervals through 2071. The projections are disaggregated by three educational levels, five origin groups, and 17 NUTS-2 regions, and implemented within a multistate framework in which education is modelled as a transitioning state. Five projection scenarios are defined, including one that assumes an improvement in the educational composition of migrants. The analysis examines (1) whether the educational profiles of migrants are likely to reinforce ethnostratification; and (2) whether Spanish regions are expected to converge or diverge in terms of educational attainment and origin composition. Results indicate that Spain's total population is projected to peak around mid-century and subsequently decline, with only seven regions experiencing population growth by 2071 under the medium scenario. Educational progress among migrants largely stagnates across regions and origin groups, except in the educational improvement scenario, where educational attainment increases and convergence is observed. Overall, population growth remains uneven and ethnostratification persists, with meaningful reductions in inequality occurring only under assumptions of improved migrant education. These outcomes, however, remain highly contingent on policy choices and sectoral employment structures. This study provides the first regional-level population projection for Spain that jointly incorporates education and origin, highlighting substantial heterogeneity across regions and offering an innovative framework for modelling social stratification in population projections.

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1. Introduction

Spain is a geographically, socio-economically diverse country that has, in recent decades, also become increasingly ethnically diverse. While the population of Spain has long been shaped by low fertility and high life expectancy, regional demographic differentials remain. Population size, density and composition as well as the size and the demographic profile of migrant populations vary significantly across regions. The largest disparities are found between the main urban cores and coastal areas (specifically the Mediterranean regions and the islands) and the interior and north-western areas of the country. Considering the demographic heterogeneity in Spain, in this paper we project the population in 17 NUTS-2 regions by age, sex, educational attainment and region of birth until 2071.

This line of research is framed within the theory of demographic metabolism, which conceptualizes social change as the succession of cohorts and their characteristics over time (Lutz et al., 1998; Lutz, 2012). The concept has been applied to analyse a variety of social transformations — from attitudinal and cultural shifts to changes in religious composition (Goujon et al., 2007; Striessnig, 2019) — but most prominently to human capital projections. Following IIASA literature, we focus on human capital as a qualitative dimension that improves the accuracy of population projections and can substantially improve their outcomes (Lutz, 1994; Lutz and Goujon, 2001; KC et al., 2010). Within the multistate projection framework, educational attainment is particularly well suited for modelling, since transitions occur early in life and follow a hierarchical pattern, with individuals progressing only to higher attainment levels and is an important source of demographic heterogeneity (Lutz and KC, 2011).

Most human capital projections have been conducted at the national level, with only a few focusing on subnational trends — such as those for Turkey (Yücesahin and KC, 2015) and India (KC et al., 2017; 2018). Yet, demographic dynamics are diverse across regions within a country.

In this paper, we focus on Spain, a particularly interesting European case. Spain ranks among the best educated countries in Europe, with 58% of females and 46.3% of males aged 25–34 holding higher education (university and other tertiary education degrees) in 2023 (INE, 2025a). The country combines high educational attainment with very low fertility (Total Fertility Rate = 1.1 in 2024) and one of the highest life expectancies at birth globally (86.34 for females and 81.11 for males in 2023). It also exhibits pronounced regional differences in economic development, labor market specialization, and demographic dynamics (Domingo et al., 2007). Demographically, its regions (NUTS-2) vary substantially in population size, ranging from around 0,32 to 8,67 million inhabitants in 2025 and exhibit considerable heterogeneity in population growth rates.

The expansion of tertiary education in Spain has been rapid, especially among females (INE). Nevertheless, the country exhibits comparatively high proportion (37%) of individuals that have not completed compulsory education from ages 15 to 64, ranking second in the EU in 2024 (Eurostat, 2025a), as well as displaying above average Not in Education, Employment or Training (NEET) rates, with 12% for ages 15-29 in the same year (Eurostat 2025b).

At the national level, earlier studies suggested that Spain continues to display a negative relationship between education and fertility, although this gradient is steeper among foreign-born mothers (Requena, 2022), as well as a generalized postponement for the high educated (Lozano et al., 2024). Regional studies based on the 2011 Census showed consistent results, though with varying intensities, and more recent evidence suggests changing trends (Blanco Iglesias 2024) such as highly educated mothers exhibiting higher parity up to the third child compared to their medium-educated counterparts (Greulich and Toulemon, 2023). Fertility differentials by origin have also been examined, whether in terms of timing, in which migration strategies influence fertility schedules (Devolder and Bueno, 2011), or revealing persistent quantum differences by mothers' region of birth as well as a trend toward convergence to native born mothers' fertility in recent years (Blanes and Esteve, 2025). An illustrative example of these dynamics can be observed among South American and African migrants. A notable characteristic of the largest migrant group, Latin

Americans, is their relatively low fertility levels. This pattern is largely driven by migration selectivity (i.e., migrating after childbearing) and the high turnover of recent 2017–2023 migration, which often delays childbearing. Declining fertility trends in countries of origin further reinforce this pattern. Other groups, such as Africans and Asians, exhibit higher fertility differentials, although these differences are rapidly converging towards native levels.

Regarding mortality, several authors have documented educational differences in lifespan inequality and causes of death (Permanyer et al., 2018; Trias-Llimós et al., 2023), despite such disparities being smaller than in other European countries (Makenbach, 2018). Life expectancy is projected to continue increasing in the coming decades (INE, 2024).

In terms of migration, Spain — like other Southern European countries — transitioned from a country of emigration and internal migration to a major immigration destination over the last two decades. The share of international migrants rose from 3.6% in 2000 to 19.3% in 2025. Latin America (Central and South America) represents the largest origin region (48.6% of foreign-born residents), followed by Europe (25.5%) and Africa (17.4%). Education composition of migrants varies substantially depending on the origin, the 25 years and older population with tertiary education are distributed as follows by place of birth in 2021: Spain 34,8%, Asia and Rest of the World 31,5%, Central and South America 30,9%, Europe 30%, and Africans 10,2% (INE, 2023).

Despite evidence suggesting that certain migrant groups are approaching educational levels of natives, it does not equate to integration within the labour market, since foreign-born workers continue to face considerably worse employment outcomes, e.g, 55.3% of employed non-EU citizens aged 20-64 were overqualified in 2024 (Eurostat 2025c). By contrast, the least-educated group (Africans) occupies a structurally disadvantaged position, concentrated in low-status occupations—particularly intensive agriculture—and faces higher unemployment and precarious employment, situating it at the bottom of Spain's ethnicised labour hierarchies (Domingo et al., 2022; Gastón-Guiu and Bueno, 2024).

These patterns are also linked to regional disparities. While migrants are generally concentrated in low-skilled sectors, regional economies vary greatly in their dependence on specific industries, creating distinct migration niches (Bolíbar, 2020). The agricultural sector, mainly in the south as well as the north-east, predominantly attracts African migrants (Pedreño and Requelme, 2006; Barros, 2017); the tourism and care sectors — the latter widespread across Spain — rely mainly on Latin American workers. Mediterranean regions have also drawn lifestyle and retirement migrants from Western and Northern Europe (Huete et al., 2013; Kordel, 2016). Regions that experienced construction booms have attracted more diversified migrant inflows (Alonso and Furió, 2010).

Although regional differences in fertility and mortality are less pronounced than in developing countries at earlier demographic stages, urban–rural divides remain strong especially in terms of migrations (Collantes et al., 2014). In recent decades, growth trends have diverged substantially, with major urban centres such as Madrid and Barcelona expanding while rural areas, particularly in central and north-western Spain, experience depopulation. Spain has experienced a substantial improvement in educational attainment over the past decade across the entire country, like other European nations, however, the disparity between rural and urban areas remains one of the largest (Konietzka and Martynovych, 2025). This context urges us to propose a projection that goes further the classic age-sex structure, and project at the regional level by five different origins or places of birth and three educational levels. This would let us project future inequalities by origin and socioeconomic condition with education as its proxy.

Using education as a socioeconomic variable closely linked to the labour market is crucial, as the relationship between international migration and labour market segmentation has been widely studied and documented in Western countries. This segmentation has been identified as a main source of ethnostratification, that is, the systematic layering of ethnic groups within social and economic hierarchies (Castles and Kosack, 1973). Ethnostratification has further been described as a structural feature of contemporary migration regimes (Castles and Miller, 1993), shaping access to

employment, income, and social mobility. Beyond the labor market, these hierarchies are reproduced through broader mechanisms such as educational inequalities, social capital, and migrant networks (Portes, 1981; 1995).
This framework is essential when incorporating education and origin as key variables in projections of future population dynamics, as it allows for capturing how central structural inequalities are likely to evolve across four dimensions: demographic, socioeconomic, ethnic, and spatial.

2. Objectives and Research Questions

Our main objective is to project future inter and intra generational (socio-economic) diversity in 17 Spanish regions, considering two main aspects, starting with two research questions:

(1) Will the future educational profile of migrants coming from different origins reinforce ethnostratification?
Regarding origin, we examine whether convergence or divergence in educational distribution—our key socioeconomic variable—will take place between different origins in the same region, and within the same origin in different regions. The immigrant population is predominantly less educated than the native-born (with some exceptions) and has been overrepresented in the lowest-paying jobs, fostering social inequalities and exclusion. Projecting the future educational attainment of different origin groups is crucial to understand whether these disparities will persist or not.

(2) Will Spanish regions converge or diverge in terms of educational attainment and origin compositions?
With this question we want to examine whether existing regional educational inequalities will diminish or intensify in the future. There is a possibility that dominant economic sectors in each region could exacerbate existing regional disparities, as some sectors often generate a high proportion of low-skilled employment that is primarily filled by foreign-born workers. Thus, significantly impacting the educational composition of foreign groups migrating to particular regions.

3. Data and Methodology

This section details the data sources, adjustments, and underlying assumptions for all demographic and educational components of our model. Assumptions regarding future change are based on growth rates observed in the official population projections published by the National Statistics Institute (INE).

3.1 Data sources

All data is retrieved from the Spanish National Statistics Institute (INE). Natural growth data are obtained from the Vital statistics (INE, 2025b). This source is a long-standing statistical operation of the INE that provides the foundational data on births, deaths, and marriages. This information is essential for calculating the official rates of natural population change, including key indicators such as age specific fertility rates and survival rates required for our analysis. We use age, sex, and education-specific mortality data for the years 2017–2021. However, there is insufficient evidence to model mortality by origin, since there is few empirical supports for origin-specific mortality for older ages. In contrast, fertility data were available by age, sex, education, and mother's place of birth.
Our analysis of internal and international migration relied on two data sources: the Residential Variation Statistics (RVS), based on the municipal register (*Padrón*), for the period 2017–2020 (INE, 2022), and the new Migration and

Change of Residence Statistics (MCRS) for the period 2021–2023, based on the annual census, implemented in 2021 (INE 2025c). The MCRS provides improved accuracy for measuring international migration flows. The substantial divergence in 2021—the only year of overlap—demonstrates this: MCRS recorded 887,960 international immigrants compared to 662,173 in the RVS (a difference of 225,787), and 696,866 international emigrants compared to 452,511 (a difference of 244,355). To establish a more robust baseline, we integrated the data from both sources to calculate migration flows from 2017 up to 2023, the latest year for which data is available.

The 2021 Census serves as our baseline population, disaggregated by age, sex, origin, and educational attainment. It also provides the education information for migration flows, as the migration sources used do not directly report this variable. To address this limitation, we used the 2021 Census migration-specific variables, specifically, the place of origin of migrants who moved within the previous five years. From this we were able to derive educational attainment for internal out-migration, internal in-migration, and international immigration flows. For international emigration flows, however, this approach could not provide the necessary information; therefore, we applied the educational distribution of the population as recorded in the 2021 Census.

We rely on the growth rates from the official projections produced by the Spanish National Statistical Institute (INE, 2024) to inform our assumptions across all demographic components. These projections span a 50-year horizon, covering the period 2024–2074, and provide annual estimates by single year of age and place of birth (Spanish-born and foreign-born). The underlying assumptions are calibrated using data from 2021 to 2023. However, it should be noted that regional projections at the NUTS-2 and NUTS-3 levels are only available up to 2039. To estimate regional growth rates for the remaining period, we calculate ratios relative to national values and extrapolate these trends for the NUTS-2 regions.

The autonomous cities of Ceuta and Melilla were excluded from the analysis due to their small population size and the subsequent inability to conduct a specific robust analysis disaggregated by age, sex, origin, and educational attainment.

3.2 Methods

Population projections provide insights into possible future demographic outcomes, typically in terms of population size, age, and sex structure. The inclusion of social heterogeneity through socioeconomic variables enriches these projections, enabling a multidimensional understanding of population dynamics. The multidimensional cohort component projection model, pioneered by Rogers (1975), introduced this heterogeneity into the classic cohort component approach. The method was first applied to project human capital in Mauritius by Lutz (1994), followed by numerous studies led by International Institute for Applied Systems Analysis (IIASA; KC et al., 2010). Later, it was extended globally to construct worldwide human capital scenarios and projections (Lutz et al., 2014; KC and Lutz, 2017; KC et al., 2024).

In this study, we apply a multistate cohort-component projection to regional populations, projecting by sex, five-year age groups, origin (place of birth), and educational attainment. This approach allows us to fully exploit the potential of the methodology by modelling not only demographic processes—fertility, mortality, and migration—but also transitions in education states. Unlike most multistate applications that focus solely on education transitions, our framework extends the multidimensional structure to incorporate origin-specific dynamics and regional differentiation within the same country.

3.3 Scenarios

Five scenarios have been built: a constant or no change scenario, a medium, low and high scenarios, and finally a high education scenario (summarized in Table 1).

- **No change scenario**:

Age specific fertility rates and age specific survival rates for mortality from 2017-2021 and age specific migration trends (including international immigration flows and rates for other migration components) from 2017-2023 are maintained across the period. Growth rates from the official projections are not applied.

- **Medium scenario**:

For mortality we use the INE projection of 2024 country level mortality improvement growth and apply it to our 2017-2021 baseline mortality data by education. We maintain the education differentials throughout the projection period. The resulting improvement in life expectancy over the 50-year period is 5,7 years for men and 4,1 years for women.
For fertility, we draw age-specific growth rates from the INE projections. As regional projections are only available up to 2039, we apply these growth rates until 2036 and subsequently extend them to the end of the projection period using region-to-national ratios. Fertility growth is applied to Spanish-born mothers uniformly across all education levels, thereby preserving existing educational differentials. Fertility rates for other origins are gradually converged towards the projected Spanish-born values, reaching full convergence by 2081; consequently, convergence is not complete by 2071 (see Appendix for calculation and plots).
For both international and internal migration, identical growth rates are applied across all origins and education levels. In the case of international immigration, growth is applied to migration flows, whereas for the remaining migration components it is applied to migration rates.

- **High and low scenarios**:

The high scenario is defined by a 10% increase in international immigration flows and fertility rates, and a 10% decrease in international emigration rates. Mortality and internal migration assumptions remain the same as the medium scenario.
Conversely, the low scenario applies a 10% decrease in international immigration and fertility rates, alongside a 10% increase in international emigration rates. As in the high scenario, mortality and internal migration assumptions are held constant.

- **High education scenario**:

To introduce variation in educational attainment—one of the core variables of interest—we define an alternative scenario that modifies the educational composition of international immigration flows. Specifically, this scenario assumes a gradual convergence of immigrants' educational distribution toward that of the Spanish-born population stock by 2071.

Table 1. Scenarios and assumptions

Scenario	Mortality	Fertility	International Migration	Internal migration	Education
Constant	Constant	Constant	Constant	Constant	Constant
Medium	Mortality rates for 2017–2021 are adjusted using the improvement patterns observed in official projections, while preserving existing mortality differentials across education groups	Spanish-born fertility rate follows INE fertility rate growth. Foreign origins converge towards Spanish fertility rate in 2081 horizon	The official projection growth of immigration flows and emigration rates are applied to the 2017-2023 baseline values	The official projection growth of migration rates is applied to the 2017-2023 baseline rates	Origin and sex specific Education Attainment Progression Ratios (EAPR) growth from trend extrapolation of the 2021 Census data
+/- 10%	Same as the medium scenario	Apply +/-10 % to the medium scenario fertility rate	Apply +/-10 % to the medium scenario immigration flows and emigration rates	Same as the medium scenario	Same as Medium scenario
Education improvement	Same as medium scenario	Same as medium scenario	Converging foreign-born education levels to 2071 Spanish-born stock education in 2071	Same as medium scenario	Same as medium scenario

3.4 Assumptions

3.4.1 Mortality

Education specific data is not available for the under 25 years, thus we used Demotools R (Riffe et al., 2019) package to calculate the life tables and complete for ages under 25 by their educational level. We employ the abridged life table function to construct five-year age groups. Population projections are then carried out up to 2071 by applying the INE growth rates to life expectancy, from which life tables are generated for each projection period. The key input required for the projection is survivorship, which is directly obtained from the life tables.

We used the non-education-specific growth rates from the INE projections by age and sex and applied them uniformly to the most recent education-specific mortality data. This approach effectively maintained the existing educational differential observed in the 2017–2021 mortality data. The resulting projection of life expectancy at birth by educational level is displayed in Figure A.1 in appendix.

3.4.2 Fertility

For fertility, educational attainment data for mothers under 25 years old were missing in the Vital Statistics data. Although the incidence of births in these ages is low, we addressed this data missingness by utilizing data from the Spanish Fertility Survey (INE, 2019). For Spanish-born mothers, we applied the age- and education- specific fertility rates observed among all Spanish mothers. For foreign-born mothers, we applied the corresponding non-Spanish-born rates, as further disaggregation by specific place of birth was constrained due to representation issues in the data.

To assess the reliability of our educational distribution of overall fertility, we conducted a comparative analysis with other Southern European countries that possess comparable data in the Eurostat database (Eurostat, 2025d). The age-specific fertility trends observed in Greece were found to be consistent with the overall Spanish distribution, lending support to our data structure. The level of missingness in births to mothers over 25 years old by educational attainment was minimal. Consequently, these missing values were distributed evenly across all three educational attainment levels to minimize bias.

We project fertility rates by applying the non-education-specific INE growth rates of fertility rates to Spanish-born mothers' fertility rates. For foreign-born mothers, we model the convergence of their fertility rates towards those of the Spanish-born population using a logistic growth model (see appendix for the formulation).

The observed yearly data from 2017–2021 indicate stable fertility levels for Spanish, Central and South American, and European origins (all three with similar levels). Conversely, origins characterized by higher initial fertility rates and significant educational differentials (Africa and the Rest of the World) show a clear trend toward convergence, as pointed out by the literature (Blanes and Esteve, 2025). Furthermore, projections from the Wittgenstein Centre Human Capital Data Explorer (KC et al., 2024) also anticipate a corresponding drop in fertility rates across these regions. Based on these observed trends and external projections, we propose the convergence model as a robust medium scenario for future fertility trends.

For improved data quality and statistical reliability, several regions were grouped based on similar fertility trends, geographic proximity, regional size, and the representativeness of all origins (see Figure A.3 in Appendix).

3.4.3 Migration

For the medium scenario, after assigning educational attainment to migrants based on census data, we applied the migration growth rates from the official projection equally to all education levels and origins. Different migration components were modelled as follows: for international immigration, we used the absolute inflows; for all other migration types (international emigration, internal in-migration, and internal out-migration), we used migration rates. Regarding internal migration, we adopted a biregional model rather than an origin-destination model. This choice was necessary due to data granularity limitations in most of the regions concerning age, sex, education, and origin specific data.

3.4.4 Education

In the case of education, we use three educational attainment levels by grouping ISCED-2011 classification categories (Unesco, 2012); primary (no education and completed primary), secondary (lower, upper and post-secondary non-tertiary education) and tertiary (university degrees and other higher education qualifications).

Following KC et al. (2017), we defined an Education Attainment Progression Ratio (EAPR) to measure progression to the next educational level, as the proportion of those that completed the upper (final) level among those that completed the bottom (starting) level. We define three cohorts in 2021 in which transitions will take place, 15-19, 20-24 and 25-29. Low to medium education transitions take place in the first two age groups, ending in the second. Medium to high education transitions take place in the second and the third age groups. After 29 years old, no education transitions take place.

Lacking reliable cohort data, we use 2021 period data from the Census to approximate improvements in educational transitions, by extrapolating EAPRs using the slope at younger ages in 2021 (Figure A.4 in Appendix), as follows. For low to medium transition, we select three values for 20-24 to 30-34, calculate the slope and extrapolate the growth of EAPR. These values will correspond to the future EAPR at age 20-24 during the projection period. The same will be applied to the medium to high transition but selecting age groups ranging from 25-29 to 35-39 (see calculation of

extrapolation and Figures A.5 and A.6 in Appendix). Finally, the projected EAPR is reconverted into the proportions for the three original education levels.

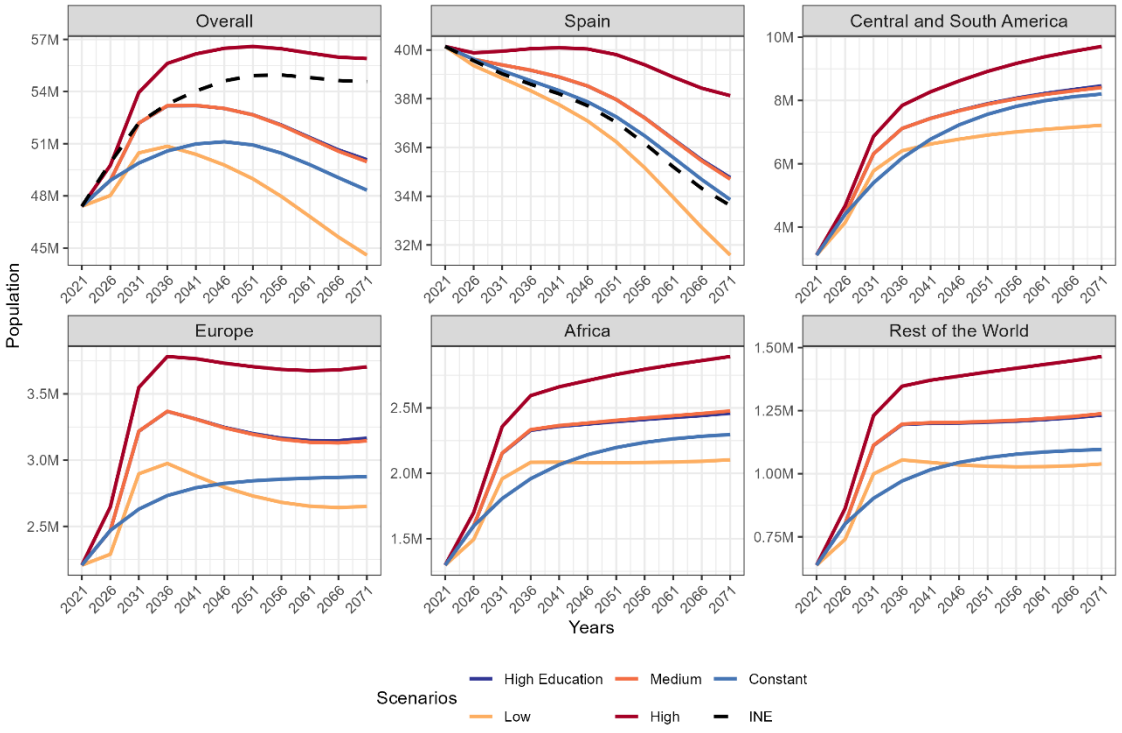
4. Results

To address our research questions on future dynamics by origin and educational attainment, we first present the results at the national level and then, more importantly, at the regional level. Results are shown for all five scenarios, with particular emphasis placed on the medium scenario.

4.1 Country level results

The population grows in all scenarios except the low scenario as shown in Figure 1. The constant scenario shows an inverted U-shape, with the population peaking in 2046 and then declining to a slightly higher level than in 2021, reaching around 48.3 million inhabitants. The medium scenario peaks earlier, in 2036, at 53 million, followed by a slight decline until 2051, after which the decrease becomes more pronounced, reaching 49.9 million inhabitants.
The minimal difference between the medium and high education scenarios stems from the fact that educational improvements are applied exclusively to the foreign-born population. Consequently, the differences between these scenarios are driven primarily by changes in education-specific mortality and, more importantly, fertility patterns among foreign-born individuals.
The high scenario peaks in 2051, reaching 56.5 million inhabitants, and then slightly declines toward the end of the period, ending at 55.8 million, whilst the low scenario peaks in 2036 at 51 million and then continuously decreases to 44.6 million, a lower population than the initial year.
Finally, when comparing our results to the INE projection, we find that in the second half of the period the official INE results align more closely with our high scenario, ending at 54.5 million inhabitants, rather than with the medium scenario, from which they begin to diverge already at the beginning of the projected period, at around 2036. This is driven by the migration component: while immigration remains higher in the INE projection and maintains a substantial difference from 2036 onward, emigration in our medium scenario exceeds the official estimate in the same year.
By origin, all foreign-born groups grow sharply during the first part of the period, reflecting the impact of the higher projected international migration influx at the beginning of the projection period. Subsequently, a steady growth is observed for all foreign-origin groups except for the Europeans, who experience stagnation followed by a gradual and moderate decline. Overall, the number of foreign-origin populations increases across all scenarios. In contrast, the native population decreases in every scenario due to low fertility rates and an ageing population structure, ranging from 38.1 to 31.5 million. Nevertheless, the medium scenario projects a higher number of Spanish-born individuals (34.7 million compared to 33.61 million in the INE projection), while only the low scenario results in a smaller population than that estimated by the INE. A larger Spanish-born population is attributable to the education specific mortality rates, and an increasing amount of the native born reaching high levels of education.

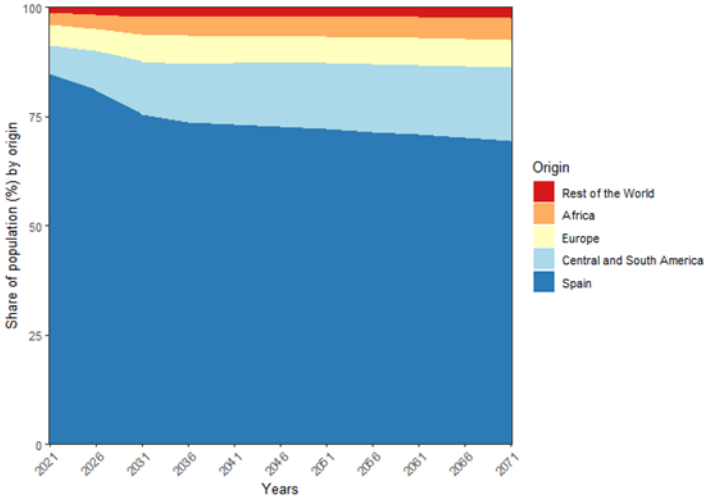
Figure 1. Population projections by origin and scenario, 2021-2071 [1]



The relative composition by origin in Figure 2 shows an increasing share of foreign-born groups, particularly those from Central and South America, which reaches 16.8% of the total population of Spain in 2071, consolidating their position as the main immigrant group. This is primarily driven by the shifting composition of the second migration wave (post-2015) in which Central and South American migrants (which were already the main foreign group) have constituted a growing share of international inflows (Domingo and Bayona-i-Carrasco, 2024). Europeans account for 6.4%, Africans for 5%, and the Rest of the world for 2.5%. The Spanish-born population represents 69.4% in the medium scenario in the same year, eight percentage points higher than in the INE Medium projection for the same year. This difference results from the official projections assuming higher net migration (based only in 2021 to 2023 data) throughout most of the period, and therefore a lower share of the Spanish-born.

[1] Overall refers to the overall population in Spain, and Spain refers to the Spanish-born population. Please also note that the y-axis, the size of the population, is plotted in a different scale in each figure.

Figure 2. Share (%) of population by origin in Spain, 2021-2071

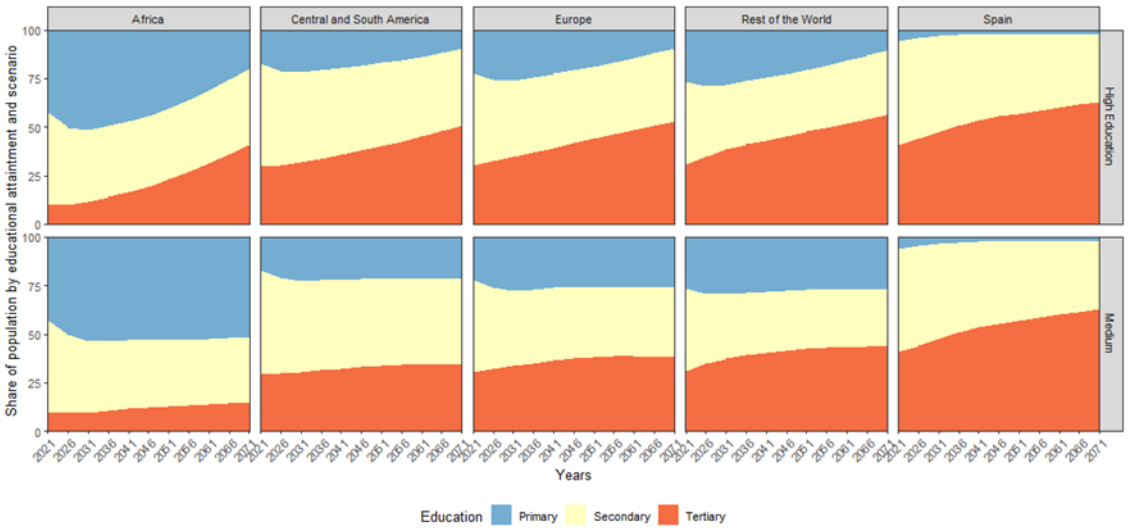


4.1.1 Education

Substantial differences emerge in the educational composition of the population between the Medium and High Education scenarios, particularly with respect to the primary and tertiary education (Figure 3). Under the medium scenario, low-educated inflows rise in the initial years before stabilising, whereas tertiary-educated inflows grow only marginally, thus not improving education distribution of foreign-born population.

In the Medium scenario, in 2071 52,1% of the 20 to 64 years old have reached high education (all origin groups combined), in comparison, in the Wittgenstein Centre of Human Capital projections, this share reaches 46,2% in 2071 for the same ages. In the High education scenario, the share of high educated population reaches 58,5% due to the improvement in foreign born groups. In the case of specific origins, the Medium and High education scenarios differ significantly (Figure 3): Spain 63,2%; Central and South Americans 34,9% vs 51,6%; Europe 39,2% vs 53,4%; Africa 15,6% vs 41,8%; Rest of the World 43,7% vs 56,2%.

Figure 3. Education share by origin, medium vs high education scenarios, 2021-2071



4.1.2 Population structure

At the national level (Figure A.7 in the Appendix), as expected, the low and high scenarios exhibit the largest changes in population size and structure. The medium and high-education scenarios produce similar population structures, although the high-education scenario induces substantial shifts in educational composition. Across all scenarios, there is a general improvement in educational attainment. In particular, the share of highly educated individuals increases significantly in older cohorts.

In the medium scenario, educational improvement is most pronounced among the Spanish-born population (Figure 4a). By 2071, a large share of older age groups has high educational levels, resulting in minimal differences across cohorts. For this group, the medium and high education scenarios yield identical outcomes, as the educational distribution of the Spanish-born population is held constant. In contrast, foreign-born groups display distinct population structures. Central and South Americans (Figure 4b) exhibit a right-skewed distribution, reflecting the predominance of female migration, whereas African migrants show a left-skewed pattern associated with male-dominated flows. Across all origins, the foreign-born population becomes older than in 2021, indicating both ageing in place among long-term residents and the application of high emigration rates at older ages, consistent with the emigration patterns embedded in the INE projections. This ageing process is more pronounced in the medium scenario relative to the constant scenario. By contrast, the high-education scenario produces a markedly different educational composition among foreign-born groups, raising their educational attainment.

Figure 4a. Population pyramids by scenario and origin

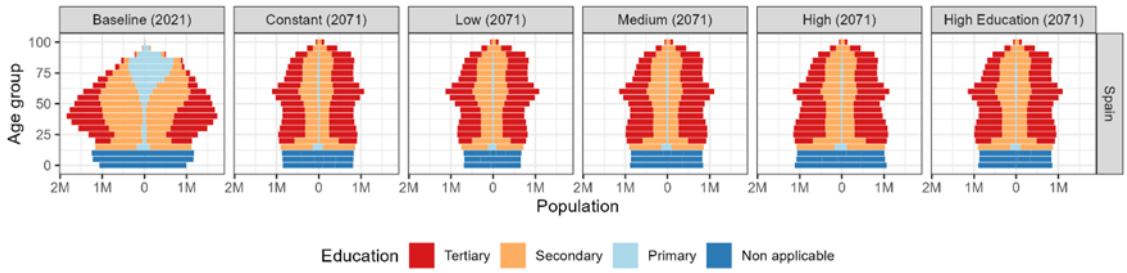
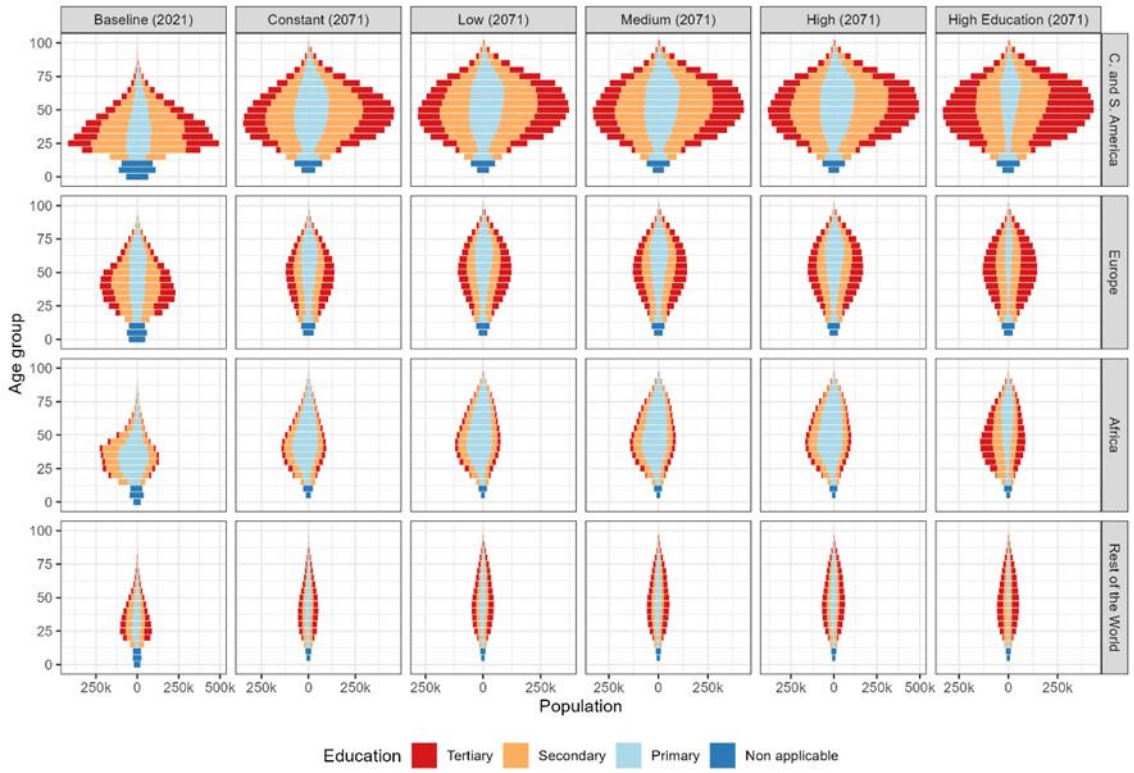


Figure 4b. Population pyramids by scenario and origin



4.1.3 Migration

Concerning migration (Figure 5), the flows follow the pattern applied from the INE projections. International immigration flows peak in 2026 to consequently descend sharply until 2036, and then steadily grow again following the growth trend applied from the official projections. This pattern is the main determinant of the population growth shown in Figure 3.

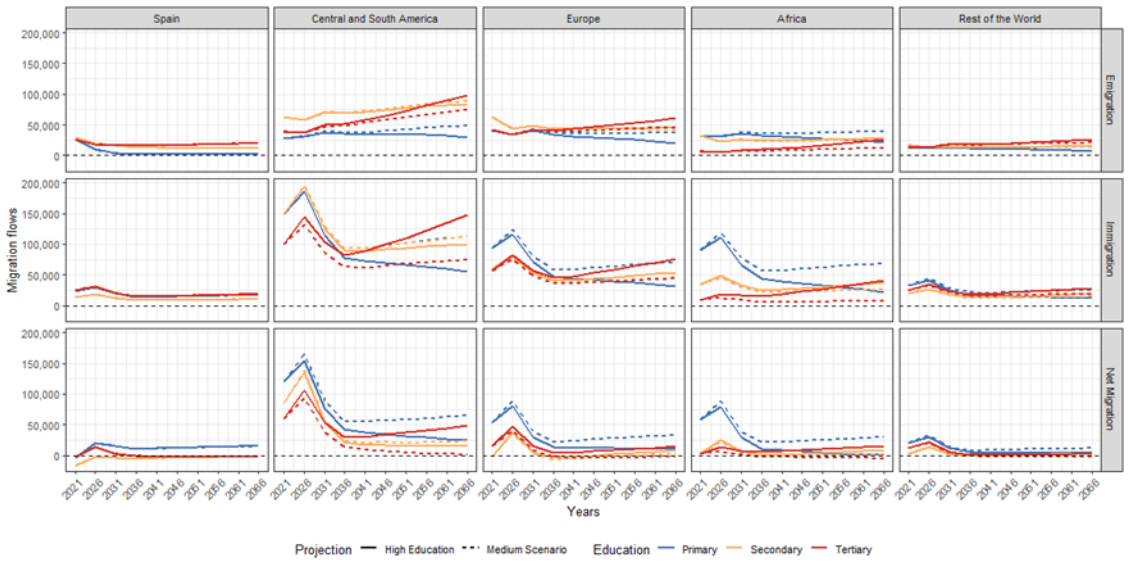
For the Spanish-born population, only a single scenario is considered, as the high-education scenario applies exclusively to the foreign-born. Net migration is initially negative across all education levels; however, from 2026 onwards, positive net migration is observed only among the low-educated. This pattern is driven by the projected return migration of older, retired migrants. In contrast, individuals with secondary and tertiary education are projected to maintain net migration balances close to zero throughout the period.

Regarding the migration patterns of the foreign-born, differences by scenarios are evident. In the medium scenario, net migration is strongly skewed towards low-educated migrants. This dynamic explains the slow improvement in educational attainment among foreign-born groups: the share of highly educated individuals increases only marginally, while the proportion of low-educated migrants remains stable or even rises during the initial years of the projection (Figure 5). By contrast, the high education scenario assumes a gradual convergence of migrants' educational profiles toward those of the Spanish-born stock population by 2071. Under the medium scenario, across all foreign-origin groups, migrants with primary education exhibit the highest net migration levels, whereas those with tertiary education consistently record the lowest. Central and South Americans stand out as the numerically dominant group and the only origin displaying persistently positive net migration across all education levels throughout the projection period.

From the midpoint of the projection period, in the high education scenario, tertiary-educated migrants become the group with the highest net migration—reaching 50.000 annually—whereas in the medium scenario, tertiary-educated

inflows remain close to zero and low-educated migrants consistently dominate. For other origins, the medium scenario shows negative or near-zero net migration among the highly educated from around 2031 onward. This pattern is reversed in the high-education scenario, most notably among African migrants. Among Europeans and migrants from the Rest of the World, net migration across educational levels gradually converges toward similar values by the end of the projection horizon.

Figure 5. Migration trends by scenario, education and origin



4.2 Regional level results

Shifting the focus to the regional level, this section addresses the core research questions concerning convergence and divergence in origin and education distribution. First, we present the projected population sizes by region and scenarios, then share by origin and region, and finally the education dimension and its evolution across regions and origin groups. Appendix Table 1.A reports regional shares by origin and total population for 2021 and 2071.

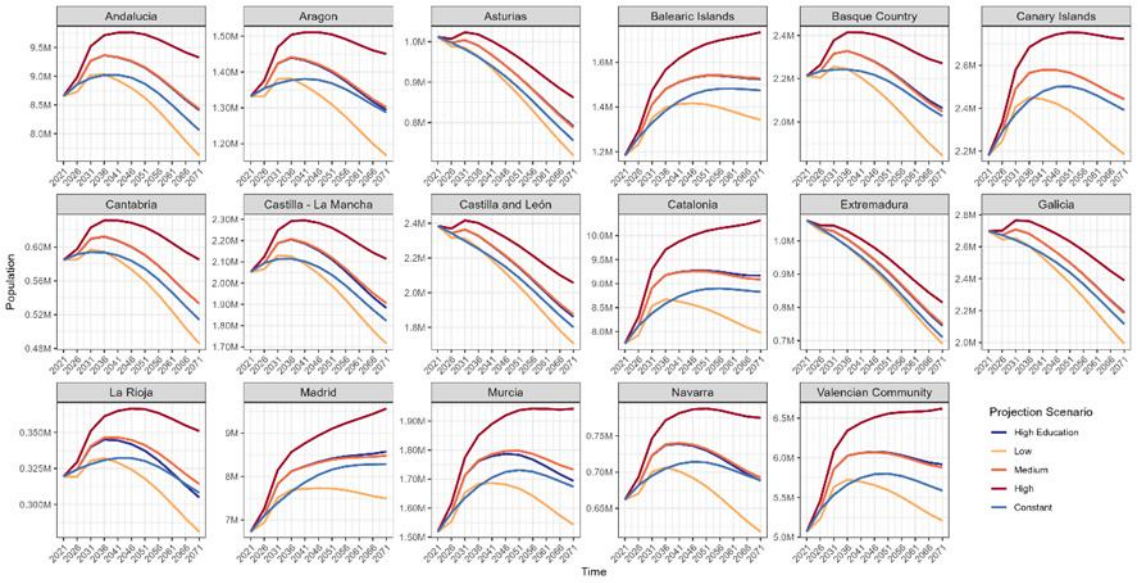
4.2.1 Evolution of population size

At the regional level, Figure 6 presents the projected population trajectories by region and scenario. As in Figure 1, the scenarios yield markedly different population outcomes, particularly in regions where immigration constitutes a key demographic component. Overall, population decline is widespread: under the medium scenario, 10 of Spain's 17 regions are projected to experience population loss by 2071. Even under the high scenario, four regions—Extremadura, Galicia, Asturias, and Castilla y León—continue to lose population, reflecting persistently low fertility, sustained out-migration of the native population, and limited international immigration. Conversely, six regions record population growth even under the low scenario, driven primarily by immigration. These regions—Balearic Islands, Catalonia, Madrid, Valencia, Murcia, and the Canary Islands—nevertheless reach a population peak before entering a phase of decline during the second half of the projection period.

Differences between the medium and high-education scenarios become more pronounced at the regional level than at the national level. This is particularly evident in regions such as Murcia and La Rioja, where baseline educational

attainment—especially among foreign-born populations—is relatively low. Under the educational improvement scenario, substantial gains in migrants' educational levels lead to convergence in mortality and, more importantly, fertility rates toward those of higher-educated groups. As a result, projected population sizes are lower, primarily due to reduced fertility. In regions such as Catalonia, Madrid, and Valencia, differences between scenarios are also observable but considerably smaller. Notably, in these regions the educational improvement scenario yields slightly higher population estimates than the medium scenario. This outcome is driven by the increasing share of migrants from Central and South America and their upward convergence toward the fertility patterns of Spanish-born women (see Figure A.2 in Appendix).

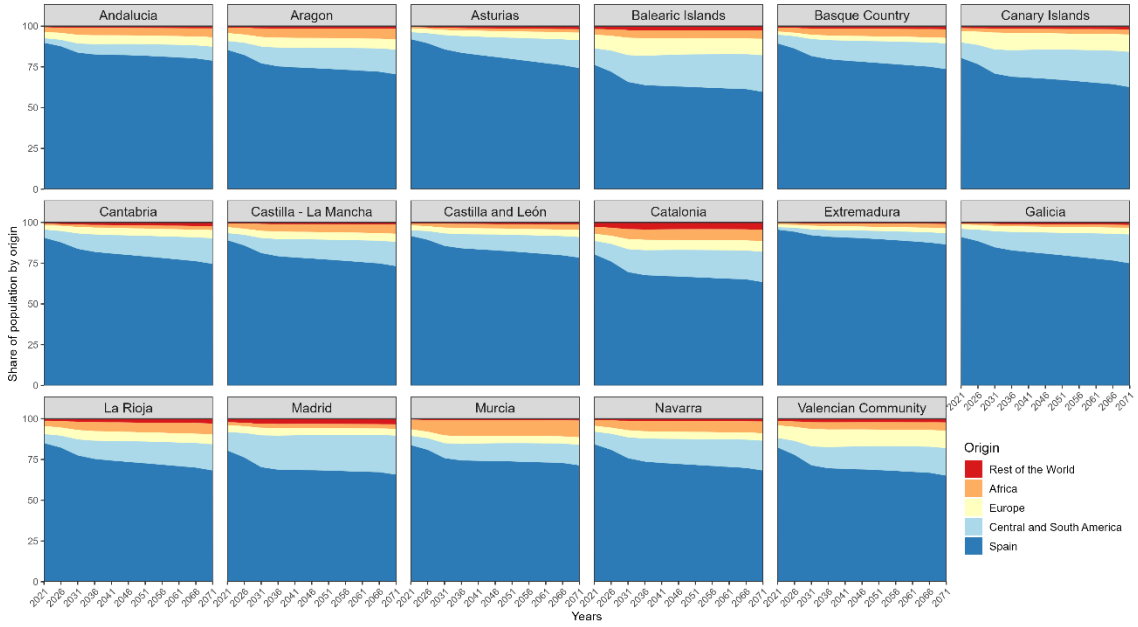
Figure 6. Population by scenarios and regions, 2021-2071



4.2.2 Regional convergence: Origin

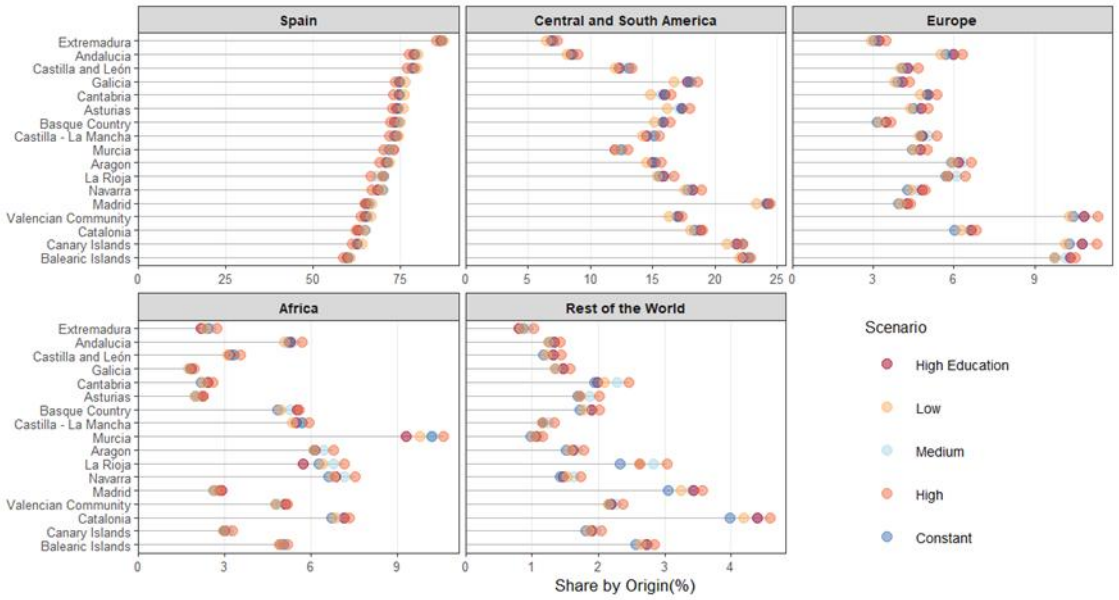
An analysis of the regional distribution of population by origin (Figure 7) shows that the regions with the highest levels of immigration in 2021 are also those in which the foreign-born share increases most consistently over time—namely the Canary Islands, the Balearic Islands, Catalonia, and the Valencian Community. One notable exception is Asturias, which, despite having a relatively small foreign-born population, ranks fifth in terms of growth. Extremadura, as in 2021, continues to display the lowest proportions of foreign-born residents. The most pronounced growth by origin is observed among individuals born in Central and South America. This group was already the largest foreign-origin population in 2021 and had experienced the fastest growth in preceding years. Under the medium scenario, they are projected to account for 24% of Madrid's population by 2071. For other origins, the highest projected shares in 2071 are as follows: Europeans in the Valencian Community (10.8%), Africans in Murcia (10.23%), and individuals from the Rest of the World in Catalonia (4.4%). Conversely, the lowest projected shares are found in Extremadura—for Central and South Americans (7%), Europeans (3.19%), and the Rest of the World (0.9%)—and in Galicia for Africans (1.83%). Overall, these results indicate that there is no generalized convergence across regions in terms of the relative weight of the foreign-born population. Rather, regions that currently attract higher levels of immigration continue to do so, reinforcing existing regional disparities in immigrant settlement patterns.

Figure 7. Share (%) by origin and region, 2021-2071



An examination of scenario differences (Figure 8) reveals that the greatest variability emerges in two types of regions: those with small populations and those where a specific foreign-born group is highly concentrated. In such contexts, differences in scenario assumptions translate into substantial divergence in projected outcomes. Regions exhibiting the widest range across scenarios are typically sparsely populated and had relatively low immigration levels in 2021. In these regions, the range of outcomes is particularly large for the Spanish-born population and for individuals born in Central and South America. For European-born populations, the largest scenario related differences are observed in the Canary Islands, the Balearic Islands, the Valencian Community, and Catalonia, reflecting the significant presence of this group. Among the African-born, the greatest variation across scenarios occurs in predominantly rural regions where their relative share is highest—namely Murcia, La Rioja, Aragón, and Navarre. In Murcia and La Rioja, the lowest projected values are associated with the high-education scenario, reflecting the pronounced educational shifts assumed under this scenario. A comparable pattern is evident for individuals born in the Rest of the World. Catalonia and Madrid—where this group is most numerically concentrated—as well as La Rioja—where its relative share is high despite a small total population—display the widest scenario differences. In this case, however, the constant scenario yields the lowest projected values.

Figure 8. Share of population by origin in 2071



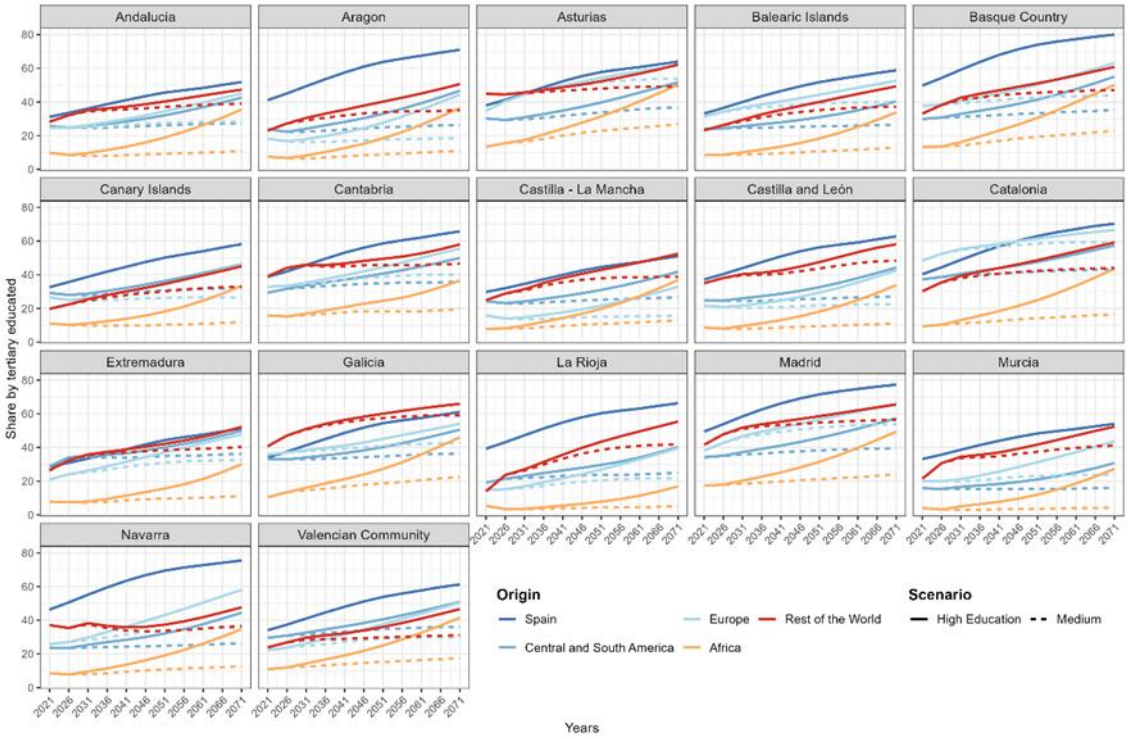
4.2.3 Regional convergence: Education

To address our research question on ethnostratification at the regional level, we consider the level of education as a proxy for the socioeconomic status. Education is relevant in two main respects. First, origin-based differences observed at the national level are also present within regions, though their intensity varies considerably. Second, individuals from the same origin group can exhibit markedly different levels of educational attainment depending on their region of residence, reflecting regional economic specialisation and associated labour demand. Under the medium scenario, these regional and origin-based disparities are projected to persist and, in some cases, to widen over time.

The share of highly educated by origin group at the regional level (Figure 9) reveals indeed two distinct trends depending on the projection scenario. Under the medium scenario, educational attainment remains largely stagnant over time, leading to the persistence—and in some cases the widening—of pre-existing educational inequalities between origin groups. By contrast, the high-education scenario shows a pronounced increase in tertiary attainment and a clear trend toward convergence across origins. This dynamic is primarily driven by groups with the lowest initial levels of education, which experience the fastest rates of improvement.

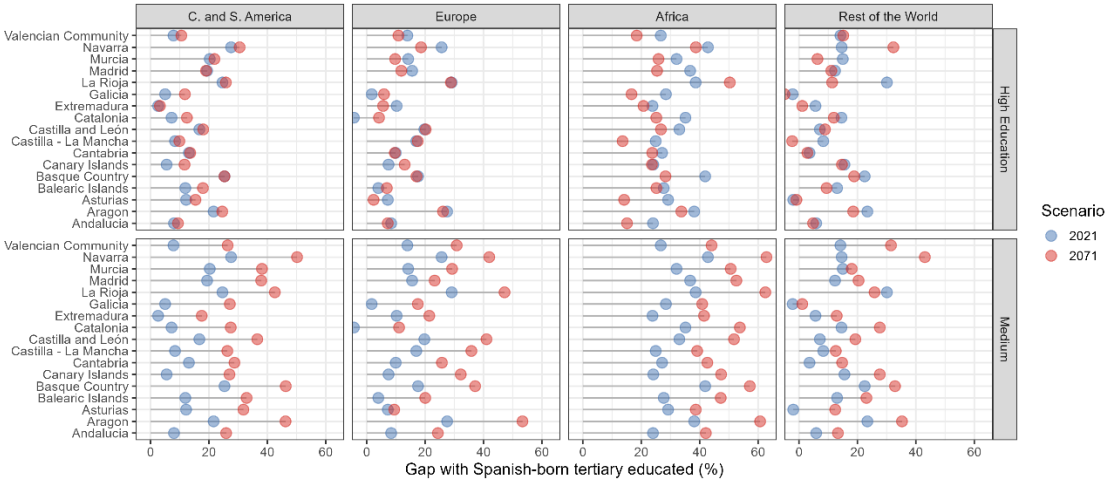
By examining annual growth rates, Africans exhibit the most substantial gains in educational attainment across nearly all regions. The only exception is La Rioja, where the highest growth is observed among migrants from the Rest of the World. Beyond reducing disparities between origin groups (Figure A.8 in Appendix), the high-education scenario also fosters convergence across regions and within origin, as evidenced by a declining coefficient of variation (Figure A.9 in Appendix).

Figure 9. Share of tertiary educated 25 to 65-year-old population by origin and region



Improvements in educational outcomes among foreign-born groups can be observed from another perspective (Figure 10), namely through the gap in tertiary educational attainment relative to the Spanish-born population. In 2021, foreign-born groups exhibited lower levels of tertiary education across all origins and regions, with substantial variation in gaps. The only exceptions were Europeans in Catalonia and individuals from the Rest of the World in Galicia, where foreign-born groups surpassed the Spanish-born population. Under the educational improvement scenario, the gap between foreign-born groups and the Spanish-born population narrows substantially by 2071, with only a few exceptions—most notably among Central and South Americans. In contrast, under the medium scenario, the distance between foreign-born and Spanish-born populations increases considerably by 2071.

Figure 10. Gap in share (%) of tertiary educated with the Spanish-born



5. Conclusions

By integrating origin and education as interacting dimensions, the model captures both demographic metabolism and the evolution of structural inequalities across regions and origins. This multistate framework is particularly well suited to analysing heterogeneous societies, as it enables the examination of how demographic change unfolds differently across sociodemographic groups and regions.

This analysis was based on assumptions derived from data spanning the years 2017 to 2023, encompassing various origin groups and educational attainment levels. As summarized in our research questions, our primary focus was the projection of two key forms of inequality: those defined by educational attainment (used as our socioeconomic proxy) and those defined by origin, particularly at the regional level.

By maintaining the medium scenario, we can conclude that educational disparities among origin groups stagnate and, in some cases, further grow. While these inequalities will be more pronounced depending on the region, the general trend shows that the African origin group has the lowest educational levels and is projected to maintain this disadvantaged position. In 2021, other origin groups narrow the educational gap with the Spanish-born population, and in some instances, even achieve parity or superior attainment. However, their attainment levels generally remain similar to those at the beginning of the period, positioning them below the native-born population by the end of the projection period. However, the situation changes substantially when we make minimal modifications to the medium scenario. By only adjusting the assumptions for international immigration of foreign-born individuals by assuming a gradual improvement toward the Spanish-born educational levels, we obtain divergent results: the groups with the lowest initial attainment levels grow the fastest, driving a clear convergence between different origins and regions. This could be a highly relevant consideration for policymakers, not only in terms of managing immigration flows by educational level, but also with respect to the predominant economic sectors at both national and regional levels that attract such migration. A continued predominance of economic sectors requiring large numbers of low-skilled and overqualified workers is clearly a key factor to consider as well.

Addressing the second objective, regional projections reveal a significant demographic divergence, replicating the trends recently observed (2017–2023). This polarization is driven by long-standing structural factors, including aging, low fertility rates, and limited migratory flows, resulting in persistent population decline in several regions over the coming decades. Specifically, the medium scenario projects that 10 of the 17 regions will lose population by 2071; population decline is evident even under the high scenario in some areas. Consequently, regions with the highest growth rates in recent years are projected to concentrate most of the future growth. These seven growing regions will increase their share of the total national population from 53% in 2021 to 63% in 2071, highlighting a pronounced polarization of population growth. Conversely, the educational attainment gap between regions is reduced under the educational improvement scenario. Regions with the lowest initial educational levels exhibit higher growth rates in high education compared to more educated regions. However, despite this positive convergence, the difference in educational levels between regions remains substantial.

Compared to the INE projections, the key methodological difference lies in the treatment of international migration. The official projections' assumptions are based solely on migrant flows observed between 2021 and 2023, drawing on newly available administrative sources and producing annual, single-year-of-age projections, which is appropriate for an official statistical exercise requiring high short-term accuracy. By contrast, our projections rely on a broader temporal window, beginning in 2021 (rather than 2024), and are structured in five-year age groups and five-year intervals. Moreover, we explicitly incorporate demographic heterogeneity (by distinguishing major migrant origins) and

socioeconomic heterogeneity (educational attainment), resulting in projections that better capture the complexity of population change and provide a more detailed and realistic long-term outlook.

5.1 Limitations

Incorporating origin and educational attainment constitutes a major strength of this study, as it allows us to introduce substantial social heterogeneity into population projections. Nevertheless, it is important to acknowledge the considerable diversity that exists within the broad origin groups analysed.

For the largest foreign-born group, Central and South Americans, countries of origin are highly heterogeneous, and both educational attainment and fertility patterns vary markedly across them. Similar internal diversity characterises other origin groups. Among African populations, pronounced differences exist between North African and Sub-Saharan migrants, particularly with respect to fertility. Among Europeans, educational levels and population structures differ substantially between Western and Northern Europeans on the one hand, and Eastern Europeans on the other. The greatest heterogeneity may be found within the residual Rest of the World category, which is dominated by Asians but also includes smaller groups such as North Americans and Oceanians.

Differences in educational attainment by origin must also be interpreted considering institutional and structural factors, such as the unequal recognition of foreign qualifications. Migrants from Latin America and Europe are likely to face fewer barriers in validating their diplomas compared with African and Asian migrants. Beyond educational attainment itself, overqualification represents a central issue in the Spanish context. Spain has one of the most overqualified labour forces in Europe (Oesch and Rodríguez, 2010), alongside Greece (Eurostat, 2025c), a phenomenon that is particularly pronounced among foreign-born workers (Muñoz-Comet, 2016). This pattern is evident among Central and South Americans, who, despite having educational levels comparable to those of natives, face even higher rates of overqualification. More broadly, the literature shows that highly educated migrants in Spain frequently struggle to obtain adequate returns on their educational investments, especially during periods of economic crises (Cebolla-Boado et al., 2015; 2019). These patterns reflect a highly segmented labour market in which migrants are disproportionately exposed to job insecurity and are systematically concentrated in lower-status positions (Mooi-Reci and Muñoz-Comet, 2016).

With respect to the fertility of foreign-born mothers, as noted above, migration influences life courses and fertility calendars in origin-specific ways (Devolder and Bueno, 2011), making direct comparisons across origin groups particularly challenging.

Finally, international migration constitutes both the most influential and the most uncertain component of the projection. A key limitation concerns the educational distribution of international emigration. Although this element plays a crucial role in shaping projected outcomes, data on emigrants' educational attainment are not directly available. Consequently, we approximate the educational distribution of emigrants by applying the education-specific emigration rates observed in the 2021 stock population. This assumption may have influenced subsequent net migration patterns and contributed to the stagnation of educational attainment observed under the medium scenario.

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Appendix

Methods

Fertility convergence

The total fertility rate (TFR) for foreign origin groups was projected using an Asymptotic Convergence Model, driven by a Convergence Weight, which is derived from a Scaled Logistic Function to shape the speed of convergence.
First, we calculate a raw, time-dependent weight $RawWeight_t$ based on the projection year *t*, a specified midpoint year and a slope parameter *k*:

$$RawWeight_t = \frac{1}{1 + e^{-k \cdot (t - midpoint)}}$$

In the implementation, the parameters are set as *midpoint* = 2051 and *k* = 0.1, a gentle value spreading the convergence into a longer period than 2071. Subsequently we calculate the Convergence weight ($ConvWeight_t$), a key parameter in shaping the rate at which the fertility gap closes (in this case, by 2071 the gap with the Spanish will be closed by 96%). To ensure the weight ranges precisely from 0 (at the start of the projection, 2021) to 1 (at the end of the convergence, 2081), the raw weights are normalized across the entire projection period:

$$ConvWeight_t = \frac{RawWeight_t - min(RawWeight)}{max(RawWeight) - min(RawWeight)}$$

The final projected $TFR_{F,t}$ for a foreign group F at time t is calculated as a weighted sum of the Spanish projected TFR ($TFR_{S,t}$) and the initial fertility differential observed in the baseline year ($TFR_{F,t} - TFR_{S,t}$).

$$TFR_{F,t} = TFR_{S,t} + (TFR_{F,t} - TFR_{S,t}) \cdot (1 - ConvWeight_t)$$

Extrapolation of Educational Attainment Progression Ratios

The EAPR is projected using a modified Asymptotic Growth Model to ensure that the growth of each population subgroup gradually slows down as it approaches a predefined maximum limit. The EAPR level E(t) for a given year t is calculated as:

$$E(t) = E_0 + (E_{max} - E_0) \cdot (1 - e^{-k \cdot (t - 2021)})$$

Where E_0 is the observed EAPR in the base year (2021) and E_{max} is the common convergence target set at 1 in the case of the transition from low to medium education, i.e., universal transition; and at 0,8 for the Medium to High transition, the highest regional value observed in 2021. The term $1 - e^{-k \cdot (t - 2021)}$ is the growth function, which scales from 0 to 1

as *t* increases. The parameter k represents the group-specific rate of convergence. This rate combines an overall model rate with the sex and origin specific growth factor slopes mentioned above. Groups exhibiting higher initial growth rates are assigned a higher *k*, meaning they are projected to converge upon the E_{max} at a faster pace.

Figures

Figure A.1. Projected life expectancy at birth by sex and education, 2021-2071

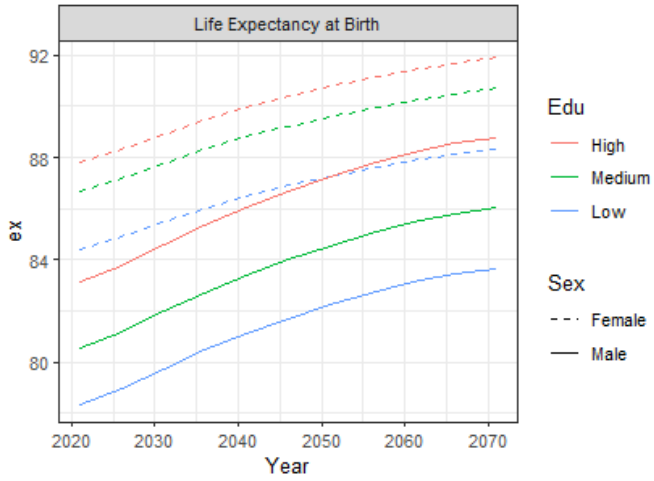


Figure A.2. TFR of Spanish-born mothers by groups of regions, 2021-2071

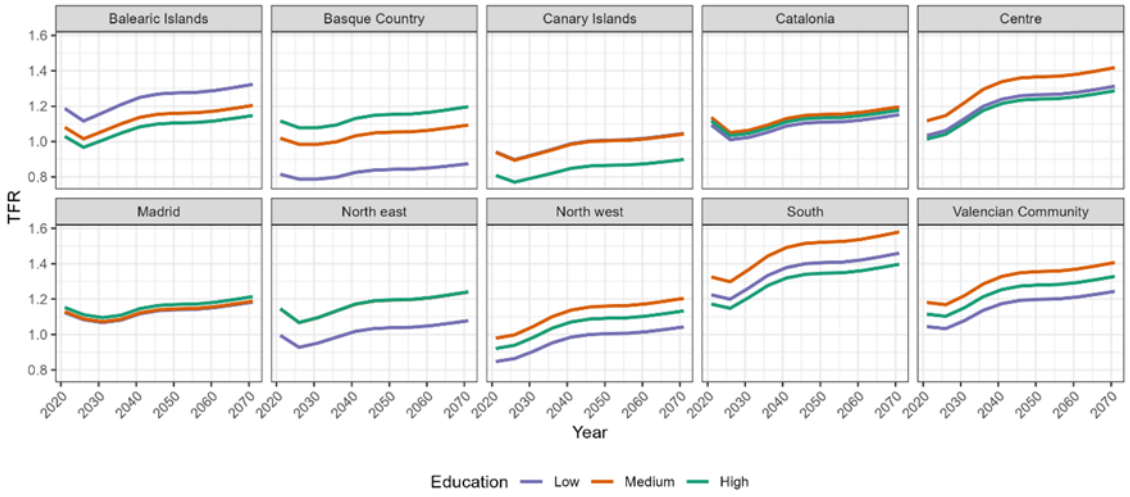
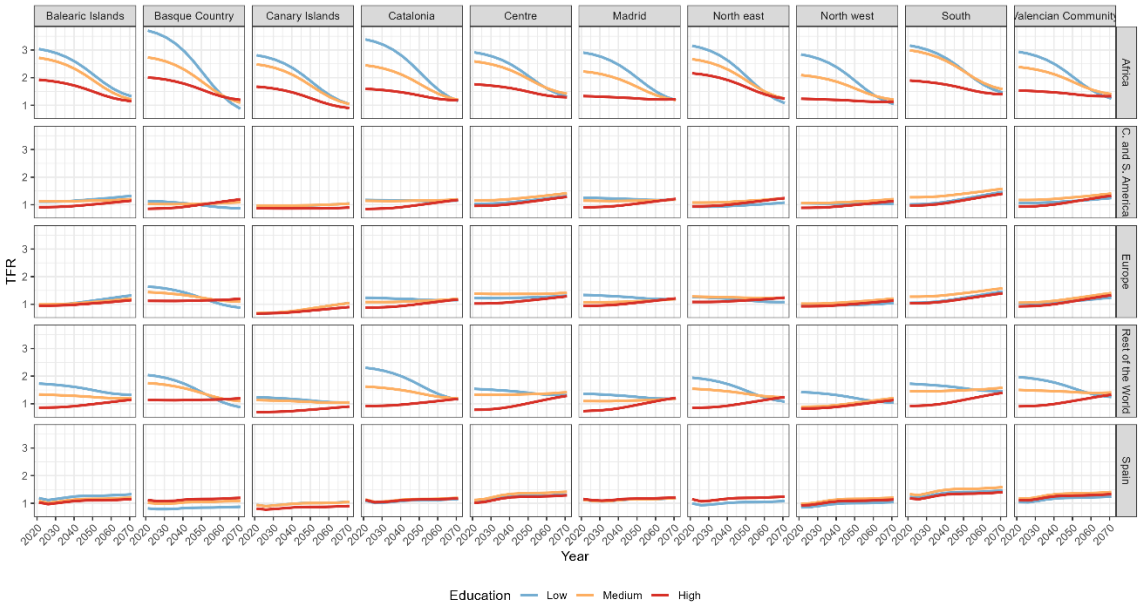


Figure A.3. TFR by origin and groups of regions, 2021-2071



The resulting groupings are as follows; Centre: Castilla y León, Castilla-La Mancha, and Extremadura; Northeast: Aragón, La Rioja, and Navarra; North: Galicia, Asturias, and Cantabria; and South: Andalucía and Murcia. The remaining regions were retained as individual units.

Figure A.4. EAPRs by age and origin and education level

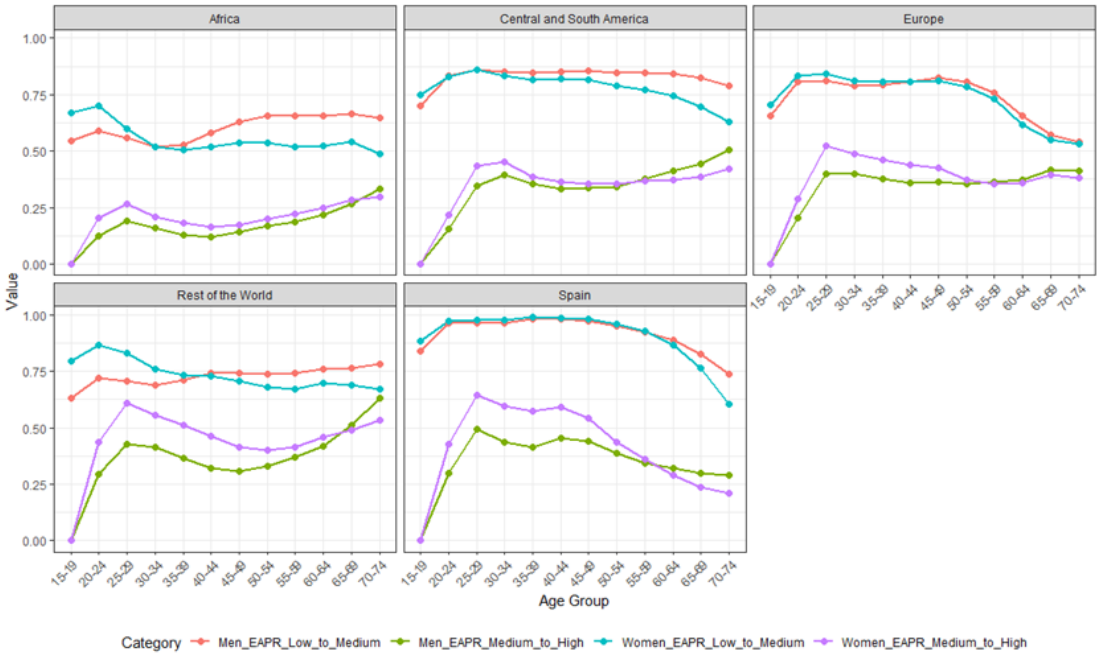


Figure A.5. EAPR extrapolation of Low to Medium transition, ages 20-24

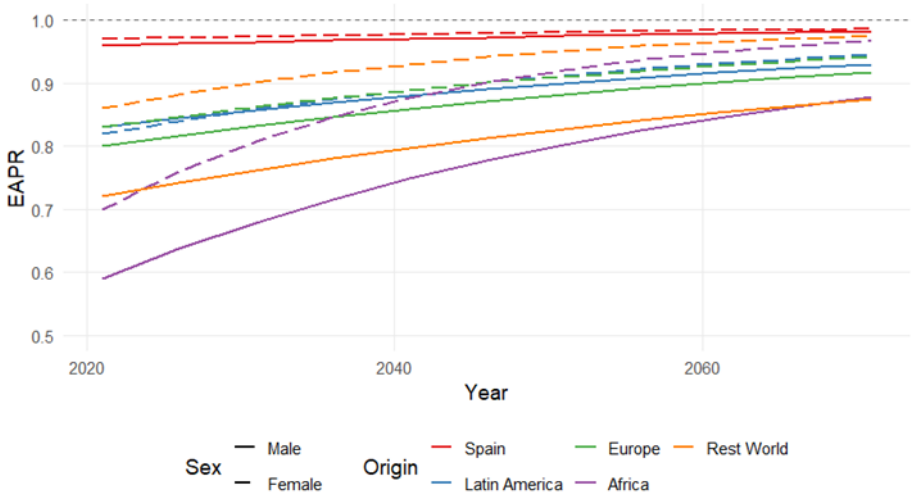


Figure A.6. EAPR extrapolation of Medium to High transition, ages 25-29

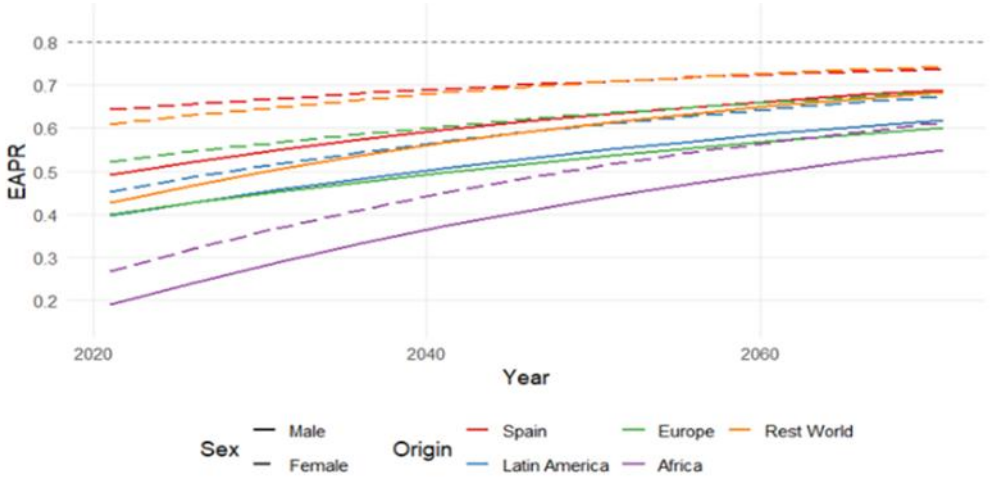


Figure A.7. Population pyramids by education, Spain 2021 and 2071

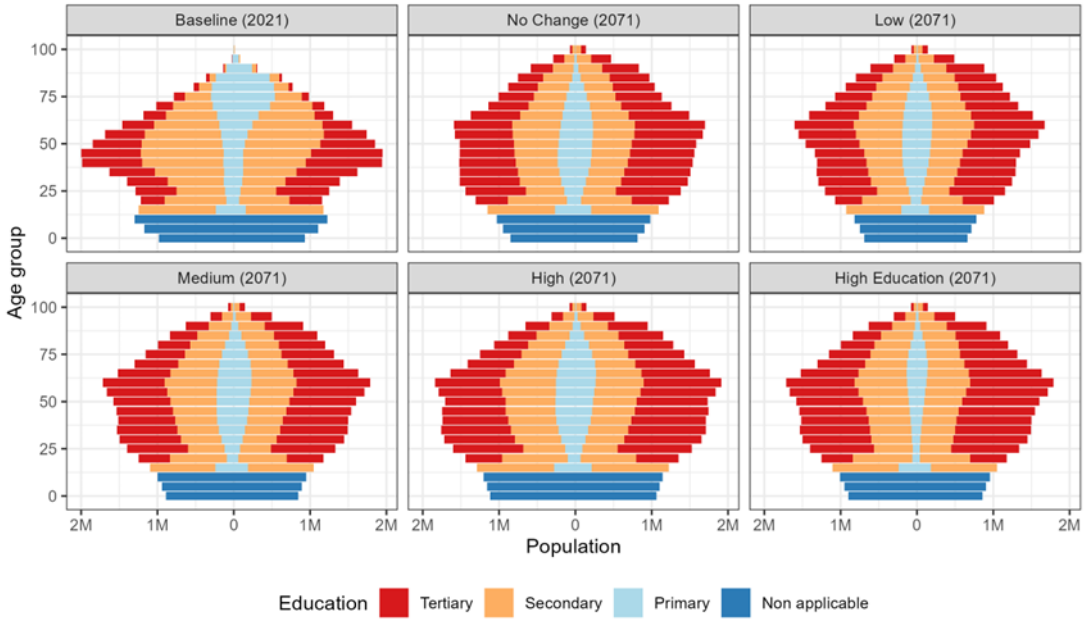


Figure A.8. Disparity (CV) of tertiary educated within regions, 2021-2071

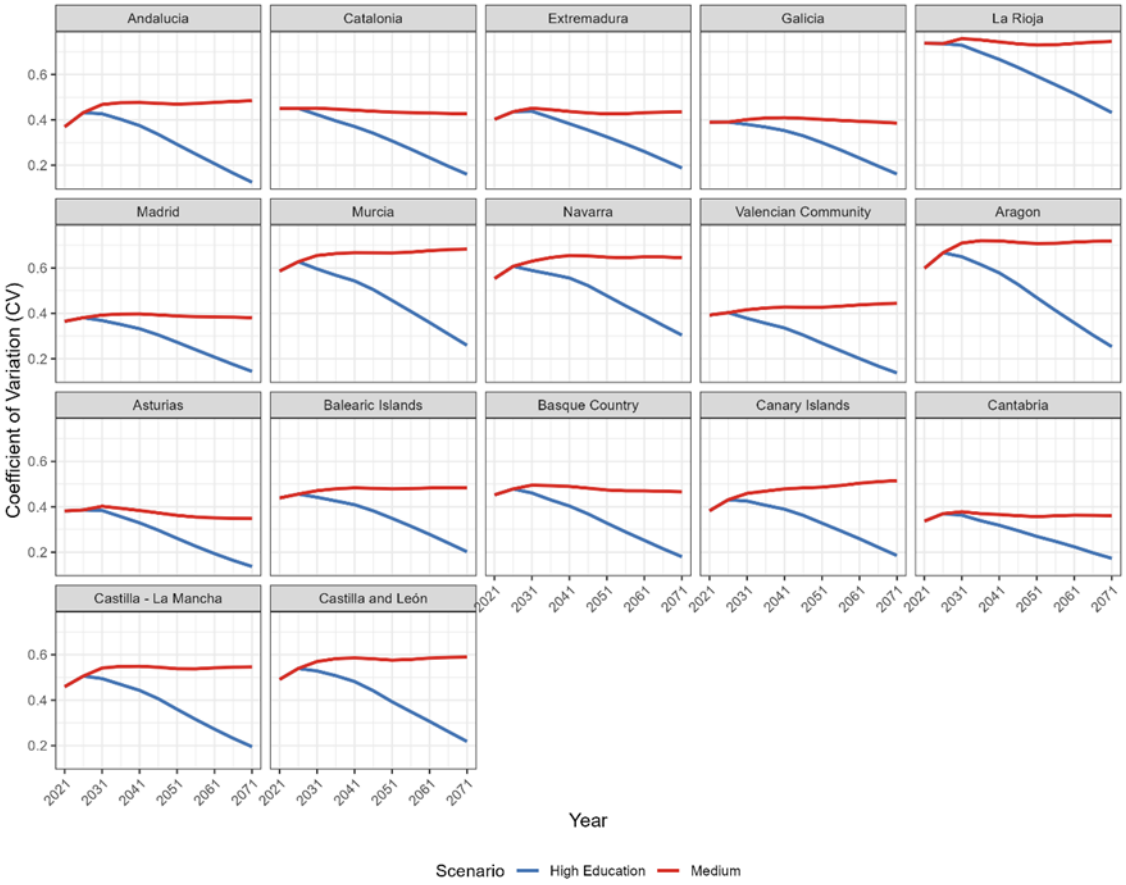
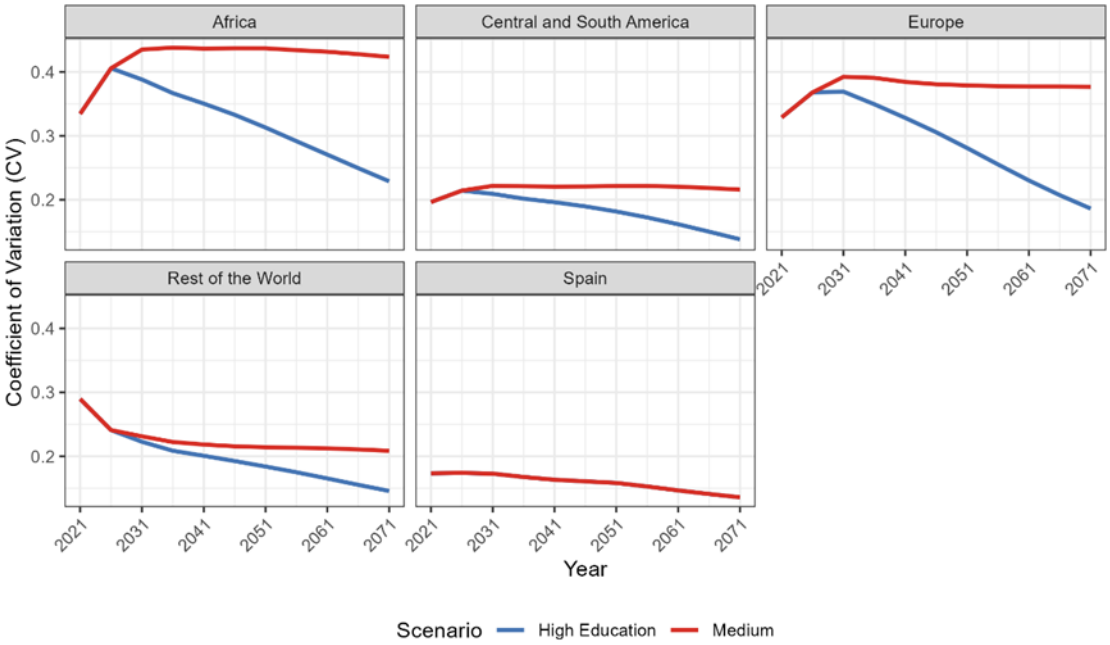


Figure A.9. Disparity (CV) of tertiary educated within origins, 2021-2071



Tables

Table 1.A. Shares by origin, total population and growth by region, 2021 and 2071

	2021						2071						2021-2071
Region	*Spain*	*C. S. Americans*	*Europe*	*Africa*	*R. World*	*Total Population*	*Spain*	*C. S. Americans*	*Europe*	*Africa*	*R. World*	*Total Population*	*Population growth (%)*
Andalusia	89,35	2,91	4,12	2,91	0,71	8.655.123	78,76	8,58	5,92	5,40	1,34	8.432.417	-2,6
Catalonia	79,71	8,54	4,63	4,39	2,74	7.749.870	63,35	18,60	6,56	7,10	4,39	9.085.460	17,2
Extremadura	95,38	1,63	1,72	0,95	0,32	1.061.700	86,43	6, 93	3,19	2,52	0,94	750.278	-29,3
Galicia	90,77	5,12	2,85	0,70	0,55	2.698.212	74,91	17,73	4,07	1,83	1,47	2.183.092	-19,1
La Rioja	84,47	5,74	5,18	3,35	1,26	319.470	68,22	16,08	6,10	6,78	2,83	314.247	-1,6
Madrid	79,67	11,66	4,57	1,98	2,13	6.726.591	65,66	23,97	4,20	2,75	3,41	8.480.525	26,1
Murcia	83,05	6,01	4,24	6,11	0,59	1.518.285	71,35	12,60	4,74	10,23	1,09	1.732.417	14,1
Navarra	83,75	8,02	3,83	3,61	0,80	661.974	68,21	18,32	4,67	7,17	1,63	692.338	4,6
Valencian Community	81,70	6,04	8,10	2,82	1,35	5.067.807	65,05	16,89	10,82	4,98	2,26	5.877.323	16,0
Aragon	84,87	5,64	5,14	3,41	0,95	1.331.904	70,43	15,16	6,30	6,44	1,68	1.301.704	-2,3
Asturias	91,75	4,43	2,46	0,76	0,60	1.012.074	74,17	17,15	4,71	2,10	1,87	786.961	-22,2
Balearic Islands	75,29	10,50	8,88	3,57	1,77	1.183.356	59,61	22,48	10,13	5,04	2,74	1.528.712	29,2

Basque Country	89,00	5,60	2,08	2,38	0,94	2.212.533	73,55	15,83	3,45	5,27	1,90	2.048.017	-7,4
Canary Islands	79,86	9,81	7,21	1,90	1,23	2.178.882	62,53	21,65	10,74	3,12	1,96	2.441.372	12,0
Cantabria	90,32	5,16	2,88	0,85	0,79	584.742	74,54	15,72	5,05	2,42	2,27	533.323	-8,8
Castilla - La Mancha	88,69	4,51	3,89	2,35	0,56	2.052.513	73,17	14,90	5,04	5,65	1,25	1.905.283	-7,2
Castilla and León	91,46	3,62	3,14	1,28	0,51	2.385.165	78,33	12,67	4,36	3,32	1,32	1.873.672	-21,4