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statistiche report

Istat Istituto Nazionale di Statistica

HOUSEHOLDS AND POPULATION PROJECTIONS | BASE 1/1/2020

Fewer residents, more elderly, smaller families

A decreasing population: from 59.6 million as of January 1, 2020 to 58 million in 2030, to 54.1 million in 2050 and to 47.6 million in 2070.

Young and elderly in a ratio of 1 to 3 in 2050: people aged 65 and more will represent 35% of the total, young people up to 14 years of age 11.7%.

Sharp decline in the working-age population: in thirty years individuals aged 15-64 dropped from 63.8% to 53.3% of the total.

The demographic crisis of the territories: within 10 years most of the Municipalities will have recorded a decline in population.

The number of households is increasing: from 25.7 million in 2020 to 26.6 million in 2040 but showing a decreasing average number of members.

Fewer couples with children, more couples without: by 2040 only 1 in 4 families made up of a couple with children; more than 1 in 5 will be childless.

50.7

The mean age of the population in 2050

From 45.7 in 2020.

2048

The year in which deaths could double live births (784 thousand against 391 thousand)

10.3 million

People expected to live alone in 2040

From 8.6 million in 2020.

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Gradual and continuous decline of the population

The resident population is expected to decrease over the next decade according to the "median" scenario (Table 1): from 59.6 million as of January 1st, 2020 (starting point of the projections) to 58 million in 2030 for an annual rate of change of -2.9 per thousand. In a medium-term perspective, however, the decrease in the population would be more pronounced: from 58 million to 54.1 million between 2030 and 2050, with an average annual rate of change of -3.4 per thousand.

In the long term, the consequences of the expected demographic dynamics on the population become more important. In fact, between 2050 and 2070 the population would decrease by a further 6.5 million (-6.4 per thousand on annual average). Under this assumption, the total population would amount to 47.6 million in 2070, resulting in an overall loss of 12.1 million residents compared to today.

Demographic projections are uncertain by definition. Such a characteristic is the more relevant the more time is further away from the base year. The future evolution of the total population fully reflects this principle after only a few years of projection. In 2050, the 90% confidence interval of the total population ranges between 51 and 57.5 million. Twenty years later it ranges from 41.1 to 54.9 million residents.

Thus, according to the more favourable assumption the population could record a loss of "only" 4.7 million between 2020 and 2070, on the other hand, a decline of 18.6 million could be achieved. Confirming what emerged in previous forecasting studies, by Istat and international bodies (Eurostat, United Nations Population Division), it is almost certain that the population will decrease. In fact, although the possibility that the demographic dynamics could lead to a population in 2070 larger than today is not entirely excluded, the empirical probability of this event is minimal, being equal to 1% (percentage of cases in favour of the event on the total of the simulations conducted).

The issue affects the whole Country, albeit with differences between the Centre-North and the South. According to the median scenario, in the short term it is expected that in the North (-1.3 per thousand per year until 2030) and in the Centre (-2.2) there may be a smaller reduction in the population than in the South (-5.4). In the medium term (2030-2050) and long term (2050-2070) this trend strengthens, with a population decline shared by all geographical areas, but more strongly in the southern one. For example, in the less disadvantaged North there is an average annual reduction of 1.4 per thousand in 2030-2050 and one of 4.3 per thousand in 2050-2070. On the contrary, in the South the reduction is 6.9 and 10.3 per thousand, respectively, in the two periods.

The evolution of the population by geographical area is also marked by uncertainty. For the North, this uncertainty makes difficult to understand the direction of demographic change. Oriented towards growth, as shown by the upper limit of the confidence interval in 2070 (28.2 million), or to decrease by looking at the lower one (20.8). Its final population, therefore, is between two values, respectively, below and above that in the base year, although the median scenario (24.3 million) shows that its decrease is more likely. The Centre and the South show a range of assumptions for the year 2070 whose maximum values (11.2 and 15.4 million, respectively) are lower than their base populations.

TABLE 1. RESIDENT POPULATION BY GEOGRAPHICAL AREA. MEDIAN SCENARIO AND 90% CONFIDENCE INTERVALS. Years 2020-2070, January 1st, million (*)

Geographic area	2020	2030	2040	2050	2070
North	27.6	27.3	27.0	26.5	24.3
		[27.0 / 27.5]	[26.2 / 27.9]	[24.9 / 28.3]	[20.8 / 28.3]
Centre	11.8	11.6	11.3	11.0	9.7
		[11.5 / 11.7]	[11.0 / 11.7]	[10.3 / 11.7]	[8.4 / 11.2]
South	20.2	19.1	18.0	16.7	13.6
		[19.0 / 19.3]	[17.6 / 18.5]	[15.9 / 17.6]	[11.9 / 15.4]
ITALY	**59.6**	**58.0**	**56.4**	**54.1**	**47.6**
		[57.5 / 58.4]	[54.8 / 58.1]	[51.0 / 57.5]	[41.1 / 54.9]

(*) Values under the confidence intervals in square brackets.

Future births will not compensate for future deaths

For several years, precisely since 2007, Italy has been facing the reality of a negative natural change, a factor that underlies the process of population reduction, despite the partial counterpart of positive migratory dynamics with foreign countries.

From this point of view, the assumptions on births and deaths amplify this process, measuring an evident tendency to annually record negative balances for the natural movement of the population. Not even in the most favourable opposing scenarios, those in which regimes of high birth-rate and low-mortality regimes intersect, would the projected number of births come to compensate for that of deaths. For example, the upper bound of the 90% confidence interval for births, corresponding to scenarios in which the total fertility rate grows from 1.24 in the base year to 1.88 in 2070, would still determine a lower number of births than the number of deaths under its lower confidence limit (Figure 1).

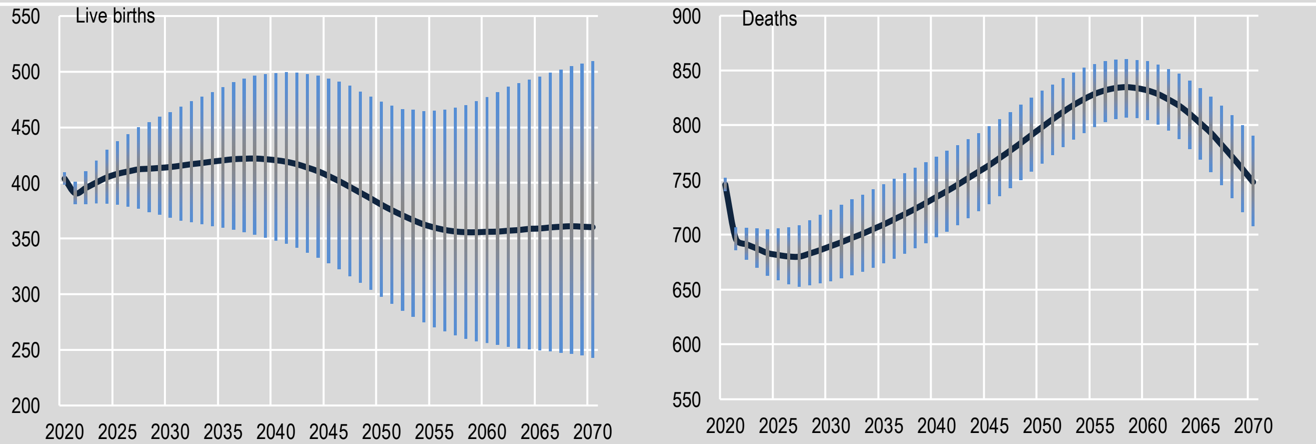
In the median scenario, once the short-term shock imposed by the pandemic has been overcome, births should start a slight recovery, up to 414 thousand in 2030 and a maximum of 422 thousand by 2038. A period, this, in which fertility is expected in increase, from 1.24 children per woman to 1.44. A trend that later, although prospected in continuation (up to 1.55 children per woman by 2070), does not however produce a further rise in births after 2038, for an intrinsic reason due to the composition of the female population in childbearing ages. In fact, women of childbearing age will gradually begin to decline as well as becoming older on average, reducing the country's reproductive potential.

In turn, deaths, once the disturbing effect of the pandemic has been reabsorbed, should continue to express their innate tendency to increase. This result, in fact, is in line with what will be the level of aging of the population, albeit in a context of good expectations on the evolution of life expectancy (86.5 and 89.5 years at birth in 2070, respectively. for men and women). The projection shows 680 thousand deaths around 2025 and 800 thousand in 2050 with an almost linear trend. A peak of 835 thousand is achieved in 2058, the year after which the decrease in the total number of deaths is in line with the absolute decrease in the population.

The uncertainty linked to the projections of births and deaths increases over time and especially for the former. This is due to two specific reasons. The projected confidence interval for fertility is objectively high, between 1.23 and 1.88 children per woman by 2070. It therefore ranges between a vision of fertility similar to that of today and one that tends just below the replacement level of generations. Furthermore, as we move further into the future, fertility levels are applied to cohorts of projected women, namely future children given from mothers still to be born.

These conditions apply in part to deaths. The confidence intervals projected to 2070 for the probabilities of death are wide (between 84.3 and 88.5 years the life expectancy at birth of men, between 87.6 and 91.5 that of women) but these have an impact over time towards individuals who, net of future migratory movements with abroad, are largely already alive today.

FIGURE 1. LIVE BIRTHS AND DEATHS IN ITALY, MEDIAN SCENARIO AND 90% CONFIDENCE INTERVALS. Years 2020-2070, thousand.



Positive but uncertain migration scenario

Once the pandemic shock has been overcome, from the year 2023 immigration from abroad could recover the average levels recorded in the five-year period 2015-2019. From that moment, with a quota of immigrants around 280 thousand units, the median scenario contemplates a substantial return to normality, in conjunction with the economic recovery and the progressive implementation of the PNRR (national plan of recovery and resilience) (Figure 2). In the medium and long term, therefore, a gradual decrease of immigrants is expected, down to the value of 244 thousand in 2070. Cumulating over the entire forecasting period, the median scenario therefore prefigures a permanent settlement of 13.3 million immigrants.

Emigration to abroad should also recover within a few years the levels recorded in the five years preceding the advent of the pandemic. In the median scenario, their stable evolution is subsequently assumed, from about 145 thousand units in 2025 to 126 thousand in 2070. In total, over the entire forecasting period, the emigrants from Italy would be about 6.9 million.

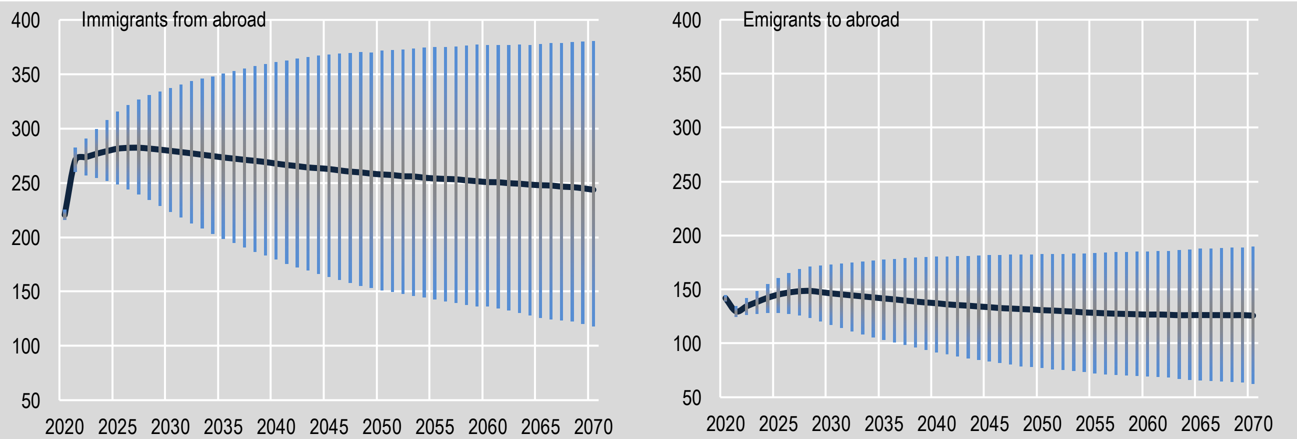
The resulting net migration with foreign countries that arises from the median scenario is therefore largely positive: after 2020 (+79 thousand units), from 2021 it returns to the value of + 141 thousand, followed by a continuous and regular decline that leads at +118 thousand in 2070.

However, migratory flows with foreign countries are marked by profound uncertainty. In fact, international migrations are governed on the one hand by policies subject to change, and on the other by socio-economic factors internal and external to the country that are not easy to interpret. Consider, for example, the migratory pressure exerted in the countries of origin, the integration policies of immigrants, the modulation of the labour market, and the emigration of citizens residing in Italy. All these factors have the potential to give rise to much diversified migration scenarios.

The share of immigrants from abroad, for example, has a 90% confidence interval in 2070 that ranges between 188 thousand and 380 thousand units. In the same year, moreover, it is expected that the value of emigrations may fall within an interval between 62 thousand and 189 thousand units.

Given that the analysis of such long-term results must necessarily be accompanied by great caution, it reveals two pictures of the future that are very different, even alternative, for the country. On the one hand that of a very attractive country, on the other that of a country that could radically change its welcoming nature to return to being a place from which to emigrate. Moreover, in the context of all the developed simulations, it emerges that the probability that the country can achieve a negative net balance with foreign countries is significant, albeit low. In fact, such an event has a probability of being experimented which increases from 1.3% in 2040 to 4.1% in 2050% and to 8.5% in 2070.

FIGURE 2. MIGRATORY SCENARIOS WITH FOREIGN COUNTRIES, MEDIAN SCENARIO AND 90% CONFIDENCE INTERVALS. Years 2020-2070, thousand.



Young and old people in a ratio of 1 to 3 by 2050

The protracted low fertility regime that has characterized Italy for the last 40 years, combined with the positive goals achieved in terms of survival, have meant that already today we can speak of a country with a high aging process. The population aged 65 and over represents 23.2% of the total, those up to 14 years of age 13%, those in the 15-64 age group 63.8%, while the mean age of the population has approached 46 years. Thus, it is certain that future prospects will be largely controlled by how the age structure of the population is already articulated today, and only to a lesser extent by the changes imagined regarding the evolution of fertility, mortality and migration. Based on a ratio of importance, approximately, of two thirds and one third respectively.

By 2050, people aged 65 and over could represent 35% of the total according to the median scenario, while the 90% confidence interval ranges from 33.1% to 36. 9%. Whatever happens, therefore, further steps will be needed to adapt social protection policies to such a growing share of the elderly population.

Young people up to 14 years of age, although in the median scenario a recovering fertility is expected, could represent 11.7% of the total by 2050, thus recording a slight decline. Anyway, the unsolved question on that year will be a 3 to 1 ratio between over 65s and children.

The impact of aging should also be highlighted in relation to the probable evolution of the working-age population. In fact, in the next thirty years, the population aged 15-64 is the component that will be most subject to sudden changes, as it would drop from 63.8% to 53.3% based on the median scenario, with a potential range between 51.9% and 54.7%. As in the case of the elderly population, therefore, also here a certain evolutionary picture, regardless of the possible alternatives. A framework whose effects on the labour market and future economic planning must be assessed, as well as the pressure that the Country will have to face in order to maintain the current welfare status.

A partial rebalancing in the population structure, albeit in the long term, is what could occur as the generations born in the baby boom years (born in the 60s and the first half of the 70s) will tend to become extinct. These generations today occupy the late adulthoods and are about to move entirely between the over 65s in the space of twenty years. According to the median scenario, the 15-64 year olds could therefore return to 54.1% by 2070 while the over 65 year olds could decrease to 34.3%. On the other hand, the youth population remained stable with a level of 11.6%.

The transformation of the age structure of the population will characterize every area of the country, although the South is characterized by a progressively more marked aging process (Table 2). In this area, which today still maintain a younger age profile, the mean age grows from 44.6 years in 2020 to 50 years in 2040. At that point surpassing the North which reaches a mean age of 49.2 years but which in the base year, however, starts from a higher level, that is, 46.3 years.

TABLE 2. MEAN AGE OF THE POPULATION BY GEOGRAPHIC AREA, MEDIAN SCENARIO AND 90% CONFIDENCE INTERVALS Years 2020-2070, January 1st, in years and tenth of year (*).

Geographic area	2020	2030	2040	2050	2070
North	46.3	48.0	49.2	49.9	49.7
		[47.8 / 48.3]	[48.4 / 50.0]	[48.5 / 51.4]	[47.1 / 52.5]
Centre	46.4	48.6	50.3	51.3	51.1
		[48.4 / 48.8]	[49.5 / 51.0]	[49.8 / 52.7]	[48.5 / 53.9]
South	44.6	47.6	50.0	51.6	52.1
		[47.3 / 47.8]	[49.3 / 50.7]	[50.2 / 53.0]	[49.4 / 54.9]
ITALY	**45.7**	**48.0**	**49.7**	**50.7**	**50.7**
		[47.7 / 48.2]	[48.9 / 50.5]	[49.3 / 52.2]	[48.1 / 53.5]

(*) Values under the confidence intervals in square brackets.

The demographic decline in the South is inevitable

The growth trajectory of aging in the South extends into subsequent years, up to the point of overtaking the Centre by 2050. On that date the mean age in the South would have reached 51.6 years compared to 51.3 in the Centre, although this latter area starts today from a much higher level of aging (46.4).

Despite a big uncertainty, which in 2070 begins to be important for an indicator such as the mean age, the South would slow down but would not stop its path reaching a mean age of the population over 52 years. At that point, however, both the North (49.7 years) and the Centre (51.1) would have already started the opposite path, that is to say that towards an age profile in a small part rejuvenated.

By 2030, most of Municipalities will have recorded a demographic decline [i)]

Within 10 years (period for which Istat defines for the first time in its history a specific forecasting methodology, consistent with the regional and national level described above) an increasing number of Municipalities will face a demographic decline. According to the median scenario, 81% of Municipalities should be in such conditions by 2030. This is due to low fertility, which affects the age structure of the populations uniformly at the base, but also to unfavourable migratory levels for some territorial realities, where both foreign and internal emigration is stronger.

At the national level, it is estimated that between 2020 and 2030 the Municipalities of rural areas may overall contract a population reduction of 6%, moving from 10.2 to 9.6 million residents (Table 3). In these areas, the Municipalities with a negative population balance are 87% of the total. The issue affects especially the areas of the South, where the Municipalities of rural areas with a negative balance are 93% of the total and where a population reduction of 8.9% is expected.

For the 1,060 Municipalities that fall into "***Internal areas***", particular areas of the national territory that are characterized by a physical distance from the supply of essential services, the demographic condition appears even more unfavourable. Here, in fact, the share of Municipalities with a negative population balance in the decade rises to 95%, recording a reduction of the population equal to 9.6% (by 10.4% considering only the South).

In a relatively better situation are the Municipalities with intermediate density (small towns and suburbs), where the expected demographic decline is 2.2%, since the population goes from 28.4 to 27.8 million in the decade. The share of Municipalities affected by a demographic decline is also lower, 72% of the total, which however rises to 85% in the South.

Finally, although to a lesser extent, cities and densely populated areas will also be interested in the issue of depopulation. The attractiveness of the areas with a stronger urbanization will in fact mean that in the decade the overall population decline is only 2.1%, with 67% of the Municipalities destined to record a negative balance among their residents.

TABLE 3. POPULATION BY URBANIZATION / INTERNAL AREA AND GEOGRAPHIC AREA – MEDIAN SCENARIO.
Years 2020 and 2030, January 1st, thousand *

Geographic area	Year	City or Densely populated area	Small town, suburb, intermediate density	Rural or scarcely populated area	Internal area	Non internal area
North	2020	9,392	13,370	4,854	501	27,115
	2030	9,369	13,231	4,656	462	26,794
Centre	2020	4,514	5,388	1,929	382	11,449
	2030	4,448	5,303	1,817	346	11,222
South	2020	7,141	9,631	3,423	1,092	19,102
	2030	6,796	9,217	3,118	978	18,153
ITALY	**2020**	**21,047**	**28,388**	**10,206**	**1,975**	**57,667**
	2030	20,613	27,752	9,590	1,786	56,169

(*) The degree of urbanization responds to the classification Degurba (Population Statistics by regular grid, www.istat.it/it/archivio/155162). Internal areas, defined by the Social Cohesion Agency, are areas of the Italian territory characterized by a significant distance from the supply of essential services. They include 1,060 Municipalities (www.agenziacoesione.gov.it).

Internal migrations one of the keys to the depopulation

A key to understanding the demographic change of Municipalities in the next decade is that of internal migration. In 2020-2029, cumulatively, it is expected that changes of residence may affect 13.1 million citizens, 24% of which inter-regional while for 76% between Municipalities within the same region.

Cities and densely populated areas will be favoured by positive interregional net migration (+108 thousand units in the decade) to the detriment of intermediate density areas (-59 thousand) and rural areas (-49 thousand). This scheme, however, is valid only when considering all the Municipalities as a whole. In fact, the characteristic of long-range migrations is to see the areas of the Centre-North favoured, where cities and densely populated areas (+312 thousand) but also areas with intermediate density (+166 thousand) and even rural areas (+37 thousand) show positive net migration. This would disadvantage the areas of the South, where the population losses would amount, respectively, to 204 thousand, 226 thousand and 86 thousand units.

Therefore, the issue of depopulation of rural areas must be framed mainly in the logic of short-range (intra-regional) migrations, which, as mentioned, concern at least 3 out of 4 internal transfers. From this point of view, the more massive is the attractiveness of small towns and areas with intermediate density, which show very positive migratory balances (+203 thousand in the decade), both towards rural areas (-54 thousand) and big cities (-149 thousand).

The prospect for the next few years is therefore the following: large urban centres, especially if in the Centre-North, will continue to exercise a good attractiveness from the most remote rural areas, especially from the South. Looking instead at the short-range migratory dynamics, large urban centres are not the preferred destination which, on the contrary, proves to be the small centre, often on the boundaries or in the vicinity of the large urban centre itself.

Families on the rise but fragmented

The projections of the number of households show an increase of almost one million units, following a trajectory that has already been in place for some time in the country: from 25.7 million in 2020 to 26.6 million in 2040, with an increase by 3.5 percentage points. Such an increase hides a specific feature of the evolution of families: their fragmentation (Table 4). In fact, households without a nucleus would increase consistently, from 9.2 to 11 million (+20%). Households with at least one nucleus, i.e. those characterized by the presence of at least one couple or a parent-child relationship, follow an opposite trend, decreasing from 16.6 to 15.6 million (-6%).

The reduction of households with nucleus is due to the consequences of long-term socio-demographic dynamics: aging of the population, the increase in marital instability, the low birth rate. The increase in life expectancy, for example, generates a greater number of lonely people. In turn, the decrease in the birth rate increases the number of childless people while the increase in marital instability increases the number of people living alone or of lone parents as a result of the dissolution of a couple bond.

TABLE 4. NUMBER OF HOUSEHOLDS BY TYPE AND AVERAGE SIZE OF HOUSEHOLDS. Years 2020*, 2030, 2040, median scenario, thousand and mean values.

TYPE	2020	2030	2040	TYPE/INDICATOR	2020	2030	2040
Total households	25,737	26,224	26,628	Childless couple	5,101	5,498	5,739
Households with one nucleus at least	16,569	16,182	15,585	Lone parent - man	587	759	892
Households without nucleus	9,169	10,042	11,044	Lone parent - woman	2,204	2,202	2,211
Lone person – man	3,619	3,892	4,252	Other type of household **	1,007	1,058	1,093
Lone person – woman	4,953	5,489	6,079	Average size	2.3	2.2	2.1
Couple with children	8,267	7,325	6,362	Average size for households with a nucleus at least	3.0	2.9	2.8

(*) The multipurpose survey on "Daily Life Aspects" are released on a two-year average. Here, however, the data refer to 1st January. For 2020 this can give rise to differences.

(**) Multi-person households (several people living together who do not form a nucleus) and households with more than one nucleus.

Smaller families and new family roles

Alongside the increase in households, there is a decrease in their average size, which would drop from 2.3 members in 2020 to 2.1 in 2040. Taking into consideration only households with the presence of a nucleus, the average size would be changed in the same timeframe from 3 to 2.8 components.

Past and prospective demographic dynamics entail a situation in which the new generations tend to shrink, both in absolute and relative terms. The age structure of the population already shows a high imbalance in favour of the older generations and at the moment there are no factors that could suggest a change of direction. The population projections show how unlikely can be a turnaround in the number of births in the years to come, even in case of favourable assumptions regarding fertility. This is because the prospect of having to deal with a decreasing number of women of childbearing age, on the one hand, as well as the tendency to postpone parenting, on the other, seem to take on increasing weight.

The analysis of the population expected by 2040 based on the role in the family jointly highlights the aging process and changes in family positions. In particular, it shows the decrease of people in couples with children, the increase of those without children and of people living alone, this latter especially if elderly (Figure 3). The younger age groups are thinning in consistency but the family position as a child remains prevalent up to the age of 30, due to the prolonged stay of young people in the family of origin.

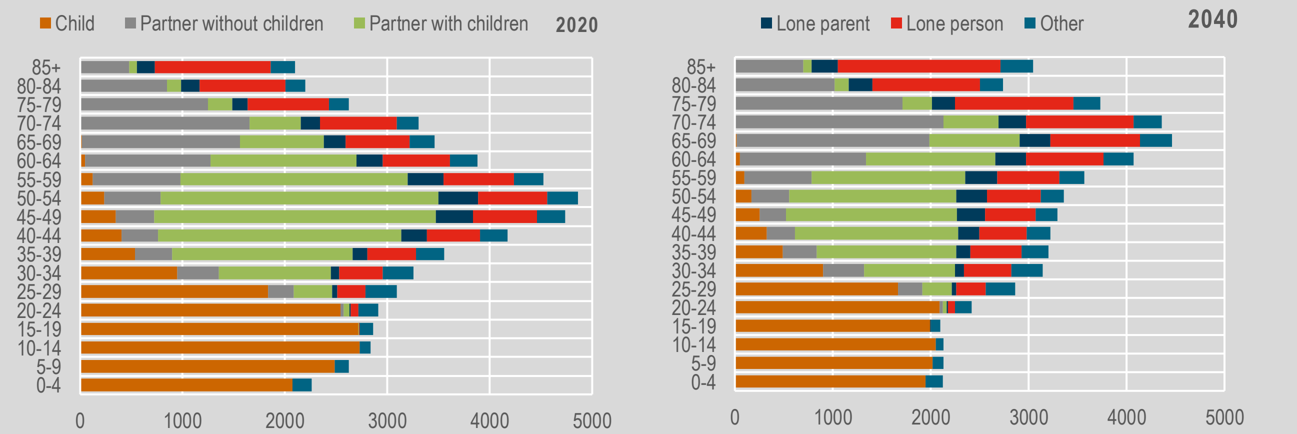
More than 10 million lonely people by 2040

Among the many dynamics that lead to the transformation of family structures, there is the one that leads to the increase of lonely people, real micro-families which are mainly responsible for the absolute growth of the total number of households.

Men living alone will increase from 3.6 million in 2020 to 4.3 million in 2040, recording a growth of 17%. Single women, on the other hand, would increase from 5 to 6.1 million (+ 23%). Because of their composition by age this type of households has an important social impact: it is, in fact, mainly in the advanced ages that single people get considerable shares.

Looking at individuals aged 65 and over, an increase of 640,000 single men and 1.2 million single women would be seen in the twenty-year period under examination. It is argued, often rightly, that a growth in survival by increasing the elderly and, among them, those alone, could lead to a future increase in the needs for assistance. However, the increase of single elderly people also has positive implications; the increase in survival in term of quantity of lived years and, it is assumed, also in term of quality of life, could allow these people to play an active role in the society. For example, as it already happens today and more likely tomorrow, by supporting the families of their children in caring for their grandchildren and guaranteeing them economic support, or even participating in the economic cycle not only as consumers of welfare services but also as capital investors.

FIGURE 3. POPULATION BY POSITION IN THE HOUSEHOLD AND FIVE-YEAR AGE GROUP. Years 2020 and 2040, median scenario, thousand.



Couples with children are decreasing

Due to the fertility levels observed in recent years, as well as on the basis of the assumptions produced under the median scenario, a substantial decrease in couples with children is expected. Between 2020 and 2040 their consistency would decrease by 23%, i.e. from 8.3 million to 6.4 million.

At the same time, childless couples will increase slightly from 5.1 to 5.7 million, for an increase of 13%. If this trend were to proceed with the same intensity expected until 2040, especially as regards the rate of decrease of couples with children, the overtaking by couples without children could already take place by 2045.

Single fathers grow up, single mothers stable

Marital instability, increasingly widespread in the country, will see an increase in single parent households, male or female, with one or more children. In 2020 there are a total of 2.8 million single parents, mostly mothers (2.2 million) than fathers (around 600 thousand), respectively representing 8.6% and 2.3% of the total households.

In the past, after a breakup of the couple, children were generally entrusted to mothers. Since the promulgation of the joint custody law in 2006, this prevalence has been decreasing. This has led to an ever greater spread of fathers as custodians in separation or divorce sentences.

It is in this key that the evolution of the single fathers curve should be read in perspective. They will remain a minority compared to single mothers, recording about 900 thousand units (3.4% of the total households) by 2040. In that year, single mothers would be numerically unchanged at 2.2 million (8.3% of the total), so that the total of single parents would be 3.1 million.

The family structure of the South converges on that of the North

The family typologies respond to demographic dynamics and specific social behaviours between the different areas of the country, especially between the North and the South. In the North, in 2020, the share of households with at least one nucleus is decidedly lower, precisely 62.8% against 67.7% in the South (Table 5). However, from this point of view the projections show a tendency to ensure that the two areas can partially converge.

In the South, a more substantial change is expected in this type of household, since in 2040 they could represent 61% of total households, recording a reduction of around 7 percentage points compared to 2020. In the North, households with at least one nucleus would have a lower reduction, equal to 5 percentage points, so that these would represent 57.5% of total households.

TABLE 5. HOUSEHOLDS BY TYPE AND GEOGRAPHIC AREA. Years 2020, 2030, 2040, median scenario, % values.

Type	North			Centre			South			Italy		
	2020	2030	2040	2020	2030	2040	2020	2030	2040	2020	2030	2040
Lone man	14,7	15,8	17,0	15,0	15,6	16,7	12,5	13,0	13,9	14,1	14,8	16,0
Lone woman	20,3	21,5	22,9	19,9	21,7	23,4	17,3	19,6	22,4	19,2	20,9	22,8
Childless couple	21,8	22,7	23,1	18,2	19,2	19,6	17,9	19,5	20,4	19,8	21,0	21,6
Couple with children	30,0	26,2	22,8	29,7	25,7	21,9	36,9	32,0	26,9	32,1	27,9	23,9
Lone parent – man	2,2	2,8	3,3	2,6	3,3	3,7	2,2	2,8	3,2	2,3	2,9	3,4
Lone parent – woman	7,5	7,3	7,1	10,3	10,1	10,3	9,0	8,9	8,9	8,6	8,4	8,3
Other type	3,5	3,7	3,8	4,3	4,5	4,6	4,3	4,3	4,3	3,9	4,0	4,1
Households with nucleus	62,8	60,3	57,5	62,9	60,3	57,2	67,7	64,8	61,0	64,4	61,7	58,5
Households without nucleus	37,2	39,7	42,5	37,1	39,7	42,8	32,3	35,2	39,0	35,6	38,3	41,5
Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

South would record a major decrease of couples with children

The type of family that is expected to undergo the most evident change in the next twenty years is that of couples with children. If these today represent 32.1% of total households, in 2040 they would go to 23.9%. The decrease in couples with children would be more pronounced in the South, equal to 10 percentage points (from 36.9% to 26.9%).

The gender gap in survival is reflected in the increase in women living alone. For Italy as a whole, this type of family is expected to constitute 22.8% of total households by 2040, from a current value of 19.2%, for a variation of about 4 percentage points. A variation that rises to over 5 percentage points in the case of the South (from 17.3% to 22.4%).

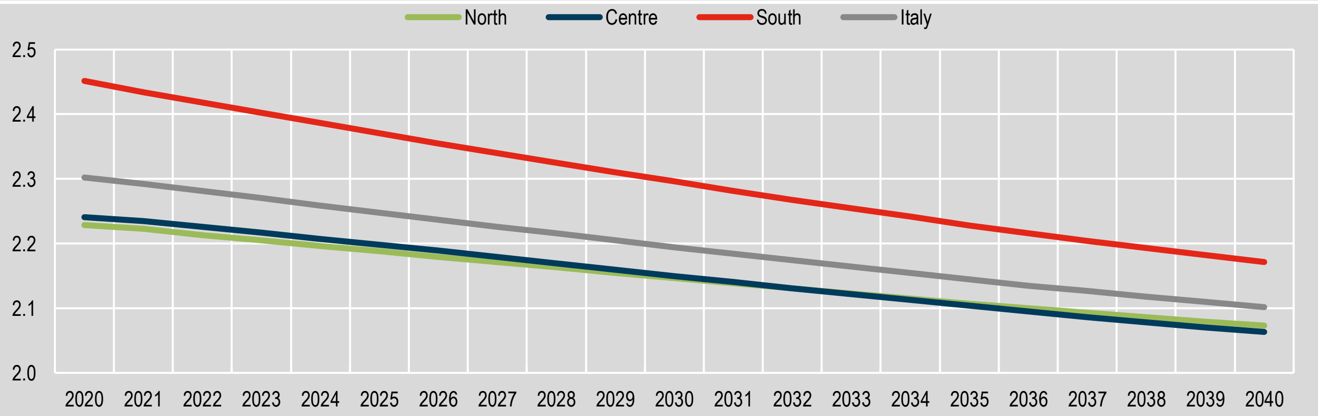
For men, territorial heterogeneity in terms of life expectancy, but also a more evident predisposition to celebrate "second marriages", mean that even the increase in single people has territorial specificities. In 2040 this household typology would constitute 16% of all households nationwide, 17% in the North.

The typology “couple without children”, which is expected to constitute 21.6% of total households in 2040 for Italy, will continue to be more widespread in the North (23.1%), although achieving a more contained increase. The strongest change is in fact expected in the South, where, despite an initial less widespread situation, couples without children would increase by about 3 percentage points in twenty years (from 17.9% to 20.4%).

The combination of family transformations underway means that the average size of households will continue to decline, not only nationally (from 2.3 to 2.1 members), but also following the demographic and social specificities of the territory.

The North and the Centre, with very similar current values and future trajectories, will reach an average value of components slightly below the national figure. The South, thanks to higher fertility rates in the not more recent past, had always shown families on average larger than the North. Today, thanks to more contained reproductive levels, this record (2.5 components) tends to become less clear. In the future, although it is expected to be maintained until 2040, the expectation is for a further decrease down to 2.2 components (Figure 4).

FIGURE 4. AVERAGE HOUSEHOLD SIZE BY GEOGRAPHIC AREA. Years 2020-2040, median scenario



Glossary

Age specific fertility (rate): the ratio of the number of live births to women between the ages of x and x + 1 and the average number of women of that age in a given year.

Average number of children per woman: the number of children a woman would have if she was subjected to the fertility calendar (in the form of age-specific fertility rates) of a given calendar year during her reproductive life span.

Birth (rate): ratio between the number of live births in the year and the average amount of the resident population, multiplied by 1,000.

Cohort component (model): the continuous calculation algorithm that in iterative mode simulates the evolution of the fundamental population equation by age group, allowing to determine the demographic flows and to obtain the surviving population at the end of each year.

Couple: two people linked by an emotional and sentimental relationship. Can be formed by opposite or same sex people. The bonds between people in couples can be formal (de jure couple: married, civilly united or de facto cohabiting pursuant to law 76/2016) or informal (de facto couple).

Death: the cessation of any sign of life at any time after the vital birth.

Demographic projection: elaboration that shows the future development of a population when certain assumptions are made regarding the future course of mortality, fertility and migration.

Deterministic demographic projection: elaboration on the future development of a population, summarized in a single series of values obtained from a single set of demographic assumptions, which does not report any measure regarding the uncertainty usually associated with the results.

Dependency ratio: ratio between the population of inactive age (0-14 years and 65 years and over) and the population of active age (15-64 years), multiplied by 100.

Elderly dependency ratio: ratio between the population aged 65 and over and the population aged 15-64, multiplied by 100.

Emigration for abroad (rate): the ratio between the number of emigrations to abroad and the average amount of the resident population, multiplied by 1,000.

Families with nucleus: includes couples with children, couples without children, single parents, families with two or more nucleus.

Families without nucleus: people living alone or multi-person families; this latter do not constitute a family unit even if composed of several people.

Family: group of people linked by ties of marriage, kinship, affinity, adoption, protection, or by emotional ties, cohabitants and having habitual residence in the same Municipality. It can also be constituted by a single person.

Family nucleus: set of people who form a couple or a parent-child relationship. It means a married couple, civilly united or cohabiting, with or without children, or even a single parent together with one or more children who have never been married. Within a family there may be one or more family nucleus, but there may also be none, as in the case of families formed by an isolated member (single-component families) or several isolated members (other resident persons).

Family typology: classification based on the presence or absence of at least one nucleus and by type of nucleus.

Immigration from abroad (rate): the ratio between the number of immigrations from abroad and the average amount of the resident population, multiplied by 1,000.

Internal emigration (rate): the ratio between the number of internal emigrations and the average amount of the resident population, multiplied by 1,000.

Internal immigration (rate): the ratio between the number of internal immigrations and the average amount of the resident population, multiplied by 1,000.

Internal migration balance: difference between the number of registrations for change of residence from another Municipality and the number of de-registrations for change of residence to another Municipality.

Internal net migration (rate): the difference between the internal immigration rate and the internal emigration rate.

Life expectancy at age "x": the average number of years that a person of completed age "x" can count to survive in the hypothesis that, in the course of his subsequent life, he was subjected to the risks of mortality by age (from age "x" up) of the year of observation.

Life expectancy at birth: the average number of years that a person can count to live from birth in the hypothesis that, in the course of his existence, he was subjected to mortality risks by age of the year of observation.

Live birth: the product of conception which, once expelled or completely extracted from the maternal body, regardless of the duration of gestation, breathes or manifests other signs of life.

Mean age: mean age of the population at a certain date expressed in years and tenths of a year.

Mean age at birth: the mean age at birth of mothers expressed in years and tenths of a year, calculated considering only live births.

Migratory balance with abroad: difference between the number of registrations for change of residence from abroad and the number of de-registrations for change of residence to abroad.

Mortality (rate of): ratio between the number of deaths in the year and the average amount of the resident population, multiplied by 1,000.

Natural balance: difference between the number of births and the number of deaths.

Natural growth (rate): the difference between the birth rate and the death rate.

Net migration with abroad (rate): the difference between the immigration rate from abroad and the emigration rate with abroad.

Old age (index): ratio between the population aged 65 and over and the population aged 0-14, multiplied by 100.

Predictive (or confidence) interval: an interval associated with a random variable yet to be observed, with a specific probability that the random variable falls within it.

Probabilistic demographic projection: elaboration on the future development of a population, summarized in a set of values or in a probability distribution, in which the variables used are of a random nature that cannot be predicted with certainty and in which not all assumptions are equally probable.

Probability of death: the probability that an individual of precise age x will die before the birthday x + 1.

Projection: development expected in the future.

Projection probability of death: the probability that an individual of age x (in years completed on 1st January) will not survive within the year.

Projection probability of interregional migration: the probability that an individual of age x (in years completed on January 1st) moves residence between two regions before the end of the year.

Range: measure of the variability of a quantitative phenomenon defined by the difference between its maximum and the minimum value.

Registration and de-registration for transfer of residence: registration concerns people who have moved to a Municipality from other Municipalities or from abroad; the de-registration concerns people who have moved to another municipality or abroad.

Resident population: constituted in each Municipality (and similarly for other territorial divisions) of people with habitual residence in the Municipality itself. Persons temporarily residing in another Municipality or abroad, for the exercise of seasonal occupations or for reasons of limited duration, do not cease to belong to the resident population.

Scenario approach: the description of the context, even conceptual, in which the population is projected. In a deterministic approach it usually refers to the main or central assumption. In a stochastic it can refer to the assumption identified as mean or median.

Simulation: the quantitative implementation of a single set of demographic assumptions to be launched in the cohort-component model in order to obtain a single set of demographic projections.

Total balance: sum of the natural balance and the total migratory balance.

Total growth (rate of): the sum of the total net migration rate and the natural growth rate.

Total migratory balance: the sum of the migration balance with abroad and the internal migration balance.

Total net migration (rate): the sum of the net internal migration rate and the net migration rate with abroad.

Methodological note

1) Population projections by region, age and sex. Years 2020-2070

Istat's regional demographic projections are built with the aim of representing the possible future trend of the population, both in terms of total numbers and in terms of age and sex structure. The information produced represents an important tool to support decisions in economic and social policies, such as those relating to pension, health, education and housing systems. The projections are periodically updated by reformulating the evolutionary assumptions underlying fertility, survival, international and internal migratory movements.

The new set of projections replace those based on 2018 published by Istat in October 2019. Istat is the owner and responsible for the production and dissemination of the projections, as documented in the National Statistical Program. The methodological framework underlying the current exercise is the same as that implemented in the previous three-year cycle, which resulted in the sequential release of the forecasts based on January 1st 2016, 2017 and 2018. This methodology was defined, between 2009 and 2015, by a working group with researchers from Istat and the Luigi Bocconi University of Milan.

The methodological approach, around which the forecasting model works, is of a semi-probabilistic nature. The fundamental characteristic of probabilistic forecasts is to consider the uncertainty associated with the predicted values, determining the confidence intervals of the demographic variables and giving the user the possibility to independently choose the degree of confidence to be assigned to the results.

Compared to the "deterministic" approach, more widely used on an international scale and also adopted by Istat in the past (up to the 2011 based projections), this represents a significant methodological advance. In fact, in the deterministic model the user does not have probability measures associated with the results. Thus, a further advantage of the probabilistic method is the fact that the user can stop to trust uncritically on the work of projection makers, who with the typical "low / high" variants define a priori the alternative boundaries to the variant retained "most likely", generally identified as "main" or “medium” or “central” scenario".

The quantification of uncertainty does not represent the only advantage of the probabilistic model. Another one is the more effective representation of the evolution of a population. In the probabilistic model, in fact, the definable scenarios are infinite on the theoretical level (although in reality, as will be seen later, a finite number is always selected), so assumptions of low survival are mixed with assumptions of high fertility or medium level of migration, or the opposite. Instead, the assumptions of the high/low scenarios of the deterministic approach are defined by pursuing an output oriented logic: the high scenario contemplates assumptions of maximum increase in survival, fertility and migrations, while, on the contrary, the low scenario contemplates only assumptions of minimum. The construction of such opposing scenarios actually captures the goal of determining a future range for the population and its structural components, but based on concomitant assumptions with low chance of occurring.

The subsequent sections contain general information and briefly illustrate the steps that made it possible to build the projections. These sections include information on the following aspects:

- base population
- projection technique
- time horizon
- panel of experts
- expert questionnaire and probabilistic model
- relationship between national and regional projections
- data
- corrective component of nowcasting for short term assumptions
- confidence intervals and median scenario
- regional fertility projections
- regional mortality projections
- regional projections on international migration
- regional projections on internal migration
- comparison with previous projections
- comparison with the projections released by Eurostat and the United Nations
- data dissemination and terms of use
- contact information and personalized data requests.

Base population

The base population is the one broken down by sex, single age group and region as of 1 January 2020, as identified by the last Census of Population and Housing. The population includes all people usually residing in

Italy, of any citizenship, while it does not include Italian citizens residing abroad, nor citizens illegally or irregularly present on the national territory who are not enrolled in any municipal register.

Projection technique

Projections are carried out with an iterative technique between 1 January and 31 December of each year, using the so-called "cohort-component" method. To the initial population, in correspondence of each age group, immigrations (from abroad or from other regions) are added while deaths and emigrations are subtracted (for abroad or for other regions), thus obtaining the population alive at the end of the year. Live births in the course of the year have also to be computed and, among them, those still alive as of December 31st, net of deaths and migratory movements that concern them.

For the population (stock), age is defined in completed years on 1 January (from 0 to 110 years and over). The same concept applies for flow data (births, deaths and migratory movements). This allows to identify, always and in any case, the demographic events by single year of birth of the subjects involved, ensuring the required consistency within the population equation.

It is assumed that demographic events may occur linearly at any time of the year. Between death and migration (internally or abroad) it is assumed incompatibility, that is, they cannot involve the same individual in the same year.

Deaths are determined by multiplying the resident population by age group on 1 January by the respective (projection-)probabilities of death, i.e. those involving subjects belonging to the same cohort.

Births in a given year are achieved in three steps. In the first, the average number of women for each fertile age (obtained as the average of the populations of that age at the beginning and end of the year) is multiplied by the respective fertility rate. In the second, the sum of the births by age of the mother is calculated, obtaining the total number of births in the year. In the third, births are broken down by sex using the fixed ratio of 106 male births per 100 female births.

Projections have a territorial profile and are built in the logic of the multi-regional model, a model which, with particular regard to internal migratory flows, simultaneously and coherently works the distinct territorial units of reference. The model on internal migration starts from the construction of a multi-regional matrix of migration probabilities by region of origin, region of destination, sex, and age. This matrix, applied to the population at risk of migration, identifies a coherent series of immigrants and emigrants in each forecasting year.

Time horizon

Projections cover the period between 1 January 2020 and 1 January 2070. The main purpose is to provide with information on the future development of the population in the short term (2030), and therefore to provide with information in the medium (2050) and long term (2070). With regard to this latter time reference information, data should be used with caution since the results become the more uncertain the further we go from the base year (2020). This risk is the more concrete the more attention is paid to the smaller territorial units, as in the case of some Italian regions.

Panel of experts

A panel of national experts supported Istat in formulating the demographic assumptions for Italy as a whole. The assumptions for the regions, on the other hand, were handled by Istat on the basis of a specific "bridge" methodology between the national and regional assumptions. The experts who replied to the questionnaire (with CAWI technique), providing with useful and complete information to define the assumptions, were 86. They were voluntarily recruited among the participants in the 13th edition of the Population Study Days organized by the Italian Association for Population Studies (AISP), which took place in Milan between 24 and 26 January 2019 at Bocconi University. In particular, there are 50 women and 36 men, mainly employed in universities (21 in Northern Italy, 11 respectively in Central and Southern Italy and 10 in foreign universities) or in other public research bodies (24). The mean age of the respondents is 44 years while their work experience is on average 16 years.

In all the phases that involved the building of the methodological framework underlying the projections, Istat made use of the concrete cooperation of Francesco Billari and Rebecca Graziani of the Bocconi University in Milan.

Expert questionnaire and probabilistic model

The probabilistic method adopted is based on the opinions of experts (expert-based model) to define the future evolution of the most important demographic indicators. It falls within the broader class of random scenario models. This model, used for the definition of probabilistic scenarios at a national level, is based on the elicitation of a series of parameters from which the future stochastic evolution of each demographic component is derived. Experts are asked to provide values at a given year "t" with regard to a series of summarized demographic indicators, conditional on the values assumed by the same indicators in instants of time prior to year "t" (Billari, Graziani and Melilli, 2012).

The method has the advantage of being simple and flexible. In fact, in the questionnaire, the necessary demographic components are summarized through the following indicators: the average number of children per woman; life expectancy at birth by sex; immigration and emigration from abroad. The other information necessary for the production of the projections, such as that regarding the age-breakdown of demographic events, is purposely kept out and subsequently processed in order to make the questionnaire and the forecasting model itself parsimonious.

TABLE A1. MEAN VALUES, VARIANCES AND CORRELATIONS UNDER ASSUMPTIONS OF THE EXPERTS BY DEMOGRAPHIC INDICATOR. Years 2019, 2050 and 2080

Indicator	Total fertility rate	Life expectancy at birth - Men	Life expectancy at birth - Women	Immigrations (thousand)	Emigrations (thousand)
Year 2019					
Observed value	1.27	81.1	85.4	333	180
Year 2050					
Mean assumption	1.51	84.7	88.1	256	131
High assumption	1.75	86.3	89.5	343	172
Variance	0.034	1,441	1,309	4,593	1,042
Year 2080					
Mean assum. conditional to 2050 mean assumption	1.55	87.1	90.0	240	127
Mean assum. conditional to 2050 high assumption	1.74	88.4	91.0	305	158
High assum. conditional to 2050 mean assumption	1.75	88.5	91.5	348	186
Variance	0.044	2,180	2,002	7,523	2,675
Correlation 2050-2080					
Correlation coefficient	0.68	0.66	0.54	0.51	0.46

Two time points are considered for each demographic indicator: an intermediate year "t1" and a year "t2" corresponding to the last forecasting year. In the questionnaire submitted to the experts, "t0 = 2019", "t1 = 2050", "t2 = 2080", thus generating two sub-intervals, 2019-2050 and 2050-2080. Expressing the value of life expectancy at birth in the year 2080, given its expected value in 2050, is a practical example of how the mechanism works.

The demographic indicators are assumed, for the sake of simplicity, independent of each other (for example, the total fertility rate is not influenced by the level of migration and vice versa), although the model allows in its generalized version the possibility of interacting among them. It is also assumed that the pair of elicitations at 2050 and 2080 of a given indicator has a bivariate normal distribution.

Under these conditions, once the mean values provided by the experts have been obtained, it is possible to estimate the variance associated with each of the two future time instants as well as the correlation between the first and the second period (Table A1). On the basis of the corresponding bivariate normal distributions, 3,000 simulations were then carried out with the Markov Chain Monte Carlo method[1].

The last estimation step is aimed at calculating the values of each parameter in the intermediate years of the two sub-intervals 2019-2050 and 2050-2080. This activity is carried out, for each of the 3,000 simulations, by interpolation with quadratic curves, passing through the known points corresponding to the years 2019, 2050 and 2080. Thus, the definition of 3,000 stochastic curves for each demographic indicator has been achieved at national level. As an example, Figure A1 describes the bundle of trajectories relating to the number of children per woman, obtained from the procedure described above.

[1] The choice fell on the years 2050 and 2080 in order to identify two time intervals of similar length. Although the availability of information collected from the experts allows us to extend the time horizon up to 2080, it was decided to stop the iterative simulation exercise up to 2070 in order to derive a forecasting period of precise 50 years.

FIGURE A1. PROBABILISTIC EVOLUTION OF THE TOTAL FERTILITY RATE IN 3,000 SIMULATIONS OBTAINED FROM EXPERT OPIONIONS. Years 2020-2070

The choice to consider a number of 3,000 simulations is the result of a compromise between two needs, both strategic: 1) faithfully representing the uncertainty of demographic events; 2) optimizing the machine times for processing the projections. The latter, despite today's availability of increasingly powerful and sophisticated hardware / software tools, represents a technical aspect which is anything but secondary, given the huge amount of data processed.

Relationship between national and regional projections

The probabilistic model releases a set of 3,000 national simulations for each summary demographic indicator. Since the objective of the Istat projections is also to give indications at a territorial level, so continuing the longstanding tradition of the multi-regional model, a "bridge" procedure has been implemented between the definition of national and regional inputs. The approach pursued is therefore top-down on the side of the assumptions building while, as will be seen later, it is bottom-up on the side of the production of final outputs.

The main action is to derive 3,000 regional stochastic scenarios from the 3,000 national ones. The first operation in this sense is to elaborate an intermediate deterministic forecast, applying the multi-regional cohort component model. From this forecast, obtained by extrapolating the regional trends considered most probable for each component (see following paragraphs), the same summary indicators of the previously described stochastic model are obtained, i.e. average number of children per woman, male and female life expectancy at birth, migratory movements with foreign countries. Such a first intermediate forecast, unique and deterministic, essentially resembles that which in a deterministic approach would be labelled with the term "central scenario".

The transition from the regional deterministic model to the regional stochastic model is achieved by multiplying, and repeating the procedure 3,000 times, the regional deterministic forecast for the relationship between the national stochastic and the deterministic forecast. In formula, indicating with "n" the generic simulation (n = 1, ..., 3,000), with "j" the regional territorial code, with DR the deterministic regional forecast, with SR the stochastic one, with DN and SN, respectively, the national deterministic and stochastic forecast, we have:

$$\mathrm{SR}^{j}_{t,n} = \mathrm{DR}^{j}_{t} \times \frac{\mathrm{SN}_{t,n}}{\mathrm{DN}_{t}}$$

thus linking, in each simulation, the vector of regional values to the national stochastic reference value. Note that with regard to the synthetic indicators of immigration and emigration from abroad, we have:

$$\mathrm{DN}_{t} = \sum_{j} \mathrm{DR}^{j}_{t}$$

$$\mathrm{SN}_{t,n} = \sum_{j} \mathrm{SR}^{j}_{t,n}$$

Once the synthetic stochastic indicators have been obtained at the regional level, we move on to the construction of the inputs necessary for the application of the cohort-component method, i.e. the (projection-)probabilities of death by age and sex, the age specific fertility rates and the distribution of immigrants / emigrants from abroad by age and sex. The procedure therefore associates each summary indicator with its own sex-age breakdown. The latter, not treated in a stochastic way, is the one that derives from the regional deterministic model and, from simulation to simulation, adapted to the specific synthetic stochastic indicator.

The coupling of the 3,000 death probability vectors (each vector develops a number of elements equal to the "number of regions X age classes X sex X forecast years") with the 3,000 fertility vectors, and the same number on immigration and emigration from abroad and, finally, with the 3,000 O / D probability matrices of internal migration, it is randomly executed.

After introducing a corrective nowcasting component (see next paragraph) relating to the very first years of forecasting, the cohort component model is then run 3,000 times, thus obtaining the required outputs: population by age and sex, demographic flows by age and sex, plus the series of demographic indicators to support the analysis, from generic rates (birth, mortality, etc.) to structural indicators (mean age, dependency rations, etc.).

The results at national level (as well as those at geographical area level) in the context of each regional simulation are obtained by sum (bottom-up approach). Therefore, the amount of the expected population, deaths, and migrations, classified by age and sex, and births by age of the mother that are determined at the national level are the sum of the forecast regional trajectories. The assumed national levels relating to the summary indicators placed into dissemination, for example regarding life expectancy or the average number of children per woman, are recalculated ex-post on the basis of these regional summaries.

It should be noted that the stochasticity introduced at the regional level, borrowed top-down from the national one and limited only to summary indicators, may result not sufficient to reproduce the randomness of the various demographic events. This is particularly true in small areas where uncertainty tends to be relatively higher. For this reason, although the number of simulations still offers ample guarantee of representativeness of the variability on a regional scale, it is more appropriate to speak of a semi-stochastic approach when referring to regional projections.

A second observation concerns the fact that in the Istat model a generalized statistical treatment of the covariance between the Regions is excluded (for example: the forecast of increase / decrease in fertility in a given region how much it conditions or how much is in turn conditioned by the forecast of increase / decrease in another). To this solution, also excluded for reasons of parsimony of the model, another one was preferred, that of territorial convergence. In fact, the initial deterministic regional model, subsequently transformed into a stochastic model through the procedure described above, is built on the assumption of very long-term convergence (2120, well beyond the last year of projections) between the regions for each fundamental demographic component. This implies that the 3,000 regional stochastic scenarios represent 3,000 different hypotheses of convergence of demographic behaviours among regions.

The main hypothesis underlying the convergence is that the socio-economic and cultural differences currently existing between the regions are destined to disappear in the long term. Therefore, their progressive cancellation would also involve a generalized rapprochement of demographic behaviours. The idea of convergence is not new in demography and there are many examples of demographic forecasts that follow it (Eurostat and the UN, in particular), including past Istat ones. In Istat projections, convergence is understood as the progressive shift of a given demographic behaviour towards a very distant point in the future which represents the instant of full regional convergence (in the sense that at that point the values would be identical for the different regions), but that in reality it is far from being reached within the time horizon considered (2020-2070). In fact, it is correct in this circumstance to speak more of a model of semi-convergence than of a model of full convergence.

Data

The assumptions defined at the regional level in the preliminary deterministic model, before the transition to the stochastic model, were obtained by extrapolating future trends from the analysis of the observed time series. In particular, these assumptions were defined using the following data series:

- for fertility, the mother's age-specific rates for the period 1977-2019;
- for mortality, the (projection-)probabilities of death by age and sex for the period 1974-2019;
- for internal and international migrations, the changes of residence by age and sex of 2015-2019.

Corrective component of nowcasting for short term assumptions

Before being launched at full capacity along the time horizon with the cohort-component method, the probabilistic projections incorporate a corrective nowcasting factor (from the term nowcast = forecast of the present). With this operation we intend to ensure that the forecast relating to the very first years is as much in line with the trend that emerged in the last period or in the last historical year (jump-off effect). This type of operation is particularly suitable in years characterized by sudden, and as such unpredictable, changes in the demographic situation. This is the case, as happened in 2020 and to a lesser extent in 2021, of the effects caused by the Covid-19 pandemic on all components of the demographic change. Not only, albeit primarily, on mortality, but also on birth rates and internal and international changes of residence. No forecasting model applied to the historical series mentioned in the previous paragraph could have been able to accurately predict the shock caused by the pandemic. Certainly not the over 746 thousand deaths found for all causes in 2020 (about 100 thousand more than expected in the light of the first assessments carried out), but not even the further decline in births (404 thousand) in the context of an overall picture already compromised by the well-known contraction of reproductive behaviours. Nor, finally, could the strong contraction recorded in migration be foreseeable, as a result of the measures undertaken at national level to contain the spread of the virus (lockdown).

Since the base population of the projections is that recorded as of January 1, 2020, it was necessary put in place some short-term correction of the predicted inputs that affected the years 2020 and 2021, directly, and those up to 2024 indirectly. With this, in fact, we want to take into account not only the exceptional events that characterized the first two years, but also the subsequent ones within which it is assumed that the pandemic effects may end and allow the short term inputs to be in line with medium and long term ones[2].

From the computational point of view, the review of the short-term assumptions is carried out by applying correction factors. For example, let E_b^j be the number of demographic events predicted in the first year based on the median scenario in region j. Instead, let $\hat{E}_b^j$ be the observed value of such events or, in the absence of the actually observed value, the best estimate that can be obtained (for example, using nowcasting procedures or similar statistical models). The ratio:

$$r_b^j = \hat{E}_b^j / E_b^j$$

represents the correction factor to be applied to the statistical measures that give rise to type "E" events in year "b" for region j. For example, if these events were the total number of births then the quantity:

$$\hat{f}_{b,x}^{n,j} = r_b^j \cdot f_{b,x}^{n,j} \text{ with } x=14, \dots, 50 \text{ and } n=1, \dots, 3000$$

represents the series of fertility rates by age of the mother (n-th simulation) corrected for year "b". Similar considerations apply to the determination of the correction coefficients relating to mortality and migratory movements.

As regards 2020, the correction factors were constructed by comparing the data of the provisional demographic balance of each region, released in March 2021 by Istat, to the projections previously produced for that year. On the other hand, as regards 2021, the availability of preliminary provisional data for the first 7 months (January-July) was completed (August-December) by applying the Holt-Winters model, a particular model belonging to the Exponential smoothing family which is well suited to the monthly historical series considered here. The annual estimates thus obtained were then placed in the numerator for the construction of the related corrective ratios with which to recalibrate, for 2021, the preliminary regional projections[3].

For the years after 2021, the correction factors are applied for a limited period of the time horizon, processing weights that progressively tend to one. In particular, the number of years for which the correction factor is applied to the series of interest is obtained from:

$$Y^j = abs\left(1 - r_b^j\right) \cdot \epsilon$$

with ϵ arbitrary quantity, appropriately chosen to ensure that, on regional average, the number of years to guarantee the return from short-term to medium-long term projections does not exceed 5 years. At this point, the levels of the correction factors for the years following "b", for a total of "Y" years, are given by:

$$r_t^j = \frac{r_b^j \cdot \left(b + Y^j - t\right) + (t - b)}{Y^j} \quad \text{with } t = b, b+1, \dots, b + Y^j - 1$$

Confidence intervals and median scenario

Once the calculation procedure inherent to the 3,000 regional simulations has been launched, uncertainty is calculated for all possible information levels, from the predicted population to the flow data, also broken down by

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[2] Furthermore, bearing in mind the iterative calculation mechanism offered by the cohort component method, i.e. a mechanism of continuous stock-flow interaction over time, the correction imposed in the first years also affects the outcome of all subsequent years, up to 2070.

[3] In particular, these annual estimates have given rise, on a national scale, to 391 thousand births, 705 thousand deaths, 271 thousand registrations from abroad and 130 thousand de-registrations to abroad.

age and sex. These margins of uncertainty depend in turn on the uncertainty inherent in the future levels of mortality, fertility and migration that are also made available. The dissemination of the results contemplates the release of only the confidence intervals of 90%, 80% and 50% but it is possible to define intervals on any scale of interest. The confidence interval provides information on how likely it is that a given demographic indicator falls within predetermined limits. From this point of view it should be remembered that this probability itself represents a forecast, as it is based on hypotheses whose validity is uncertain. Furthermore, in no case should the extremes of the confidence interval be interpreted as extreme limits, upper or lower, of future demographic behaviour.

The construction of a confidence interval is here based on the determination of the percentiles in the distribution of the 3,000 simulations. For example, the 90% confidence interval for a given indicator is determined by considering the distribution values that fall between the 5th and 95th percentiles. It is also recalled that the uncertainty always refers to the domain of the specific estimated parameter. The limits of the confidence interval for a given hierarchical level are estimated on their own, and not constructed by summation of limits obtained at a hierarchically lower level of disaggregation. The criterion is also applied in non-territorial hierarchical contexts; for example in the composition by age of the population or in that by sex.

The "median scenario" was built with the aim of defining a "punctual" forecast that can be adopted as the most likely reference of future demographic evolution. This scenario corresponds to a 3001-th simulation, obtained by construction, but which in fact was not detected in the observation field of the 3,000 simulations. Its set of assumptions is identified by taking as a reference the median value between all the simulations at the level of the individual demographic components (fertility, mortality, migration) within the possible combinations of the covariates age, region and year of forecast. For example, the median scenario specific fertility rate at the age of 32 in the Tuscany region, in the year 2040, is identified as the median value with these characteristics identified among all the simulations. The same specific rate but at the following age, or in the following year, is identified with the same procedure but it probably arises from a different simulation. For the identification of the median scenario on mortality and migration, the procedure is identical but with the additional covariate of sex. Furthermore, for internal migrations, the selection also includes the region of origin and destination.

The scenario is therefore “median” from the side of the fundamental inputs. From the point of view of the outcome (population and expected flows) that this scenario generates once the procedure for cohort-components has been launched, for the typical properties of the median it returns values very close to the median ones.

Regional fertility projections

For regional fertility the projections concerned the classic parameters of intensity and age-breakdown, i.e. the average number of children per woman and the distribution of specific fertility rates by age of the mother.

The average number of children per woman was represented using ARIMA models (n, p, k), searching, separately for each region, the one most suitable for predicting the future intensity of reproductive behaviour. On the basis of the 1977-2019 historical series the predominantly model was an ARIMA (2,0,0) with intercept.

The fertility age profile was modelled using a quadratic splines function system (Schmertmann, 2003). This model functionally describes the curve of specific fertility rates standardized as a function of three parameters: the age of onset of the fertile age α; the age P in which fertility reaches its maximum level; age H, subsequent to P, in which fertility is halved compared to the maximum level. By specific standardized fertility rate we mean the specific fertility rate normalized to the unit, where the value one corresponds to the maximum value observed within its age distribution.

The quadratic splines model fits five second-degree polynomials to the fertility curves. The final function is continuous with the first derivative also continuous. Moreover, thanks to suitable mathematical restrictions it is uniquely determined by the three parameters [α, P, H] mentioned above.

In practice, the prediction of the specific fertility rate is transformed into the prediction of the three parameters (through ARIMA models) which express it functionally, once the series has been estimated in the period 1977-2019. To do this, a hypothesis of convergence between the Italian regions was adopted, assuming that the territorial differences in terms of reproductive behaviour tend to decrease in the long term. From an operational point of view, full convergence was set in 2120. In particular, the convergence constraint provides that, from 2020 to 2120, the parameters of the regional vector [α, P, H] converge linearly to the values of a hypothetical national vector, specially designed for the operation.

Regional mortality projections

Regional mortality projections were produced using the Lee-Carter model (1992) in the variant proposed by Lee-Miller (2001), a model in which the adjustment procedure leads the fitted probabilities of death to reproduce precisely the observed level of life expectancy at birth, rather than the total deaths observed as in the original version. Furthermore, here the model is applied to death probabilities rather than to mortality rates of the original formulation.

The model approximates the logarithmic form of the probability of death using three synthetic parameters, one of which is related to the trend [k(t)] and two related to the age distribution [(a(x), b(x)].

As for fertility, also for mortality the construction of the model originates from the definition of a provisional reference scenario at national level. The forecast is determined by projecting into the future the only national trend parameter k(t), whose series is identified over the period 1974-2019, while the parameters a(x) and b(x) remain invariant over time in this phase. In particular, due to its substantial linearity, the k(t) parameter was projected to 2070 with a random walk with drift.

The assumptions at the regional level are derived from the provisional national reference scenario, by first estimating the regional values of the three parameters in 1974-2019 with the same methodology and, subsequently, by making each regional parameter converge to the corresponding national parameter at 2120. Therefore, as a consequence of the convergence process and unlike the classical approach of the Lee-Carter model, here the regional parameters a(x) and b(x) are also varied over time.

Regional projections on international migration

In order to capture the most recent trends, the regional projections of migratory flows with abroad focus the analysis only on the last five years, namely 2015-2019. This need, considering the complexity of predicting international migratory flows by resorting to analysis of long historical series, leads to use a very simple model. Without forgetting that at this level of operations it is a question of structuring an intermediate deterministic model, whose values are subsequently calibrated on the intensities produced by the expert-based stochastic model.

In the first year of the projection, the total values of immigration and emigration from abroad are set equal to the mean value observed over the last five years. In accordance with the general convergence framework of the deterministic model, it is therefore assumed that in each region inflows and outflows converge linearly in the long term (2120) at the same level, which is to the initial half sum of the two values.

Once the totals of inflows and outflows up to 2070 have been determined, the associated age and sex breakdown are derived by applying the Castro-Rogers model (Rogers and Castro, 1981) to the 2015-2019 series. With this model it is shown that the characteristic age profile of migrants can be described, regardless of the intensity of the phenomenon, by a mathematical function composed of 4 additive components and up to 11 predictive parameters. These parameters, whose estimate in the observed period is produced thanks to a generalized procedure for non-linear models (category in which the Castro-Rogers function fully falls), are kept constant in the forecast period. The conclusive result is therefore that the global intensity of migratory flows with abroad may vary over time but on the basis of a constant composition by age.

Regional projections on internal migration

Interregional migrations are developed according to a multidimensional approach, which allows to simultaneously consider the areas of origin and destination of migratory flows, to define the entrances in a given area as the sum of the exits with that destination from all the other areas of the system. The system is by construction consistent for all the forecast years since the marginal row and column of the O/D matrix, corresponding respectively to the inflows and outflows in/from each region, give the same sum, corresponding to the amount total of movements within the national territory.

The probability of migration specific for age (110), sex (2), region of origin (21) and destination (21) represents the basic component of the O/D matrix composed of 110x2x21x21 = 97020 cells for each calendar year. The probabilities are estimated on the basis of the levels observed in the individual years of the 2015-2019 period. The probability vectors thus obtained, at the level of each annuity, are subsequently modelled using the Castro-Rogers function.

Therefore, indicating with

$$m_{x,s,t}^{i,j}$$

a generic (projection-)probability of migration for an individual of age "x" and sex "s" between the region "i" and the region "j" relating to the year "t" (t = 2015, ..., 2019), is assumed that this represents a normal random variable with an average equal to the mean value of the five-year period and variance equal to the variance detected in the five-year period:

$$\mu_{x,s}^{i,j} = E\left(m_{x,s,t}^{i,j}\right)$$

$$\sigma_{x,s}^{i,j} = E\left(m_{x,s,t}^{i,j} - \mu_{x,s}^{i,j}\right)^2$$

From the above mentioned random variables, 3,000 values are randomly extracted for each of the 97,020 elements of the O/D matrix, thus giving rise to the random creation of 3,000 different matrices. The O/D matrix relating to the median stochastic scenario is identified by taking as a reference the median value between all the simulations within the possible combinations of the covariates sex, age, region of origin and region of destination. This median matrix is also used with the preliminary purpose of producing the deterministic forecast of the population, prior to the transition to the actual stochastic model (see previous paragraph on the relationship between national and regional projections).

Note that in the context of each simulation (including the median scenario) the O/D matrix is assumed to be invariant over time. The hypothesis underlying the model is based, in fact, on maintaining a propensity for mobility that remains constant throughout the time horizon. This implies that internal migratory flows evolve over time only because of the variations affecting level and age structure of the population exposed to the risk of migration.

Comparison with previous projections

The comparison between the current projections and the previous ones, although of interest, is partly improper for at least three kinds of reasons. First of all, the temporal distance, equal to two years, compared to the closest edition (base 2018). Secondly, the fact that the previous projections adopt a pre-census population base (i.e. not in line with the 2020 Census of the population but with the previous one in 2011). Finally, the fact that the methodological approach of the current exercise is renewed as regards the opinions of the experts.

That said, a partial assessment of the change that occurred between the last two rounds can be made by comparing the median scenarios of the projections based on 2018 and 2020. First of all, there is a rather important difference between the total base population 2018 (60 million 484 thousand) and that of 2020 (59 million 641 thousand). According to the inter-census estimates of the population, recently produced by Istat[4], as of January 1, 2018 there were an estimated 59 million 938 thousand residents, that is 546 thousand less than what is taken as a reference in the projections based on 2018.

TABLE A2. 2018 AND 2020 MEDIAN SCENARIO ASSUMPTIONS FOR THE MAIN DEMOGRAPHIC INDICATORS. Years 2020, 2030, 2050 and 2065.

Median scenario	Total fertility rate	Life expectancy at birth - Men	Life expectancy at birth - Women	Immigrations (thousand)	Emigrations (thousand)
Year 2020					
Base 2018	1.34	81.2	85.7	331	152
Base 2020	1.24	79.3	84.1	221	142
Year 2030					
Base 2018	1.47	82.6	86.9	316	136
Base 2020	1.37	82.2	86.2	279	146
Year 2050					
Base 2018	1.55	84.8	88.9	287	129
Base 2020	1.50	84.7	88.1	258	131
Year 2065					
Base 2018	1.59	86.1	90.2	271	132
Base 2020	1.54	86.1	89.2	248	126

On the side of the expected flows in the period of common projection (2020-2065), a much more expansive assessment can be seen in the projections based on 2018, where for example 20.3 million births were expected against the current 18.1 million. The difference is also important with regard to flows with foreign countries, due to more immigrants and fewer emigrants in the projections based on 2018: 13.7 and 6.1 million respectively against 12.1 and 6.2 million. On the other hand, the difference with respect to the volume of deaths is more modest: 34.8 million in the 2018 scenario compared to 34.7 million in the 2020 one. As a result of these different demographic dynamics, the population forecast at the end of 2065 in the 2018-based scenario amounted to 53.5 million against 48.8 million in the current one.

The difference between the two final populations of the two distinct exercises is therefore partly attributable to the different starting populations, but also to the review of the assumptions, both in term of summary indicators and age-breakdown of the demographic events. Table A2 highlights how the process of reviewing the assumptions

[4] Intercensal population estimates by age, sex and municipality – Years 2002-2018, https://www.istat.it/it/archivio/255173.

for all demographic components mainly affected the first years of the projections and, to a lesser extent, the medium-long term ones.

Comparison with the projections released by Eurostat and the United Nations

In order to compare the projections produced by Istat with those of other bodies, it makes sense to take as a reference the projections released by Eurostat and the United Nations Population Division (UNPD). For years, the statistical institute of the European Union has been carrying out the task of producing demographic forecasts on a regular basis for all member countries. The latest release is based on 2019, whose main reference scenario is the so-called baseline scenario. The UNPD, in turn, also produces demographic projections on a regular basis through the World Population Prospects, which include all the countries of the globe. Also in this case, the latest available exercise is based on 2019 and the main reference scenario is the so-called medium variant.

It should be noted in the introduction that, despite the comparability on the level of projective technique, the exercises produced by the two international organizations present some methodological differences compared to the Italian one. Among these, in the first place, the fact that the Eurostat and UNPD projections are based on 1 January 2019, that is, they project a population that is not in line with the results of the 2020 census and, in particular, with respect to the latter, a significantly higher population. Secondly, it should be mentioned that the two international models examined here are uninational, i.e. they project the resident population in Italy as a whole without taking into account the demographic development of the regions.

TABLE A3. MAIN ASSUMPTIONS FROM ISTAT MEDIAN SCENARIO IN COMPARISON WITH 2019-BASED EUROSTAT AND UNPD MAIN VARIANTS. Years 2020, 2030, 2050 and 2070.

Scenario	Total fertility rate	Life expectancy at birth - Men	Life expectancy at birth - Women	Net migration (thousand)
		Year 2020		
Istat Median	1.24	79.3	84.1	79
Eurostat Baseline	1.33	81.3	85.7	161
UNPD Medium	1.30	81.5	85.7	117
		Year 2030		
Istat Median	1.37	82.2	86.2	133
Eurostat Baseline	1.37	82.6	86.9	224
UNPD Medium	1.35	82.9	86.9	93
		Year 2050		
Istat Median	1.50	84.7	88.1	127
Eurostat Baseline	1.45	84.9	89.0	214
UNPD Medium	1.50	85.4	89.2	57
		Year 2070		
Istat Median	1.55	86.5	89.5	118
Eurostat Baseline	1.52	87.0	90.9	207
UNPD Medium	1.58	87.6	91.5	59

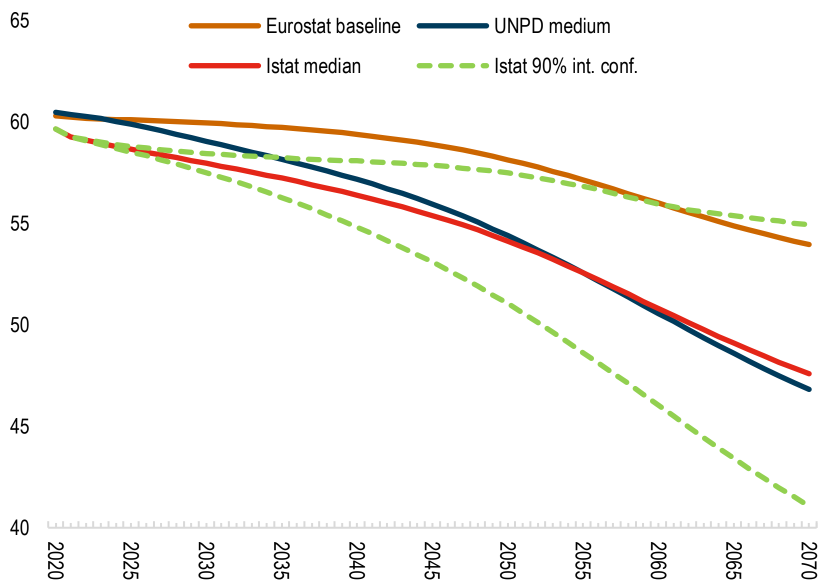
Table A3 shows the main scenario assumptions compared. As regards migratory flows, the comparison is limited to net migration as both Eurostat and UNPD build the assumptions directly on this indicator (without distinction between immigrants and emigrants).

For all the demographic components, the assumptions are initially very different between Istat and Eurostat/UNPD. This is due to the fact that, unlike the Istat scenario, Eurostat and UNPD projections do not take into account the 2020 demographic shock produced by the Covid-19 pandemic. After this period, however, the assumptions continue to be quite different among the various producers. In particular, with regard to migratory flows, where compared to a UNPD which is rather cautious about Italy, Eurostat shows a much more optimistic vision. This evidence is partly due to the Eurostat methodology, which, in addition to predicting the underlying evolution of net migration, incorporates an additive replacement-migration component into the model[5].

The assumptions on fertility are quite similar, although in the medium-long term Eurostat produces less favourable forecasts than both Istat and UNPD. The assumptions on survival are also not particularly distant, however Eurostat and especially UNPD highlight very favourable expectations about the lengthening of life expectancy, which are only partially glimpsed in the Istat model.

The development of the different demographic assumptions therefore gives rise to differences in terms of expected results which, as regards the evolution of the total population, can be appreciated in Figure A2. Unfortunately, the initial difference due to the different population bases adopted in the Eurostat/UNPD projections make the comparison with the Istat scenario rather spurious. Nonetheless, the evolutionary trajectory of the population is consistent between the three scenarios. In fact, all of them foresee a progressive decline of the population which tends to worsen in the medium-long term. The Eurostat scenario, given the significant impact of a more sustained net migration, is particularly optimistic. Up to the point of maintaining a population even wider than the upper limit of the 90% confidence interval of Istat projections for most part of the time horizon. The UNPD scenario, on the other hand, once the difference with respect to the base population of Istat projections has been absorbed, tends to approximate the median scenario.

FIGURE A2. TOTAL POPULATION ACCORDING TO ISTAT, EUROSTAT AND UNPD SCENARIOS. Years 2020-2070, million.



Data dissemination and terms of use

The detailed picture of the assumptions underlying the projections and the main results can be consulted both on the general internet site dati.istat.it (topic: Population and families> Demographic projections) and on the thematic site demo.istat.it.

Data dissemination is divided into three sections including tables on the structure by sex and individual age group of the population, on the components of population change and on the main supporting demographic indicators. Each table shows the values of the median scenario and the lower and upper limits of the confidence intervals at 90%, 80% and 50%.

The components of the population change include:

- population at start and end of the year, total growth;
- live births and deaths, natural growth;
- immigrants and emigrants with abroad, net migration with abroad;
- Interregional immigrants and emigrants, net interregional migration.

The data described above and those relating to the age distribution of the population are rounded to the nearest unit.

[5] This component assigns in each forecast year an additional quota of net migrants in the measure equal to 10% of the reduction found in the population of working age (15-64 years).

As regards the demographic indicators, the tables include:

- live birth rate, mortality rate and natural growth rate;
- immigratory, emigratory and net migration rate with abroad;
- immigratory, emigratory and net migration rate with internal regions;
- total net migration and total growth rate;
- mean age of the population;
- % of population aged 0-14, 15-64, 65 years and more, 85 years and more;
- dependency ratio, elderly dependency ratio, aging index;
- total fertility rate;
- life expectancy at birth and at 65 years by sex.

The reproduction of the information contained in this note and in the databases dati.istat.it and demo.istat.it is left free, provided that the Istat source is quoted.

Contact information and personalized data requests

Istat periodically produces demographic projections as part of the line of activity "Population estimates and projections", in accordance with the provisions of the National Statistical Program, "Demographic projections" project (PSN code IST-01448).

For customized data requests, in addition to disseminated information, it is necessary to contact the Cont@ct Centre at https://contact.istat.it/ or, alternatively, write to richieste.dati@istat.it.

2) Households projections, by region. Years 2020-2040

Household projections show the future trend of the number and type of households that will characterize the population in Italy from 2020 to 2040. These projections derive from the application of a static method, based on propensity rates, applied to the projected population. The purpose is to provide with an integrated system of information that can be useful to several users, both public and private, who deal with goods and services intended for families rather than for individuals. Given the importance of the role of the family, both at the protective level and for individual choices and paths, the demand for information on households arises from planning needs in various areas. First of all, we can consider the decisions to be taken in economic and social policies, such as those relating to housing, social and welfare systems for the young and the elderly. Last, improve the planning of productive strategies of durables goods for households and energy consumption is another potential task.

Territorial level and time horizon

Household projections are disseminated at regional and national level. The base population is the one observed on 1.1.2020 while the elaborations cover the period from 2020 to 2040.

Data

Several set of data have been implemented. Among them, the official probabilistic projections - base 1.1.2020 of the median scenario to be used as reference for the future evolution of the resident population by sex, age and region; the Base Population Register at 1.1.2019 and 1.1.2020 to estimate the share of population living in institutional cohabitation by sex and single year of age; the Multipurpose Survey "Aspects of daily life", which provide with a long time series (from 2002 to 2019), to derive the family structures by typology and position. The concept of household here in use is the "de facto family". Adopted in all Istat Multipurpose surveys, it identifies a household as "the set of people linked by ties of marriage, kinship, affinity, adoption, protection, or from emotional ties, cohabitants and having habitual residence in the same Municipality".

Model

The model is based on an adaptation to the Italian context of the method known as "Propensity model". Such a model has been used for recent years by the Australian Bureau of Statistics (ABS) to project households in Australia and New Zealand (ABS, 2019). It is a static method that goes beyond the classic “Headship rate model”, overcoming the concept of 'head of household' and providing a much more detailed set of information. Predictions of the number of future households, their average size and composition can be easily obtained. The method relies on Propensity rates, defined as the proportion of people of age x in household position i at time t

$$\text{Propensity Rate}_{x,i,t} = \frac{P_{x,i,t}}{P_{x,t}}$$

For example, the propensity for a 30-year-old person to live in a couple with a partner will be given by the ratio between the number of 30-year-old people living in a couple and the total population of 30-year-olds.

The advantages of the method are many: it ties easily to population projections; there is no need to analyse transitions between potential family positions, typical of a dynamic model; it is simple to apply and provides with high detailed results. However, some drawback is also present, which arise mainly from the static nature of the method, do not allowing to reproduce the process of household formation and dissolution. Thus the application of propensity rates to the resident population may in some cases determine inconsistencies in term of global results, for example between sexes or for household positions within age-classes, a problem that it is therefore necessary to solve with ex-post adjustments.

The method consists of 5 steps:

- Step 1. Estimate the base-year and projected population living in households
- Step 2. Calculate household propensity rates
- Step 3. Modelling future trends of household propensity rates
- Step 4. Derive the projected population in the different household positions
- Step 5. Calculate the number, type and size of projected households.

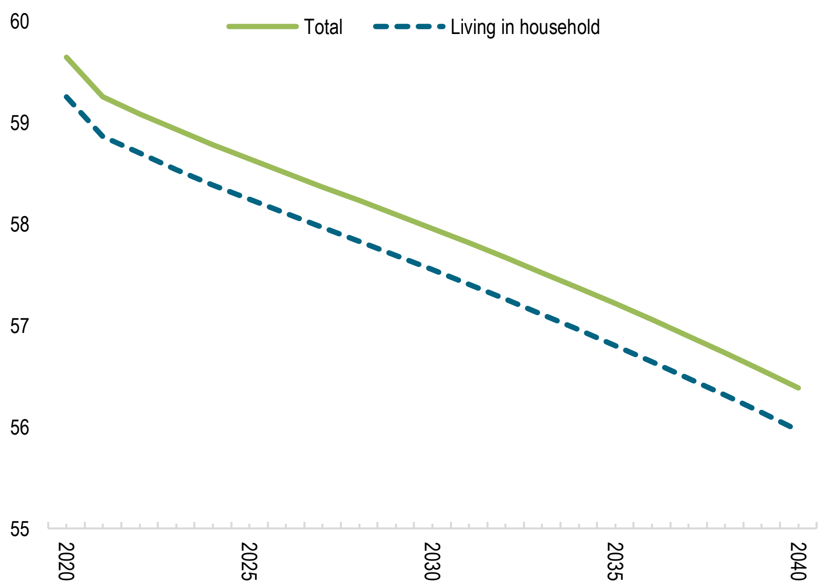
The various steps are explained in detail below.

Step 1. Estimate the base-year and projected population living in households

The base-year population is represented by the resident population by gender, age and region at January 1st, 2020, as collected from the last register-based Census. Then, making a preliminary estimate of the population living in households, excluding individuals residing in institutional cohabitation (hospitals, barracks, prisons, nursing homes, religious buildings, etc.) is necessary. This operation should then be repeated for every projected year, deducting from the regional projections (whose reference is also in this case the overall resident population) the share of the institutionalized population.

From the Base Population Register as of 1.1.2019 and 1.1.2020, the (average) percentage incidences of the population living in institutions by sex, five-year age group, and region were calculated. Given the substantial stability of this population over time, these percentage values are assumed to be constant throughout the time horizon of the projection. Applying the 100 complement of these incidences to the total population from 2020 to 2040, we obtained the population living in households by region, sex, and age group (Figure A1).

FIGURE A1. TOTAL POPULATION AND POPULATION LIVING IN HOUSEHOLD. Years 2020-2040, median scenario, million.



Step 2. Calculate household propensity rates

The second step consists on calculating the propensity rates to live in a given household position by gender and 5-year age groups for the following 8 household positions:

1. one person;
2. person in multi-person household (e.g., 2 siblings living together or a divorced individual who has returned home to a parent);
3. person in a couple without children;
4. person in a couple with children;
5. single parent with children;
6. child (living with one parent in a couple or with a single parent);
7. other person living in a family household[6];
8. person in a household with 2 or more families.

Positions 3 through 7 refer to individuals in one-family households. People living in households with 2 or more families have been considered in a separate category, since this typology constitutes a small share of the total number of households (approximately 1.5%).

As mentioned above, propensity rates are constructed as the proportion of persons of age x in category i. In this context, the age variable was considered in five-year classes and the rates were also disaggregated by sex, as the latest variable is very discriminating in household behaviour. Hereinafter, these rates are referred to as *Living Arrangement Propensities* (LAP):

$$\text{Propensity Rate}_{x,i,s,t} = \frac{P_{x,i,s,t}}{P_{x,s,t}} = LAP_{x,i,s,t}$$

where x= five-year age group 0-4, 5-9, ..., 80-84, 85+, i= family position, s=sex, t=time.

LAPs are calculated using data from the *Aspects of Daily Life* (AVQ) survey, along the entire 2002-2019 time series. Since regional estimates by sex and age groups leads to a paucity of data in small regions, it was decided to group regions into "macro-regions".

A multivariate statistical analysis, including various sociodemographic context factors[7], has generated the following 5 groups of regions:

- Group 1 - North-west (Piemonte, Valle d'Aosta, Lombardia, Liguria);
- Group 2 - Eastern Adriatic (Veneto, Emilia-Romagna, Trentino-Alto Adige, Friuli-Venezia Giulia, Marche);
- Group 3 - Tyrrhenian (Toscana, Lazio);
- Group 4 - South (Campania, Puglia, Calabria, Sicilia);
- Group 5 - Central (Umbria, Sardegna, Abruzzo, Molise, Basilicata).

Step 3. Assumptions on future trends of household propensity rates

It is now necessary to make assumptions about the evolution of household propensities from 2020 to 2040. To this end, some modifications to the Propensity rates method have been introduced. The new approach is based on the introduction of a new synthetic indicator, constructed as the sum by age of the LAP, weighted by the years lived at the various ages (L_x). This new indicator is named *Total Intensity Rate per Family Position* (TPT):

$$TPT_{i,s,t} = \sum_{x=0-4}^{85+} LAP_{x,i,s,t} * L_{x,s,t} = \sum_{x=0-4}^{85+} \frac{P_{x,i,s,t}}{P_{x,s,t}} * 100 * L_{x,s,t}$$

where i=family position, s=sex, x=five-year age class, t=time.

$L_{x,s,t}$, representing the number of years lived in the age class x by sex s in year t, are derived from the projected life tables of the median scenario.

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[6] Family refers to people who form a couple or a parent-child relationship. It means a married couple, civilly united or cohabiting, without children or with single children, or even a single parent together with one or more children who have never been married. Within a household there may be one or more families (family households), but there may also be none, as in the case of households formed by a single member (one person household) or several isolated members (multi-person household).

[7] In order to identify homogeneous groups of regions, united by common family structures and similar evolution over time, a dynamic principal component analysis was carried out using the STATIS methodology. The analysis examined the main socio-demographic variables at the regional level in the years 2002-2019, including: fertility rates, mean age at birth, average size of families, separation and divorce rates, female employment rates, internal and foreign migration rates, quotes of some family types (single people, couples with and without children, single parents, etc.). The procedure was optimized by eliminating the variables with low latent variability explained by the axis.

The TPT for a given household position represents how many years on average a generation of individuals expects to live in that position, assuming over the life course the family behaviours and mortality conditions as observed in a given calendar year. It is, therefore, a life expectancy in that family status, shifted from the cross-sectional to the longitudinal observational dimension. In other words, it takes on the same meaning that better-known cross-sectional indicators have, such as the average number of children per woman, the life expectancy at birth or the total marriage rate.

As can be seen in Table A1, if in 2002 a man counted on living as a single person an average of 5.8 years (out of a total life expectancy of 77.2), in 2019 the expected time in this state rises to 9.4 years (out of a total of 81). In contrast, as a result of declining birth rates, in 2002 women expected to live as a person in a couple with children 22.7 years (out of a total of 83), but in 2019 this expected time has fallen to 19.6 years (out of a total life expectancy that has since risen to 85.3 years). As a final example, the time in "child" status has increased from 30.4 to 31 years for males and from 27.7 to 28.6 for females, due to the prolonged stay of young people within the family of origin.

TABLE A1. TOTAL INTENSITY RATES BY FAMILY POSITION (TPT) AND SEX. Years 2002-2019

Household position	MEN					WOMEN				
	2002	2005	2010	2015	2019	2002	2005	2010	2015	2019
Lone person	5.8	6.1	7.5	8.5	9.4	10.7	11.1	12.0	12.5	12.9
Person in multi-person household	0.9	1.1	1.1	1.4	1.6	1.7	1.7	1.6	1.7	1.7
Partner without children	13.2	13.6	14.7	14.1	13.7	12.2	12.6	13.7	13.2	12.7
Partner with children	23.2	22.6	21.6	20.4	19.7	22.7	22.0	21.1	20.2	19.6
Lone parent	0.8	1.1	1.0	1.2	1.4	4.2	4.3	4.6	4.8	5.4
Son/daughter	30.4	30.7	30.2	30.9	31.0	27.7	28.1	27.8	28.3	28.6
Other position	0.8	0.6	0.8	0.9	0.9	1.5	1.4	1.1	0.9	1.0
Person in household with 2+ families	2.1	2.3	2.4	2.7	3.3	2.3	2.3	2.4	3.0	3.4
Total	77.2	78.1	79.3	80.1	81.0	83.0	83.5	84.3	84.6	85.3

In order to hypothesize future trends in propensities, we proceeded to project the "total intensity rates by single family position, and then to estimate its distribution broken down by age group ($LAP_{x,i,s,t}$) in each projected year. Predicting total intensity in a first step made it possible, on the one hand, to more easily translate the assumptions about family behaviour and, on the other, to keep together the trends in the various household positions. These latter, if projected separately by single age group, would be more difficult to control with the risk of obtaining unreliable results (e.g., a higher rate for the “child family position” at intermediate ages than at younger ones).

The final goal of Step 3, which is to define the projected LAPs from 2020 to 2040 by region, was achieved by first performing the projection in the 5 established territorial groups (Step 3.1), and then moving from these to a regional detail (Step 3.2).

Step 3.1 Projecting LAPs in the 5 territorial groups

The total intensity of each household position and sex ($TPT_{i,s,t}$) was predicted through trend extrapolation over the period 2002-2019, using time series analysis models. For each household position and sex, the models described in Table A2 were applied. These models were found to be valid for the all 5 groups, irrespectively from household position and sex.

The assumptions regarding the future evolution of the TPTs are represented in Figure A2, where, as an example, the North-West territorial group is shown. On brief, the variations in time spent in different household positions express the following changes:

- an increase of “single people”;
- a decrease of “partners with children”;
- a slight increase of “partners without children”;
- an increase of people in “child” position;
- a slight increase of “lone parents”, especially fathers;
- a substantial stability of "other people" living with a family household;
- a slight increase of “persons in households with 2+ families”.

Estimation of the predicted distribution by age, i.e. $LAP_{x,i,s,t}$ from 2020 to 2040, was obtained using predicted TPT, predicted years lived L_x, and observed distributions from AVQ survey data over the three-year period 2017-19.

For this latter purpose, the mean 2017-19 distributions by single position in the household were weighed by two coefficients: one to account for the predicted TPT in year t relative to that in the 2017-19:

$$WP_{s,i,t} = \frac{TPT_{s,i,t}}{TPT_{s,i,2017-19}} \qquad t = 2020, \dots, 2040$$

and a coefficient expressing changes in mortality over time:

$$WL_{x,s,t} = \frac{L_{x,s,2017-19}}{L_{x,s,t}} \qquad t = 2020, \dots, 2040$$

Therefore, household propensities throughout the projection horizon were calculated using the formula:

$$LAP_{x,s,i,t} = LAP_{x,s,i,2017-19} * WP_{s,i,t} * WL_{x,s,t} \qquad t = 2020, \dots, 2040$$

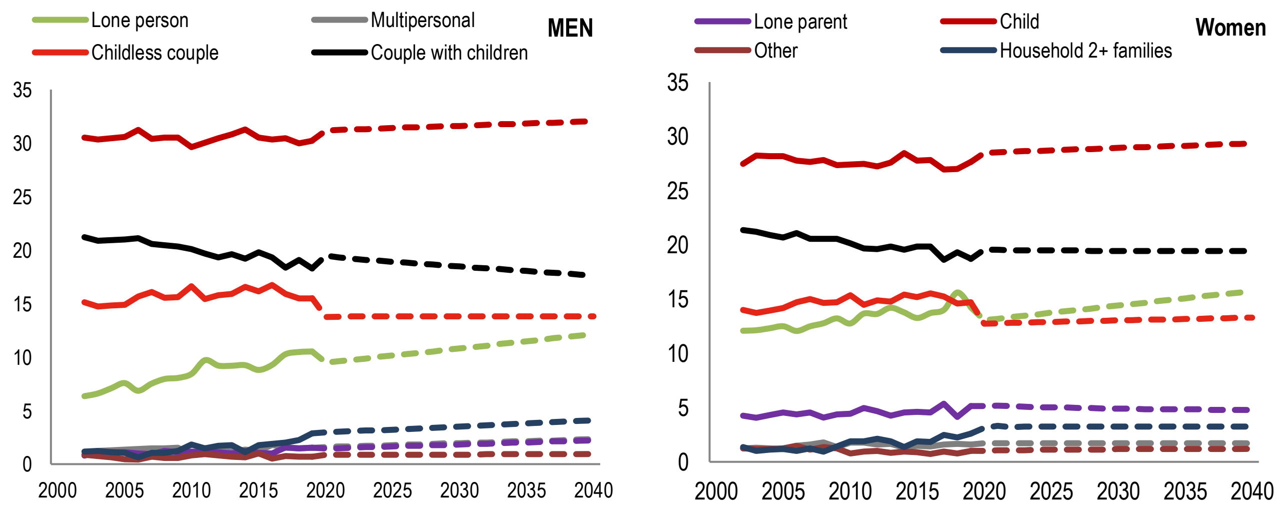
where: x=age groups 0-4, ... ,85+, s=sex, i=role in household.

TABLE A2. PREDICTIVE MODELS OF TOTAL INTENSITY RATES BY FAMILY POSITION AND SEX *.

Household position	MEN	WOMEN
Lone person	RWD || ARIMA(1,0,0)	RWD
Person in multi-person household	RWD*	RWD
Partner without children	ARIMA(2,0,0)	RWD
Partner with children	RWD || ARIMA(2,1,0)	RWD || ARIMA(2,1,0)
Lone parent	RWD	RWD || ARIMA(2,0,0)
Son/daughter	RWD	RWD
Other position	RWD	ARIMA(1,0,0)
Person in household with 2+ families	ARIMA(1,1,0)	ARIMA(1,1,0)

*RWD=*Random Walk with Drift model*; ARIMA=*AutoRegressive Integrated Moving Average model*.

FIGURE A2. TOTAL INTENSITY RATES BY FAMILY POSITION AND SEX. North-west. Years 2002-2040.



The method of estimation do not assume annual variation about the age distribution of LAPs. It was implicitly assumed that behaviours in terms of family choices would maintain in the future an age-group distribution proportional to that found in the AVQ survey in the three-year period 2017-2019. Last, the sum of LAPs by family position in each age group approximates but does not always equal the value of 100, so ex-post adjustments were necessary.

Step 3.2. Projecting LAPs in the regions

In order to project households at the regional level, it is necessary to ensure that each region has its own socio-demographic specificity within the projecting group to which it belongs. Considering that, a regional correction factor has been defined to be applied to the LAP projections of the various territorial groups in order to obtain those specific to each region:

$$FC_{r,i} = \frac{TPT_{2017-19,i,r}}{TPT_{2017-19,i,G}}$$

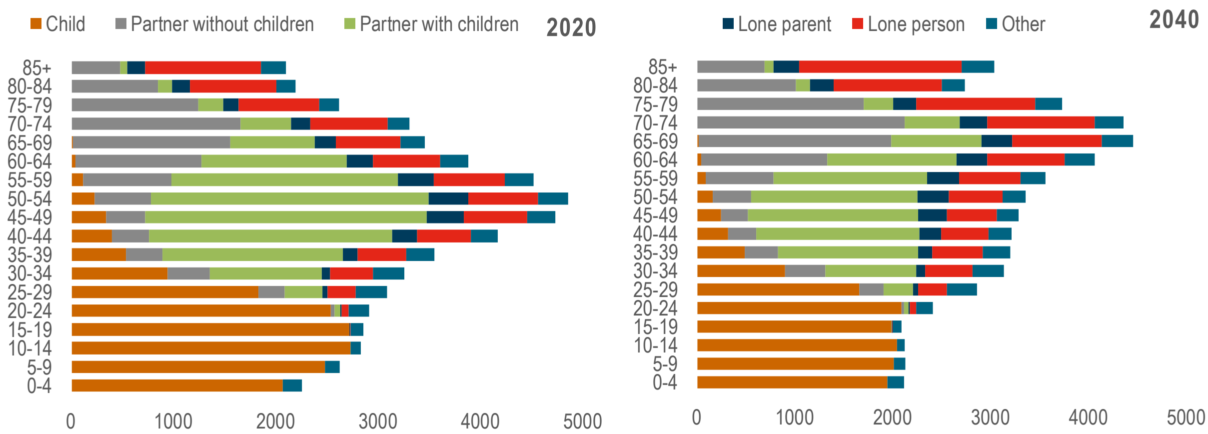
where i=family role, r=region, G=group to which region r belongs.

Next, the projected LAPs for the spatial groups are multiplied by the regional adjustment factor calculated in this way, determining the series of regional LAPs from 2020 to 2040. For example, for the single-person household position, the TPT found in Piemonte is 10.79 while in group 1 it is 10.42. The correction factor is therefore equivalent in this case to 1.04. This means that, since Piemonte has a TPT higher than that of the group to which it belongs, it is necessary to make an adjustment by multiplying all the LAPs at the various ages and the various projection years by 1.04, increasing the level slightly.

Step 4. Obtain the projected population by single household position.

In this step, the regional propensities are applied to the projected population living in households, as it was obtained in Step 1. We thus derive the projected population in the different household statuses by sex, age group, and region from 2020 to 2040. Figure A3 shows the structure by age and family position in 2020 and 2040 at the Italy level.

FIGURE A3. POPULATION BY POSITION IN THE HOUSEHOLD AND FIVE-YEAR AGE GROUP. Years 2020 and 2040, median scenario, thousand



Step 5. Calculate the number, type, and size of projected households

The projected number of households is obtained directly from the population separated by family position, gender, and age, as:

- each "single person" represents 1 household (coefficient=1);
- persons in a couple constitute 0.5 of a family (coefficient=0.5);
- each "single parent" represents 1 family (coefficient=1);
- “multi-person households" are obtained by dividing the number of persons living in multi-person households by the average size of this type of household, substantially stable over time and equal to about 2.1 members (coefficient=2.1);
- households "with 2 or more families” are obtained by dividing the number of persons living in households with 2 or more families by the average size of this type of household, which assumes time series coefficient values between 5 and 5.4 depending on the territorial group of reference.

Applying these coefficients to the population of sex s and age x yields as a final product the number of households by the family types of interest.

The average number of members is then calculated by dividing the population living in the household to the number of households. It can be disaggregated for total households and those with at least one family (excluding single persons and multi-person households).

For dissemination purposes, multi-person households and those with 2 or more families are considered together in the "other type of household" item. Table A3 shows the projected number of households by type and the average number of household members for the years 2020, 2025, 2030, 2035, and 2040.

TABLE A3. FAMILIES BY TYPE AND AVERAGE NUMBER OF MEMBERS. Years 2020-2040, median scenario.

	2020 *	2025	2030	2035	2040
Male lone person	3,618,643	3,727,303	3,892,183	4,078,456	4,251,616
Female lone person	4,953,422	5,195,014	5,489,075	5,792,028	6,079,054
Couple without children	5,100,534	5,270,971	5,498,220	5,675,411	5,739,371
Couple with children	8,267,009	7,812,824	7,324,895	6,825,038	6,362,153
Male lone parent	587,026	672,989	758,798	829,465	892,229
Female lone parent	2,203,724	2,196,800	2,202,387	2,205,509	2,210,750
Other type of household	1,006,978	1,031,936	1,058,221	1,080,539	1,093,248
Family households	16,568,501	16,358,225	16,182,266	15,925,626	15,584,663
Non family households	9,168,835	9,549,612	10,041,513	10,560,821	11,043,759
Total	25,737,335	25,907,838	26,223,779	26,486,446	26,628,422
Average household size	2.3	2.2	2.2	2.1	2.1
Average family household size	3.0	2.9	2.9	2.9	2.8

(*) Data from "Aspects of daily life" survey are generally released on a two-year average. Here, the data refer to 1 January of the year indicated. For 2020 this can give rise to differences.

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Note

[i] The contents of the paragraph refer to an *Experimental Statistic* in circulation from 29 November 2021. Considering the minimum territorial detail taken as a reference, the data commented on in it must be treated with extreme care, remembering that population projections become more uncertain the more one moves away from the starting point, especially in small geographical entities. It should also be stressed that population projections represent a what-if exercise. In other words, they are elaborations in which the calculations carried out show a particular evolution of the population which is the result of the specific assumptions adopted regarding the demographic behaviour. For information about the methodological process and for access to the database www.istat.it/it/statistiche-sperimentali.