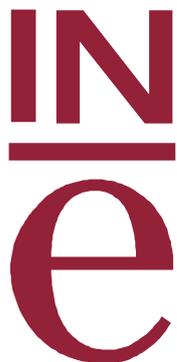


INSTITUTO NACIONAL DE ESTADISTICA



Intercensus Population Estimates

Methodology

December 2015

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1 Introduction

1.1 Calendar adjustment

The Population Census is the operation designed to measure, at 10-yearly intervals, the population resident in Spain and in each of its municipalities, in accordance with internationally recognised definitions. Using these, the INE compiles estimates of the population resident in Spain, in each Autonomous Community and in each province for periods in between censuses (Intercensus Population Estimates) and for the subsequent period up to the latest available census. These figures are used as reference in all of the INE statistical production (Spanish national accounts, surveys, indicators, etc.) and are regularly transmitted as official population figures for Spain and its regions on an international level.

In order to do this, Intercensus Population Estimates have been calculated, according to the 1970, 1981, 1991, 2001 and 2011 Censuses, also using data about births, deaths and migrations available for the corresponding Intercensus periods.

Intercensus Population Estimates series are calculated up to 1 January 2012 and comprise intermediate censuses (1981, 1991, 2001 and 2011) as well as Population Figures published as of 2013 and for the period after the 2011 Census. It all constitutes, together with the censuses prior to 1970, the population figures for Spain historical statistical series.

The Intercensus Population Estimates provide the series of figures of the population resident during the period between two consecutive Population Censuses. Specifically:

- Specifically, the 2001-2011 Intercensus Population Estimates constitute an estimation of the population resident in Spain, in each Autonomous Community and in each province (and island, in the island provinces) at the 1st day of each month in the period from 1 January 2002 to 1 January 2012, broken down by sex, year of birth, age, country of nationality and country of birth, linking the results of the 2001 Population Census with those of the 2011 Population Census.
- Specifically, the 1991-2001 Intercensus Population Estimates constitute an estimation of the population resident in Spain, in each Autonomous Community and in each province at the 1st day of each month in the period from 1 January 1991 to 1 January 2001, broken down by sex, year of birth, age, country of nationality and country of birth, linking the results of the 1991 Population Census with those of the 2001 Population Census.
- Specifically, the 1981-1991 Intercensus Population Estimates constitute an estimation of the population resident in Spain, in each Autonomous Community and in each province at the 1st day of each month in the period from 1 January 1981 to 1 January 1991, broken down by sex, year of birth, age, country of nationality and country of birth, linking the results of the 1981 Population Census with those of the 1991 Population Census.

- and the 1970-1981 Intercensus Population Estimates constitute an estimation of the population resident in Spain, in each Autonomous Community and in each province at the 1st day of each month in the period from 1 January 1971 to 1 January 1981, broken down by sex, year of birth, age, country of nationality and country of birth, linking the results of the 1970 Population Census with those of the 1981 Population Census.

From April 2013 and up to December 2014, intercensus estimates corresponding to the 1970-1981, 1981-1991, 1991-2001 and 2001-2011 periods were available. However, those corresponding to the first three periods have been elaborated according to diverse processes of smoothing by age, so that they do not constitute a homogeneous series.

Throughout 2014 1981-1991 and 1991-2001 Intercensus series have been recalculated, and throughout 2015 1971-1981 Intercensus series have been recalculated, obtaining a continuous and unified population figures series that starts 1 January 1971 and links with the last period published in Population Figures.

The general calculation methodology of the 1971-2011 Intercensus Population Estimates basically consist of the following:

1st. Carry out an accounting of demographic events occurring (births, deaths, migrations and acquisition of Spanish nationality) during the Intercensus period so that, according to the resident population figures at the reference date of the initial Population Census, a resident population figure is obtained as a result in the second Census.

2nd Adjustment of the results from the previous step to the figures of the population resident in Spain, in each Autonomous Community and in each province (and island, in the island provinces), according to sex, year of birth, country of nationality and country of birth from the 2011 Census, through a distribution of the difference between them, throughout each year in the period considered, at each breakdown level.

2 1971-2011 Inter-census estimates

2.1 Input: sources and statistical processing

The figures for the population resident in Spain, in each Autonomous Community and in each province (and islands, in the island provinces), according to sex, year of birth, country of nationality and country of birth, at 1 November 2001 and 2011, provided by the respective 2001 and 2011 Population Censuses, are taken as reference points.

On the other hand, the accounting of demographic events is carried out using the following information sources:

1. **Births:** Final results of the Vital Statistics of all years from 1971
2. **Deaths:** Final results of Vital Statistics from 1971
3. **Migrations:** data compiled using the information registered in the Municipal Register, to which the statistical processing detailed in sections 2.001 and 2.003 has been applied. For the years previous to 2001 a migrations accounting has not been carried out, due to the fact that there are no reliable information sources
4. **Acquisition of Spanish nationality:** As of 2001 and up to 2011, they are provided by the data on concessions of Spanish Nationality by the Ministry of Justice and provided by that organism¹, adjusted according to the criteria specified in section 2.4. For the years after 2011 no accounting of acquisitions of nationality has been carried out, as for this period of time there are no reliable information sources.

2.1.1 METHODS FOR WORKING-DAY ADJUSTMENT

Final results on births of mother resident in Spain of Vital statistics have been used since 1971.

1971-74 period:

VS provides Data of births for a bracket comprised between 1971 and 1974, but the breakdown level in the same is lower than that as of 1975

In particular, for the births occurring between 1971 and 1974:

- There are data by province of birth inscription, but not by province of residence of the mother.
- For each province there are annual data of births by sex.
- There is a total of births, not by sex, by province except for Ceuta and Melilla.

It is to this end that a Statistical processing applies to the available information on births for the 1971-1974 period, based on the observation of the frequency

¹ Strictly speaking, the acquisition of Spanish nationality has no legal effects until the person is registered in the Civil Register, once granted by the Ministry of Justice.

distribution in later periods, for which a higher level of detail is applied, in order to obtain the necessary breakdown for the first half of the decade.

a) Births estimate by province of residence of the mother

It being $f_{I,R}^t = \frac{Nac_{I,R}^t}{Nac_I^t}$ birth distribution for each province of registration (I), regarding the province of residence of the mother (R).

An estimate of frequency distribution of the pair formed by the variables "province of registration (I)" and "province of residence (R)" according to the distribution observed for the 1975-1984 period. The period observed is divided in two brackets, 1975-1979 and 1980-1984, and works according to the following criteria:

$$a1) \hat{f}_{I,R}^t = 0 \text{ si } \sum_{t=1975}^{1979} f_{I,R}^t < 1, \forall t \in [1971, 1974]$$

$$a2) \hat{f}_{I,R}^t = \frac{1}{5} \cdot \sum_{t=1975}^{1979} f_{I,R}^t \text{ if } I \text{ and } R \text{ are adjacent provinces, } \forall t \in [1971, 1974]$$

$$a3) \hat{f}_{I,R}^t = \frac{1}{5} \cdot \sum_{t=1975}^{1979} f_{I,R}^t \text{ if } I \text{ and } R \text{ are not adjacent provinces}$$

$$\text{and } \sum_{t=1975}^{1979} f_{I,R}^t > 1 \text{ y } \sum_{t=1980}^{1984} f_{I,R}^t > 1, \forall t \in [1971, 1974]$$

$$a4) \hat{f}_{I,I}^t = 1 - \sum_{R \neq I} \hat{f}_{I,R}^t, \forall t \in [1971, 1974]$$

b) Monthly births estimate registered in Ceuta and Melilla.

For the 1971-1974 period there is only the total annual births registered in the provinces of Ceuta and Melilla, but its monthly distribution is needed.

Births registered in each province of Ceuta and Melilla for the years from 1971 to 1974 are estimated applying to the annual total the average monthly distribution obtained during the 1975-1979 period. That is,

$$\widehat{Nac}_{Ix}^{m,t} = Nac_{Ix}^t * \hat{f}_{Ix}^{m,t} \quad \forall m = 1 \dots 12,$$

$Ix = \text{province or registration, } x = \text{Ceuta or Melilla,}$

$$\hat{f}_{Ix}^{m,t} = 1/5 \cdot \sum_{t=1975}^{1979} f_{Ix}^{m,t}$$

Lastly, and adjustment on the month with higher incidence of births is carried out, in order for the total of monthly births estimated to coincide with the total of births registered:

$$Sea D_{ix}^t = Nac_{ix}^t - \sum_{m=1}^{12} \widehat{Nac}_{ix}^{m,t}$$

$$then \widehat{Nac}_p^{M,t} = \widehat{Nac}_p^{M,t} + D_p^t, \text{ being } \widehat{Nac}_p^{M,t} = \max_m(\widehat{Nac}_p^{m,t})$$

c) Estimation of monthly births registered in each province by sex

For the 1971-1974 period there is a total of annual births registered in the provinces, by sex. For monthly data there is only a total of births and sex distribution is needed. It is obtained as explained:

$$f_i^t(s) = Nac_i^t(s)/Nac_i^t, \quad s \in \{men, women\}$$

$$\widehat{Nac}_i^{m,t}(s) = f_i^t(s) \cdot Nac_i^{m,t}, \quad \forall m = 1 \dots 12$$

d) Obtaining of Births by Province of residence, sex and month.

$$\widehat{Nac}_R^{m,t}(s) = \widehat{Nac}_I^{m,t}(s) \cdot f_{I,R}^t,$$

$$\forall m = 1 \dots 12, \quad s \in \{men, women\}, R \in \{01,02, \dots, 51,52\}$$

1975-2001 period:

VS provides Data of births for the range comprised between 1975 and 2011 for every necessary breakdown level, so that it is not necessary to carry out any additional estimates for this period.

2002-2011 period:

For the last Intercensus period, a population breakdown is included by nationality and place of birth.

For this reason, a previous imputation of said variable has been carried out for those born whose nationality does not appear in the VP files. This imputation is established according to the current regulations on acquisition of origin of Spanish Nationality. The following two situations must be considered in this imputation process:

- a. Imputation of Spanish nationality of the child born: this considers the rules relating to the statement of Spanish nationality included in article 17.1 of the Civil Code, and the rules that have been dictated in the interpretation thereof¹. Based on this, Spanish nationality has been imputed when at least one of the parents is Spanish or born in Spain.

¹ With regard to those children born in Spain, this establishes that "the following are Spaniards in origin:

- a. Those children born to a Spanish father or mother.
- b. Those children born to foreign parents, if at least one of them was born in Spain. An exception is made for the children of accredited diplomatic or consular civil servants in Spain.
- c. Those children born in Spain to foreign parents, if both parents lacked a nationality, or if the legislation of neither of them attributes a nationality to the child.
- d. Those children born in Spain whose affiliation is not established. For this purpose, those minors whose first known place of residence is within the Spanish territory are considered to have been born in Spain."

Furthermore, Spanish Nationality has been acquired for those born in Spain in the following cases, according to the application of the doctrines¹ by General Department for Registries and Notaries Yearbook of the Ministry of Justice regarding budgets by which Spanish Nationality declaration proceeds or not, as provided by article 17.1.c of the Civil Code:

- When both parents have Argentinean, Brazilian, Colombian, Cuban, Peruvian or Venezuelan nationality.
 - When both parents are Ecuadorian, but neither was born in Ecuador, and the birth is after 15 December 2008.
 - When both parents are Ecuadorian and the birth is prior to 16 December 2008.
 - When both parents are Chilean and the birth is prior to 16 December 2008.
 - When both parents are Bolivian and the birth is prior to 21 May 2009.
 - When both parents are stateless.
- b. Imputation of foreign nationality of the child born: the nationality of the mother has been imputed to those children born and to whom Spanish nationality has not been imputed.

2.1.2 DEATHS

Final results about Deaths of residents in Spain of Vital statistics since 1971 have been used.

1971-1974 period:

VS provides Data of deaths for the bracket comprised between 1971 and 1974, but the breakdown level in the same is lower than that as of 1975

In particular, for deaths between 1971 and 1974 the following is established:

- Deaths (annual figures) by sex and age registered in each province except for Ceuta and Melilla.
- Monthly Deaths registered in each province except for Ceuta and Melilla
- Deaths (annual figures) by sex registered in Ceuta and Melilla.

It is to this end that a statistical processing of information on deaths for the 1971-1974 period, based on observation of frequency distribution in later periods for

¹ Compiled in the Instruction of 28 March 2007, the General Department for Registries and Notaries, on the competence of municipal Civil Registries and other regulations regarding records of declaration of Spanish nationality with a simple presumption value, modified by Circular of 16 December 2008 of the General Department for Registries and Notaries on the application of section 17, number 1, c) of the Civil Code regarding the children of foreigners born in Spain and its complementary of 21 May 2009.

which there is a higher level of detail, in order to obtain the necessary breakdown for the first half of the decade.

a) Monthly deaths estimate by sex, age and province of registration (excluding Ceuta and Melilla)

Given:

$Def_I^t = \text{annual deaths in year } t, \text{ registered in province } I$

$Def_I^t(s) = \text{annual deaths in year } t, \text{ registered in province } I, \\ \text{of persons of sex } s$

$Def_I^t(s, e) = \text{annual deaths in year } t, \text{ registered in province } I, \\ \text{of persons of sex } s \text{ and age } e$

$Def_I^t(s) = \text{annual deaths in year } t, \text{ registered in province } I, \\ \text{of persons of sex } s \text{ and age } e$

$Def_I^{m,t} = \text{monthly deaths in month } m \text{ during year } t, \text{ registered in province } I$

$I = \text{Province of registration } \in \{01, 02, \dots, 49, 50\}$

$s \in \{\text{men}, \text{women}\}$

In the first place, sex and age distributions are obtained according to the respective annual frequencies observed in each registration province, that is:

Deaths estimate distribution by sex,

$$\hat{f}_I^t(s) = Def_I^t(s) / Def_I^t$$

Deaths estimate distribution by sex and age

$$\hat{f}_I^t(s, e) = Def_I^t(s, e) / Def_I^t(s)$$

Monthly deaths by sex and age are estimated applying both distributions to the total monthly deaths.

$$\widetilde{Def}_I^{m,t}(s, e) = Def_I^{m,t} \cdot \hat{f}_I^t(s) \cdot \hat{f}_I^t(s, e) \quad m = 1 \dots 12$$

Province of registration $\in \{01, 02, \dots, 49, 50\}$

b) Annual deaths estimate by sex and age in Ceuta and Melilla.

Given $Def_{Ix}^t(s) = \text{annual deaths registered in Autonomous City } x, \\ \text{of persons of sex } s$

Deaths frequency distribution is obtained by five-year age groups (Ag) for the 1975-1979 period, for which there is an age breakdown:

Death frequency distribution by five-year age group

$$\hat{f}_{Ix}^t(s, Ge) = \frac{\sum_{t=1975}^{1979} Def_{Ix}^t(s, Ge)}{\sum_{t=1975}^{1979} Def_{Ix}^t(s)}, Ag \in \{0-4, 5-9, \dots, 95-99, 100+\}$$

Death distribution by simple ages

$$\hat{f}_{Ix}^t(s, e) = \frac{\sum_{t=1975}^{1979} Def_{Ix}^t(s, e)}{\sum_{t=1975}^{1979} Def_{Ix}^t(s, Ge)}, \text{ and } e \in \{0, 1, \dots, 99, 100+\}$$

Annual deaths by sex and age are estimated according to these distributions applied by $Def_{Ix}^t(s)$

$$\widetilde{Def}_{Ix}^t(s, e) = Def_{Ix}^t(s) \cdot \hat{f}_{Ix}^t(s, Ge) \cdot \hat{f}_{Ix}^t(s, e), e \in \{0, 1, \dots, 99, 100+\}$$

Ix = province of registration, x = Ceuta or Melilla,

Deaths estimates are rounded and the rounding is adjusted to the total of deaths unit by unit in each simple age starting by the majority in the five-year group that more deaths presents.

c) Monthly deaths estimates by sex and age in Ceuta and Melilla.

Monthly distribution of average deaths from 1975 to 1979 is the one that will allow to estimate monthly deaths for the 1971-1974 period in Autonomous Cities, that is:

Deaths frequency distribution by month

$$\hat{f}_{Ix}^{m,t} = \frac{\sum_{t=1975}^{1979} Def_{Ix}^{m,t}}{\sum_{t=1975}^{1979} Def_{Ix}^t}$$

This distribution is applied by annual deaths by sex and age to estimate monthly deaths.

$$\widetilde{Def}_{Ix}^{m,t}(s, e) = \widetilde{Def}_{Ix}^t(s, e) \cdot \hat{f}_{Ix}^{m,t} \quad m = 1 \dots 12$$

Ix = province of inscription, x = Ceuta or Melilla,

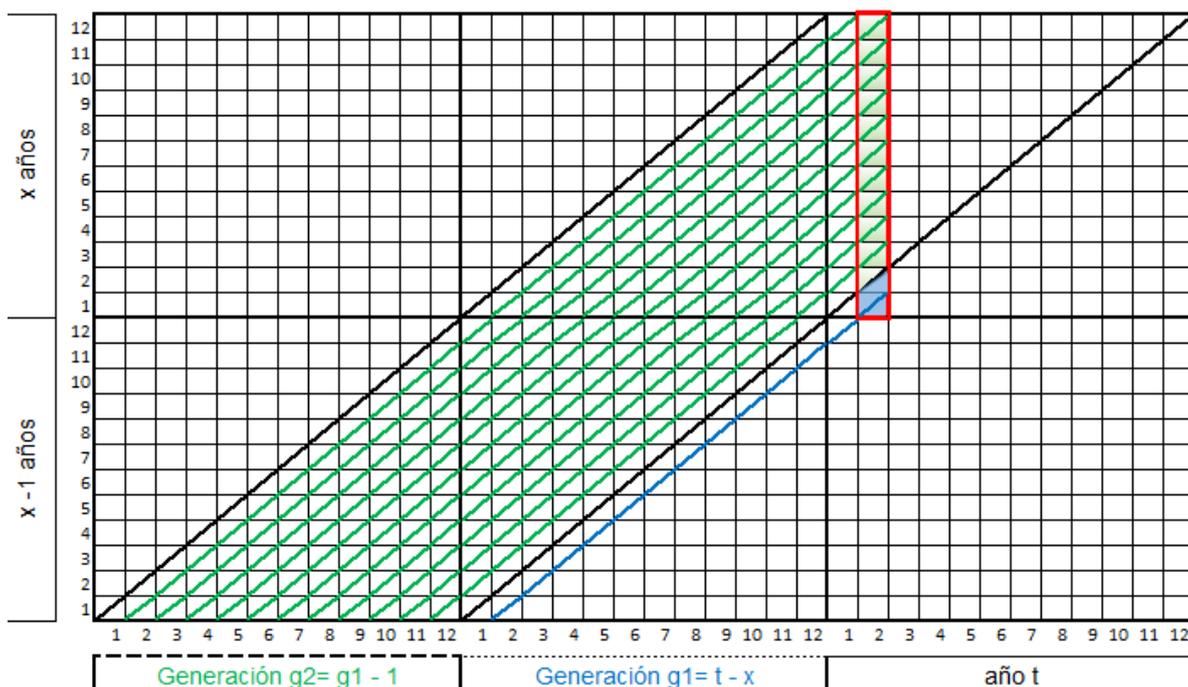
d) Monthly deaths estimate by sex and generation

In a determined t reference year, individuals of a determined e age can belong to 2 generations:

$$g1 = t - e$$

$$g2 = g1 - 1$$

Deaths of each age in each month have to be distributed between the 2 generations that constitute that age, but taking into account the month of the death and the possible months of birth. The best way to see it is through Lexis diagram:



From this classification the following distribution among generations and ages appears:

$$\widetilde{Def}_I^{m,t}(s, g1) = \widetilde{Def}_I^{m,t}(s, e) \cdot 21/24$$

$$\widetilde{Def}_I^{m,t}(s, g2) = \widetilde{Def}_I^{m,t}(s, e) \cdot 3/24$$

$$e \in \{0, 1, \dots, 99, 100+\}, g1=t-e; g2=g1-1$$

e) Death estimate by province of residence of the diseased

It being $f_{I,R}^{t} = \frac{Def_{I,R}^t}{Nac_I^t}$, the death distribution by registration province (I), regarding the province of residence of the diseased (R).

An estimate of frequency distribution of the pair formed by the variables "province of registration (I)" and "province of residence (R)" according to the distribution observed for the 1975-1984 period. The period observed is divided in two brackets, 1975-1979 and 1980-1984, and works according to the following criteria:

- e1) $\hat{f}_{I,R}^t = 0$ si $\sum_{t=1975}^{1979} f_{I,R}^t < 1, \forall t \in \text{NUMURUMU}$
- e2) $\hat{f}_{I,R}^t = \frac{1}{5} \cdot \sum_{t=1975}^{1979} f_{I,R}^t$ if I and R are limit provinces, $\forall t \in \text{NUMURUMU}$
- e3) $f_{I,R,t=1/5 \cdot t=1975-1979} f_{I,R,t}$ si I y R son provincias no limit
 $y \sum_{t=1975}^{1979} f_{I,R}^t > 1 y \sum_{t=1980}^{1984} f_{I,R}^t > 1, \forall t \in [1971, 1974]$
- e4) $\hat{f}_{I,I}^t = 1 - \sum_{R \neq I} \hat{f}_{I,R}^t, \forall t \in [1971, 1974]$

In order to obtain deaths by province of residence this distribution is applied $\hat{f}_{I,R}^t$ ti deaths by sex, generation and month registered in each of the 52 provinces each year from 1971 to 1974:

$$\widehat{Def}_R^{m,t}(s,g) = \widehat{Def}_I^{m,t}(s,g) \cdot \hat{f}_{I,R}^t$$

$$\forall m = 1 \dots 12, \quad t \in \{1971, 1974\},$$

$$s \in \{\text{men. women}\}, R \in \{01, 02, \dots, 51, 52\}$$

1975-2001 period:

VP provides deaths data for the interval between 1975 and 2011 for all breakdown levels needed, so that it is not necessary to make any kind of additional estimate.

2002-2011 period:

For the last Intercensus period, a breakdown of the population by nationality and country of birth is included.

Regarding this period, the country of birth has been imputed as the nationality in those cases which it appears as an invalid country code, and if this variable also had an invalid code, both were imputed with Spain as the nationality and country of birth.

2.1.3 MIGRATIONS

For the years previous to 2001, migrations are not taken into account due to the lack of reliable and quality sources of information.

The reconstruction of the external and internal migratory flows of Spain during the years from 2001 to 2011 has been carried out using the movements recorded in the Municipal Register, processed statistically as described below. The data obtained for the 2008-2011 period coincides with the results of the Migration Statistics.

Firstly, the movements for the years 2001 to 2011 recorded in the Register database up until January 2013 have been collected, which we consider must be associated with real migratory flows, according to the following criteria:

- With foreign immigrations:
 - o *Registrations due to Change in Residence* with origin abroad, as stated by the interested party in her/his municipal registration record.
 - o *Registrations due to Omission, with or without origin abroad*, of individuals with foreign nationality, given that at some point in time, even if we do not know exactly when, said population must have immigrated to Spain.
- With foreign emigrations:
 - o *Delistings due to Change in Residence* , with destination abroad, as stated by the interested party in her/his municipal registration record.
 - o *Delistings due to Undue Registration* of foreign nationals, understanding that if the Municipal Council has detected that the interested party no longer resides in the municipality and has not registered in any other municipality, this person must have left Spain, even if we do not know when.
 - o *Delistings due to Expiry*, as the interested party has not renewed her/his municipal registration, the Municipal Council has detected that the interested party no longer resides in the municipality, and has not registered in any other municipality, and therefore, s/he must have left Spain, though there may not be proof of .
- With domestic migrations (inter-Autonomous Community, inter-provincial or inter-island): *Registrations (Delistings) due to Change in Residence* with origin in another Spanish municipality located in an island, province or Autonomous Community other than that of origin.

Regarding said information, the following statistical procedures have been applied:

1. Estimation of the date of occurrence of the emigrations abroad quantified using *Delistings due to Undue Registration* and *Delistings due to Expiry*. In general, said estimation has been carried out using a random assignation between the latest municipal register variation prior to the delisting and the date of the delisting itself, bearing in mind that the corresponding emigration abroad must have taken place during said time period¹.

¹ In the case of the Delistings due to Undue Registration from the process of checking residence for community and non-community persons with a permanent residence permit, if the person is registered in the Central Register of Foreign Nationals (RCE), then the lower limit of the bracket within which the estimated date of emigration is chosen at random is:

- the maximum between the date of the latest municipal register variation prior to the delisting and the date of expiry of the permanent residence permit or community scheme permit, in case of having it.

2. Adjustment to the definition of migration, and in line with this, to the definition of regular residence, both being internationally recognised¹. According to them, migratory movements are considered to be only those in which a person establishes, or intends to establish, regular residence in the place of destination for at least twelve months:

Those consecutive immigrations and emigrations that, carried out by the same individual, have occurred with less than 12 months' difference, have been subtracted from the prior quantification of municipal register variations identified with foreign migrations, according to the aforementioned criteria. For said purpose, the following processing of the information recorded in the Municipal Register has been carried out, consisting in subtracting the following from the prior accounting of the municipal register variations:

- a. Those municipal register registrations initially identified with foreign immigrations and for which a subsequent municipal register delisting has been recorded as emigration abroad occurring in the twelve months following the municipal register registration. In the same way, the said delisting in the accounting of emigration movements has also been subtracted.
- b. Those municipal register delistings initially identified with an emigration abroad and for which a subsequent municipal register registration has been recorded for the same individual prior to twelve months following said estimated date of exit from the country, as well as the corresponding municipal register registration. This filtering has a greater degree of complexity, given that if a delisting occurs in the Municipal

- the maximum between the date of the latest municipal register variation prior to the delisting and the date of registration in the (RCE), in the case of not having been issued a permanent residence permit or community scheme permit.

¹ According to European Parliament and Council Regulation (EC) no.862/2007, of 11 July 2007, regarding Migration and Asylum Statistics, the following definitions are established:

-- Immigration: action by which a person establishes her/his regular residence in the territory of a Member State for a period that is, or that is expected to be, at least twelve months in duration, having previously been a regular resident of another Member State or of other country.

-- Emigration: action by which a person, having previously been a regular resident in the territory of a Member State, ceases to have her/his regular residence in that Member State for a period that is, or that is expected to be, at least twelve months in duration.

Consistent with the above, European Parliament and Council Regulation 763/2008, of 9 July 2008, regarding the Population and Housing Censuses, defines a regular residence as the place where a person normal spends the daily rest period, regardless of temporary absences for leisure purposes, holidays, visits to friends or relatives, medical treatment or religious pilgrimage. Regular residents in the geographical area in question may only be:

i) those persons who have lived in their regular place of residence for an uninterrupted period of at least twelve months prior to the reference date, or

ii) those persons who have arrived at their regular place of residence in the twelve months prior to the reference date, with the intention of remaining there for at least one year.

When the circumstances described in i) or ii) cannot be determined, the "regular residence" will be understood to be the place of legal or registered residence.

Register, the individual loses her/his personal identifier in said register, in such a way that, in order to detect that a subsequent registration corresponds to the same individual, a probabilistic link according to the remaining variables constituting the municipal register has been required.

- c. Those municipal register registrations and delistings that had been identified initially as domestic migratory movements, in the case in which they establish stays of less than twelve months in the corresponding geographical entity. To this end, we have proceeded hierarchically, from greater to lesser territorial units.
3. Given the time lag existing between the date at which the migratory movement occurs and the time when this event is recorded as a Municipal Register variation, at the time of the estimate, we only have partial - not complete - information on the migratory movements that have occurred in the past, and the more recent they are, the more scarce the information is. An estimation mechanism is carried out, which allows exceeding this limitation of the administrative register for a comprehensive description of the phenomenon in the most recent years:

Thus, migratory flows occur in every month of a determined year. From the year 2006¹, they are estimated, basically, from the corresponding variations registered in the Municipal Register until the estimation time, multiplying them by an expansion coefficient that replies the arrival of the information to the INE central services, based on the regularity observed by such arrival of the information².

Firstly, the delay variable is defined, r , as the number of months that a certain type of municipal register variation occurring in a given month and recorded in the Municipal Register takes in being confirmed and included as such variation in the centralised database of the Municipal Register. It is, then

¹ As of the year 2009, in the case of *Delistings due to Expiry*, considering that the expiry procedure of municipal register registrations of non-community citizens without a permanent residence permit did not enter into force until the end of 2005, and as a result, the significant record of this type of delisting did not occur until some time after.

² Such estimations are considered to be sufficiently precise when the expansion coefficient to be applied is less than 5. In another case, the estimation of the municipal register variations of the most recent months has been carried out using the tendency and seasonal behaviour of the series of monthly variations estimated for each type of variation in the Municipal Register. To this end, a monthly growth coefficient of the series is defined, built as the convex linear combination of one trend coefficient and another seasonality coefficient. The former, deduced as an average, for the twelve previous months, of

the growth coefficients for each month, over the sum of the two before it (trend coefficient), C_{tend} ; the latter, deduced as an average, for the same month of the two previous years, of the growth coefficients

for each month, over the sum of the two months before it (seasonality coefficient), C_{est} . In this way, the growth coefficient used in the estimation results from the expression:

$$C = \alpha \cdot C_{tend} + (1 - \alpha) \cdot C_{est}, \text{ with } 0 \leq \alpha \leq 1$$

$\hat{V}_{m,a-1}$ the total of such variations that is estimation when they have occurred during the month m of the year $a - 1$ ¹ (previously estimated with this same methodology) and $V_{m,a-1}^r$ the number thereof included in the centralised database of the Municipal Register up until r months following the month m . We then define the expansion coefficient corresponding to month m of the year a for lag r as quotient²:

$$CE_{m,a}^r = \frac{\hat{V}_{m,a-1}}{V_{m,a-1}^r}$$

It is, then $CE_{m,a}^r$ the total number of municipal register variations recorded in the Municipal register occurring in month m of the year a and received in the INE Central Services up until r months following the month m . Then, the estimation of the total variations occurring in month m of the year a , $\hat{V}_{m,a}$, then results from:

$$\hat{V}_{m,a} = CE_{m,a}^r \cdot V_{m,a}^r$$

As a result of these three steps, a weighted *microdata* file is obtained of municipal register variations. The weighting of each register is the *expansion coefficient* defined above, corresponding to the type of municipal register variation in question.

2.1.4 ACQUISITION OF SPANISH NATIONALITY

For the years previous to 2001, migrations have not been taken into account due to the lack of reliable and quality sources of information for those years.

This has used, as an approximation to the data on the acquisition of Spanish nationality, the register of granting of Spanish nationality of the Ministry of Justice passed between the years 2001 and 2011. From this register, the small number of cases in which some of the variables of interest for the calculation were blank or had invalid values have not been considered.

¹ $a - 3$, in the case of *Delistings due to Undue Registration* and of *Delistings due to Expiry*.

² $CE_{m,a}^r = \frac{\hat{V}_{m,a-3}}{V_{m,a-3}^r}$, in the case of *Delistings due to Undue Registration* and of *Delistings due to Expiry*.

2.2 Calculation of the population figures 1971-2011

2.2.1 DEMOGRAPHIC EVENT ACCOUNTS

The inclusion of 2002 in the breakdown by nationality and place of birth forces to carry out two different processes for calculating the Intercensus Population Estimates before and after the Population Census of 2001. Therefore, the calculation process is divided in two sections: 1971-2001 period and 2001-2011 period.

On one hand, an accounting of the demographic phenomena (births and deaths) between 1 January 1971 and 1 November 2001 determines the population of each sex and year of birth resident in Spain, in each Autonomous Community and each province on 1 November 2001, if we take as a reference the population figures for each one of these desegregations provided by the Population Censuses of 1970, 1981, 1991 and 2001. To this end, we proceed according to the equations:

$$P_{i,s,g}^{m+1} = P_{i,s,g}^m + N_{i,s,g}^m - D_{i,s,g}^m$$

for $m = 1, 2, \dots, 122$ it being $m = 1$ the first period corresponds to 1 January 1971 and $m = 122$ the second to last period that corresponds to 1 February 1981, for the Intercensus period from 1971 to 1981. For $m = 1, 2, \dots, 120$ it being $m = 1$ the first period that corresponds to 1 March 1981 and $m = 120$ the second to last period that corresponds to 1 February 1991, for the Intercensus period from 1981 to 1991. And for $m = 1, 2, \dots, 128$ it being $m = 1$ the first period corresponding to 1 March 1991 and $m = 128$ the second to last period corresponding to 1 October 2001, for the Intercensus period from 1991 to 2001. Where:

$P_{i,s,g}^m$ is the population resident in the province i , of sex s and year of birth g on the first day of the month m .

$N_{i,s,g}^m$ are the births to women resident in the province i , of sex s and year of birth g occurring throughout the month m .

$D_{i,s,g}^m$ are the deaths of residents in the province i , of sex s and year of birth g occurring throughout the month m .

An account of the demographic events occurring (births, deaths, migrations and acquisitions of Spanish nationality) between 1 November 2001 and 31 December 2011 establishes the population for each sex, year of birth, country of nationality and country of birth, resident in Spain, in each Autonomous Community and in each province (islands, in the island provinces) at 1 January 2012, using the population figures for each of those breakdowns provided by the 2001 Population Census. To this end, we proceed, successively, according to the following equations:

$$P_{h,s,g,España,j}^{m+1} = P_{h,s,g,España,j}^m + N_{h,s,España,j}^m - D_{h,s,g,España,j}^m + I_{h,s,g,España,j}^m - E_{h,s,g,España,j}^m + I_i^m_{h,s,g,España,j} - E_i^m_{h,s,g,España,j} + \sum_i Nac_{h,s,g,i,j}^m$$

If $i \neq España$

$$P_{h,s,g,i,j}^{m+1} = P_{h,s,g,i,j}^m + N_{h,s,i,j}^m - D_{h,s,g,i,j}^m + I_{h,s,g,i,j}^m - E_{h,s,g,i,j}^m + I_i^m_{h,s,g,i,j} - E_i^m_{h,s,g,i,j} - Nac_{h,s,g,i,j}^m$$

Where:

$P_{h,s,g,i,j}^m$ is the population resident in the province (island, in the case of the island provinces) h , of sex s , year of birth g , country of nationality i and country of birth j on the first day of the month m .

$N_{h,s,i,j}^m$ are the births to women residence in the province (island, in the case of the island provinces) h , of sex s , country of nationality i and country of birth j occurring throughout the month m .

$D_{h,s,g,i,j}^m$ are the deaths of persons resident in the province (island, in the case of the island provinces) h , of sex s , year of birth g , country of nationality i and country of birth j occurring throughout the month m .

$I_{h,s,g,i,j}^m$ are the immigrations from abroad in province (island, in the case of the island provinces) h , of persons of sex s , year of birth g , country of nationality i and country of birth j occurring throughout the month m .

$E_{h,s,g,i,j}^m$ are the emigrations abroad of persons residents in the province (island, in the case of the island provinces) h , of sex s , year of birth g , country of nationality i and country of birth j occurring throughout the month m .

$I_i^m_{h,s,g,i,j}$ are the immigrations from the rest of Spain in the province (island, in the case of the island provinces) h , of persons of sex s , year of birth g , country of nationality i and country of birth j occurring throughout the month m .

$E_{h,s,g,i,j}^m$ are the emigrations with destinations in the rest of Spain in the province (island, in the case of the island provinces) h , of sex s , year of birth g , country of nationality i and country of birth j occurring throughout the month m .

$Nac_{h,s,g,i,j}^m$ are the acquisitions of Spanish nationality of persons resident in the province (island, in the case of the island provinces) h , of persons of sex s , year of birth g , country of nationality i and country of birth j occurring throughout month m .

2.2.2 ADJUSTMENT TO POPULATION CENSUSES

The inclusion of 2002 in the breakdown by nationality and place of birth forces to carry out two different processes for calculating the Intercensus Population Estimates before and after the Population Census of 2001. Therefore, the calculation process is divided in two sections: 1971-2001 period and 2001-2011 period.

As a result of the accounting of demographic phenomena after the reference date of the first census, of the Intercensus period studied, resident population figures in Spain are obtained, in each Autonomous Community and province (and island, in insular provinces) at the reference date of the second census of the Intercensus period, by sex, year of birth, country of nationality and country of birth. Said figures differ from those provided by the 2011 Population Census, with the difference being attributable either to overestimation or underestimation errors of the respective 2001 and 2011 censuses, or to errors in the measurements of the demographic events occurring in the period between the reference dates thereof. Because of the impossibility to determine the cause of such difference, a population stocks adjustment, derivatives of accounting of demographic phenomena for every Intercensus period to the Census results of 1981, 1991, 2001 and 2011, is carried out through a uniform distribution of said difference for each breakdown level considered, in each date (first day of the month) of the three Intercensus periods.

Each Intercensus period has a number of months to estimate differently, depending on the date of reference of the implied censuses in each section, which implies a different adjustment process for each period.

1971-1981 period:

It is determined by:

$P_{i,s,g}^{1-3-1981}$ the figure of resident population in province i , of sex s , and year of birth g on 1 March 1981, according to the result described in section 2.2.1 of this document.

$\hat{p}_{i,s,g}^{1-3-1981}$ said figure according to the 1981 Population Census.

The difference is then:

$$D_{i,s,g} = \hat{p}_{i,s,g}^{1-3-1981} - p_{i,s,g}^{1-3-1981}$$

The difference $D_{i,s,g}$ is distributed uniformly in each month of the period from January 1971 to February 1981, yielding the following:

- For $g \leq 1971$:

$$d_{i,s,g}^{m+1} = \frac{m}{122} D_{i,s,g}, \text{ for } m = 1, 2, \dots, 122$$

- For $g = 1972, 1973, \dots, 1981$:

$$d_{i,s,g}^{m+1} = \frac{m - (12(g-1972) + 10)}{122 - (12(g-1972) + 10)} D_{i,s,g}, \text{ for } m = 122 - (12(g-1972) + 10), \dots, 122$$

And in both cases, the figure $P_{i,s,g}^{m+1}$ resulting from point 2.2.1, is replaced by $p_{i,s,g}^{m+1} + d_{i,s,g}^{m+1}$

1981-1991 period:

It is determined by:

$p_{i,s,g}^{1-3-1991}$ the figure of resident population in province i , of sex s , and year of birth g on 1 March 1991, according to the result described in section 2.2.1 of this document.

$\hat{p}_{i,s,g}^{1-3-1991}$ said figure according to the 1991 Population Census.

The difference is then:

$$D_{i,s,g} = \hat{p}_{i,s,g}^{1-3-1991} - p_{i,s,g}^{1-3-1991}$$

The difference $D_{i,s,g}$ is distributed uniformly in each month of the period from March 1981 to February 1991, yielding the following:

- For $g \leq 1981$:

$$d_{i,s,g}^{m+1} = \frac{m}{120} D_{i,s,g}, \text{ for } m = 1, 2, \dots, 120$$

- For $g = 1982, 1983, \dots, 1991$:

$$d_{i,s,g}^{m+1} = \frac{m - (12(g-1982) + 10)}{120 - (12(g-1982) + 10)} D_{i,s,g}, \text{ for } m = 120 - (12(g-1982) + 10), \dots, 120$$

And in both cases, the figure $P_{i,s,g}^{m+1}$ resulting from point 2.2.1, is replaced by $p_{i,s,g}^{m+1} + d_{i,s,g}^{m+1}$

Period 1991-2001:

It is determined by:

$P_{i,s,g}^{1-11-2001}$ the figure of resident population in province i , of sex s , and year of birth g on 1 November 2001, according to the result described in section 2.2.1 of this document.

$\hat{P}_{i,s,g}^{1-11-2001}$ said figure according to the 2001 Population Census.

The difference is then:

$$D_{i,s,g} = \hat{P}_{i,s,g}^{1-11-2001} - P_{i,s,g}^{1-11-2001}$$

The difference $D_{i,s,g}$ is distributed uniformly in each month of the period from March 1991 to October 2001, yielding the following:

- For $g \leq 1991$.

$$d_{i,s,g}^{m+1} = \frac{m}{128} D_{i,s,g}, \text{ for } m = 1, 2, \dots, 128$$

- For $g = 1992, 1993, \dots, 2001$:

$$d_{i,s,g}^{m+1} = \frac{m - (12(g - 1992) + 10)}{128 - (12(g - 1992) + 10)} D_{i,s,g}, \text{ for } m = 128 - (12(g - 1992) + 10), \dots, 128$$

And in both cases, the figure $P_{i,s,g}^{m+1}$ resulting from point 2.2.1, is replaced by $P_{i,s,g}^{m+1} + d_{i,s,g}^{m+1}$

2001-2011 period:

It is determined by:

$P_{h,s,g,i,j}^{1-11-2011}$ the figure for the population resident in province (island, in the case of the island provinces) h , of sex s , year of birth g , country of nationality i and country of birth j On 1 November 2011, according to the calculation described in section 2.2.1 of this document.

$\hat{P}_{h,s,g,i,j}^{1-11-2011}$ said figure according to the 2011 Population Census.

The difference is then:

$$D_{h,s,g,i,j} = \hat{P}_{h,s,g,i,j}^{1-11-2011} - P_{h,s,g,i,j}^{1-11-2011}$$

The difference $D_{h,s,g,i,j}$ is distributed uniformly in each month of the period from November 2001 to October 2011, yielding the following:

- For $g \leq 2001$:

$d_{h,s,g,i,j}^m = \frac{D_{h,s,g,i,j}}{120}$ and the figure $P_{h,s,g,i,j}^{m+1}$ resulting from point 2.2.1, is replaced by $P_{h,s,g,i,j}^{m+1} + m \cdot d_{h,s,g,i,j}^m$, for $m = 1, \dots, 120$.

- For $g = 2002, 2003, \dots, 2011$:

$d_{h,s,g,i,j}^m = \frac{D_{h,s,g,i,j}}{120 - (12 \cdot (x - 2002) + 2)}$ and the figure $P_{h,s,g,i,j}^{m+1}$ resulting from point 2.2.1, is replaced by $P_{h,s,g,i,j}^{m+1} + (m - (12 \cdot (x - 2002) + 2)) \cdot d_{h,s,g,i,j}^m$, for $m = 120 - (12 \cdot (x - 2002) + 2), \dots, 120$.

Lastly, with the population figures, according to year of birth, obtained for each date, province and population group, the figures have been derived by age, under the hypothesis of uniform distribution of the birthday of the individuals of each generation throughout the year.