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A Methodology for their Reconstruction

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Consumer Populations and Nutritional Transition in Spain in the Twentieth Century.

A Methodology for their Reconstruction**

Abstract. One feature of modern nutritional transition is the growing consumption of animal proteins. Previously, the most common approach in the quantitative analysis of this change was the study of food consumption averages. This mode of analysis, however, seems to be incomplete unless the number of consumers is also known, and data on consumers are not usually published in historical statistics. This article introduces a methodological approach for reconstructing consumer populations, based on assumptions about the diffusion process of foodstuffs and on the modeling of consumption patterns. The specific case of milk consumption in Spain between 1925 and 1981 is used to illustrate the approach. The results correlate reasonably well with other data and with the sources available, which show that this dietary change was a slow and belated process. The reconstruction of consumer populations could shed new light on the study of nutritional transitions.

Résumé. Les populations consommatrices et la transition nutritionnelle dans l´Espagne du xx^e^ siècle. Une stratégie méthodologique pour leur reconstruction. Une des caractéristiques de la transition nutritionnelle moderne est la consommation croissante des protéines animales. La démarche la plus habituelle dans l'analyse quantitative de cette transition est l'étude des moyennes de consommation des aliments par habitant. Cependant, ce type d'analyse reste incomplet du fait de la méconnaissance du nombre de consommateurs. Cet article présente une stratégie méthodologique pour la reconstruction de la population des consommateurs, fondée d'une part sur des hypothèses concernant le processus de diffusion des aliments et, d'autre part sur la modélisation des distributions de la consommation. Ce processus d'estimation est illustré dans le cas spécifique de la consommation du lait en Espagne de 1925 à 1981. Les résultats concordent avec d'autres données et de sources indirectes qui montrent que ce changement de régime alimentaire a été lent et tardif. La reconstruction de la population consommatrice peut apporter de nouvelles perspectives d'études sur les transitions alimentaires.

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One feature of modern nutrition transition is the growing consumption of animal proteins. Of particular note among these is the contribution of foodstuffs such as meat and milk. In Western Europe this process went with changes in the organization of agricultural and livestock farming, as well as in consumption preferences, under the momentum of industrialization and urbanization[1]. Quantitative study of consumption patterns provides a basic approach to illustrating changes in nutritional status.

The study of a nutritional change of this nature, however, comes up against a significant limitation. An accurate description of this process requires knowledge not only of average consumption, but also of the number of consumers. If a dietary change is considered in terms of a diffusion process, it is therefore essential to take both parameters into account. This second parameter – number of consumers – is only rarely estimated despite its obvious relevance. Historical statistics permit the calculation of a mean consumption but not of the number of consumers.

One of the major consequences is the lack of information about distribution patterns of food consumption and, therefore, of the population's nutritional status. The hypothesis and the associated evidence that in the initial stages of industrialization and urbanization nutritional status was unequally distributed have been subject to intensive research. One method of approaching these difficulties has been anthropometry: the pattern of height distribution might reflect the underlying effects of food consumption levels and other environmental factors[2].

The need of distributional assumptions to study the nutritional of a population is well shown[3]. When individual data is not available – the most common in historical studies –, then the basic indicators stem from aggregate statistics and are used to compute average levels of consumption. In these cases major differences in indicators are a consequence of the geographical information provided by published sources. Thus, those levels of consumption can reflect averages from local to national level. Beyond all these spatial scales, however, the averages suffer the same flags: if a particular foodstuff does not have a pattern of universal consumption, the average obtained from the tabulated data cannot be used to accurately estimate the 'true' level of consumption. This is because the total average ($\overline{X}$) is calculated as the total output consumed on the total population

1. Popkin, B. M., 1993; Crigg, D., 1995
2. Steckel, R. & Floud, R., 1997, p. 1-16 review all these effects.
3. Fogel, R, 1992.

(O/P).when the number of consumers is lower than the total population it can be seen that $\overline{X}_{statistical} < \overline{X}_{true}$ 'true' value[4]. A simple and hypothetical example may illustrate this problem. There are two countries, A and B, with the same population, one million inhabitants, but different consumptions levels. In country A, consumption stands at around 70kg per person per year and in country B, 130kg. If the proportion of consumers is 50 per cent of the total population in country A and 100 per cent in B, *i.e.* universal consumption, it is clear that the effective consumption level would be greater in country A (around 140kg) than in country B (130kg). As the historical process shows, changes in consumption involve not only an increase in the consumption *per capita* of certain products, but also a growing number of new consumers[5]. Because of these two dimensions researchers must be very cautious when comparing patterns of food consumption between different countries. In fact, without first applying a « standardization » (or statistical adjustment) in some basic indicators such as the mean, any conclusion about differences in consumption levels will be biased by differences in the number of consumers.

The relationship between the mean and its underlying distribution is a common topic in textbooks on statistics. Measures of central tendency and dispersion are related but not in a univocal way. It is well known that the same mean can be the result of different distributions, and testing differences between means involves certain assumptions about distributional patterns.

This article deals with this problem[6]. Despite the simple way the problem can be set out, its solution is far from easy. This article does not provide a theoretical solution to this issue; only an empirical one: a new methodological approach is developed under some assumptions to estimate the consumers' population. Clearly, the consumers' population differ according to the analysed foodstuff. In this paper, the estimation methodology will be

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4. Here *population* denotes the total number of inhabitants living in an area. Population numbers in this article are drawn from censuses. By consumers we mean individuals capable of consuming a good *i.e.* food on a daily or weekly basis. It is important to note good would not have to have been bought in food markets. Number and characteristics of consumers change according to demographic, economic, social and spatial factors, but this many aspects cannot be taken into account in the present research. Number of consumers will be used here as equivalent to a subset of the total population.

5. A historical perspective on these changes in the demand of goods and the behavior of consumers can be found in J. De Vries, 2008. See chapter 4.

6. This is nothing new in historical research, where exploring relationships between mean and distributions has been discussed in research on economic history and historical demography. See, for example, D. McCloskey, 2001 and S. R. Johansson, 2000.

tested on the specific case of milk consumption in Spain. The evolution of the consumption of this food covers central years of the nutritional transition in this country throughout the twentieth century[7].

This article has three sections. In the first, the basic problem is introduced as well as the strategy followed to solve it. In the second, the methodology for correcting and adjusting the average consumption levels computed from the published statistics is presented. Finally, in the third section, the methodology is applied to the Spanish data on milk consumption in order to estimate patterns of consumer population distribution from 1925 to 1981. The main results will be related to the information available on the evolution of milk consumption in Spain in the twentieth century. The conclusion briefly summarizes the basic principles and results in the methodological strategy applied, with some final remarks on their strengths and weaknesses.

1. Posing the problem and exploring a solution. The case of the evolution of milk consumption in Spain

As it has been indicated in the previous section, the problem and proposed solution will be illustrated by the evolution of milk consumption in Spain between 1925 and 1981. The choice of this food can be justified by three factors: a) Milk is one of the foodstuffs acting as « indicators » of nutritional transition because it is a form of animal protein that can be consumed directly through various products containing fresh milk or can be transformed into cheese, butter, etc. b) As has been noted previously, changes in milk consumption belong to the central decades of the Spanish nutritional transition. c) Basic data are provided by consumption statistics from official sources published in relation to agriculture and livestock activities; this is not always the case with other foods because the available data were previously published only as production statistics.

During the studied period here an average of around 80 per cent of the total amount of milk produced in Spain was consumed by the population as fresh milk, and 9 per cent was transformed into cheese. The main type of fresh milk consumed was cow milk. Accordingly, the evolution of the percentage of this type of milk can be estimated at between 79 and 91 per cent of the total amount consumed between 1925 and 1981. The remainder consisted of goat milk. Table 1 shows the mean consumption levels per year,

7. Cussó, X, 2005. Cussó, X. & Garrabou, R, 2007.

and the associated standard deviation, calculated using the provincial data and the mean consumption levels calculated for the entire Spanish population between 1925 and 1981. These data are derived from two statistical sources: livestock statistics and household budget surveys[8]. The first kind of sources provides data on the number and type of livestock as well as the total production and milk consumption levels for each province, while the second offers data on the consumed quantities and family expenses. In short, the first group of sources pertain, in chronological order, to the statistics published by the *Asociación General de Ganaderos del Reino* (General Association of Livestock Owners of the Kingdom) in 1925[9], the *Censo de la ganadería en España* (Livestock Census in Spain) with data for 1933[10] and the new series on direct human consumption of animal milk published by the Ministry of Agriculture[11] in the *Resúmenes estadísticos de la producción, destino y valor de la leche* (Statistical summary of the production, destination and value of milk) from 1954 and 1955. About the second group, the data from 1965 and 1981 on the consumption per person per year at provincial level correspond to those published in the « Household Budget Surveys »[12]. There is clearly a significant lack of information between 1933 and 1965. This can be explained by the Spanish Civil War (1936-39) and the post-war period that lasted until the mid 1950s. The rationing imposed on the population during this period quite logically made statistics on consumption unnecessary[13]. With the exception of the estimates for provincial consumption *per capita* provided directly by the results from the Household Budget Surveys (HBS), the remaining values have been calculated using the consumption data provided by the sources and the provincial population corresponding to that year. The provincial populations are obtained by linear

8. The *Statistical Yearbooks*, published regularly in the twentieth century since 1912, also record data about livestock, production and, to a lesser extent, annual consumption, and are derived from the aforementioned livestock statistics.

9. AGGR, 1925. This involves a publication that is normally dated to around 1923. However, according to the bibliography of the *Revista de Higiene y Sanidad Pecuarias* (*Livestock Health and Hygiene Magazine*), published in February 1926, p. 138, the actual date of publication is 1925 (Thanks to Ismael Hernández for providing this information).

10. Ministerio de Agricultura, 1934.

11. Ministerio de Agricultura, 1954, 1955.

12. INE 1969, 1983.

13. Provincial data on provincial production and consumption of milk were published in the first yearbooks after the Spanish Civil War, but they only covered the years 1941 and 1943. The estimates derived from this data reveal a drop of almost 50 per cent in the production and consumption of fresh milk. The reduction in head of cattle (beef and goat) approaches 20 per cent. However, it is surprising that in this context, according to the same data, the production per head of cow's milk rose by almost 50% between 1941-1943, compared to 1929-1933, and that of goat's milk rose by 30 per cent.

interpolation between the two chronologically closer censuses. In all cases data have been used at a provincial scale because this is the way they were collected.

Table 1 distinguishes between two features of the long term evolution of milk consumption; the increase in average levels of consumption, and the reduction in standard deviation values. The provincial differences become more noticeable in what seems to be a strong period of growth between 1925 and 1933 with an increase in the standard deviation from 38.80 to 70.80. Following this it progressively decreases towards what seem to be improvements in the mean consumption levels, together with a major universalization of these.

Table 1. *Milk consumption in Spain (1925-1981)*
(Liters per person per year)

Year	*Mean Consumption Total Population*	*Mean(1) Consumption Provinces*	*Standard Deviation*
1925	36.46	34.05	38.80
1933	63.32	60.99	70.80
1955	65.89	69.87	57.72
1965	79.14	78.49	40.25
1981	128.39	138.30	42.25

(1) Arithmetic mean estimated from per capita consumption for each Spanish province.

Source. AGR, 1925; Ministerio de Agricultura, 1934; Ministerio de Agricultura, 1934; Ministerio de Agricultura, 1954 and 1955, INE (Instituto Nacional de Estadística), 1969; INE, 1981.

Given that the basic data are provincial, Table 2 offers a panoramic view of the evolution of the distribution of consumption at this scale between 1925 and 1981, in accordance with some intervals of consumption, and highlights the values of the maximum and minimum consumption levels at each point and the name of the provinces to which they correspond. In some Spanish provinces the minimum consumption levels were always below 20 liters between 1925 and 1965, and in the years 1925 to 1933 they were always below 10 liters, in the same way that between these two dates a considerable proportion of the provinces had constant levels of consumption that were under 25 to 50 liters per person per year. The data reflect how the distance between minimum and maximum consumption increased between 1925 and 1933 and then went on to decrease from 1955 onwards. This distance reveals differences in the consumption magnitudes of this

foodstuff, but also in habits of consumption. Moreover, from a territorial point of view, which cannot be studied in detail here, these differences between maximum and minimum consumption levels are very stable. As we can see in Table 2 some provinces reappear throughout these years at both extremes of the distribution. All of this could be interpreted as evidence for a process of diffusion of consumption in which an initial stage of low and homogenous average consumption levels is followed by a stage of expansion, with a growing territorial disparity, studied the process ends with one of the highest average levels of consumption and again homogenous. This represents a typical inverted U shaped trajectory, highlighted by a stage of expansion, accompanied by a growing territorial disparity culminating in one of the highest average levels of consumption and again homogenous[14].

Table 2. *Distribution of Spanish provinces according to consumption intervals (Liters per person per year)*

Intervals	*1925*	*1933*	*1955*	*1965*	*1981*
< 25	29	17	5	4	0
25 - 49	12	15	18	6	0
50 - 74	3	8	11	17	0
75 - 99	1	1	5	10	9
100 - 124	1	1	5	7	11
125 - 149	0	0	2	3	13
150 >	3	7	4	3	17
Number of provinces	49	49	50	50	50
Maximum consumption	175	309	278	202	203
(Name of province)	Guipúzcoa	Guipúzcoa	Lugo	Santander	Santander
Minimum consumption	4	5	14	15	78
(Name of province)	Cuenca	Cuenca	Cuenca	Cuenca	Alicante
Consumption Differences	171	304	264	187	125

Source. Statistics cited in Table 1.

All these data serve to illustrate some of the limitations in average estimates. In some Spanish provinces in the 1930s the mean consumption was around 5 liters per person (Table 2); quite a low value. Obviously this reflects low consumption standards but it is most probably a consequence of there

14. Williamson, J. G, 1965.

being a high proportion of population who were not consuming this food. In fact, a contemporary observer wrote: « Thousands of Spanish households don't usually have milk, with the exception of sick people »[15]. Thus, the comparison of averages of milk consumption between Spanish provinces, or within the same province but in two different periods of time, may lead to erroneous conclusions if the consumer population is not taken into account.

Other aspects of average estimates should also be considered. On this point it might be useful to distinguish between two parameters: the quantities consumed, and their frequency. In terms of the first parameter the most reasonable thing would be to think of some magnitudes that could be expressed according to the fractions of a basic and viable unit of consumption. With regard to the second parameter, it would be fair to accept that in the case of this foodstuff consumption could be regular, daily, occasional or lacking entirely. The evidence from the data suggests that these elements should be taken into account in any analysis. For example, if the mean annual consumption per inhabitant in a province in 1925 is 4 liters (the province of Cuenca in Table 2) this would imply 11 ml a day, which is an unrealistic quantity in practical terms. It seems unlikely that the consumption of a product, in a time when prolonged conservation was not possible, would have occurred using utensils other than cups or glasses, the normal size of which, due to their own design, exceeds such quantities. These modalities of consumption should be expressed in equivalences, or fractions, of a bowl of milk (250 ml); for example, a half or a quarter of its size. This way, this level of provincial consumption would only make sense if it meant expressing a non-daily consumption frequency; if, for example, it were once a month, the quantity would be closer to 250 ml. Alternatively, as reasoned in the previous argument, such a figure could indicate that the proportion of the non-consumer population was very high. It is obvious that, at the other extreme of consumption levels, the provinces with over 150 liters per person per year would involve a daily consumption close to half a liter of milk. Behind this value is likely to be an almost universal pattern of consumption in the entire provincial population.

The previous discussion and the problem to be resolved can be expressed formally:

$$\overline{X}_{\text{Observed–Consumption}} = \frac{\text{Total Consumption}}{\text{Total Population}} \times \frac{1}{f_c} = \frac{\text{Total Consumption}}{\text{Consumer Population}} = \overline{X}_{\text{Effective–Consumption}} \quad (1)$$

15. Carrasco, E., 1934.

The problem is set out in order to adjust specific average levels of observed consumption, computed from published statistics ($\overline{X}_{Observed-Consumption}$), which could even be rather improbable, to other more realistic ones; the effective consumption levels ($\overline{X}_{Effective-Consumption}$). In short, this would mean transforming the likely difference between these two means into an equality as a consequence of the introduction of a correction factor (fc) into the average consumption level obtained from the statistics, where such a factor would be equivalent to the proportion of the consumer population[16]. Logically, if the total population is also the consumer population, this factor would be equivalent to the unit. This relationship between consumption levels and proportion of the existing consumer population for the total Spanish population would be applied in the same way to each « j » province, because at this scale the disparity would also be met and the « correction » or adjustment of this could be obtained by estimating the proportion of the consumer population for each of the provinces.

This equation also illustrates the main difficulty to be dealt with the presence of two unknowns. If an estimate of the effective consumption were available from equation (1), calculating the consumer population would be straightforward[17]. The adjustment of observed consumption to effective consumption seems to be an arbitrary solution if it is taken without reference to a particular foodstuff. It requires some assumptions, and data on patterns of distribution and diffusion of consumption in the population. In this case the evolution of milk consumption in Spain from 1925 to 1981 will be used to illustrate this approach and methodology.

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16. $f_c = \frac{\text{Consumer population}}{\text{Total population}}$ because when it is replaced in (1) it guarantees correspondence between both sides of the equation, that is between statistical and effective mean consumption.

17. From expression (1) if the total output consumed and the effective consumption per capita are known, the estimate of consumer population would be :

$$\text{Consumer Population} = \frac{\text{Total Consumption.}}{\overline{X}_{Effective-Cons.}}$$

2. Methodology for adjusting the consumption levels and the estimate of the number of consumers. Basic principles and approach.

In the first place, it seems necessary to have a statistical model for the distribution of consumption that would permit us to infer what proportion of the population would consume particular quantities. On this point, the use of log-normal distribution would be the most appropriate because it has been used for modelling various economic activities, including the consumption of different types of products or services[18]. The distribution of the consumer population of this foodstuff could thus be estimated using the following density function applied to the Spanish provincial statistics data:

$$f(x_j) = \frac{1}{x_j \sigma \sqrt{2\pi}} \exp\left[-\frac{1}{2\sigma^2} \left(\ln x_j - m \right)^2 \right] \quad (2)$$

Where $f(x_j)$ corresponds to the total population consuming a given quantity of milk on a daily basis in province « j », x_j corresponds to the average of consumption of each « j » province and the two parameters « m » and « σ » make reference to the averages and standard deviation of the distribution obtained from all the provincial values. The $f(x_j)$ values describe a theoretical distribution of consumers for the total Spanish population according to the mean and variance provincial values. One of the characteristics shape of this distribution is its asymmetric nature, deviated towards the left: as a consequence the mean, mode and median do not present identical values[19]. This property would be of greater interest if a study of the temporal evaluation of consumption habits were to be considered, because its leaves open to consideration the fact that the variations in mean or mode do not have to be of the same magnitude and therefore follow similar trajectories.

It would of course be better to verify that the statistical model adopted for reconstructing the distribution of the consumption of this foodstuff were the most appropriate option. Due to the lack of individual data

18. A revision of various applications in economic studies in R. Lawrence, 1988. In the specific case of historic populations, the study made by R. Fogel, 1992, assumes this same distribution in the analysis of the nutritional state of the population. A critical evaluation of this hypothesis can be found in T. D. Logan, 2006.

19. In log-normal distribution the median is included between the mode and the mean, closer to the first than to the second. In short, the median is twice as close to the mean than to the mode.

the only confirmation can be provided by the provincial values. Table 3 displays the results of the two statistics that test the hypothesis where the distribution of the logarithms of the aforementioned provincial consumption averages adjusts itself to the normal distribution[20]. In any event, as the significance levels show, the null hypothesis cannot be rejected[21]. It thus seems reasonable to suppose that the consumption of milk follows this model of distribution.

Table 3. *Distribution of average provincial consumption of milk, in Spain (1925-1981). Normality Tests*

Year	*Statistics Kolmogorov-Smirnov-Lilliefors*		*Statistics Shapiro Wilk*	
	D (n)	*Sig. Level*	*W*	*Sig. Level*
1925	0.086	0.200	0.967	0.181
1933	0.091	0.200	0.972	0.295
1955	0.085	0.200	0.983	0.687
1965	0.100	0.200	0.968	0.198
1981	0.112	0.169	0.965	0.156

Source. Statistics cited in Table 1.

Moreover, knowledge about patterns of consumption cannot be approached without being considered, as it has been advised, as a process of diffusion. From a theoretical perspective, the most basic representation of a process of diffusion is that in which the people adopting it follow a normal distribution pattern where the different categories of these people are located[22]. Therefore, 2.5 per cent of the innovators and 13.5 per cent of the early adopters out of the population would have become integrated at an early stage. In this phase the rest of the population would either have practiced sporadic consumption or they would not have consumed milk at all. In the following stage 34 per cent of the denominated early majority

20. Remember that a random variable follows the log-normal distribution if its logarithm follows the normal distribution. Formally, therefore, the null hypothesis to test is $H_0 : \log x_j \approx N(\mu_{(\log x_j)}, \sigma^2_{(\log x_j)})$, where x_j corresponds to the mean consumption of milk for each province.

21. D(n) in the Kolmogorov-Smirnov-Lilliefor and W in the Shapiro-Wilk tests measure the discrepancy between the observed and expected cumulative frequencies (most commonly, the normal distribution) under the null hypothesis that the population is normally distributed. If the p-value is less than the chosen alpha level (Sig. Level) usually 0.05 or 0.01 the null hypothesis can be rejected.

22. Rogers, E. M., 2003, p. 279-283.

and 34 per cent of the late majority of adopters would have joined. Consumption as well as its frequency would have become generalized, and the distance between those sectors consuming more and those consuming less would have increased. In the final stage, 16 per cent of late adopters would have joined, at which point the generalization of consumption would have been accompanied by higher average levels and a greater uniformity in consumption habits.

The adoption of milk as a foodstuff for daily use in Spain, according to the quantitative and qualitative information available, should be understood as a process with these characteristics. This is a foodstuff that for reasons of technology, health and food culture at the end of the nineteenth and beginning of the twentieth century was an object of restricted consumption, often related to therapeutic purposes; it went on gradually to form part of the diet of particular social groups and sections of the population, for example, children and young people[23]. But milk was also used in the preparation of certain dishes (such as desserts and pastry) in pastoral regions with high levels of milk production, mainly in the North of Spain[24].

It is beyond the scope of this article to introduce a detailed account of this process of diffusion. Unfortunately, sources of data are scarce. For example, medical surveys[25] conducted by doctors in many Spanish localities in the nineteenth and first half of the twentieth centuries give more qualitative than quantitative information about nutritional habits and conditions of the inhabitants[26]. More quantitative sources are available in hospitals, but this kind of data has not always been published[27], or can be found only in some special surveys. Two documents can be mentioned here. One is the report written by The Commission on the Reform of Consumption Tax in

23. Nicolau-Nos, R., Pujol-Andreu, J. & Hernández, I., 2010.

24. An overview of the regional patterns of Spanish food consumption in the first third of the twentieth century can be found *in* J. Dantin Cereceda, 1934. A number of regional Spanish recipe books of the same period also include dishes made with fresh milk. See for example, F. Agulló, 1933.

25. These surveys, known as medical topographies or medical geographies and submitted to the Royal Academy of Medicine, were not always published.

26. For example, of 45 surveys conducted in Catalonia from 1798 to 1907, only 7 gave quantitative information on milk consumption. Nicolau, R., Pujol-Andreu, J., & Hernández, I., 2010.

27. References to different amounts of milk consumed in Spanish health centers and hospitals prior to 1936 can be found in R. Nicolau, J. Pujol-Andreu & I. Hernández, 2007. In the case of data on milk consumption in hospitals, around 200 liters per stay, per year, would be compatible with daily averages situated at the maximum levels of 350 ml adopted here.

1908[28] (Table 4) and the other is a piece of research on the nutritional status of the population living in rural areas of the province of Jaen (in the region of Andalusia) in the first years of the 1930s, carried out by the physician F. Jiménez and the pharmacist M. Jiménez[29].

The report from the 1908 Commission surveyed only 79 families (434 individuals) and this document clearly cannot be considered as representative of the entire Spanish population of the time; however it does offer two types of results that are of interest for our topic. On the one hand, an average level of consumption *per annual capita* of 42 liters would not be too far above the averages known for the beginning of the twentieth century, estimated at around 35 or 45 liters (Table 1)[30]. On the other hand, this permits an estimate of the social differences in consumption, depending on the various levels of income of the *breadwinners* and, as a result, it illustrates the different modalities of consumption. An aspect of particular interest is the use disparity between the annual (and daily) milk consumption averages for social groups of higher and lower income. In the case of the first group this would mean taking around the equivalent of a quarter of a liter a day, while for the rest of the groups these daily quantities would be so meager that they could be interpreted as evidence of irregular or occasional consumption. Additional information in the report shows that the high income group was composed of entrepreneurs, landowners and stockholders, whereas civil servants, service workers, liberal professions and other middle class occupations were surveyed as a middle income group.

The research on the nutritional status of the population of the rural area of the province of Jaen carried out in the first years of the 1930s surveyed 3,592 persons older than 8 years. Data were collected from 70 out of 98 villages of the province. Detailed information on daily consumption of every foodstuff was even collected at household level but unfortunately the estimates were not published. However, the abstract with the main results show the proportion of daily consumers of certain foods such as meat, eggs and milk. Around 97 per cent of the families from the high social class were consuming milk daily whereas this proportion was 63 per cent for the middle class families and 9 per cent for the working class. According to the aforementioned around 1908 consumption data and those available for the

28. *Documentos y trabajos de la comisión consultiva para la transformación del impuesto de consumos*, vol. IV, 198 (Documents and Works by the Consultative Commission for the Transformation of the Consumptions Tax).

29. JIMÉNEZ, F. & JIMÉNEZ, M., 1934.

30. Cussó estimates a consumption of 36 liters per person per year in 1865 (CUSSÓ, X., 2001, p. 322; HERNÁNDEZ, I., 2005, p. 156, of 44 liters per person per year in 1917.

rest of the first third of the twentieth century, there would exist social groups with daily consumption of that foodstuff.

Table 4. *Distribution of milk consumption according to the breadwinner's income level circa 1908*

Income level	Individuals	(%)	Milk consumption	
			per capita/year (liters/kg)	per capita/day (ml/gr)
Low	183	43.26	10	28
Intermediate	134	31.68	43	119
High	106	25.06	97	266
Total	423		42	116

Notes. Mean Income level per family (pesetas 1908): Low: 1,838; Intermediate: 6004; High: 25,781.

Source. « *Documentos y trabajos de la comisión consultiva para la transformación del impuesto de consumos* » (Documents and studies from the consultative commission for the transformation of consumption tax), tome IV, Madrid, 1910, p. 198.

The idea that, within the entire Spanish population, these groups of new consumers could have represented about 16 per cent of the population – the proportion of adopters in the basic diffusion model – seems plausible in the mid 1920s in the light of the 1920 census data[31]. With some 21,338,381 inhabitants, this would mean accepting that close to three and a half million people would be daily consumers. An indirect clue for calibrating this is the classification of the population by profession. Despite the corresponding problems of interpretation, the total amount of registered *employers* in agriculture, industry and trade, plus those linked to the administration, liberal professions and rentiers amounts to almost two million individuals (1,921,917 persons). These groups have a social profile close to that of the high income group surveyed in the Commission report of 1908. Around 70 per cent were enumerated as married. If each one is the breadwinner of a household, when they are multiplied by the number of members, for example 3 or 3.5, the percentage of potential daily consumers fluctuates between 18 and 22 per cent.

The first Household Budget Survey for the period 1964-1965 collected the most complete evidence for consumption patterns of the Spanish population in the twentieth century. Here it is collated detailed information about the quantities of milk consumed in various groups from within the popula-

31. Ministerio de Trabajo Comercio e Industria, 1922, vol 4, p. 421-424.

tion[32]. The data tabulated per socioeconomic category of the main breadwinner of the household allows for estimations (considering *averages* only; see Table 5) a rang between 120 ml for farm workers and 365 ml for white collar workers; this is between the equivalent of half a cup, and a cup and a half of milk a day. These values could be considered as evidence of quite a complete process of diffusion of this foodstuff because 8 out of 11 social groups were having 250 ml or more per person per day. Only one group still remained at the low consumption levels of 120 ml per day, the result of either irregular consumption or a remarkable proportion of non-consumers.

Table 5. *Household Budget Surveys in Spain, 1964-1965. Levels of milk consumption per socioeconomic category of the main breadwinner*

	Average	*Consumption per person per household*	
Socioeconomic category	*Household Size*	*Liters Annual*	*Milliliters (gr) Daily*
Farmers (Landowners)	4.18	81.49	223
Farm Workers	4.30	43.70	120
Entrepreneus and the self-employed	4.30	90.29	247
Liberal professions	4.36	121.29	332
Managers and company directors	3.97	115.93	318
White collar workers	3.38	133.27	365
Industrial Workers	4.25	74.65	205
Sector Service Workers	3.70	73.27	201
Military personnel	4.42	98.67	270
Not classified	3.55	91.23	250
Non usually economically active persons	2.22	90.27	247

Source. Household Buget Survey 1964-1965; INE, 1969.

Despite the scarcity of data available from the beginning of the twentieth century by comparison with the first Household Budget Survey from 1964-1965, the best evidence available is that the diffusion of milk consumption in the Spanish population was based, on the one hand, on the existence of consolidated groups of regular consumers and, on the other hand, on the increase in the quantities consumed and the number of con-

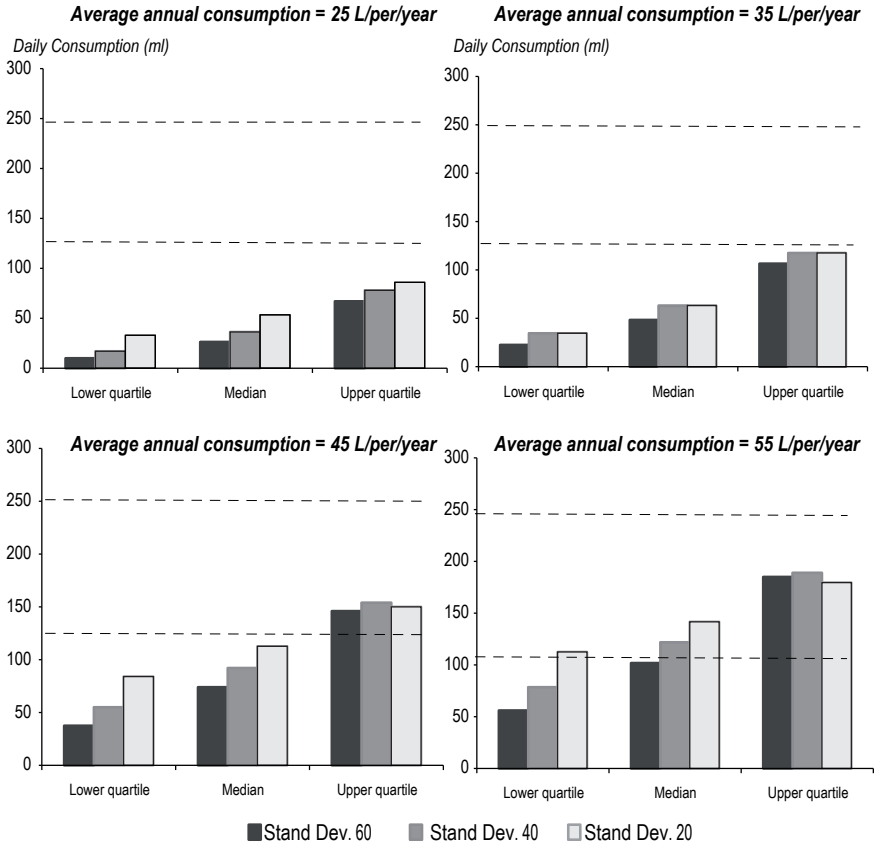
32. These statistics do not include consumption of other related foods such as cheese, butter, etc., but they do take into account own consumption in all socioeconomic categories.

sumers. It is important to note that initial high consumption standards seem to converge to similar levels of between 100 and 130 liters per person per year. In this case, these values fit with the historical statistics of high consuming countries or, even for the most recent periods, with the information collected from surveys on consumption. Here all the data available seem to suggest that with consumption above 350 ml per day per person (130 liters per person per year), over 90 per cent of the population should have been consuming (always in terms of mean values)[33]. At the other extreme, data on minimum consumption do not converge to similar levels. This result could be expected because, as has been previously observed, these means compute not only irregular – non-daily – consumption but also total lack of consumption. This last observation suggests that the search for a *reasonable* level of minimum consumption, under a general pattern of diffusion would be more the result of a simulation than of data collection. A simulation based on modelling consumption patterns through a log-normal distribution could therefore be put forward. The results should justify the final choice of a minimum average level of consumption related to a *critical mass* of daily consumers.

Figure 1 presents the different levels of daily consumption that correspond to the first, second (median) and third quartiles of consumption distributions. These have been calculated using some levels that would situate the average consumption per person per year within 25, 35, 45, and 55 liters, and magnitudes of standard deviation of 20, 40 and 60 liters, which cover a large part of the provincial variations in the observable consumption patterns of the twentieth century (see Table 1). Table 6a and Table 6b show estimates of the proportions of consumer populations having more than or equal to 250 ml and 125 ml a day according to the same values of average consumption and standard deviation as Figure 1.

33. Data from FAO statistics published in 1953, cited in C. AGENJO, 1957, p. 315 indicate that in the five-year period of 1930-1934 those countries with consumption levels over 130 liters/inhabitant/year were Austria, Denmark, Ireland, Holland and the United States and those with consumption levels close to 200 litres were Sweden, Switzerland, New Zealand, Norway and Canada. In fact, this would be a high estimate, if the most recent data were taken into account (the data corresponding to the year 2007) which would situate the average consumption per person per year in Spain at around 88 kg, calculating that 96 per cent of the population consume milk on a daily basis (see the report from FENIL, 2008).

Figure 1. *Proportion of the consumer population in quartiles according to average dispersion levels of consumption of milk per person per year*



Source. Own elaboration.

At the lowest levels of consumption, 25 and 35 liters per person per year (Figure 1), distributions would not have reached average daily quantities which can be expressed as fractions of 250 ml, the equivalent of one cup a day (marking the limits with some discontinuity between 125 and 250 ml). These distributions suggest, at the very best sporadic consumption. According to the levels that correspond to the higher quartiles, we could talk about a weekly amount of something over three quarters of a liter, which would not actually add up to more than three cups. Under these conditions there would be no regular or stable consumer population. Table 6a and Table 6b confirm these appreciations. Estimates of the proportion of consumers with

25 liters on average show how, at that low level of consumption, a critical mass of daily consumers might hardly exist: fewer than 4 per cent (see mean values) would be consuming 250 ml or more a day and 13 per cent 125 ml or more a day. With 35 liters, patterns of consumption are improving but people consuming more than 125 ml a day still represent a mean lower than 25 per cent. The coexistence between occasional and other consumption patterns might be better reflected between 45 and 55 liters of average consumption per person per year. In both cases, the higher quartiles would have included the consumer populations of 125 ml and above.

Tables 6 show how, with 45 liters and 55 liters per person per year, between one third and half of the consumer population would have 125 ml or more a day and between 10 and 16% 250 ml or more. These values are close to the theoretical percentage of innovators and early adopters mentioned before. This group of results illustrates how the gradual increase in consumption levels per person per year would have led to distributions in which the upper quartiles, given the daily levels that they would have reached, would have facilitated daily habits of milk consumption.

The confirmation of this trend can now be verified by the distributions associated with levels of consumption higher than those used: for example, from 65 to 75 liters per person per year (Figure 2). In both cases, at least 50 per cent of the population could have been drinking 125 ml or more of milk a day, as is confirmed by the estimates in Tables 6. In the case of 75 liters this number of consumers almost achieves 80%.

Table 6a. *Proportion of consumers of 250 ml or more a day according to average and dispersion levels of consumption of milk per person per year*

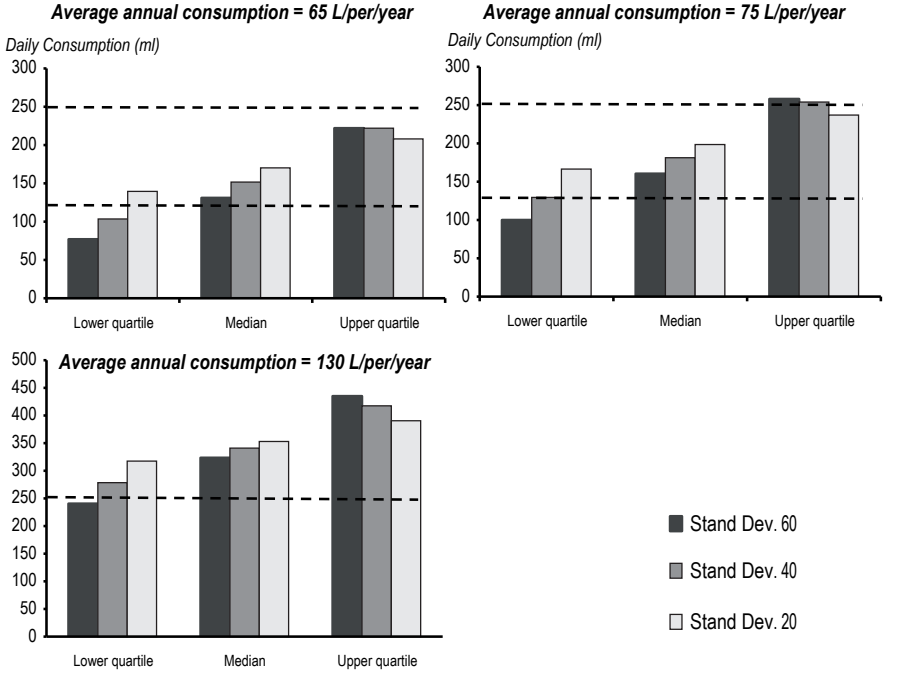
Consumers of 250 ml	*Standard Deviation*			*Mean*
Average levels	*60*	*40*	*20*	
25	5	4	1	3.7
35	8	7	2	5.5
45	11	10	3	8.0
55	16	13	5	11.5
65	21	19	10	16.6
75	26	26	19	23.9
130	72	85	99	85.3

Table 6b. *Proportion of consumers of 125 ml or more a day according to average and dispersion levels of consumption of milk per person per year*

Consumers of 125 ml	*Standard Deviation*			*Mean*
Average levels	*60*	*40*	*20*	
25	13	14	11	12.7
35	21	29	22	24.0
45	30	35	40	35.1
55	41	49	64	51.2
65	52	64	85	67.0
75	64	77	96	79.2
130	99	100	100	99.5

Source. Own elaboration.

Figure 2. *Proportion of the consumer population in quartiles according to average and dispersion levels of consumption of milk per person per year*



Source. Own elaboration.

In terms of maximum levels of consumption, a guarantee of the generalized diffusion of consumption, the simulation has been run with mean values of 130 liters per person per year (approximately the average consumption of the Spanish population in 1981). The results displayed in Figure 2 show how, under the same magnitudes of standard deviation as in previous cases, practically the entire population would have consumed a quarter of a liter of milk per day of this product. The estimates in Table 6a and Table 6b illustrate this observation with values close to 90 per cent.

The results of this simulation exercise suggest that, assuming the existence of a small group of early and innovator consumers in the Spanish population, the scale of minimum to maximum consumption might span 45 to 130 liters per person per year. 45 liters has been chosen as the minimum value because, according to the previous results and the scarce historical information available, it represents a sort of threshold between a first stage of reduced number of daily consumers and a second one of a greater proportion which seems to fit better the likely consumption patterns of milk in Spain during the first decades of the twentieth century.

In view of all the results and observations put forward so far, the methodological strategy to be followed would be the one represented in Figure 3. This methodological strategy is based on either displacing the initial levels of consumption upwards or applying a direct correction to the observed data. More specifically, the basic characteristics of this methodology are the following.

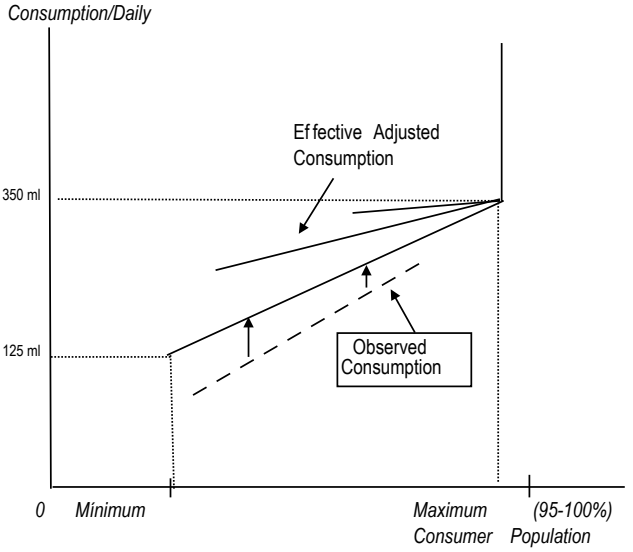
a) The scale of consumption variation is delimited within that of the proportion of the associated consumer population, between a minimum of 125 ml and a maximum of 350 ml a day or their equivalents in terms of average levels of 45 or 130 liters per person per year (Appendix 1). Adopting this minimum value means accepting, first, that consumption of this foodstuff was in *discrete* units equivalent to a cup (250 ml) or half a cup (125 ml); second, there was a group of stable, daily, consumers of this foodstuff in all the Spanish territory and so in each of its provinces. In terms of the maximum value, it is understood that there would not be as much of an increase in the number of consumers as in the quantities consumed when the consumer population was close to 100 per cent.

b) The populations do not reach universal consumption of this foodstuff. For reasons of consumer preference, taste, or digestive diseases a per-

centage of the population would have been impeded from drinking milk on a regular basis (here this would be equal or less than 5 per cent)[34].

c) As a consequence of the same process of diffusion, the relationship between average levels of consumption and proportion of the consumer population varies over time. Therefore, as shown in Figure 3, with the increase in average levels of consumption of the total number of inhabitants not only would the distance between the minimum and maximum levels decrease, but its slope would change, tending towards a more horizontal position as an effect of the growing homogeneity of consumption habits.

Figure 3. *Relationship between daily consumption and the percentage of the consumer population*



34. Data on the population that does not consume certain foodstuffs, in the specific case of milk consumption, is not always collected in dietary surveys. In the Spanish case, of the entire population only the estimate provided by a survey from the *Foro Interalimentario* (Interfood forum) of 2006 (see FENIL, 2008) was found, which places the amount of people who never consume milk at 2 per cent of the Spanish population. On the other hand, the biological-anthropological studies on Spanish adult populations detect some rather low percentages compared to Nordic populations made up of lactose positive individuals – individuals who persist in continuing intestinal lactase activity initiated in infancy – of around 45 per cent compared to 95 per cent in the Scandinavian countries (PEÑA, J. *et al*. 2002). Other estimates for Spain situate this amount at 70 per cent (MACE, R., JORDAN, F. & HOLDEN, C., 2003).

3. Applying the methodology. Reconstruction of consumer population of milk in Spain (1925-1981)

This approach allows for a transformation of the observed data into the effective levels of consumption to be made for each province and from here a process follows that ends in the final estimate of the magnitude of consumer populations, at provincial as well as a national scale. The stages required by the entire procedure will be illustrated step by step with the reconstruction of the consumer population in 1925 (Tables Appendix 2a, 2b and 2c); other tables will present summary statistics and indicators for all years.

Stage 1. The observed consumption average is identified with one that falls within the scale previously mentioned, between 125 and 350 ml (see Appendix 1 with the table of equivalences)[35]. For example: as shown in Appendix 2.a, provinces with under 5 liters per person per year in column (2) were replaced by 45 liters in column (3), which is the minimum consumption adopted according to the discussion on simulations in the previous section. At the opposite extreme of the consumption scale, those provinces with computed milk consumption in excess of 130 liters per person per year remain practically unchanged; they see only a slight increase in order to introduce the assumption that there is no universal consumption (100 per cent of the provincial population consuming this product).

Of course, the average level of consumption and its standard deviation from the basic data are altered to new statistics in the new scale. Table 7 presents the differences between the averages and the standard deviation of the provincial consumption levels observed from published statistics and those proposed in the table of equivalences; these values in the year 1925 can also be observed at the end of columns (1) and (2) in Appendix 2.a. As expected, these differences between observed and adjusted values decrease as the general levels of consumption rise.

35. The averages of consumption for each province are set in the new scale through the use of linear interpolation.

Table 7. *Average milk consumption and standard deviation in Spanish provinces (1925-1981) (Observed and adjusted values at provincial level, liters/person/year)*

Year	*Statistical Data*		*Adjusted data according to consumption scale*	
	Average consumption	Standard deviation	Average consumption	Standard deviation
1925	34.05	38.80	66.41	30.24
1933	60.99	70.80	88.08	61.64
1955	69.87	57.72	79.73	21.03
1965	78.49	40.25	93.04	33.45
1981	138.30	42.25	137.5	29.85

Source. Statistics cited in Table 1.

Stage 2. Based on the new statistics, the distribution of the consumer population can be generated through the log-normal distribution (according to the formulation (2))[36]. This theoretical consumer population is presented using a cumulative function in column (6), Appendix 2b. The results of this operation for each province in the year 1925 are shown in ascending order in both columns in this table. The pattern of variation in the corrected consumption levels by comparison with the increasing proportion of consumer population allows for the estimation of the functional relationship between these two variables. Figure 4 shows the adjusted function, which is exponential and not linear, as it was assumed in applying the initial scale in Appendix 1. The results for the remaining years are displayed in Table 8. They make evident how, in the first place, basic levels of consumption have been increasing over the decades, as the progressive increase in the constant value of the equation reveals. At the same time, new consumers are being encompassed, as indicated by the decreasing tendency of the exponent which, therefore, causes the relationship between levels and proportions of consumers to approach a horizontal line.

36. Mean (m) and variance (σ^2) of the distribution have been calculated from the empirical – provincial data – mean ($\bar{x}$)and variance (V) according to the following expressions:

$$m = \ln\left(\frac{\overline{x^2}}{\sqrt{\overline{x^2} + V}}\right) \quad \sigma^2 = \ln\left(1 + \frac{V}{\overline{x^2}}\right)$$

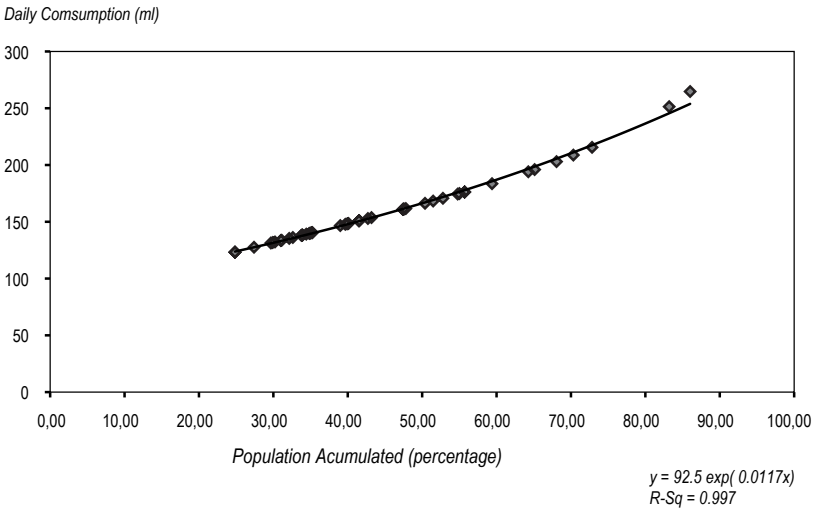
Table 8. *Daily consumption and proportion of the consumer population (Adjusted using log-normal distribution)*

Year	*Adjusted equation*	*R-Squared*
1925	y(j)= 92.5 exp (0.0117x(j))	0.997
1933	y(j)= 87.6 exp (0.0166x(j))	0.999
1955	y(j)= 119.1 exp (0.0131x(j))	0,999
1965	y(j)= 146.7 exp (0.0098x(j))	0,994
1981	y(j)= 267.1 exp (0.0064x(j))	0.991

Notes. y(j) = Corrected medians for provincial consumption
x(j) = Proportion of consumer population according to lognormal distribution.

Source. Own elaboration.

Figure 4. *Relantionship between daily consumption and acumulated Spanish consumer population in 1925*



Stage 3. The parameters of the functions adjusted in Table 8 will be a starting point for the aforementioned readjustment of the initial scale. Given that the basic data are provincial averages and that the proportion of the consumer population is unknown, such parameters can only be applied to

the total of provincial populations, to be organized hierarchically (from the smallest to the largest) for each year studied according to the following formula:

$$\overline{X}_{\text{real-C(j,k)}} = \beta \text{Exp}^{\left(\beta \sum_{k}^{n}\left(\frac{\text{Pop(j,k)}}{\text{Total Population}}\right)\right)} \quad (3)$$

Where « α » and « β » correspond to the two parameters estimated in Table 8 and the component of the exponent represent the percentage of accumulated population from each province « j » according to an established hierarchical order of consumption « k ». In Appendix 2c column (9) this procedure applies to the 1925 data. In this case, expression (3) applied to column (8) gives a result of 101 ml, as for example in the case of the province of Almeria (37 liters per person per year)[37]. The result obtained is the final adjusted provincial consumption average per person per day (column 9) and per year (column 10).

Stage 4. Once these final corrected levels of consumption have been established, the rest of the procedure is immediate. Therefore, in the first place, the consumer population can be calculated for each province according to the expression:

$$\text{Consumer Pop.}^{\text{est}}_{j} = \frac{\text{TC}_{j}^{\text{obs}}}{\overline{X}_{\text{Effective–Cons(j)}}} \quad (4)$$

Where the numerator corresponds to the Total Consumption (TC) of the province « j » according to the published statistics and the denominator to the effective or adjusted average level of consumption of the same province, as obtained in (3). So, finally, it will be possible to obtain the final percentage of the total consumer population from the sum of the estimated consumers in each province, according to expression (4), divided by the total of the Spanish population, for each of the years under study. In the case of Spanish consumption for the year 1925, this procedure is applied in columns (12) and (13) in Appendix 2c. The final estimate of consumer population was 43 per cent of the total Spanish population and the adjusted level of consumption per person per year was 84.53 liters.

37. This estimate is $101 = 0.0925e^{(0.0117 \times 7.84)}$ where 0.0925 and 0.0117 are the parameters of the adjusted equation in Table 8 and 7.84 the percentage of accumulated population of Spanish provinces in Appendix 2c.

The final results of this procedure are presented in Table 11. Finally, the log-normal distribution permits calculation of the milk distribution percentage for the consumer population during the various intervals of consumption for each year, presented in Table 12 and Figure 5. Before the analysis of the results it could be useful to evaluate, through a sensitivity analysis, some of the basic assumptions made in this reconstruction procedure.

As it has been stated, a central step in this approach is the adjustment of the statistical means with the scale presented in Appendix 1. In spite of the final adjustment in the third stage of the procedure it is quite obvious that this initial scale might have strongly conditioned the results. Tables 9 and 10 display the results of a sensitivity analysis for the years 1925 to 1965, before the proportion of consumer populations achieved 95 per cent. This analysis evaluates the effects caused by a change in the initial scale, particularly in minimum levels of consumption, on the final estimates of consumers and their consumption statistics (mode, median and mean). Two different assumptions about the range of variation in the scale of adjustment have been adopted: (A) Between 35 and 130 liters per person per year and (B) Between 55 and 130 liters per person per year. These values 35 and 55 are 10 liters above and below the 45 liter minimum consumption level in Appendix 1.

Table 9. *Sensitivity analysis in the estimates of consumer populations, in 1925, 1933, 1955 and 1965*

Item	*1925*	*1933*	*1955*	*1965*
Consumer population (%) (Table 11)	43	56	59	78
Change in minimum consumption Consumer population (%):				
(A) 55 liters	39	51	55	72
(B) 35 liters	49	59	63	80
Differences Estimates-(A)	4	5	4	6
(%)	9.04	7.07	6.78	7.69
Differences Estimates-(B)	-6	-3	-4	-2
(%)	-14.64	-7.98	-6.78	-2.05

Source. Own elaboration.

As it might be expected, if minimum consumption had been higher (55 liters), the proportion of consumers would have been overestimated (Table 9). For example in the year 1933 it would have been 51 rather than 55 per cent. If minimum consumption had been lower (35 liters), these ef-

fects would have run in the opposite direction. However, the differences between estimates shown in Table 9 suggest that changes in the initial scale of adjustment do not involve strong variations in the estimates of population proportions. Most differences are of less than 5 per cent and, in general, intervals do not alter appreciations about consumption patterns for each year. For example, an interval of consumers estimated for 1925 would be between 39 and 49 per cent, always showing that less than half of the Spanish population consumed milk. At the end of this period, 1965, a range of variation in consumer population between 72 and 80 per cent does not modify any basic conclusion about the fact that three quarters of the population were drinking milk daily.

Table 10. *Sensitivity analysis in the estimates of statistics of consumption, in 1925, 1933, 1955 and 1965 (daily consumption per person ml/gr)*

Item		*1925*	*1933*	*1955*	*1965*
	Mode	131	135	212	226
	Median	163	203	258	248
	Mean	182	249	284	259
Change in minimum consumption:					
(A) 55 liters	Mode	161	157	231	241
	Median	188	223	275	257
	Mean	204	266	300	266
(B) 35 liters	Mode	99	115	190	222
	Median	136	184	240	242
	Mean	159	234	271	253
Diff Mode-Mode(A) (%)		-22.48	-16.70	-8.89	-6.53
Diff Mode-Median(A) (%)		-15.13	-9.99	-6.56	-3.90
Diff Mode-Mean(A) (%)		-11.69	-6.78	-5.41	-2.60
Diff Mode-Mode(B) (%)		24.46	14.96	10.77	1.96
Diff Mode-Median(B) (%)		16.85	9.14	6.81	2.38
Diff Mode-Mean(B) (%)		12.76	6.08	4.76	2.59

Source. Own elaboration.

As far as the estimates of basic consumption statistics are concerned, Table 10 shows how they change – according to the levels of minimum consumption – in the expected way. The magnitude of the statistics is greater with 55 liters rather than 35 liters. In any case, these sets of estimates seem

to converge during the years when consumption was increasing. Differences between those minimum levels and the initial scale (45 liters) are greater at the lower consumption levels than at the higher ones, for example if 1925 and 1933 are compared with 1955 and 1965. Between the three statistics, the range of variation in the estimates of the mean consumption is lower than the other two. In absolute values, the error would be of around 15% in the worst estimate. Mode reflects the statistics with a less accurate estimate, especially in 1925 when the results varied between 99 to 161 ml per person per day. Table 10 shows that the most difficult consumption patterns to reconstruct are the lower ones, but it is important to note that in any case, the obtained rank of variations does not change the conclusions about the probable scale of consumption. For example, in 1925, all estimates were far from the daily cup of milk.

Two general conclusions can be drawn from these results. First, data correction for low levels of consumption seems more difficult and is subject to greater uncertainty. Second, this range of variation of approximately +10/-10 liters around the minimum scale of 45 liters per person per year does not seem to modify significantly the initial conclusions.

Unfortunately the lack of estimates for proportions of consumers requires indirect testing of the validity of results. The basic criteria will be to place these results in connection with other published data on consumption of milk in the Spanish population.

From a more historical perspective it is worthy to remember that animal milk – cow or goat – does not seem to have been particularly important in the traditional Spanish Mediterranean diet. But, as it has been mentioned previously, this foodstuff was incorporated into the diet of the Spanish population, particularly during the first third of the twentieth century[38]. The results obtained from this study affirm that this was a relatively slow and uneven process of diffusion, in terms of its evolution in the average consumption levels and the number of consumers. These results fit well with general appreciations about the difficulties faced by Spanish agriculture in the first half of the twentieth century in reallocating resources to livestock production and in specializing its production to develop a national milk market[39]. From an international perspective these new results do not change the fact that in terms of real consumption Spain, like other Mediterranean

38. Nicolau-Nos, R., Pujol-Andreu, J. & Hernández, I., 2010.

39. Simpson, J., 1995, p. 257-262; Domínguez Martín, R., 2003.

countries, remains at a low level by comparison with western and northern European nations[40].

Prior to the Spanish Civil War, in the mid 1930s, almost 45 per cent of the population did not consume milk (Table 11). Observations on both the lack of consumption and the lack of certain nutrients the milk offers, such as calcium, carried out using modern food science techniques since the 1930s,[41] demonstrate this fact. In any case, the quantities obtained confirm the opinion held by contemporary researchers in connection with the fact that a substantial part of the Spanish population would not have consumed this foodstuff at the beginning of the 1930s[42]. From a broader perspective, these estimates around 1925 give empirical support to general assumptions about the distribution of the calories in the Spanish population around 1900. According to these, about 50 per cent of the population obtained less than the minimum requirement.[43] According to the distribution frequency of consumers in 1925, practically three quarters of the consumer population would have consumed less than 225 ml per day (the equivalent to approximately one cup a day), with 27 per cent consuming less than half this amount (Table 12).

Table 11. *Reconstruction of basic statistics indicators of milk consumption of the population, in Spain (1925-1981)*

	1925	*1933*	*1955*	*1965*	*1981*
Consumer population (%)	43	56	59	78	95
Non-Consumer population (%)	57	44	41	22	5
Average consumption liters/ pers/year (Observed mean)	36.46	63.32	65.89	79.14	128.39
Average consumption liters/ pers/year (Corrected mean) Population level	84.53	115.22	111.9	101.32	135.99

Source. Statistics cited in Table 1 and own elaboration.

40. From data collected by FAO and published by C. AGENJO, 1956, p. 315. Liters of milk consumption in the periods 1934-1938 and 1950-1951 for Germany were 127 and 119 respectively; for Denmark 167 and 170; for Sweden 250 and 237; and for Switzerland 241 and 238. For the same periods, however, these values were 86 and 91 in France and 36 and 48 in Italy.

41. See J. BERNABEU-MESTRE, J. X. ESPLUGUES-PELLICER, & E. GALIANA-SÁNCHEZ, 2007. Another element that could be highlighted is the contrast between the estimates for nutritional requirements of calcium for the Spanish population between 1930 and 1960, around 850 Mg, and its availability within the diet, between 418 and 518 Mg according to the year (CUSSÓ, X., 2005).

42. CARRASCO, E., 1934.

43. SIMPSON, J,, 1995, p. 371-379.

Table 12. *Distribution of Daily Milk Consumption Spanish Population (1925-1981), (Percentage of Consumers)*

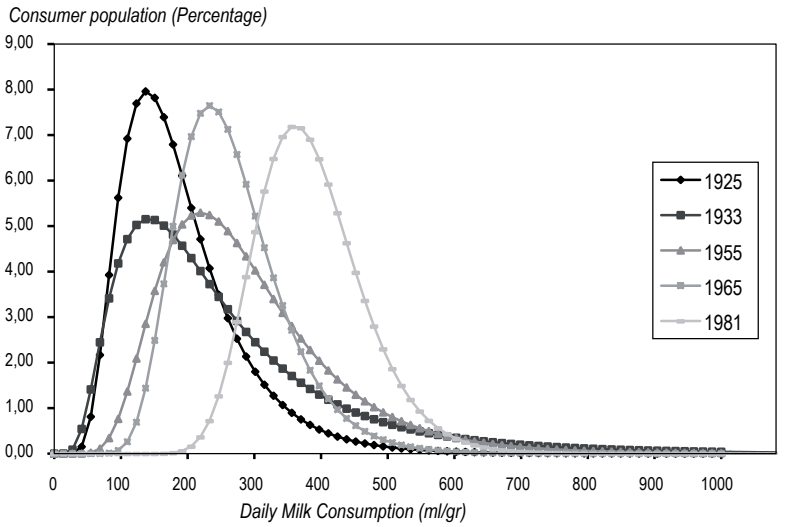
Milk	*1925*	*1933*	*1955*	*1965*	*1981*
< 125 ml	28.28	22.62	5.00	1.16	
125-174 ml	27.50	18.92	13.92	11.29	
175-225 ml	19.49	15.92	18.90	25.04	0.86(a)
225-274 ml	11.43	12.00	17.96	26.07	6.89
275-324 ml	6.33	8.65	14.23	18.06	18.91
325-374 ml	3.29	6.14	10.21	9.93	25.78
375-424 ml	1.74	4.34	6.93	4.78	22.09
425-474ml	0.92	3.07	4.56	2.13	13.80
>=475 ml	1.12	7.83	8.18	1.54	11.67
(a) < 225 ml 50% Cons	55.78	50.00	52.49	51.11	48.70
	< 175 ml	< 200 ml	150-299 ml	175-274 ml	300-399 ml

Source. Statistics cited in Table 1 and own elaboration.

Between 1925 and 1933 a considerable increase in consumption would have occurred. Average consumption – corrected mean – increased from 84.5 to 115 liters (Table 9). The change inferred by the 1933 distribution lies in the extension of consumption to higher daily quantities. Figure 5 shows this change in the form of a distribution chart. The comparison of the figures for consumption between 1925 and 1933 suggests that a double process of generalization and polarization of consumption was consolidated in the 1930s. Differences between mode and mean achieved the highest level in the century. Although approximately 25 per cent continued to consume less than the equivalent of one cup a day, the remainder now acceded to higher quantities; so 8 per cent of the population would have consumed over 475 ml a day, the equivalent to almost 175 liters per person per year[44] (Table 12).

44. Amounts that are, for example, very close to the Danish consumption averages of the 1930s. See footnote 40.

Figure 5. *Distribution of consumer populations according to daily milk consumption intervals in Spain (1925-1981)*



Mean and mode of daily milk consumption (ml/gr)

	1925	*1933*	*1955*	*1965*	*1981*
Mode	131	135	212	226	351
Mean	182	249	284	259	375
Mean-Mode Difference (%)	39	84	34	15	7

Source. Statistics cited in Table 1 and own elaboration.

The return to levels of consumption previous to the Spanish Civil War took time to occur, as confirmed by the slight increase in the proportion of the consumer population (around 3 per cent) and the stability of averages of the effective estimated consumption from 1933 to 1955 (situated between 115 and 112 liters per person per year). This trend contrasts with the changes observed in the 1955 distribution: 52 per cent would have consumed between 150 and 299 ml and almost 45 per cent of the consumers would have drunk over 275 ml a day.

From the second half of the 1950s and the first half of the following decade, the average effective consumption did not show relevant changes, but the proportion of consumers entered a stage of expansion that reached, according to estimates made from the HBS, almost 80 per cent of the population. This led, therefore, to a phase of generalized consumption in the

1980s. It is important to observe that between 1965 and 1981, in contrast to what had occurred in previous stages, a double process of increase in consumption and increase in the number of consumers took place. At this point, however, it should be remembered that the average consumption estimated for 1981, close to 136 liters per person per year, was equivalent to that reached by the German population in the 1930s[45]. The HBS of 1965 and 1981 infer consumption distributions of very different tendencies to the years 1925 and 1933. The distribution of 1955 could be described as closer to the patterns of the following, than the past years. Figure 5 shows a displacement to the right and a remarkable increase in the mode. The distribution of 1965 could contribute evidence of a step forward in the nutritional transition in Spain. Indeed, in those years a substantial proportion of those who consumed milk did so in quantities that were close to the equivalent of one cup a day; 50 per cent of the population drank between 175 and 275 ml a day, whereas in 1955 it was only 37 per cent. In fact, in 1965 around 63 per cent were consuming over 225 ml a day (Table 12). Distributions estimated from the years 1965 and 1981 demonstrate both the growth and generalization of consumption: the progressive approximation of the mode and average consumption reveal this fact (Figure 5). From the 1960s, together with the regular improvement of income in Spain, this foodstuff, just like all other animal based foodstuffs, would begin a trajectory of growing averages of consumption per capita as well as the universalization of milk consumption.

This last characteristic, according to the results obtained, should have been reached in the 1970s. Milk and milk-derived products constituted, between 1969 and 1984, a regular proportion – around 55 per cent – of the total animal-based foodstuff consumed per person per year, which in terms of its calcium attributes represented 7 and 9 per cent of the total diet[46]. Towards 1981, the rise in consumption was consolidated in levels above 351 ml. So it was necessary to wait until the last decades of the twentieth century to witness the growing importance of dairy products in the national diet[47].

45. AGENJO, C., 1956, p. 315
46. RODRÍGUEZ, F. *et al*. 1996.
47. VARELA, G., 2000; MORENO, L. A. *et al*., 2002.

*

Nutritional transitions involve not only changes in levels of consumption, but also in numbers of consumers. The reconstruction of consumer populations is not an easy task because most of the historical statistics do not publish this kind of data. In countries with statistical yearbooks, the data available only allow the computation of statistical means at some spatial scale, according to the administrative units defined in each country. In order to overcome this limitation a methodological approach has been presented here. This methodology has been illustrated with the case of milk consumption, because an increase in the use of milk and its derivatives, as well as in the use of animal proteins in general, constitutes one of the main components of the modern nutritional transition, as it was the case in Spanish too. A basic step in the approach implemented in these pages has been the initial adjustment applied to the observed consumption levels, for them to become effective consumption levels, where the latter were the main unknown factor. In order to avoid an arbitrary solution this paper has presented an approach based on the combination of certain hypotheses about the diffusion of this foodstuff in the Spanish population with some results obtained from simulations of log-normal distributions. Such a combination has given a reasoned solution, but not a definitive one. This would explain why these results should be viewed as reconstructive. Unfortunately these estimates can only be tested indirectly, but they seemed to fit very well with the available information and evidence on the evolution of Spanish milk consumption in the twentieth century. In synthesis they suggest that, from the point of view of the number of consumers, there was a slow and late process of diffusion. Because this is a reconstruction the assumptions could be a source of error; this has been evaluated through a sensitivity analysis. The effects of a 10 liters variation in minimum consumption levels around the adopted scale of adjustment, between 45 and 130 liters, have shown that the conclusions previously obtained should not be significantly altered.

This kind of reconstruction has some drawbacks. On the one hand, without further historical information on the population's consumer habits it is difficult to evaluate effective consumption levels; on the other hand, the published statistics present two types of important limitations. First, the data were published according to certain administrative units, for example provinces. In the best cases, consumption means can be estimated, but not variances, so any calculation requires accepting variance at national scale as representative of that at a provincial level. Second, a lack of information on internal trade can either underestimate or overestimate levels of consumption. If all the above mentioned aspects are taken into account this ap-

proach could be extended to other foodstuffs involved in the same process of nutritional change. The possibility of estimating levels and trends in the evolution of consumer populations may shed new light on the study of the nutritional transition.

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Appendix

Appendix 1. *Linear scale od adjustement of the consumption observed in the estimate*

Liters observed person/year	*Estimate Daily Millilitres*	*Liters Person/year*
5,0	0.125	45.6
7.5	0.130	47.3
10,0	0.134	49.0
12.5	0.139	50.7
15,0	0.143	42.4
17.5	0.148	54.1
20,0	0.153	55.7
22.5	0.157	57.4
25,0	0.162	59.1
27.5	0.167	60.8
30,0	0.171	62.5
32.5	0.176	64.2
35,0	0.180	65.0
37.5	0.185	67.6
40,0	0.190	69.2
42.5	0.194	70.9
45,0	0.199	72.6
47.5	0.204	74.3
50,0	0.208	76.0
52.5	0.213	77.7
55,0	0.217	79.4
57.5	0.222	81.1
60,0	0.227	82.7

62.5	0.231	84.4
65,0	0.236	86.1
67.5	0.241	87.8
70,0	0.245	89.5
72.5	0.250	91.2
75,0	0.254	92.9
77.5	0.259	94.5
80,0	0.264	96.2
82.5	0.268	97.9
85,0	0.273	99.6
87.5	0.278	101.3
90,0	0.282	103.0
92.5	0.287	104.7
95,0	0.291	106.4
97.5	0.296	108.0
100,0	0.301	109.7
102.5	0.305	111.4
105,0	0.310	113.1
107.5	0.315	114.8
110,0	0.319	116.5
112.5	0.324	118.2
115,0	0.328	119.9
117.5	0.333	121.5
120,0	0.338	123.2
122.5	0.342	124.9
125	0.347	126.6
127.5	0.351	128.3
130,0	0.356	130.0

Apendix 2a. *Estimate process of consumer population year 1925*

Spanish Provinces	*Total Population (1)*	*Consumption p/cap/ year observed (2)*	*Consumption p/cap/ year adjusted (3)*
Álava	101,524	30	62
Albacete	311,597	4	45
Alicante	527,557	8	48
Almería	357,045	9	48
Ávila	215,949	25	59
Badajoz	672,792	11	50
Baleares	349,413	21	56
Barcelona	1,545,304	54	79
Burgos	344,203	28	61
Cáceres	429,164	11	49
Cádiz	539,359	13	51
Canarias	490,791	33	64
Castellón	306,341	10	49
Ciudad Real	455,918	9	48
Córdoba	602,439	17	54
Coruña	736,7	43	72
Cuenca	296,302	4	45
Girona	327,408	25	59
Granada	596,211	32	64
Guadalajara	203,854	10	49
Guipúzcoa	282,101	175	184
Huelva	335,549	12	50
Huesca	241,247	19	55
Jaén	552,447	13	51
León	423,955	25	59
Lleida	304,741	20	56
Logroño	200,423	33	64
Lugo	465,998	73	92
Madrid	1,157,766	47	74
Málaga	577,659	13	51
Murcia	647,132	24	59
Navarra	341,365	81	97

Ourense	419,662	50	76
Oviedo	741,258	151	160
Palencia	220,101	13	51
Pontevedra	547,555	32	64
Salamanca	334,633	17	54
Santander	344,753	117	121
Segovia	172,076	27	61
Sevilla	743,174	19	55
Soria	152,229	18	54
Tarragona	351,413	13	51
Teruel	248,802	6	47
Toledo	463,431	18	54
Valencia	1,001,983	12	50
Valladolid	294,608	42	71
Vizcaya	440,474	154	164
Zamora	276,119	12	50
Zaragoza	509,569	37	67
Mean		34.05	66.41
Standard Deviation		38.80	30.24

Source. Column (1) and (2) statistics cited in Table 1 and own elaboration.

Appendix 2B. *Estimate process of consumer population year 1925*

Spanish Provinces Sorted	*Consumption per cap/year adjusted sorted (liters) (4)*	*Daily consumption (ml) (5)*	*Consumer Population Accumulative Percentage (6)*
Albacete	45	123	25
Cuenca	45	123	25
Teruel	47	128	27
Alicante	48	131	30
Almería	48	132	30
Ciudad Real	48	132	30
Castellón	49	134	31
Guadalajara	49	134	31
Cáceres	49	135	32
Badajoz	50	136	33
Huelva	50	138	34
Valencia	50	138	34
Zamora	50	138	34
Málaga	51	139	34
Cádiz	51	140	35
Palencia	51	140	35
Jaén	51	140	35
Tarragona	51	140	35
Córdoba	54	147	39
Salamanca	54	148	40
Soria	54	148	40
Toledo	54	149	40
Huesca	55	151	41
Sevilla	55	151	42
Lleida	56	153	43
Baleares	56	154	43
Murcia	59	161	47
Girona	59	161	47
León	59	161	48
Ávila	59	162	48
Segovia	61	166	50

Burgos	61	168	51
Álava	62	171	53
Granada	64	174	55
Pontevedra	64	175	55
Canarias	64	176	56
Logroño	64	176	56
Zaragoza	67	184	59
Valladolid	71	194	64
Coruña	72	196	65
Madrid	74	203	68
Ourense	76	209	70
Barcelona	79	216	73
Lugo	92	251	83
Navarra	97	265	86
Santander	121	332	95
Oviedo	160	438	99
Vizcaya	164	449	99
Guipúzcoa	184	504	100

Source. Own elaboration.

Appendix 2c. *Estimate process of consumer population year 1925*

Spanish Provinces Sorted	*Population % (7)*	*Population Accumulated (8)*	*Consumption p/cap final estimate*		*Provincial*	*Consumer population estimates*	
			Daily (ml) (9)	*Yearly (liters) (10)*	*Consumption (liters) (11)*	*Consumers (12)*	*Consumers (per cent) (13)*
Guipúzcoa	1.27	100.00	298	184	49,361,661	268,27	95
Vizcaya	1.98	98.73	294	164	67,834,700	413,626	94
Oviedo	3.34	96.75	287	160	111,581,548	697,385	94
Santander	1.55	93.41	276	121	40,315,127	333,183	97
Navarra	1.54	91.85	271	99	27,507,369	278,152	81
Lugo	2.10	90.32	266	97	34,188,451	351,986	76
Barcelona	6.96	88.22	260	95	83,427,640	880,279	57
Ourense	1.89	81.26	239	87	21,106,489	241,598	58
Madrid	5.21	79.37	234	85	54,630,582	639,318	55
Coruña	3.32	74.15	220	80	31,971,748	397,69	54
Valladolid	1.33	70.83	212	77	12,477,264	161,346	55
Zaragoza	2.30	69.51	209	76	18,689,307	245,456	48
Logroño	0.90	67.21	203	74	6,559,750	88,497	44
Canarias	2.21	66.31	201	73	16,044,254	218,751	45
Pontevedra	2.47	64.10	196	71	17,508,868	244,974	45
Granada	2.69	61.63	190	69	18,921,173	272,485	46
Álava	0.46	58.95	184	67	3,016,636	44,829	44
Burgos	1.55	58.49	183	67	9,775,307	146,047	42
Segovia	0.78	56.94	180	66	4,701,635	71,53	42
Ávila	0.97	56.16	178	65	5,363,114	82,337	38
León	1.91	55.19	176	64	10,432,932	162,005	38
Girona	1.47	53.28	173	63	8,186,437	129,993	40
Murcia	2.91	51.81	170	62	15,823,683	255,637	40
Baleares	1.57	48.89	164	60	7,170,581	119,862	34
Lleida	1.37	47.32	161	59	6,119,244	104,189	34
Sevilla	3.35	45.95	158	58	14,140,272	244,656	33
Huesca	1.09	42.60	152	56	4,574,635	82,312	34
Toledo	2.09	41.51	150	55	8,210,206	149,617	32
Soria	0.69	39.43	147	54	2,671,000	49,878	33
Salamanca	1.51	38.74	146	53	5,797,078	109,126	33

Córdoba	2.71	37.23	143	52	10,069,224	192,918	32
Tarragona	1.58	34.52	139	51	4,701,741	92,987	26
Jaén	2.49	32.94	136	50	7,354,495	148,17	27
Palencia	0.99	30.45	132	48	2,891,904	59,984	27
Cádiz	2.43	29.46	131	48	7,008,453	147,065	27
Málaga	2.60	27.03	127	46	7,303,472	157,674	27
Valencia	4.51	24.43	123	45	12,162,733	270,697	27
Zamora	1.24	19.91	117	43	3,368,425	79,033	29
Huelva	1.51	18.67	115	42	4,046,819	96,342	29
Badajoz	3.03	17.16	113	41	7,430,439	180,052	27
Guadalajara	0.92	14.13	109	40	1,981,292	49,743	24
Cáceres	1.93	13.21	108	39	4,553,123	115,546	27
Castellón	1.38	11.28	106	39	2,941,616	76,358	25
Ciudad Real	2.05	9.90	104	38	4,062,548	107,171	24
Almería	1.61	7.84	101	37	3,085,212	83,368	23
Alicante	2.38	6.23	99	36	4,440,350	122,265	23
Teruel	1.12	3.86	97	35	1,589,849	45,011	18
Albacete	1.40	2.74	96	35	1,216,154	34,885	11
Cuenca	1.33	1.33	94	34	1,075,370	31,358	11
Spain				84.53	809,391,911	9,575,641	43