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Carmen Arrext, Rolando Mellafe
and Jorge L. Somoza

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FERTILITY ESTIMATE THROUGH THE OWN-CHILDREN METHOD. AN APPLICATION TO DATA FROM ARGENTINA, 1895

SUMMARY

This paper presents the derivation of a fertility estimate for Argentina based on the information collected by the national population census, taken in 1895. The procedure used, the own-children method, utilizes information on the population below 15 years of age and the female population aged 15 to 64.

A fertility estimate, prepared in 1967, was available for Argentina, based on the information on children ever born by ever married women gathered in the same population census. The estimated Total Fertility Rate (TFR) was 6 children, i.e., 6 children per women.

The own-children method offered the possibility of revising that estimate on fertility starting from independent information that could presumably be more reliable than the one used previously. The result in terms of TFR is 7 children per woman, with an age distribution of fertility rates quite different from the existing one. The revised estimate on fertility also determines an upward revision of the rate of natural growth.

RESUMEN

Se presenta en este documento una estimación de la fecundidad de la Argentina basada en información del censo nacional de 1895 sobre la población menor de 15 años y la población femenina de 15 a 65 años, clasificadas por edades simples, mediante el método de hijos propios.

Existía una estimación de la fecundidad, elaborada en 1967, que se basó en la información sobre el número de hijos tenidos por las mujeres alguna vez casadas recogida en ese mismo censo. Esta estimación se sintetiza en un valor de la Tasa Global de Fecundidad (TGF) de 6 hijos por mujer.

El método de hijos propios para estimar la fecundidad ofrecía la posibilidad de elaborar una nueva estimación, con información más sólida y que merece, por lo tanto, más confianza. Se obtuvo como resultado una estimación de la fecundidad, de la TGF, equivalente a 7 hijos por mujer al cabo de su vida fértil. La estructura de las tasas de fecundidad resultó también diferente a la estimada anteriormente. Las nuevas estimaciones modifican las existentes sobre la tasa de crecimiento natural de la población en esa época.

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I. BACKGROUND INFORMATION

There exists an estimate of the fertility level of the population of Argentina prepared in 1967 (1), based on information collected by the national census of 1895 on the number of children born to ever-married women.

The method applied in that occasion, to derive the estimate of annual fertility rates by ages, was based on the mean number of children born to women in different age groups. Accepting as valid the mean numbers corresponding to the foreign-born population, that were the highest, a curve of the accumulated fertility was drawn. Therefrom, through procedures frequently employed in Demography, the annual fertility rates by age were derived.

The analysis was based on the highest points observed on the mean number of children born by age, for two reasons: a) it was reasonable to assume that the census data had underestimated the fertility of the total population, because the question on children born was limited to only ever-married women, not taking into account the non-married mothers who considerably contributed in an important proportion to the total number of births, and b) it could be expected that one of the frequent errors, occurring even in surveys presently undertaken, was present in that census: the omission, due to different reasons, in the reporting of children.

The mentioned estimate, which is summarized in a value of the Total Fertility Rate (TFR) of 6 children per woman, was calculated on a poor statistical basis. The age structure of rates, derived from that information of dubious quality, should also be taken with caution, as it is acknowledged in the document itself.

The "own-children method" to estimate fertility, described below, offered the possibility of elaborating a new estimate. This was brought into practice counting on the computer programs, recently provided to CELADE's

Data Bank by the East-West Population Institute (EWPI), and on the cooperation of the Instituto Nacional de Estadística y Censos (INDEC) that furnished to CELADE a copy of the basic data of the sample of the population census taken in 1895 (2).

From the application of this method an estimate of fertility, higher than the existing one, becomes available, a TFR of 7 instead of 6, and an age structure of the rates which is also very different from the one obtained before. The new results are more reliable. They modify the existent image of the fertility level of Argentina by the end of the nineteenth century and, consequently, also change the existent estimates on the rate of natural increase of the population. From the methodological point of view, the "own children method" proved to be very efficient, as well as the computer programs, elaborated by Julio Ortúzar of CELADE.

II. SOME CONSIDERATIONS ON THE POPULATION OF ARGENTINA IN THE LAST DECADES OF THE NINETEENTH CENTURY

After the battles of Caseros (1852) and Pavón (1861), the federal constitutional solution permitted Argentina to get rid of half of a century of "caudillismo" and anarchy. A rapid expansion of agriculture was then initiated and the insertion of the country in the world agrarian markets, consolidated, while a strong penetration of European capitalism, through money, credits and investments was starting to take place. Symptoms and consequences of all of it was the rapid territorial occupation of the inner pampas for agrarian exploitation purposes, the accelerated growth of Buenos Aires and from, approximately, 1870, the growing establishment of consumption and service goods industries (3).

Such an accelerated dynamics could not have been possible without a correlative growth of the population, which could not have been attained by natural growth only, but, to a great extent, by in-migration. Since the middle of the century Argentina held an annual population growth which fluctuated from 1.5 per cent to 3.5 per cent, depending on the annual rate of

increase, of decrease or lack of the immigration flow. The census of 1869 gave a total of 1 737 000 inhabitants, and the one of 1895, of 3 395 911. These figures would indicate an annual growth of 3 per cent for the inter-censul period. This percentage would be more reliable if, on the one hand, the measures of the natural growth, (birth rate minus death rate) and on the other, the European net migration, were more exactly known. We must say that since 1857 until the year when the 1895 census was taken, 2 117 741 immigrants had entered the country. There is no certainty about the annual return migration, but we know it was considerable, though it decreased towards the end of the century.

Since mid nineteenth century the population of Argentina was affected by a series of factors that negatively influenced on its growth. Its demographic incidence has not been yet sufficiently studied and evaluated: the War of Paraguay (1865-1870), the economic crises of 1866, 1873, 1882 and particularly, that of the 1889-1990 period, which was very strong in the Rio de la Plata region. To this, provincial riots and the civil wars of 1870, 1872 and 1880 should be added, as well as, some years of drought and food shortage, and the yellow fever epidemic of 1871. The monetary crisis of 1889-1890 brought about a fall in salaries, unemployment, high prices and food shortages that stroke the populous quarters of Buenos Aires.

The low labor conditions were immediately reflected in a series of sometimes, bloodstained conflicts, that became more frequent and important towards the end of the century: in 1890, four strikes from important trade unions broke out in Buenos Aires, in 1892 seven of them and two years later, nine. In the census year, on which our study is based, nineteen strikes took place and in 1896, twenty six (4).

The above conditions, particularly the existence of an annual rate of natural growth of around 1.5 percent, seem to be consistent with the new fertility estimate that we present here.

If the total fertility rate for the period 1880-1895 is, as we believe, 7 children per woman, one feels closer to dealing with a type of traditional peasant families, devoted to agriculture or handicraft, with rural customs. The idea about the influence that a large mass of salaried

industrial workers, together with a considerable sector of the urban middle class, would have exerted on the demographic determinants of those years, seems premature.

It should be born in mind that in 1895, the 73 per cent of the total population of Argentina, was still rural. This figure decreased to 47,5 only around 1914 (5). An accurate study of the evolution of the economically active population, based on censuses of 1869, 1895 and 1914, could, in our opinion, help clarifying the situation. It is remarkable that, for example, until 1895 only 22,2 per cent of the active population was involved in industrial activities and, although the number of industrial enterprises grew from 4 700 in Buenos Aires in 1887, to 8 000 in 1895, the amount of craftsmen and manually occupied workers at their homes was extremely high. According to the 1895 census, there were in the country 120 000 seamstresses and 40 000 weavers. There are some other examples which could diminish the percentages of industrial workers as enumerated by the census (6).

Whatever the importance that may be assigned to the demographic indicator we present here we believe it is a good starting point to initiate a critical review of some elements that, until now, have been accepted as valid to interpret the evolution of the society of Argentina in the last decades of the nineteenth century.

III. APPLICATION OF THE "OWN CHILDREN METHOD"

Estimate of mortality

To apply the "own children method", for estimating fertility, to the 1895 census data, an estimate on mortality, in years previous to the census, is needed. This estimate is not critical in the results that are being obtained. For this reason, and because of the lack of available information that would permit a better estimate of mortality than the existent one, this one was adopted. Such estimate was the one used in the fertility analysis (1) mentioned above. It is summarized in Table 1.

Table 1

PROBABILITIES OF SURVIVAL ADOPTED ON WHICH THE UTILIZED LIFE TABLES ARE BASED

Age interval	Symbol	Males	Females
Between ages 0 and 5	p(5)	.6739	.6914
Between ages 0 and 28	p(28)	.4499	.4228

Two elaborations were performed with those data. The first one was the construction of the L_x function, the number of survivors in a stationary population, in the age interval x, x+1, for both sexes, necessary for estimating births in years previous to 1895, starting from the amount of enumerated children aged below 15. The second elaboration, dealing with female population, had the purpose of determining the values of the same function for quinquennial intervals, ${}_5L_x$, between the ages 15-60. This one is necessary to reverse-survive the female population in order to calculate from it, births occuring between 1880 and 1895.

In Table 2 the values of the L_x function, for both sexes, are presented; in Table 3, the corresponding to ${}_5L_x$, for the female population. In Appendix 1 a description of the method utilized in the construction of such tables, starting from the information contained in Table 1, may be found. Besides, and indirect check of the adopted value p(5) is presented.

Table 2

LIFE TABLE FOR BOTH SEXES. AGE INTERVAL 0-14. FUNCTION L_x

Age x	Survivors L_x	Age x	Survivors L_x	Age x	Survivors L_x
0	.8570	5	.6795	10	.6585
1	.7560	6	.6741	11	.6557
2	.7167	7	.6695	12	.6526
3	.6979	8	.6655	13	.6494
4	.6867	9	.6618	14	.6457

Table 3

FEMALE LIFE TABLE. AGE INTERVAL 15-60. FUNCTION $_5L_x$

Age	Survivors				
x	$_5L_x$	$_5L_{x+1}$	$_5L_{x+2}$	$_5L_{x+3}$	$_5L_{x+4}$
15	3.2149	3.1881	3.1586	3.1272	3.0947
20	3.0620	3.0294	2.9972	2.9653	2.9337
25	2.9022	2.8710	2.8401	2.8094	2.7787
30	2.7479	2.7170	2.6859	2.6546	2.6229
35	2.5908	2.5583	2.5253	2.4916	2.4574
40	2.4225	2.3866	2.3497	2.3119	2.2731
45	2.2332	2.1920	2.1494	2.1054	2.0597
50	2.0125	1.9640	1.9142	1.8630	1.8104
55	1.7563	1.7003	1.6422	1.5822	1.5202
60	1.4565				

Estimate of fertility

It is convenient to divide the analysis of fertility into two parts: the first one, is intended to provide the age structure of the fertility rates; the second one, the level of fertility.

Age structure of the fertility rates

The "own children method" (9) is used to calculate the age structure of the rates.

It consists, firstly, in assigning, when possible, the enumerated children within a family to their presumed mothers, selected among the women who constitute the family. After doing this and having established consequently, the age of the presumed mothers, at the time of the census, it is an easy task, with the aid of the mortality hypothesis, to reverse-survive the female population, keeping its age composition, and to derive from the

information on children, grouped by age of their presumed mothers, the number of births. The ratio between the number of births and of women, in a particular year, defines the fertility rate for the age group considered.

To facilitate the explanation of this last part, we will analyze an illustrative example. Let us consider children aged 3 in 1895, i.e., with exact ages between 3 and 4. They were born during a year between 1891, four years before the census, and 1892, three years before the census.

Part of this group of children is assigned to women, their presumed mothers, whose ages are known. Let us continue examining a particular case: the group of children assigned to women with attained ages 23-27 in 1895, that we denote by $N_3(23\text{-}27)$.

The number of births that occurred between 1891 and 1892, arising from women that were 23-27 years old in 1895 and that during the mentioned year, were 20-24, is given by:

$$_5B_{20}(1891\text{-}1892) = N_3(23\text{-}27)/L_3$$

Let us consider the women that were alive during 1891 and 1892, with ages between 20-24. We will first calculate the ones that were alive four years before the census, in 1891, and then those that lived three years before the census in 1892. The former are aged 24-28 years in 1895. We represent them with the symbol $_5N_{24}$. The latter aged 23-27 in 1895, are designed as $_5N_{23}$.

They are the survivors of the ones alive in 1891 and 1892, respectively, aged 20-24. To estimate such numbers we do:

$$_5N_{20}(1891) = {}_5N_{24} \cdot {}_5L_{20} / {}_5L_{24}$$

$$_5N_{20}(1892) = {}_5N_{23} \cdot {}_5L_{20} / {}_5L_{23}$$

The mean number of women aged 20-24 along the year 1891-1892 results from an average of the two values obtained above:

$$_5N_{20}(1891\text{-}1892) = 1/2\ ({}_5N_{20}(1891) + {}_5N_{20}(1892))$$

Finally, the fertility rate for 1891-1892 and for the age group 20-24 results:

$$_5f_{20}(1891\text{-}1892) = {}_5B_{20}(1891\text{-}1892)/{}_5N_{20}(1891\text{-}1892)$$

As the objective here is to determine the structure, not the level of the rates, it has minor importance if in the census there has been omission in the enumeration of children at certain age or if there were mis-statements of ages. Also it has no great relevance if a proportion of the total of children at any age could not be assigned to a presumed mother. As mentioned above, the assignment of children to their presumed mothers was performed by using a computer program prepared in CELADE, following the guide lines established by the EWPI. The information of the Argentinian census of 1895 is not suitable for the application of a program. Those prepared by the EWPI assume the existence of a grouping of persons within a family, in a census schedule, and a classification of people according to their relationship to the head of the household. Therefore, the elaboration had to be performed assuming that the members of a dwelling, not of a family, formed a family and without the possibility of utilizing information on the relationship to the head of the household.

The assignment considered the limited information available namely: the age of children and women, the number of children born reported by ever-married women (and occasionally, also by single women) and on maternal orphanhood, that was investigated in the population below 15. The assignment, besides, imposed the condition that the age of the presumed mother, at the time of childbirth, had to be included between 15 and 49 years. Furthermore, when more than a woman, within the same dwelling, could have been selected as a presumed mother of a child, it was decided, arbitrarily, to assign the child to the youngest of them.

This exercise yielded satisfactory results in the sense that a high proportion of the children below 15 could be assigned to a presumed mother. Table 4 presents the enumerated population below 15, in the sample of the Argentinian census, classified according to the age of their presumed mothers.

Table 4

SAMPLE OF THE ARGENTINIAN CENSUS OF 1895. FEMALE POPULATION BY AGE AND CHILDREN AGED BELOW 15 CLASSIFIED BY AGE OF THEIR PRESUMED MOTHERS

Age female population	Number of females	Age of children														
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
15-63	28769	2401	3476	3609	3727	3438	3507	3248	3461	3143	2652	3065	2298	2901	2124	2409
15	1314	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	1107	10	10	-	-	-	-	-	-	-	-	-	-	-	-	-
17	1027	24	18	4	-	-	-	-	-	-	-	-	-	-	-	-
18	1326	47	47	35	14	-	-	-	-	-	-	-	-	-	-	-
19	882	45	51	23	16	10	-	-	-	-	-	-	-	-	-	-
20	1375	98	125	87	75	33	19	-	-	-	-	-	-	-	-	-
21	695	50	96	63	59	32	16	14	-	-	-	-	-	-	-	-
22	1107	116	150	134	98	56	52	27	20	-	-	-	-	-	-	-
23	788	99	106	109	108	76	54	42	26	19	-	-	-	-	-	-
24	856	83	172	132	123	92	81	59	42	25	16	-	-	-	-	-
25	1310	172	216	247	206	177	183	120	95	57	50	32	-	-	-	-
26	854	117	164	137	157	134	104	99	79	48	37	24	22	-	-	-
27	684	74	133	147	125	118	99	91	92	74	36	35	19	24	-	-
28	1020	121	170	201	183	190	153	147	127	104	90	78	40	37	29	-
29	520	79	101	91	124	97	101	93	82	68	55	52	28	22	17	13
30	1602	161	227	280	278	285	289	247	250	206	169	175	107	99	72	70
31	292	27	56	55	66	76	48	69	44	49	42	34	32	26	15	16
32	697	76	123	140	139	151	144	149	136	109	109	94	87	70	55	57
33	504	48	79	112	90	100	124	92	130	96	84	94	67	74	53	46
34	460	58	72	79	82	87	81	86	95	84	69	72	61	56	38	37
35	1158	110	164	200	195	201	213	192	229	183	158	183	143	184	113	113
36	546	39	81	65	107	92	105	111	118	109	111	129	86	107	78	68
37	449	42	64	86	77	64	99	67	88	91	71	97	62	75	45	70
38	697	63	90	96	114	100	114	110	125	116	109	134	104	135	93	104
39	350	21	52	48	37	54	62	58	60	59	58	65	60	65	57	48
40	1384	67	100	133	172	154	195	177	209	242	161	229	135	201	160	174
41	202	11	22	24	23	43	28	42	32	26	28	39	25	34	28	31
42	401	17	26	33	54	45	51	72	65	49	67	57	65	75	63	65
43	249	9	29	26	30	38	42	43	57	35	47	40	39	51	40	40
44	258	9	19	25	32	36	31	32	51	38	35	37	41	41	37	53
45	750	21	43	33	65	60	83	75	96	116	74	112	88	120	81	89
46	278	12	9	17	17	29	30	31	41	45	36	43	44	48	50	56
47	206	4	5	11	15	13	18	13	20	26	29	20	31	23	29	30
48	354	12	20	17	22	25	32	43	36	65	46	53	44	64	43	60
49	178	4	5	12	12	11	14	15	21	13	16	28	21	23	24	29
50	863	-	40	37	41	46	61	59	70	66	65	93	58	91	62	88
51	83	-	-	3	-	1	9	6	12	7	9	6	15	9	10	8
52	166	-	-	-	5	9	2	9	15	9	18	21	20	17	23	17
53	127	-	-	-	-	5	5	6	8	9	6	12	7	21	12	14
54	162	-	-	-	-	-	7	5	9	12	12	22	12	22	16	11
55	313	-	-	-	-	-	-	16	20	19	17	19	15	24	27	32
56	147	-	-	-	-	-	-	-	8	9	7	5	9	15	19	18
57	91	-	-	-	-	-	-	-	-	5	1	8	2	11	5	7
58	148	-	-	-	-	-	-	-	-	-	9	12	4	14	10	15
59	70	-	-	-	-	-	-	-	-	-	-	4	4	5	3	7
60	544	-	-	-	-	-	-	-	-	-	-	-	10	33	28	27
61	40	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2
62	82	-	-	-	-	-	-	-	-	-	-	-	-	-	3	5
63	53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Total allocated		1949	2885	2942	2961	2740	2749	2517	2608	2288	1947	2158	1607	1918	1438	1523
Not allocated		452	591	667	766	698	758	731	853	855	705	907	691	983	686	886
Allocated/Total (%)		81	83	82	79	80	78	77	75	73	73	70	70	66	68	63

It also shows the total of not assigned children and the female population according to age. Examining the table, it can be seen that the percentage of the total of children, that could be assigned to a mother, oscillates between 63 and 83.

In the example chosen to illustrate the method, we find that children aged 3, allocated to mothers aged 23-27, are 719 (the annual groups, as can be verified in Table 4, are 108, 123, 206, 157 and 125, ordered according to the mother's age between 23 and 27). To that number of children aged 3 corresponds a number of births, between 1891-1892: $719/{}_5L_3 = 719/.6979 = 1030$ (See ${}_5L_3$ value in Table 2).

The total number of women aged 24-28 and 23-27 in 1895 is obtained by adding up the proper values shown in Table 4. It results 4 724 and 4 492, respectively. To pass from these, to the number of women aged 20-24 in 1891 and 1892, four and three years previous to 1895, respectively, we must do:

$$ {}_5N_{20}(1891) = 4724 \cdot {}_5L_{20}/{}_5L_{24} = 4724 \times 3.0620/2.9337 = 4930 $$

$$ {}_5N_{20}(1892) = 4492 \cdot {}_5L_{20}/{}_5L_{23} = 4492 \times 3.0620/2.9653 = 4638 $$

The average of the two values, representing the number of women aged 20-24, when the births occurred, results:

$$ {}_5N_{20}(1891\text{-}1892) = 1/2\ (4930+4638) = 4784 $$

Finally, the annual fertility rate for the age group 20-24 in 1891-1892, is defined:

$$ {}_5f_{20}(1891\text{-}1892) = {}_5B_{20}(1891\text{-}1892)/{}_5N_{20}(1891\text{-}1892) = 1030/4784 = .215 $$

This rate does not reflect the fertility level since it does not take into account the non-assigned children (actually, the births they imply). If they are distributed according to the age of the mother, using the same distribution shown by the assigned cases, the rate has to be multiplied by the fraction 3 727/2 961, which terms are, respectively, the total of children aged 3, and the total of children assigned to presumed mothers of the same age. The rate thus adjusted results: .215 x 3727 / 2961 = .271.

As mentioned above, we are not interested in establishing the level of the rates, but only their distribution according to age. This last correction, therefore, has no relevance as to the analysis we are doing at this point.

Table 5 presents the results obtained on the distribution of the fertility rates by age. They were obtained following the same procedure described above, as an illustrative example, grouping the information in triennial periods in order to simplfy the elaboration, to diminish the effects of wide fluctuations derived from mis-statements of age -of the children and the female population- and to reduce random oscillations derived from the small number of cases in the extreme age groups, within the reproductive period.

Table 5

DISTRIBUTION OF THE FERTILITY RATES BY AGES CALCULATED FOR TRIENNIAL PERIODS 1880-1895

Age of the children in 1895	0-2	3-5	6-8	9-11	12-14	0-14
Years in which they were born	1892-1895	1889-1892	1886-1889	1883-1886	1880-1883	1880-1895
Age groups	Age distribution of the rates					
15-19	5.20	5.45	6.23	6.68	7.16	6.14
20-24	19.52	17.55	17.16	17.54	17.18	17.79
25-29	23.36	23.54	22.49	21.52	20.59	22.30
30-34	21.35	20.01	19.54	20.45	21.13	20.50
35-39	15.60	16.56	17.29	16.12	14.72	16.06
40-44	9.22	10.44	10.80	12.29	12.47	11.04
45-49	5.75	6.45	6.49	5.40	6.75	6.17
Sum	100.00	100.00	100.00	100.00	100.00	100.00
Mean age ($\bar{m}$)	31.16	31.59	31.64	31.51	31.67	31.52
Standard deviation	7.85	8.00	8.12	8.10	8.33	8.07

We obtained, therefore, five distributions that are represented in Figure 1. It can be concluded, by observing the figure and the values shown in Table 5, that there is quite a satisfactory stability in the distribution of the fertility rates by age between 1880 and 1895.

Were it not by the fact that the information is affected by obvious errors of mis-statements of age, selective omissions, errors that have surely been introduced in the allocation of children to presumed mothers, etc., it could be concluded that there is a certain trend in the variation of rates through time, that might be reflecting a fertility decline. In fact, the mean age of the distribution diminishes from 31.67 to 31.16 years, with some oscillations, while the dispersion, the standard error, tends also to become smaller. Both characteristics, a younger mean age and a smaller dispersion in the distribution of rates are normally associated with a declining fertility. Somoza had conjectured about the possible decline of the Argentinian fertility at that time on the basis of information from the 1895 census that showed different fertility levels in different sectors of the population.

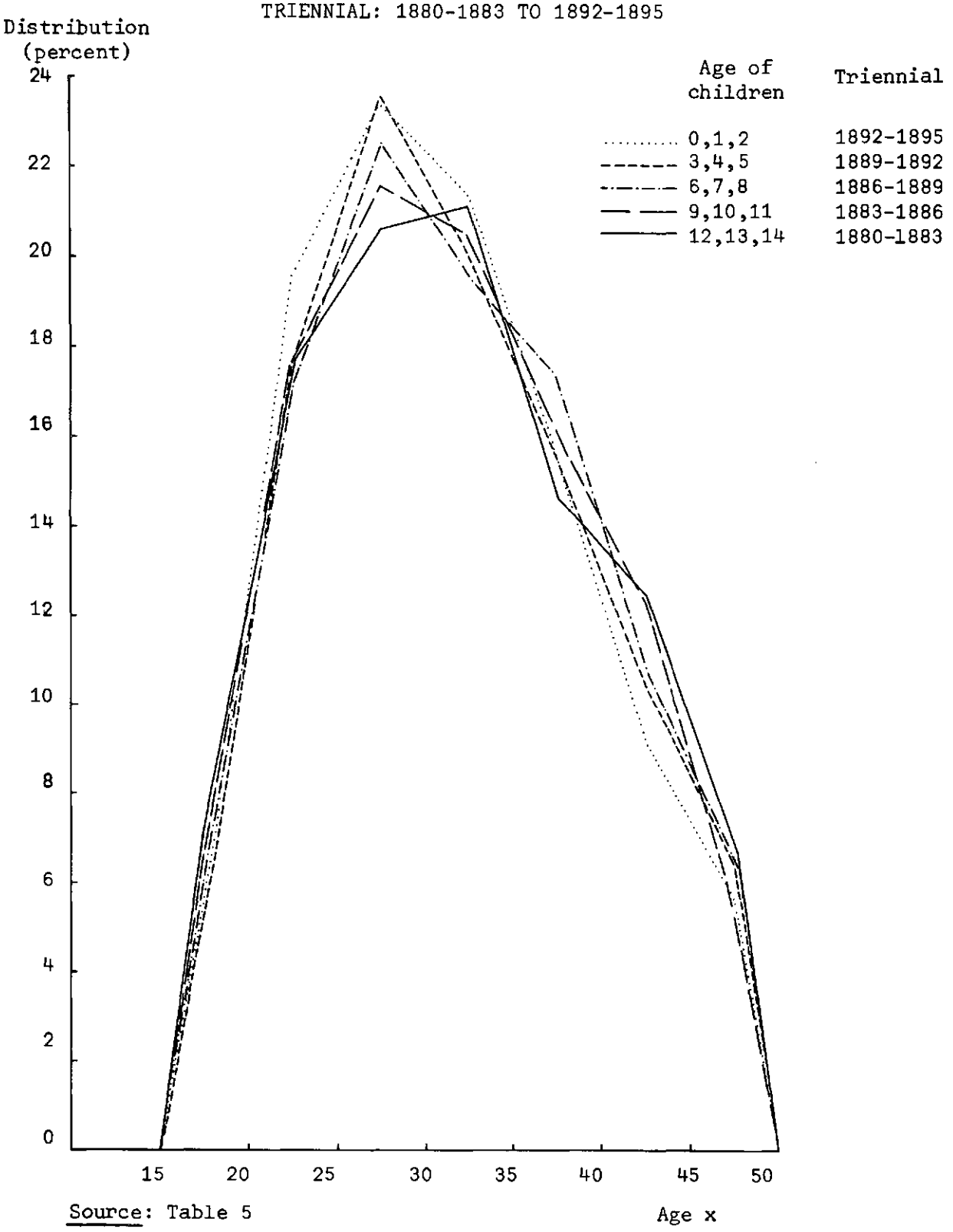
We do not pretend to force the argument that a decline in fertility was real. We consider that the conclusion, though plausible, would have had a weak statistical basis. We are after a more elementary objective which is to determine the level of fertility, only approximately, for the period 1880-1895 taken as a whole. For this purpose, it seems reasonable the criterion we adopted to accept as distribution of the rates by age, the mean values of the five distributions shown in Table 5. The results are presented in the same table and in Figure 2.

The fertility level in the period 1880-1895

Now we will estimate the fertility level in the past, using for this purpose the age structure of the rates that has been established above. The procedure consists in adopting, arbitrarily, three levels for the Total Fertility Rate (TFR), 6, 7 and 8, and to calculate the hypothetical number of births occurring in the last fifteen years, given the assumed mortality, if the fertility would have been constant at each of those three levels.

Figure 1

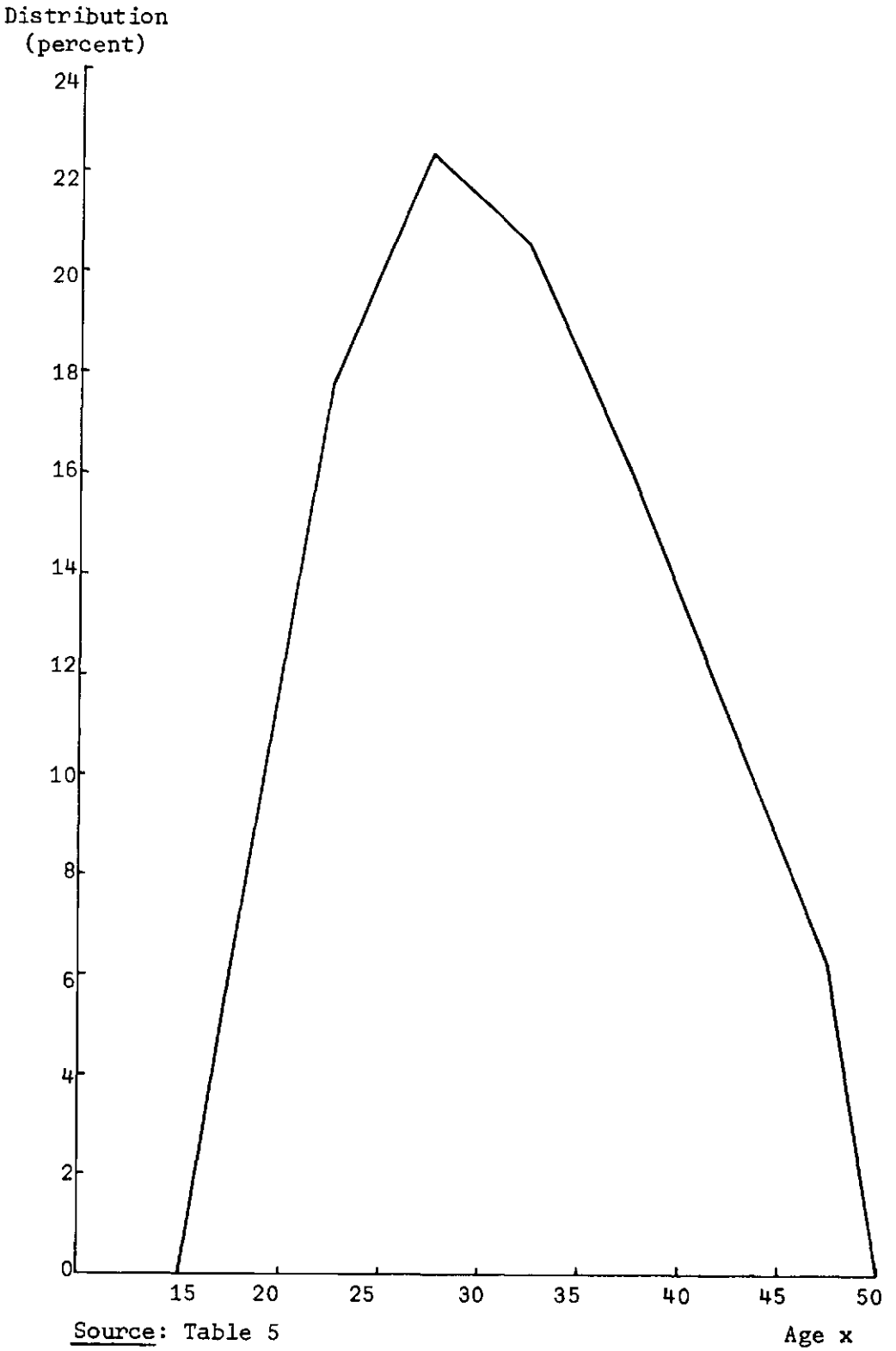
DISTRIBUTION OF THE FERTILITY RATES BY AGE.
TRIENNIAL: 1880-1883 TO 1892-1895



Source: Table 5

Figure 2

DISTRIBUTION OF THE FERTILITY RATES BY AGE.
AVERAGE OF THE 1880-1895 PERIOD



Source: Table 5

The procedure is similar, from the methodological point of view, to the one utilized above when the structure of the rates by age was calculated: we reverse-survive the female population, classified by age, and hypothetical fertility rates are applied to the population thus reverse-survived. The result is the expected number of births in a year.

The resulting annual series of births between 1880 and 1895, the three series, one for each adopted level of TFR, are compared with the one that results from reverse surviving the number of children up to estimating the original annual number of births. The results of this exercise are given in Table 6 and are represented in Figure 3.

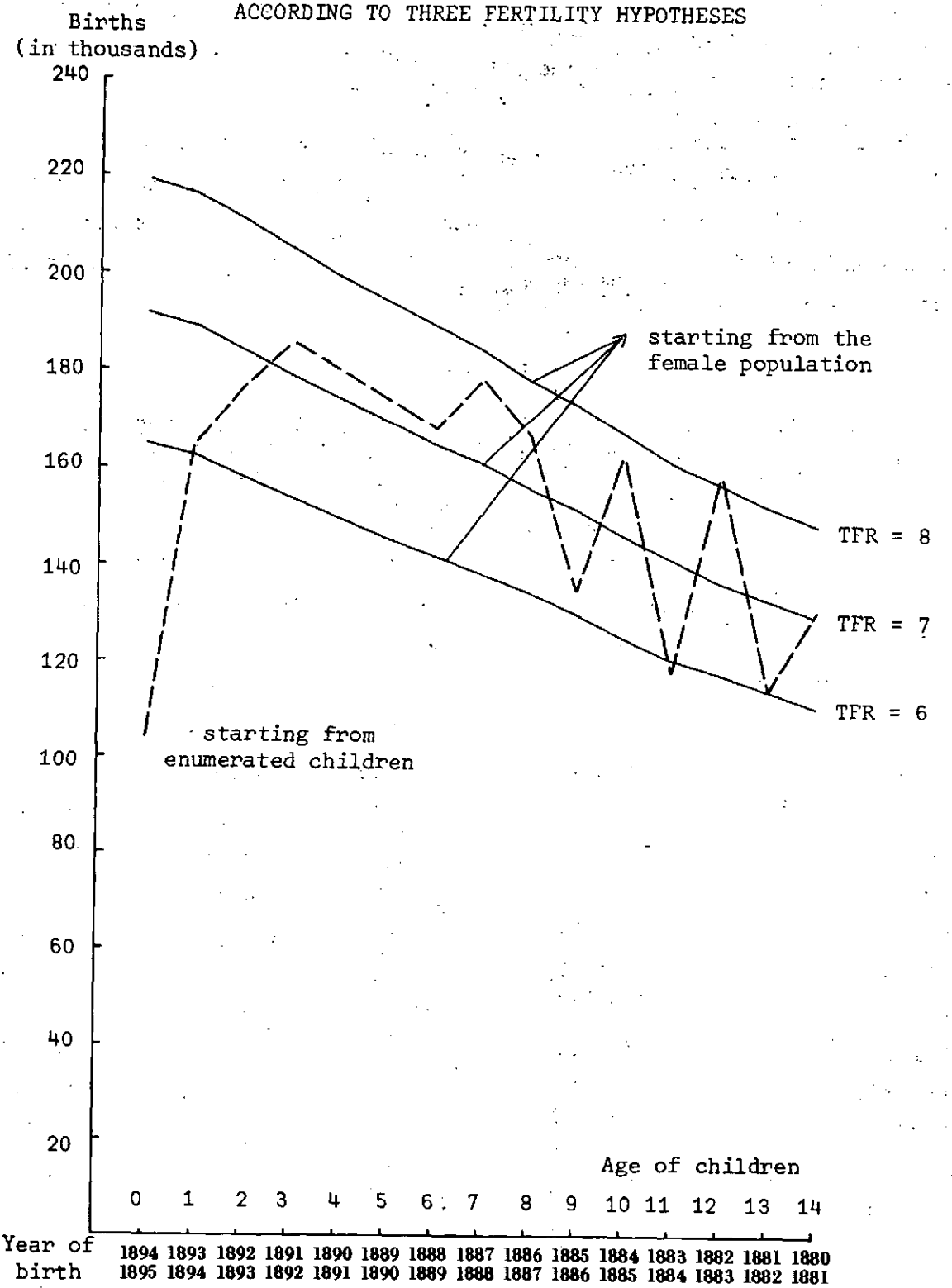
Table 6

SAMPLE OF THE ARGENTINIAN CENSUS OF 1895. COMPARISON BETWEEN THE ANNUAL SERIES OF BIRTHS THAT IS IMPLIED IN THE ENUMERATED CHILDREN BELOW 15, WITH THOSE RESULTING FROM THREE HYPOTHESES ON THE PAST LEVEL OF FERTILITY

Year of birth	Age of children	Reverse-survival of enumerated children	Assumed level of past fertility		
			TFR=6	TFR=7	TFR=8
1894-1895	0	102 993	164 560	191 932	219 282
1893-1894	1	163 761	162 400	189 406	216 397
1892-1893	2	175 760	158 322	184 654	210 966
1891-1892	3	185 173	153 636	179 199	204 727
1890-1891	4	179 717	149 495	174 380	199 216
1889-1890	5	174 163	145 398	169 616	193 760
1888-1889	6	168 073	141 677	165 280	188 798
1887-1888	7	178 118	138 117	161 120	184 052
1886-1887	8	167 450	133 708	155 966	178 080
1885-1886	9	134 692	129 952	151 573	173 068
1884-1885	10	162 377	125 163	145 963	166 758
1883-1884	11	117 744	120 636	140 668	160 713
1882-1883	12	157 200	117 798	137 366	156 938
1881-1882	13	114 387	114 082	133 044	151 996
1880-1881	14	129 600	110 935	129 386	147 812

Figure 3

ANNUAL SERIES OF BIRTHS A) IMPLIED IN THE NUMBER OF CHILDREN ENUMERATED BELOW 15, AND B) DERIVED FROM THE FEMALE POPULATION ACCORDING TO THREE FERTILITY HYPOTHESES



Source: Table 6

Several conclusions can be drawn from these results:

- the variation of the values of the annual series of births, based on the information of enumerated children with ages below 15, shows very low values in the first two years, derived from the number of children aged 0 and 1 in 1895. This can be attributed to larger omission in the enumeration of children in those ages;
- the same series reflects mis-statements of age that produce numbers of annual births clearly exaggerated or under-estimated, if compared with mean values, depending on the age of the children being considered. Exaggeration if ages 7, 8, 10, 12; under-estimation if ages 9, 11, 13;
- the three series derived from the number of women estimated by age in the past and the three hypotheses on fertility show a regular variation, probably closer to the real trend;
- the series corresponding to a TFR=8 can be taken as the highest limit of the fertility level that we are trying to estimate: only with the number of enumerated children aged 12 in 1895, such level could be justified. It would correspond to the year 1882-1883;
- The series corresponding to a TFR=6, on the contrary, can be taken as the lowest limit of the fertility level: only the enumerated children aged 11 and 13 could support that level, if we disregard the enumerated children aged 0 and 1;
- finally, the series corresponding to a TFR=7 is considered a good representation of the general level of the observed series, disregarding, once again, the two first points. In other words, the hypothetical fertility rates, when taken at a level equivalent to a TFR=7, are consistent with the enumerated number of children in 1895. Therefore, that level is adopted as representative of the fertility between 1880 and 1895.

We do not pretend that the estimate constitutes a precise measure of the fertility levels. We only intend to get an estimate of its order of magnitude. It would be deceptive, given the quality of information that is handled, to try to refine the result proving, for example, that 7.2 is a

better estimate than 7. Perhaps it is, but we do not believe that the roughness of the procedure utilized to derive the estimate, the uncertain validity of the mortality hypothesis, and the deficiency of the data would permit a precision of the estimate further than 7, a round number.

Comparison of the results obtained with the former ones

It is interesting to complete this part comparing the fertility estimates that have been obtained, the age structure as well as the level, with those that were formerly derived. This is done in Table 7.

Table 7

COMPARISON OF THE RESULTS OBTAINED WITH THE FORMER FERTILITY ESTIMATES

Age group	Fertility rates by age		Per cent distribution	
	Former	Present	Former	Present
15-19	.140	.086	11.67	6.14
20-24	.270	.249	22.50	17.79
25-29	.290	.312	24.17	22.30
30-34	.260	.287	21.67	20.50
35-39	.140	.225	11.67	16.06
40-44	.090	.155	7.50	11.04
45-49	.010	.086	0.83	6.17
TFR	6	7	100.00	100.00
Mean age ($\bar{m}$)	28.75	31.52	28.75	31.52

The previous estimate, TFR=6, results clearly lower than the present one, TFR=7. We believe that the new estimate has a more strong basis and is preferable to the former one. As it was indicated in the first chapter, the existent estimate was based on information on children ever borne, that is usually defective, even in modern censuses, and it excluded the component of illegitimate fertility, that was important. It resulted, however,

consistent with the age structure of the population as it was indicated in the mentioned study. In Appendix 3 this point is carefully analyzed.

In what age structure of the rates is concerned, the new estimate radically modifies the existing one. The "own-children method" that permitted the derivation of the new structure of the rates, is superior to the one used before. We have no doubt that the new results are more reliable. The estimate of fertility now derived presents a mean age clearly higher than before: 31.52 instead of 28.75 years.

The birth rate of the population

If we apply the series of estimated rates to the female population enumerated in 1895 we obtain the expected number of births in a year. That number (B(1895) = 192 485) divided by the total population plus a correction for the apparent omission of children at ages below 3 (3 954 911 + 101 983 = 4 096 894) gives an estimate of the crude annual birth rate for the period 1880-1895 of 47.45 per thousand. This value, again, exceeds the former estimates; not only the one derived by Somoza, 45 per thousand, (1) but also the estimated by Collver, 43-45 per thousand (10).

Appendix 1

HYPOTHESIS ON MORTALITY

a) Mortality of both sexes in the age interval 0-14

Starting from the information presented in Table 1 in the text, and reproduced in Table A, a life table for both sexes between ages 0-15 was elaborated, defining a model life table within Brass' system, (11) that maintains the adopted values p(5) and p(28).

The essential part of such elaboration may be seen in Table A:

- values p(5) and p(28) for both sexes, derived from the adopted probabilities for men and women with a sex ratio at birth of 105 men per 100 women;
- the logits of the values 1-p(5) and 1-p(28) that are denoted Y(x), and the logits of Brass' general standard table designed YS(x);
- the resultant values of parameters A and B that define the general relation $Y(x) = A + B \cdot YS(x)$;
- by means of such relation, the values of p(x) are computed, for x varying between 0 and 15. From these L_x function is derived, which is presented in Table 2 in the text.

Table A

LIFE TABLE FOR BOTH SEXES BETWEEN AGES 0 TO 15

Item		Age x=5	Age x=28
Probability of survival.	Males p(x)	.6739	.5501
Probability of survival.	Females p(x)	.6914	.5772
Probability of survival.	Both sexes p(x)	.6824	.5633
Logit of 1-p(x) = Y(x)		-.3824	-.1273
Logit of the standard tables YS(x)		-.6015	-.3413
System of equations:	Y(5) = A + B·YS(5)	-.3824 = A + B(-.6015)	
	Y(28)= A + B·YS(28)	-.1273 = A + B(-.3413)	
Therefore:	A = .2073		
	B = .9804		

b) Female mortality in the age interval 15-64

Starting from the information contained in Table A regarding the female population, i.e., the values of p(5) and of p(28), and relation, similar to that previously shown, was established between the logits of such values and the logits from the general standard life table of Brass, that permitted the computation of constants A and B. The result was A = .1693, B = .952.

As the known values of YS(x) refer to function p(x) and what is required for the elaborations described in the text is the function L_x, for the sake of simplicity, it was assumed:

- $\overline{YS}(x) = 1/2\ (YS(x) + YS(x+1))$ being $\overline{YS}(x)$ the logit of $1-L^s_x$
- $\bar{Y}(x) = A + B \cdot \overline{YS}(x)$ being $\bar{Y}(x)$ the logit of the function $1-L_x$ that we search.

The results of this elaboration appear in Table 3 in the text.

c) Exercise for determining q(2) starting from census information ever-born and surviving children in the age group of females 20-24

The number of ever-born children reported in the census by females aged 20-24 was 3 822. A total of 2 884 enumerated children were assigned to such group. If we accept that all of the surviving children of these young mothers were living with them (what seems a reasonable hypothesis for that age group but surely not very reliable for mothers at higher ages), we may interpret the difference, 3 822 - 2 884 = 938, as the number of the children. Its proportion to the total, denoted D_2 is .2454.

There exists a relation, originally derived by Brass (12), and more recently elaborated by Sullivan (13), that permits to calculate the value of the probability of dying between ages 0 and 2, q(2), starting from D_2 and using the ratio P_2/P_3, i.e., the ratio between the mean number of the children born to women aged 20-24 and 25-29, respectively.

The fertility hypothesis that has been developed, permits the computation of P_2 and P_3. Their values are: $P_2 = 1.0525$ and $P_3 = 2.455$. The ratio P_2/P_3 is .429.

Applying Sullivan's relation:

$$q(2) = D_2 \ (1.30 - .54 \ P_2/P_3)$$

we obtain $q(2) = .2454 \ (1.30 - .54 \times .429) = .2622$.

It is interesting to compare this mortality estimate, up to age 2, with the one that has been utilized, up to age 5.

To make them comparable it is calculated with value of q(5) corresponds to the estimated value of q(2), in a model life table in Brass' system, with B = 1. First, the value of A is determined, resulting.1978. With it, the value of p(5) can be established and, therefore, also q(5).

The results are:

- previous estimate of q(5) for both sexes: .3176
- estimate of q(5) starting from the formerly obtained result of q(2): .3084

two values that are very close to each other. In spite of the caution with which the data ought to be considered, due to the hypotheses that had to be introduced in the elaboration, this verification constitutes an important indication that the utilized hypothesis on childhood mortality is reasonable.

Appendix 2

THOMPSON'S REPLACEMENT INDEX

When the existent fertility estimate, that we have examined, was elaborated, the result was supported by a study on Thompson's index of replacement. From this index an estimate of the net reproduction rate followed and then an estimate of the Total Fertility Rate (TFR). The result obtained was 5.8, a value of the same order of magnitude than 6, the estimated one.

It is interesting to reexamine the point, bearing in mind the new TFR, now 7, in order to find out if the figures that are being handled are consistent.

The Thompson's replacement index may be calculated for any age group. In this analysis we exclusively deal with age groups of children aged 5-9 and 10-14. So, we define only two indexes:

$$J_2 = \frac{{}_5N_5}{{}_{25}N_{20}} \Big/ \frac{{}_5L_5}{{}_{25}L_{20}} \qquad J_3 = \frac{{}_5N_{10}}{{}_{25}N_{25}} \Big/ \frac{{}_5L_{10}}{{}_{25}L_{25}}$$

where:

${}_5N_5$ and ${}_5N_{10}$	are the numbers of children aged between 5-9 and 10-14, respectively,
${}_5L_5$ and ${}_5L_{10}$	are the similar numbers in a stationary population with mortality equal to the one of the population under study,
${}_{25}N_{20}$ and ${}_{25}N_{25}$	are the number of females aged 20-44 and 25-49, respectively. In these groups of ages are concentrated the mothers of the children previously considered,
${}_{25}L_{20}$ and ${}_{25}L_{25}$	are the females, in equal age groups, in the stationary population.

The J index, as may be seen in Lotka's work (14), is a good approximation to the net reproduction rate.

When calculating J_3, in the study conducted in 1967, the total number of native children and only 2/3 of the foreign-born, within the group aged 10-14, were considered. It was done in this way, on the assumption that a certain number of mothers of foreign-born children were not included in the census. This argument, that is unquestionably valuable when examining higher age groups, does not seem very strong when dealing with ages below 15. Anyway, to be consistent with the present estimate on fertility, which was derived taken into account births implied in all enumerated children in the 1895, we must now compute J_3 taking into account all the foreign-born children, not only 2/3 of them. This procedure determines an increase in the J_3 value from 1.64 to 1.73.

In the elaboration that follows, an average of J_2 and J_3 is calculated. Before, this average equalled 1.75, now, 1.785 as a result of the modification in J_3.

In order to pass from the average replacement index, which we design J, to the net reproduction rate, which we denote R_o, a relation derived from an analysis by Lotka, regarding information on the United States around 1930, was utilized. Therein, this relation, R_o/J is, approximately, .932. The data Lotka examined, however, do not seem representative of the conditions of mortality and fertility of Argentina around 1895. Using the relations valid for model stable populations, calculated by Coale-Demeny (15), it could be established that for the estimated levels of fertility and mortality for Argentina, the relation R_o/J should be somewhat higher than 1, for example, 1.026, rather than lower than 1. This is the second modification introduced to the former calculations.

Finally, in the former calculations, when passing from the net reproduction rate, R_o, to the gross reproduction rate, R', it was divided by p(28), equivalent to .5775. According to present estimates on fertility and mortality, the value should be .5546. It is not proper, of course, to use data on fertility to derive an independent estimate. It is more suitable to compare the net reproduction rate derived from Thompson's index, which

results 1.83, with the one calculated according to the fertility estimate (TFR = 7) and to the mortality assumption, which results 1.89. They are values of the same order of magnitude. If the elaboration is carried further on, it is because it is intended to clarify each one of the differences regarding former computations up to the end of the exercise.

From the gross reproduction rate obtained starting from the net rate, before, with a survival probability of .5775, now .5546, we derive a Total Fertility Rate (TFR), multiplying by 2.05, to include the births of males. The results are: 5.8 before, 6.8 now. Value 6.8 is of the same order of magnitude than 7 (as it was seen above when comparing net reproduction rates).

Table B summarizes all the steps taken in the above paragraphs.

Table B

COMPARISON OF THE DERIVATIONS OF THE TOTAL FERTILITY RATE (TFR) STARTING FROM THOMPSON'S INDEX: A) IN EXISTENT COMPUTATIONS AND B) IN THE ONES BASED ON THE NEW FERTILITY ESTIMATES

Item	Former computations	Present computations
Children in the 10-14 age group	200 970	211 230
J_2	1.84	1.84
J_3	1.64	1.73
Average (J)	1.75	1.785
Relation R_o/J based on	Lotka U.S.A.	Coale-Demeny model
Value of relation R_o/J	.932	1.026
Estimated value of R_o	1.63	1.83
Survival probability	.5775	.5546
Estimated value of R'	2.82	3.30
Estimated value of the TFR	5.8	6.8

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