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Assessing Aggregate Welfare: Growth and Inequality in Argentina

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Abstract

This paper has two main goals. The first is to complement the Argentine mean income series with inequality estimates in order to obtain aggregate welfare series. Average income figures are estimated from National Accounts while income inequality indices are calculated from the Permanent Household Survey (EPH). Household income from the survey is adjusted for nonresponse, underreporting and demographics. The second objective of the article is to check the statistical significance of changes in inequality and welfare measures. Bootstrapping techniques are used to that aim. One of the main conclusions is that while welfare assessments coincide among different value judgments in some periods (e.g. 1991-1994), they widely vary in some others, particularly in the last four years (1994-1998), where the economy experienced moderate growth and large increases in inequality. It is argued that the period 1994-1998 provides an unprecedented laboratory for distinguishing the social preferences of different analysts according to their evaluation of the performance of the Argentine economy.

Key words: Income distribution, inequality, welfare, Latin America, Argentina

JEL classification: D3, D6, C4

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I. Introduction

A general way of evaluating the economic performance of a country is through its per capita income. However, this practice is valid only when the evaluator's welfare function is utilitarian. Except in this extreme case, measuring aggregate welfare involves not only knowing the mean but also other elements of the income distribution. Particularly, a relevant characteristic accompanying the mean is the degree of inequality.

As is the case of several Latin American countries, Argentina has recently undergone a period of drastic economic reforms aimed at stabilizing the economy and controlling high inflation. The implementation of the Convertibility Plan succeeded in controlling prices, and the economy grew rapidly as measured by its per capita GDP. On the other hand, income has become more unequally distributed.

The main purpose of this work is to complement the Argentine mean income series with inequality estimates, with the goal of obtaining aggregate welfare series which would constitute a better measure of Argentina's economic performance than the commonly used per capita income statistics.[1]

The strategy of this paper is to take as given the mean income statistics from National Accounts, in which the traditional evaluations of economic performance are based, and complement them with our inequality estimates based on microeconomic information from the main household survey in Argentina: the Permanent Household Survey (EPH) conducted by the National Institute of Statistics and Census (INDEC). A considerable effort in obtaining the most accurate measure of the degree of inequality is made. In particular, the original data is adjusted for non-response, income underreporting and demographic factors.

The inequality and welfare indices are constructed using information originated in surveys and, therefore, are subject to sampling variability. Nevertheless, the usual practice is, for instance, to compare the value of some inequality index for two different years, and assert that the distribution has become more or less unequal according to the sign of the difference between these two values. This practice ignores the problem of sample variability, since the difference in values may not be large enough from a statistical point of view to assert with relative certainty that it comes from distributions with different dispersion. A second goal of this paper is, precisely, to formally test the significance of the changes in the inequality indices and the welfare measures.

The rest of the article is organized in the following way: section II briefly presents the conceptual framework, and in section III some methodological aspects are described. Non parametric estimations of the distribution and basic statistics of mean income, inequality, and welfare are presented in section IV. Section V includes the significance analysis. Finally, section VI presents some concluding remarks.

II. Conceptual framework

A usual way of evaluating an economy is using a Bergson-Samuelson social welfare function (*W*). This function aggregates individual welfare levels, usually approximated by household income adjusted by demographic factors (y_t). Analytically,

$$W = W(y_1, y_2, ... y_N) \qquad 2.1$$

where *N* is the number of individuals in the economy. The function *W* should not be interpreted as the result of some social aggregation mechanism, but as an instrument of the analyst or the policy-maker for evaluating the welfare of an economy. This exercise necessarily involves the aggregation of individual welfare levels: the *W* function simply proposes an ordered and consistent way of implementing this exercise.

Social welfare functions are naturally arbitrary since they depend on the analyst's value judgments. Nevertheless, it is common in the literature to propose anonymous, paretian, symmetric and quasiconcave functions.[2] Within the family of *W* functions, the *abbreviated welfare functions* are of special usefulness, since they only have as arguments the mean (m) and an inequality parameter (*I*).

$$W(y_1, y_2, ... y_N) = V(m, I) \qquad 2.2$$

Naturally, it is expected that *V* be non decreasing in m and non increasing in *I*. Additionally, other restrictions on *V* and *I* are necessary to assure the properties of Pareto, symmetry and quasiconcavity.[3] Even if restricted to the set of abbreviated functions that satisfy these requirements, the number of possible choices is infinite. In this paper we limit the analysis to functions that use the Gini coefficient (G) and the Atkinson index (A) as inequality measures. For the case of the Gini coefficient, the abbreviated welfare functions used are those proposed by Sen (1976):

$$W_s = m.(1-G) \qquad 2.\ 3$$

and Kakwani (1986):

$$W_k = \frac{m}{(1+G)} \qquad 2.\ 4$$

A more general function, proposed by Atkinson (1970) and extensively used in the literature is

$$W_a(e) = \left(\frac{1}{N} \sum_{i=1}^{N} \frac{Y_i^{1-e}}{1-e} \right)^{\frac{1}{1-e}} \quad \text{for } \varepsilon \geq 0,\ e \neq 1 \qquad 2.\ 5$$

$$\ln W_a = \frac{1}{N} \sum_{i=1}^{N} \ln y_i \quad \text{for } e = 1 \qquad 2.\ 6$$

The parameter e regulates the convexity of the social indifference curves and it can be interpreted as the degree of inequality aversion. When e tends to 0, the social welfare function tends to the utilitarian one, *i.e.* inequality becomes irrelevant. When e approaches infinite, the function converges to a Rawlsian one where only the income of the poorest individual is relevant. This work considers two alternative values for the parameter of inequality aversion: 1 and 2. In these cases the welfare function takes the following form:

$$W_a(e) = m.(1 - A(e)) \quad \text{with } \varepsilon = 1{,}2 \qquad 2.\ 7$$

where $A(e)$ is Atkinson's inequality index using the parameter e.[4]

Finally, a utilitarian welfare function (or Bentham function) reflects indifference to income inequality, *i.e.*

$$W_b = m \qquad 2.8$$

The use of social welfare functions is not necessary to evaluate the economic performance of an economy when generalized Lorenz curves do not cross (Shorroks, 1983). In this work the number of intersections is large, since many years are compared. For this reason and for simplicity, we preferred presenting the analysis directly in terms of welfare functions.

III. Methodological issues

In order to calculate welfare it is necessary to have estimates of mean income and some inequality measure. Ideally, both parameters should be estimated based on the same distribution, typically the one arising from household surveys. Nevertheless, given the motivation of this work (complementing with distributive considerations the traditional evaluation of the Argentine economy based on per capita income calculated with data from National Accounts) the methodology used is somewhat different. The remaining part of this section is devoted to explain this methodology.

We use the concept of equivalent household income for approximating individual welfare levels. Equivalent household income comes from dividing total household income by the number of equivalent adults in the family, raised to a parameter t, smaller than one, that captures household economies of scale. The equivalent scale is the one calculated by INDEC and the parameter t takes the arbitrary value of .8, reflecting moderate scale economies.

The inequality indices (*i.e.* the values of I in 2.2) are estimated with data from the Permanent Household Survey (EPH) for the Greater Buenos Aires area, for each year between 1980 and 1998. The mean equivalent income (*i.e.* the value of m) could also be computed with data from these surveys. However, we decided to estimate changes in m from National Accounts, as this is the traditional source used for evaluating the Argentine economic performance. As we do not have aggregate series of equivalent income, its changes are estimated from changes in disposable per capita income estimated with information of National Accounts. Specifically, (i) incomes from EPH are adjusted so as the evolution of per capita income of this survey matches the evolution of disposable per capita income, and (ii) mean equivalent income is recalculated using the adjusted data.[5]

Summing up, this article takes the evolution of m as it is estimated from National Accounts and makes efforts for obtaining precise estimates of I with data from the EPH. The remaining part of this section gives details of the adjustments implemented to obtain more precise estimations of the degree of inequality in the income distribution.

Adjustment for non-response

Not all the individuals selected to respond the EPH answer the questions about income. This phenomenon can bias the inequality estimations if (i) non-response depends on income, and (ii) if the percentage of non-response varies with time. Unfortunately, we have strong presumptions about the fulfilling of condition (i) and certainty about the fulfilling of condition (ii). The number of people with incomplete household income report was about 25% at the beginning and in the middle of the eighties and rose to 28% at the end of that decade. In the nineties the efforts of the INDEC to mitigate the problem of non-response succeeded: the percentages fell all over the decade until they reached an 8% in the 1998 survey. Paradoxically, this decrease can cause a bias in the usual inequality estimations that ignore non-response.

We use the predictions of an income determination model to assign incomes to people that do not answer. That is to say, those individuals that declare to work, but who deny to answer how much they earn are assigned an income that is “similar” to that of people in “similar” working, demographic, and socio-economic conditions. In this paper the concept of “similar” makes reference to a multivariate regression context. The Appendix gives details about the procedure implemented to assign incomes.

Adjustment for income underreporting

A common phenomenon in household surveys is that of income underreporting. As in the case of non-response, underreporting is a problem if it differs between income brackets and if it varies in time. Unfortunately, it does not exist a similar mechanism to that of income imputation for the correction of this problem, because it is not possible to identify people who underreport their incomes. The procedure we follow for attenuating this problem is to adjust for differential underreporting by income source. The total income coming from each source is compared to the values from National Accounts for 1993.[6] Due to lack of information, the adjustment coefficients are assumed to be constant in time. The adjustment used implies that the coefficients for underreporting are increasing in income. The richest people are the ones who underreport in a greater proportion because they generate a bigger fraction of their income from returns to capital, being this factor the one that is, on average, more underreported than the others.

IV. Inequality and welfare

In this section estimates of mean income, inequality and welfare in Argentina are presented. After an illustration of the distributions with non-parametric methods (subsection IV.1), indices are calculated and interpreted (subsection IV.2). All the estimations are based on information of the October waves of the EPH for Greater Buenos Aires (Capital Federal and Conurbano) for the following years: 1980, 1982, and 1985 to 1998.

IV.1. Non-parametric estimations

Usually, the study of income distribution is made using only some relevant measures that capture different aspects of interest. For instance, changes in mean income capture changes in the position of income distribution; inequality measures refer to the degree of concentration of the income mass, independently of its position; and welfare measures try to capture both characteristics jointly. Although these measures generally give enough information about economically relevant distributive issues, it is sensible to start by estimating the income distribution itself, so as to count with an adequate description of its main characteristics and temporal evolution. Given the clearly explorative character of these estimations we use non-parametric techniques which provide relevant information about the distribution without relying on arbitrary and probably unrealistic assumptions.

Using the *kernel method* we estimated densities for equivalent household income in 1980,1982, and 1985 to 1998. Due to space restrictions, only the figures for the densities of the logarithm of equivalent household income for some selected years are presented. The details of the estimation process are presented in the Appendix. Figure 4.1 shows a strong shift to the left of the distribution between 1986 and 1989. The distribution of 1991 shifts again to the right, without reaching its position for 1986.

- Place figure 4.1 here -

The three densities shown in figure 4.2 are representative of what happened in the nineties. An important part of the central mass of income shifts to the right, while the lower tail of the distribution tends to accumulate more income. This contrasts with the behavior observed in the eighties where the period of extreme inflation shifts the whole distribution. Hence, the mean increases during the 90's are essentially due to a rising mass accumulation in the upper tail that more than compensates the accumulation in the lower tail. Naturally, this fact has important consequences over the evaluation of aggregate welfare that will be analyzed in the next subsection.

- Place figure 4.2 here -

IV.2. Summary measures

Table 4.1 presents the results of the estimations of the main series related to welfare analysis: mean equivalent income estimated from National Accounts, Gini and Atkinson inequality indices, and Bentham, Sen, Kakwani, and Atkinson welfare functions. All the series are presented in indices making 1980=100.

- Place table 4.1 here -

Average equivalent income is shown in Figure 4.3. The average living standard fell strongly during the "lost decade". After the economic crises of the beginning of the 80's, income recovered until 1987, but decreased again in the final part of the decade, reaching the minimum levels of the series in 1990. At the beginning of the nineties a phase of sustained growth started. Mean equivalent income grew at high rates since 1991 to 1994, fell in 1995 and increased again during the following three years, but at lower rates. The average standard of living in 1998 was the highest of all the period considered (according to National Accounts).[7]

- Place figure 4.3 here -

The evolution of inequality presented in the second panel of Table 4.1 is illustrated in Figure 4.4. The distribution of equivalent income became more unequal between 1980 and 1982, slightly improved towards 1985 and became successively more unequal in 1987, 1988 and 1989. After a peak during the hyperinflation of 1989, income dispersion declined substantially, reaching the most egalitarian point of the period in 1991. Since then a new period of increasing inequality begun. Almost all the indices show a sustained increase until the present. In fact, 1998 appears to be the year of greatest inequality in the whole period for any of the indices considered.[8,9]

- Place figure 4.4 here -

Changes in the social welfare level are the result of changes in the mean and in the degree of inequality of the distribution. It is interesting to investigate the joint evaluation of these changes made by alternative welfare functions. Figure 4.5 shows the five welfare series presented in the last panel of table 4.1. Given that the evolution of $W_a(1)$ does not differ significantly from the evolution of W_s, only the latter is presented.

- Place figure 4.5 here -

In general, the qualitative evaluation of the annual changes in the economy is similar between the different functions considered. Welfare falls drastically between 1980 and 1982 because of a strong income contraction and an increase in inequality. The decrease in aggregate welfare lasted until 1985, although there was a slight distributive improvement. The two following years showed an opposite behavior: welfare improved due to the increase in mean income, and in spite of the increase in inequality.[10]

In the period 1988/89 Argentina experimented a strong contraction in the average living standard and a substantial increase of inequality that led welfare to unprecedented low levels. In 1990 there was a new contraction, this time slighter, in the GDP, but inequality levels decreased substantially. Only the Bentham function does not show an increase in the aggregate welfare level.

Between 1991 and 1994 the highest growth rates of the last two decades were observed. The magnitude of these changes more than compensated the increase in inequality in almost every year of the subperiod. This is the reason why all the indices show successive increases in aggregate welfare, until reaching similar levels to those of 1980. It is interesting to note the coincidence, between the value judgments implicit in the different functions, that aggregate welfare in Argentina returned in 1994 to the level of 1980.

In 1995 the Argentine economy experimented a strong contraction in its product and a substantial increase in inequality that was translated into an important decrease of aggregate welfare. The evaluation of the magnitude of this decrease greatly differs among the alternative welfare functions.

Since 1996 the growth path interrupted in 1995 was restarted. Growth rates were generally smaller in comparison to the previous expansive period. Inequality indices continued to exhibit increases. In spite of this fact, there is coincidence between the different functions considered in showing a rise in welfare between 1995 and 1998.[11] In spite of the coincidence in the qualitative evaluation, the evaluation of the magnitude of the improvement differs substantially between functions.

It is possible to distinguish two types of periods in the last 20 years: (1) periods of economic crises with a strong decrease in the GDP and important rises on inequality, and (2) periods of economic recovery with moderate increases in inequality. In the first group we find the crises of 1980/82, 1988/89 and 1995. The expansive periods of 1986/87, 1991/94 and 1996/98 correspond to the second group. In 1985, 1990 and 1991 inequality decreased. These years do not fit in any of the groups mentioned above. The periods of type (1) implied drastic falls in welfare, while periods of type (2) generated increases.

From the analysis of this section it is possible to conclude that the sign of the annual change in welfare is the same as the sign of the annual change in mean income. However, the magnitudes of these variations can differ significantly, especially for functions that give a greater weight to inequality. This implies that while almost every function coincides in the direction of the annual change in welfare; there may exist huge differences when comparing the extreme points of longer periods. Take the case of 1998 compared to 1994. While for the Bentham and Kakwani functions aggregate welfare in 1998 was clearly higher than in 1994; both years are similar for the Sen and Atkinson (with ϵ=1) functions. In contrast, for the Atkinson function with ϵ=2 the evolution is opposite: welfare in 1998 was lower than welfare in 1994. In fact, the economic performance in 1998 is evaluated as inferior to 1991 and similar to 1987, two years that are clearly worse than 1998 for the other functions considered.

This point suggests that the different opinions about the economic performance of the country, especially in the last years, could be caused by different value judgments applied to the same reality. Even after reaching a consensus about all empirical issues related to the measurement of aggregate welfare, it is probable that individuals with different value judgments have very different assessments of the Argentine economic performance, not only in quantitative terms, but also in qualitative terms. Note that the divergence among value judgments in the assessments of the performance of the economy is not an obvious phenomenon. In fact, it is noticed only in some subperiods of recent economic history, particularly in the last 4 years.

This point also suggests that the experience of the last years can be used to learn the social preferences of a given evaluator. For example, a positive assessment of the economic performance in the period 1994-1998 is consistent with some value judgments, and inconsistent with others. In accordance to Figure 4.5 these last four years are an unprecedented laboratory to distinguish the social preferences of different analysts.

V. Statistical significance of the results

Since surveyed households change period by period, the differences in the indices studied in the previous section could be due to changes in income distribution, or simply to the fact that the sample had changed, or to both factors. This section formally addresses the statistical significance of the changes in inequality and welfare measures. The problem of sample variability is studied particularly for the inequality measures coming from the EPH. While the computation of per capita income by National Accounts is surely subject to a similar problem, we do not count with the necessary data to evaluate its relevance.

We use resampling techniques like the *bootstrap*, which provide interval estimations and dispersion measures for the inequality and welfare indices, in a simple and efficient way. Additionally, the same tool is used to implement tests for evaluating the null hypothesis of no changes between two periods. For simplicity, the analysis concentrates in the Gini coefficient and in the Sen index.

For the case of the Gini coefficient, the bootstrap is implemented as follows:[12]

1. Using the original sample for a given period, compute the Gini coefficient.
2. Using the original sample as it were the population, take a sample (with replacement) and calculate the Gini coefficient for this subsample.
3. Repeat the previous step a sufficient number B of iterations. Now there will be B estimations of the Gini coefficient.[13]
4. Using the estimations of the previous step, calculate the standard error of the estimated Gini coefficients. This represents the sample variability of the Gini estimated with the original sample.
5. For the calculation of the confidence interval (G_I, G_S) at a 95% of significance, sort the Gini coefficients estimated in (3) from lowest to highest. Take as inferior limit G_I the value that leaves below a 2.5% of the estimated coefficients, and as superior limit G_S, the value that leaves above the 2.5% of the estimated coefficients.
6. Repeat the procedure for all the periods desired.

The procedure used to evaluate the null hypothesis that the Gini coefficients for two distributions are the same is similar to the previous one. In this case, the population of interest consists of the incomes for a pair of given years. The bootstrap takes a sample with replacement for each of the years involved in the comparison, calculates the Gini coefficient for each and computes the difference between them. According to the duality between the interval estimation and the hypothesis test, the test rejects the hypothesis of equality between the coefficients if the confidence interval estimated for the difference of the Gini coefficients does not include the number zero.

The remaining part of the section presents the results of applying this procedure to the Gini coefficient and the Sen welfare index.

Inequality

Table 5.1 shows the estimated Gini coefficient for each year, its bootstrapped standard error, and the corresponding confidence interval for a 95% of significance. Given the large size of the sample, we can expect the Gini coefficients to be estimated with high precision. This is reflected in the low values of the standard errors. The fourth column, that contains the coefficients of variation of the Gini, shows that the standard error is almost always inferior to the 2% of the coefficient.

- Place table 5.1 here -

Table 5.2 shows the results of the equality test for the Gini coefficients for several pairs of years.[14] The third column shows the differences between the Gini coefficients for each pair of years. Columns 4 to 7 show the percentiles of the distribution of these differences. For example, the numbers in columns 5 and 6 correspond to a confidence interval of 90%. According to the previously described procedure, the null hypothesis of equality between the Gini coefficients is rejected if the confidence interval for this difference does not include the number zero. In each row it is indicated with a "*" whether the null hypothesis is rejected for a significance level of 0.95. The table indicates that, for example, compared with 1997, the years 1982, 1985, 1991 and 1993 had lower levels of inequality (as measured by the Gini), even considering the problem of sample variability. The only years with a higher Gini coefficient are 1989 and 1995. However, in none of these two years the difference in the Gini coefficients was significantly different from zero in statistic terms.

- Place table 5.2 here -

Table 5.3 shows a summary of the results for the nineties. As it can be observed, the cases in which equality can not be rejected correspond, in general, to comparisons between successive years. Except in two cases (1994 and 1995 with respect to their previous years), in the rest of the comparisons between consecutive years it is not possible to reject the null hypothesis of absence of changes in the Gini coefficient. This implies an important point: changes in inequality occur slowly. In general it is precipitated to enounce propositions about the evolution of inequality from the observation of the Gini coefficient for two consecutive years. This result also has implications about the recommended frequency of the distributive analysis based on household surveys. According to the evidence of the last years, a frequency smaller than two years would possibly capture more sample variability (noise) than real changes (signal).

- Place table 5.3 here -

Welfare

Welfare measures have two sources of sample variability: the inequality measure and the mean come from random samples. The previous section discussed strategies for dealing with sample variability in inequality measures. Unfortunately, this procedure can not be applied to the estimation of per capita income from National Accounts due to lack of disaggregate information. So, the analysis is exclusively concentrated in the sample variability that comes from the variability in the inequality index. For simplicity in the exposition, only the results for the Sen index are presented. Table 5.4 shows the observed value for this index with base 1980=100, and the estimates, using the *bootstrap* procedure, of the standard error, the coefficient of variation and the confidence interval at a 95%.

- Place table 5.4 here -

The inequality tests presented in Table 5.5 show a higher degree of rejection of the hypothesis of equality between two years than in the case of the Gini. For example, although the difference between the Gini coefficients for 1991 and 1993 is not statistically significant, the increase of mean income between these years was big enough to generate a statistically significant difference in the Sen index (assuming absence of mean variability). There are years in which a contrary phenomenon is observed. The Gini coefficient for 1993 is significantly lower than the one for 1997, but the Sen indices are not different in a statistic sense.

- Place table 5.5 here -

The results of this section confirm that the analysis of changes in income distribution and welfare performed in the previous section is in general not contaminated by the problem of sampling variability since most of the observed changes reflect indeed changes in the underlying distributions of income.

VI. Concluding remarks

The measurement of an economy's performance is an obviously relevant task. This paper presents results for the case of Argentina, which experienced a process of drastic economic reform in the last decade. The per capita income series is complemented with estimates of the degree of inequality in the distribution, so as to obtain alternative aggregate welfare measures. The calculation of inequality includes some adjustments to the original EPH data that are generally not considered jointly in the literature. Finally, the article emphasizes the need of evaluating the statistic significance between two indices for enouncing propositions about the change in inequality or welfare.

One of the main conclusions of the paper is that though in general for all value judgments considered the sign of the annual change in welfare is the same as the sign of the annual change in mean income, the welfare assessment of longer periods widely varies across different value judgments. In particular, for some functions welfare has clearly increased in the period 1994-1998, while for some other functions it has decreased. This point suggests that the different opinions about the economic performance of the Argentine economy could be caused by different value judgments applied to the same reality. This divergence in the assessments of the economy is not an obvious phenomenon. In fact, it is noticed only in some subperiods of recent economic history, where a rapid GDP expansion and a marked increase in inequality leave room for divergences in the welfare appraisal of the economy. It is argued that the period 1994-1998 provides an unprecedented laboratory for distinguishing the social preferences of different analysts according to their evaluation of the performance of the Argentine economy.

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Appendix

Income imputation for non-response [15]

Income imputation for non-response is made for two separated groups of individuals: those who have labor earnings and those who are retired. For the first group we run a regression of the logarithm of hourly labor income as a function of several independent variables that try to capture demographic characteristics (age, age squared, sex, marital status), occupational characteristics (work experience, formal or informal, sector of activity and skills) and the maximum educational level attained by the worker. The estimated model is used to predict the hourly income of workers that do not answer the income question of the survey. That hourly income is multiplied by the number of working hours reported in the survey to obtain the monthly labor income. The model is estimated by least squares weighted by the importance of the household in the population (using the weights provided by the EPH).[16] The regression is estimated for individuals who are between 14 and 74 years old with positive monthly working hours smaller than 85 and who declare to have incomes from wages or from self-employment. For 1998 the imputed average hourly wage was 18% higher than the average per hour wage of the workers who answered the income questions.

In the case of retired individuals the absence of potentially relevant variables in the survey decreases the explanatory power of the regression. The variables included (age, age squared, sex, civil status and maximum educational level) are all significant, at 10%, with the expected signs and order of magnitudes. For 1998, in contrast to the case of active workers, the average value of the predictions arising from the model is lower than the real average.

Non-parametric estimations[17]

Let Y be a continuous and positive random variable that represents the income distribution, that has the distribution function $F_y(y)=\Pr(Y \leq y)$, and denote with $f(y)$ the density function. For the estimation we count with a sample of n observations, whose realizations are denoted with $Y_i = 1,...,n$. The *kernel estimator* of $f(y)$ is:

$$\hat{f}(y) = \frac{1}{n} \sum_{i=1}^{n} \frac{1}{h} K\left[\frac{y - Y_i}{h} \right]$$

where *K(z)* is any continuous, symmetric at zero, and unit integral function. *h* is known as the smoothed parameter. Intuitively, the estimator can be interpreted as the proportion of points that fall into a "window" of width *h* around the point *y*, where the contribution of each one of them to the total is regulated by the weight function *K(z)*. For example, if $K(z)=1$ if $z \in (0,1)$ and 0 otherwise, then the estimator counts the proportion of observations that fall in a symmetric interval of width *2h* around *y*, what usually corresponds to a histogram.

The choice of the smoothing parameter implies a trade-off between bias and variance: a higher *h* implies considering information that is more far away from the point of interest *y*, what reduces the variance of the estimator by increasing the number of points, but with the cost of introducing a higher bias by considering less relevant information. A small *h* tends to produce unbiased but very variable estimations, while a very big *h* produces smooth but biased estimations. The problem of the choice of the bandwidth is crucial, and even being intensively studied in the literature, it does not exist an automatic and commonly accepted solution. Given the exploratory character of this work, several authors (Silverman (1986), Deaton (1997)) suggest choosing *h* by visual inspection, starting with a small *h* and increasing it until a reasonable smoothing has been reached. This is the procedure followed for this paper. The choice of the kernel is a less important problem (Silverman, 1986). For simplicity we have worked with a gaussian kernel, *i.e. K(z)* corresponds to the standardized normal density function.

Figure 4.1

Density of the logarithm of equivalent income
Greater Buenos Aires, 1986, 1989 and 1991
Non-parametric estimation

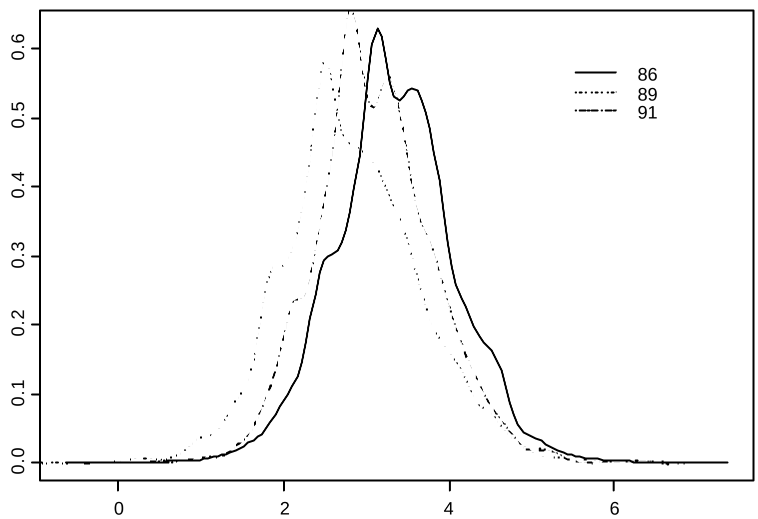


Figure 4.2

Density of the logarithm of equivalent income
Greater Buenos Aires, 1991, 1995 and 1998
Non-parametric estimation

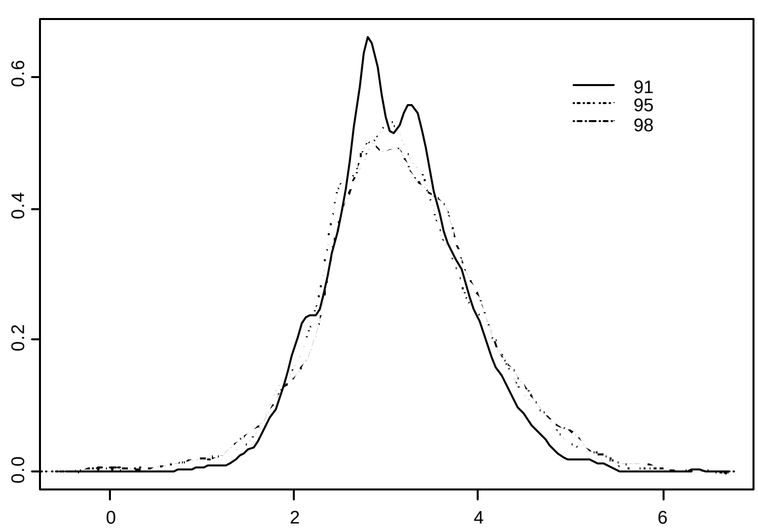


Table 4.1
Mean, inequality and welfare indexes
Argentina, 1980-1998. Index base 1980=100

	Mean	*Inequality*			*Welfare*				
		Gini	A(1)	A(2)	Wb	Ws	Wk	Wa(1)	Wa(2)
1980	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1982	93.9	103.2	107.2	104.4	93.9	91.8	93.0	91.5	90.6
1985	82.4	102.4	103.6	102.8	82.4	81.0	81.9	81.4	80.6
1986	87.8	102.1	105.1	104.1	87.8	86.5	87.2	86.3	84.9
1987	93.6	107.9	113.5	110.3	93.6	88.5	91.5	89.3	86.0
1988	91.7	108.6	118.6	119.6	91.7	86.2	89.5	85.9	77.4
1989	82.5	113.8	124.7	123.7	82.5	74.5	79.3	75.5	66.9
1990	80.9	99.8	99.9	102.4	80.9	81.0	80.9	80.9	79.3
1991	85.4	97.4	93.1	92.2	85.4	86.9	86.0	87.4	90.6
1992	91.9	99.7	99.3	98.5	91.9	92.2	92.0	92.1	93.0
1993	97.5	99.7	99.3	104.2	97.5	97.7	97.6	97.7	94.3
1994	101.7	105.1	108.9	103.4	101.7	98.1	100.2	98.6	99.0
1995	98.9	112.5	124.1	120.5	98.9	90.3	95.4	90.8	82.8
1996	103.2	111.5	122.2	124.7	103.2	95.0	99.9	95.4	82.9
1997	108.8	112.5	126.6	122.5	108.8	99.3	104.9	98.9	89.3
1998	110.4	115.4	129.6	127.6	110.4	98.5	105.6	99.3	86.1

Source: Author's calculations based on data from National Accounts and the Encuesta Permanente de Hogares, October, GBA. *Mean* corresponds to the average equivalent income estimated from EPH and national per capita disposable income (constructed with information of National Accounts, DGI, ANSES, ANA, BCRA and INDEC). Gini and Atkinson (with ϵ=1,2) inequality indexes are computed from the EPH of the Greater Buenos Aires. W_b=Bentham, W_s=Sen, W_k=Kakwani and $W_a(\varepsilon)$ = Atkinson with a parameter ε.

Figure 4.3
Mean equivalent income
Argentina, 1980-1998

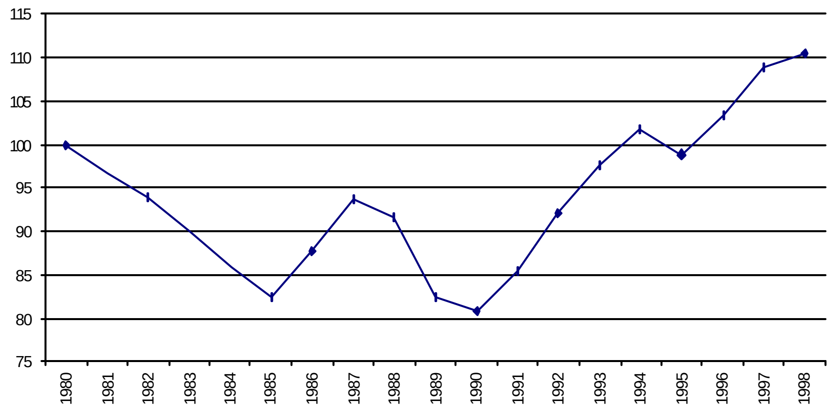


Figure 4.4
Inequality in the distribution of equivalent income
Greater Buenos Aires, 1980-1998

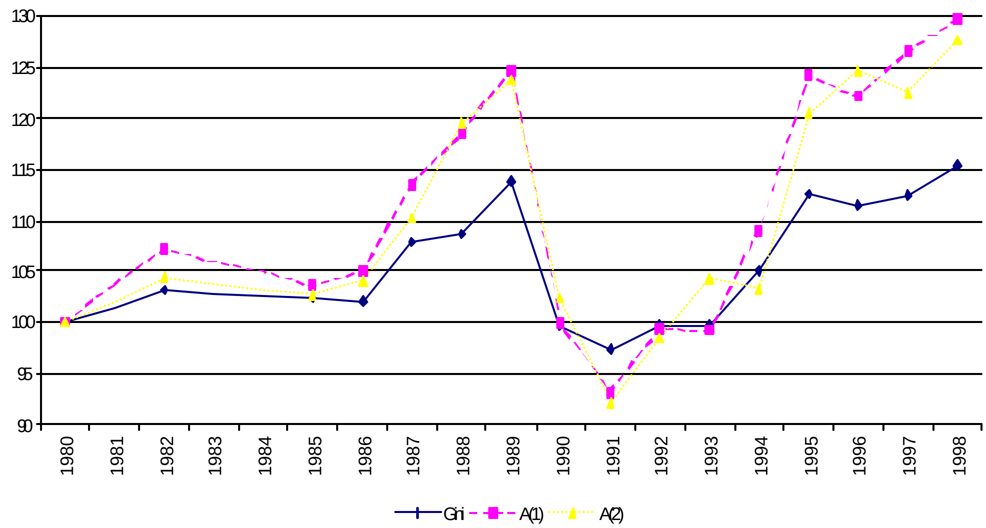
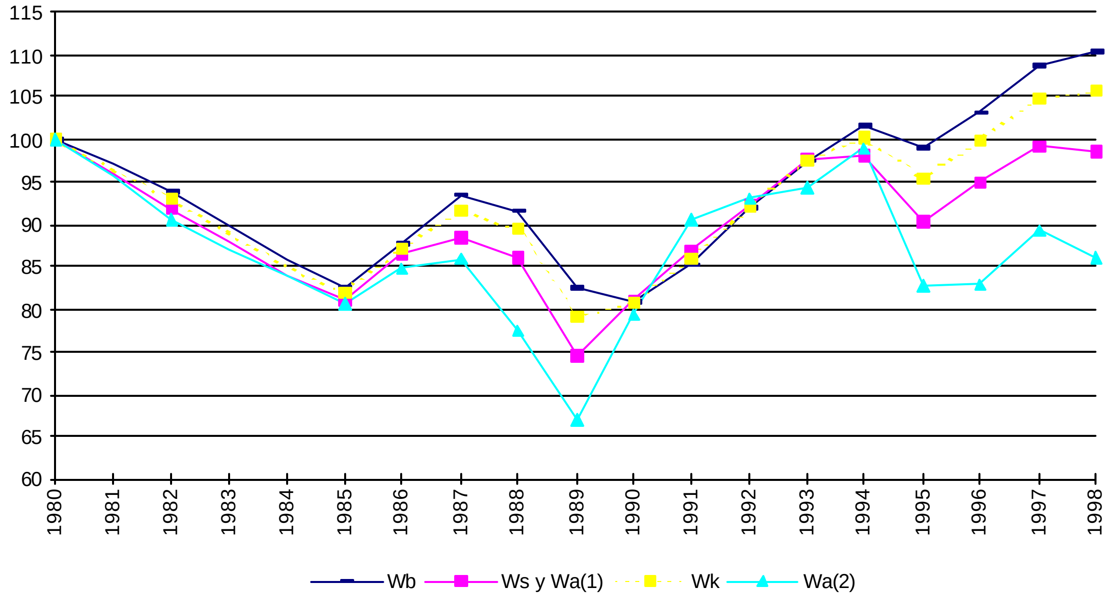


Figure 4.5
Welfare
Argentina, 1980-1998



Note: W_b=Bentham, W_s=Sen, W_k=Kakwani and $W_a(\epsilon)$=Atkinson

Table 5.1
Sample variability of the Gini coefficient
Observed values, standard errors, coefficients of variation and confidence intervals

Year	Observed	Standard error	Coefficient of variation	Confidence interval 95%	
1980	0,4104	0,0085	2,1%	0,3931	0,4269
1982	0,4233	0,0161	3,8%	0,3928	0,4576
1985	0,4195	0,0092	2,2%	0,4021	0,4383
1986	0,4190	0,0066	1,6%	0,4072	0,4326
1987	0,4426	0,0082	1,8%	0,4273	0,4584
1988	0,4457	0,0069	1,5%	0,4335	0,4606
1989	0,4671	0,0069	1,5%	0,4532	0,4804
1990	0,4095	0,0086	2,1%	0,3938	0,4282
1991	0,3999	0,0083	2,1%	0,3852	0,4154
1992	0,4090	0,0076	1,8%	0,3942	0,4243
1993	0,4092	0,0061	1,5%	0,3976	0,4204
1994	0,4313	0,0074	1,7%	0,4152	0,4455
1995	0,4617	0,0080	1,7%	0,4483	0,4768
1996	0,4573	0,0079	1,7%	0,4428	0,4738
1997	0,4617	0,0083	1,8%	0,4444	0,4764
1998	0,4737	0,0079	1,7%	0,4594	0,4890

Source: Author's calculations based on the EPH.

Table 5.2
Equality tests for the Gini coefficient

Years		Difference	Percentiles				Standard	Rejects
			0,025	**0,05**	**0,95**	**0,975**	**Error**	**equality**
1982	1985	0,0038	-0,0330	-0,0266	0,0371	0,0429	0,0199	
1982	1987	-0,0193	-0,0509	-0,0464	0,0156	0,0262	0,0206	
1982	1989	-0,0437	-0,0755	-0,0732	-0,0114	-0,0023	0,0196	*
1982	1991	0,0235	-0,0089	-0,0047	0,0554	0,0597	0,0182	
1982	1993	0,0141	-0,0203	-0,0142	0,0472	0,0522	0,0192	
1982	1995	-0,0384	-0,0754	-0,0687	-0,0092	-0,0046	0,0184	*
1982	1997	-0,0384	-0,0738	-0,0656	-0,0053	-0,0020	0,0201	*
1982	1998	-0,0504	-0,0803	-0,0776	-0,0213	-0,0175	0,0165	*
1985	1987	-0,0231	-0,0427	-0,0412	-0,0047	-0,0005	0,0116	*
1985	1989	-0,0475	-0,0690	-0,0659	-0,0281	-0,0259	0,0117	*
1985	1991	0,0197	-0,0032	-0,0004	0,0368	0,0410	0,0121	
1985	1993	0,0103	-0,0084	-0,0050	0,0283	0,0304	0,0101	
1985	1995	-0,0422	-0,0652	-0,0630	-0,0249	-0,0202	0,0116	*
1985	1997	-0,0422	-0,0635	-0,0619	-0,0247	-0,0211	0,0116	*
1985	1998	-0,0542	-0,0778	-0,0740	-0,0355	-0,0325	0,0121	*
1987	1989	-0,0245	-0,0460	-0,0418	-0,0089	-0,0065	0,0103	*
1987	1991	0,0427	0,0267	0,0287	0,0615	0,0648	0,0105	*
1987	1993	0,0334	0,0157	0,0184	0,0485	0,0515	0,0093	*
1987	1995	-0,0191	-0,0372	-0,0341	-0,0022	0,0012	0,0103	*
1987	1997	-0,0191	-0,0390	-0,0363	0,0003	0,0017	0,0110	
1987	1998	-0,0311	-0,0545	-0,0491	-0,0135	-0,0112	0,0113	*
1989	1991	0,0672	0,0463	0,0493	0,0850	0,0880	0,0112	*
1989	1993	0,0579	0,0391	0,0416	0,0730	0,0780	0,0103	*
1989	1995	0,0053	-0,0161	-0,0126	0,0229	0,0294	0,0114	
1989	1997	0,0054	-0,0145	-0,0122	0,0249	0,0275	0,0110	
1989	1998	-0,0066	-0,0260	-0,0230	0,0095	0,0110	0,0103	
1991	1993	-0,0093	-0,0288	-0,0262	0,0057	0,0116	0,0104	
1991	1995	-0,0619	-0,0840	-0,0802	-0,0421	-0,0381	0,0118	*
1991	1997	-0,0618	-0,0819	-0,0792	-0,0437	-0,0415	0,0110	*
1991	1998	-0,0738	-0,0925	-0,0908	-0,0543	-0,0507	0,0111	*
1993	1995	-0,0525	-0,0764	-0,0702	-0,0360	-0,0316	0,0109	*
1993	1997	-0,0525	-0,0709	-0,0683	-0,0361	-0,0335	0,0100	*
1993	1998	-0,0645	-0,0825	-0,0804	-0,0502	-0,0470	0,0095	*
1995	1997	0,0001	-0,0197	-0,0178	0,0211	0,0246	0,0118	
1995	1998	-0,0120	-0,0308	-0,0280	0,0058	0,0082	0,0102	
1997	1998	-0,0120	-0,0309	-0,0284	0,0064	0,0079	0,0105	

Source: Author's calculations based on the EPH.

Table 5.3
Observed difference in the Gini coefficients
Equality tests for the nineties

	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
1992	(-.0092)						
1993	(-.0093)	(-.0002)					
1994	-0.0314	-0.0223	-0.0221				
1995	-0.0619	-0.0527	-0.0525	-0.0304			
1996	-0.0575	-0.0483	-0.0481	-0.0261	(.0044)		
1997	-0.0618	-0.0526	-0.0525	-0.0304	(.0001)	(-.0043)	
1998	-0.0738	-0.0647	-0.0645	-0.0424	(-.012)	-0.0164	(-.012)

Note: The numbers between parenthesis correspond to the cases where equality between coefficients is not rejected

Table 5.4
Sample variability of the Sen welfare index

Year	**Observed**	**Standard Error**	**Coefficient of Variation**	**Confidence Interval 95%**	
80	100.00	1.45	1.45%	97.19	102.92
82	91.83	2.56	2.79%	86.38	96.69
85	81.12	1.28	1.58%	78.49	83.55
86	86.52	0.98	1.14%	84.49	88.28
87	88.48	1.30	1.47%	85.97	90.91
88	86.20	1.07	1.24%	83.89	88.10
89	74.57	0.97	1.29%	72.70	76.51
90	81.01	1.17	1.45%	78.45	83.17
91	86.92	1.20	1.38%	84.67	89.04
92	92.11	1.18	1.28%	89.73	94.42
93	97.69	1.01	1.04%	95.85	99.61
94	98.09	1.27	1.30%	95.65	100.86
95	90.28	1.34	1.48%	87.75	92.54
96	94.98	1.37	1.45%	92.09	97.52
97	99.33	1.53	1.54%	96.62	102.51
98	98.54	1.48	1.51%	95.68	101.21

Table 5.5
Equality tests for the Sen welfare indexes

Years		**Difference**	**Percentiles**				**Standard**	**Rejects**
			0.025	**0.05**	**0.95**	**0.975**	**Error**	**equality**
82	85	6.3184	1.6704	3.0583	8.9218	9.4822	1.8418	*
82	87	1.9754	-1.8076	-1.3982	4.7330	5.2247	1.7696	
82	89	10.1825	6.0853	6.9759	12.8856	13.0665	1.7780	*
82	91	2.8979	-0.5296	0.1500	5.2670	5.3978	1.7047	*
82	93	-3.4525	-7.2336	-6.5595	-0.8492	-0.5695	1.7159	*
82	95	0.9146	-2.9809	-2.3009	3.6206	3.9369	1.7633	
82	97	-4.4199	-7.9906	-7.5040	-1.7724	-1.5435	1.7979	*
82	98	-3.9536	-7.9622	-6.8545	-1.7385	-1.1156	1.7749	*
85	87	-4.3429	-6.1499	-5.9466	-2.5646	-2.3083	1.0394	*
85	89	3.8641	2.1785	2.5068	5.4217	5.6699	0.9011	*
85	91	-3.4205	-5.1147	-4.8508	-1.7348	-1.5267	0.9615	*
85	93	-9.7709	-11.8916	-11.3067	-8.2042	-7.8466	1.0019	*
85	95	-5.4038	-7.4774	-7.1874	-3.5963	-2.9257	1.1459	*
85	97	-10.7382	-12.6422	-12.2825	-9.0054	-8.7186	1.0663	*
85	98	-10.2719	-12.3559	-12.0595	-8.3401	-8.1668	1.0580	*
87	89	8.2071	5.9766	6.5118	9.8402	9.9377	0.9776	*
87	91	0.9225	-0.9883	-0.7932	2.3282	2.7257	0.9893	
87	93	-5.4280	-7.4207	-7.0608	-3.9502	-3.7651	0.9682	*
87	95	-1.0608	-3.0572	-2.8325	0.4765	0.9055	1.0254	
87	97	-6.3953	-8.5883	-8.2517	-4.4956	-4.2243	1.1445	*
87	98	-5.9290	-8.3041	-7.7790	-4.1780	-3.8385	1.0982	*
89	91	-7.2846	-9.4172	-8.9370	-5.7884	-5.7018	0.9642	*
89	93	-13.6350	-15.1846	-14.8561	-12.1209	-12.0504	0.8453	*
89	95	-9.2679	-11.4880	-10.8886	-7.8184	-7.6616	0.9905	*
89	97	-14.6023	-16.9641	-16.6023	-12.9340	-12.3297	1.0989	*
89	98	-14.1361	-16.0602	-15.6545	-12.5357	-12.1697	1.0015	*
91	93	-6.3504	-8.3321	-7.9870	-4.6853	-4.4963	1.0233	*
91	95	-1.9833	-3.6703	-3.4127	-0.1911	0.1132	1.0058	*
91	97	-7.3177	-9.3269	-8.9986	-5.3486	-4.9376	1.1252	*
91	98	-6.8515	-8.8156	-8.4327	-5.1907	-4.8973	1.0286	*
93	95	4.3671	2.5082	2.7631	6.2253	6.6455	1.0491	*
93	97	-0.9673	-2.9322	-2.6666	0.9888	1.4555	1.1183	
93	98	-0.5010	-2.5793	-2.2867	0.9831	1.1315	1.0409	
95	97	-5.3345	-7.6185	-7.1886	-3.7470	-3.4646	1.1278	*
95	98	-4.8682	-7.0035	-6.7318	-3.0513	-2.6735	1.0931	*
97	98	0.4663	-1.7931	-1.5845	2.0631	2.3179	1.1504	

Note: The differences correspond to the level of the Sen index.

Source: Author’s calculations based on the EPH.

Acknowledgement

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[1] Previous work on welfare estimation for Argentina are Diéguez and Petrecolla (1976), Gasparini and Weinschelbaum (1991) and Gasparini (1999).

[2] See, for example, Lambert (1993) and Mas Colell et al. (1995).

[3] See Lambert (1993) and Amiel and Cowell (1996).

[4] In fact, when ε=2, the right-hand side of (2.7) represents the absolute value of the resulting abbreviated welfare function.

[5] Naturally, this procedure has pitfalls caused by the lack of information on relevant variables. Particularly, while the mean is calculated at national level, the distribution refers to Greater Buenos Aires, mainly due to the absence of surveys that cover the whole analysis period for the rest of the country.

[6] There is no information for the national income discriminated by income source for other years of this decade.

[7] The evolution of mean equivalent income estimated from the EPH for Greater Buenos Aires is fairly consistent with figure 4.3. The greatest difference is the significantly lower levels of mean income registered in the EPH in the nineties, with respect to National Accounts. It would be very important to have a study of the possible causes of these differences.

[8] Note that this analysis is based on indices that come from a sample of the population, and consequently, they are subject to the problem of sample variability. In the next section an evaluation of the robustness of the propositions about the changes in inequality based on sample measures is made.

[9] In Convenio (1999) the impact of the three income adjustments is evaluated: non-response, income underreporting and demographic factors. The main result is that while the three adjustments significantly modify the inequality level, they do not alter the majority of the conclusions with respect to its trend.

[10] All these propositions are subject to the statistic significance analysis of the next section.

[11] There are divergences in the evaluation of 1998 compared to 1997: while the Bentham, Kakwani, and Atkinson (with ϵ=1) functions show an increase of welfare, the rest of the functions shows a decrease.

[12] This section is based on Gasparini and Sosa Escudero (1999) and Mills and Zanvakili (1997) who have recently used bootstrap techniques for evaluating the significance of the income distribution measures. We refer to these sources for technical details and an evaluation of the performance of the bootstrap in this case.

[13] The appropriate number of replications is an important issue, and is actually being discussed in the literature. Generally, it is recommended to use a number of replications not smaller than 200 for the estimations of the standard errors. See Buchinsky and Andrews (1997).

[14] To save space, not all the possible combinations are shown. They could be obtained by request from the authors.

[15] See Convenio (1999) for a more detailed description of the method used and some results.

[16] The estimation by OLS could generate selection bias by ignoring the individuals that do not declare incomes. In this case it would be convenient to estimate the model using the Heckman correction. However, as we do not have a satisfactory model for the decision of not declaring incomes, we decided to use OLS. The possible selection bias is accepted to avoid the possible bias introduced by misspecification of the selection model. Several authors (see Maloney (1998)) have reported and quantified the fact that the selection bias is comparatively smaller than the bias introduced by misspecification.

[17] Silverman (1986) and Pagan and Ullah (1999) present abundant details on the subject. Hall (1994) and Deaton (1997) are relevant references from an econometric point of view. Recent applications to the problem of estimation of income distribution are Schulter (1996), Burkhauser et al. (1999), and for the Argentine case, Botargues and Petrecolla (1999).