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# On Multivariate Distributions of Well-Being: The case of the Argentine Provinces in the 1990s

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# On Multivariate Distributions of Well-Being: The case of the Argentine Provinces in the 1990s*

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**Abstract**

This paper utilises multidimensional methods to study changes (if any) in the distribution of welfare in Argentina during 1990s. We compare 1991 and 2001 trivariate welfare distributions across Argentine provinces. The dimensions considered are income, health, and education; the indicators utilized are average per capita household income; life expectancy at birth; and proportion of adult population with at least complete primary schooling, respectively.

We apply item-by-item and aggregative strategies. We conclude that we are unable to arrive at unambiguous orderings of the univariate distributions of income, health and education across provinces hence suggesting the relevance of a multivariate approach. While health and education distributions improved during the decade, income distribution worsens. Second, depending on the measure utilised and value of parameters, the ranking obtained from an exclusive concentration on the distribution of income among Argentine provinces could differ from that obtained using aggregative techniques. Income distribution analyses might, in fact, be missing relevant aspects of the welfare inequality among provinces in Argentina.

**Keywords**: multidimensional distributions, inequality, Argentina.
**Approximate Word Count**: 9,980

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# 1. Introduction

There is a general agreement that we should use a multidimensional approach to study the distribution of people's well-being (Atkinson and Bourguignon 2000; Sen 2000; Sen and Foster 1997). Income distribution analyses as such might be missing relevant aspects of the welfare of the population claim welfarist, basic needs, and capabilities approaches. In recent years, there has been immense progress towards describing well-being not only by income but also by other attributes, such as health, education, civil rights, or housing indicators. In the poverty area, many studies have advanced in this direction both theoretically and in the search for more appropriate measures of well-being and deprivation that help us to describe and identify the poor (Bourguignon and Chakravarty 1999; 2003; Ruggeri Laderchi *et al.* 2003; Sen *et al.* 1987; Tsui 2002). In the field of welfare distribution, however, the improvements towards a 'multidimensional perspective' have been less prominent. So far, a relatively small number of papers have emerged following this approach (among others, Atkinson and Bourguignon 1982; Kolm 1977; Maasoumi 1986; 1999; Tsui 1995). They clearly set a solid basis for the area.

The purpose of the paper is to utilise multidimensional methods to study the changes (if any) in the distribution of welfare in Argentina during the 1990s. Specifically, it will compare 1991 and 2001 trivariate welfare distributions across Argentine provinces through various techniques. Differences (and similarities) in results will help us examine the consequences of prioritising one technique or assumption over others. The dimensions considered are income, health, and education; the indicators employed are *real per capita household income*, *life expectancy at birth*, and the *proportion of the adult population with at least complete primary schooling*, respectively. The underlying hypothesis is that multidimensional distribution analysis – as opposed to univariate income analysis – contributes to the understanding of welfare inequalities in Argentina. The deep economic and social transformations experienced in recent years make Argentina a case of singular interest.

During the 1990s, Argentina put in place a currency board exchange rate arrangement, known as the *Convertibility system*. The regime came together with a model of massive privatisations of public utilities,

deep trade and financial opening, and deregulation of domestic markets. In clear contrast with previous decades, Argentina enjoyed fast economic growth and a drastic fall in inflation rates. On the other hand, the unemployment rate tripled while income inequality and poverty rates increased to levels of unprecedented magnitude. At the same time, health and education indicators continued with the positive trends from the previous decades. Still, the trend and magnitude of changes observed in these dimensions were not alike among provinces. A fuller description and analysis of the regional distribution of welfare represents, in my view, a fundamental element for the understanding of the consequences of the economic changes on the population's quality of life[1]. This paper will focus on the distribution of regional average performance, hence abstracting from inequalities within provinces. Without disregarding the importance of the latter, the present study serves to emphasise the spatial implications of the economic system in place. Additionally, following Stewart, 'horizontal inequalities' – in this case, geographically defined – can be regarded as key determinants of political cohesion within a country (Stewart 2000), particularly relevant in the Argentine federal setup.

At present, there exist basically three strategies for the comparisons of multivariate distributions: *item-by-item* (each dimension's distribution is analysed separately); *aggregative approach* (through the use of an inequality measure applied to a composite index of welfare or of multivariate measures); and *non-aggregative strategies* (stochastic dominance: multivariate distributions are compared through first and second-order dominance conditions). The first method can be blamed to ignore the multidimensionality problem. The other two, instead, try to deal with it, acknowledging the relation between dimensions. Of these, the first approach, relatively simpler, involves a great loss of information in the process of aggregation; the second, information-wise richer, rarely arrives at unambiguous ranking of distributions. Thus, its applicability may be limited.

The paper is structured as follows. Section 2 presents a macroeconomic overview of Argentina during the 1990s. Section 3 describes methods to study multivariate distributions of well-being, in particular the *aggregative strategies*. In section 4 we compare Argentina's 1991 and 2001 provincial welfare distributions. The exercise shows that, first, through an item-by-item approach we are unable to arrive at unambiguous orderings of the univariate distributions of income, health and education across provinces; while health and education distributions improved during the decade, income distribution worsens. Second, the rankings obtained from an exclusive concentration on the regional distribution of income might differ from those when other dimensions enter into the definition of welfare, i.e. when using aggregative techniques. Income distribution analyses might, in fact, be missing relevant aspects of the welfare inequality among Argentine provinces. Section 5 concludes.

[1] Achievements in health and education indicators are influenced by both economic- and non-economic factors. I focus the analysis on the former, though not disregarding the relevance of the latter. Additionally, today's achievements in well-being variables might also be due to yesterday's changes. Thus, the performance during the 1990s in terms of quality of life is probably influenced by policies and other factors that occurred in previous decades.

# 2. Argentina: Macroeconomics of the 1990s

During the 1990s Argentina went through a process of adjustment, stabilization, rapid output expansion, and a final collapse of the economy. The drastic movements in the country's economic activity will, not surprisingly, have an effect on the level and distribution of the population's well being. Also, the various events had a significant impact on the prevailing differences in living standards across provinces within the country.

The previous fifteen years were characterised by a drastic contraction of economic activity, financial restrictions with increasing public debt and interest rates, and peaks of hyperinflation. During the 1980s, GDP contracted 4.5%, per capita GDP reduced by 22%, and the unemployment rate more than doubled – though it remained below 7% (Beccaria 2003a; Frenkel 2002; Heymann 2000). Both income inequality and absolute poverty levels increased. Between 1974 and 1990 the ratio of income of the top decile to the bottom decile doubled – from 8 to 16[2]. The proportion of people below the absolute poverty line shows an even more dramatic increase – from 8% in 1980 to 26% in 1991 – particularly linked to inflation peaks[3] (Altimir and Beccaria 1999a; 2001; Gasparini *et al.* 2002) (Table 3.1).

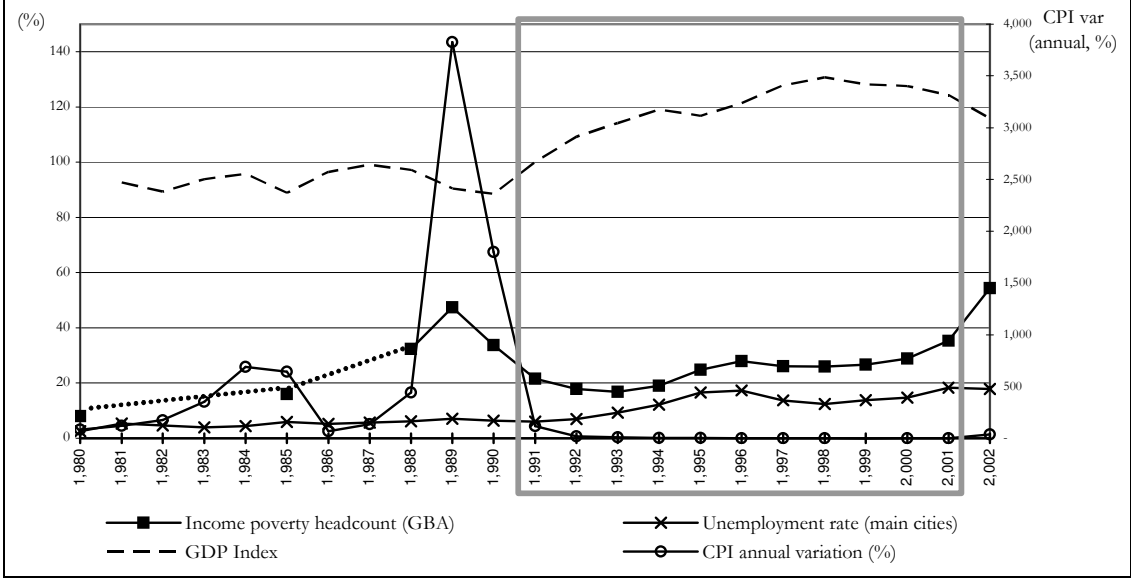
At the end of the eighties, the country experienced two drastic peaks of hyperinflation. Menem - president since 1989 – after some unsuccessful attempts to stabilise the economy, implemented in 1991 a new programme. Based on a currency board system fixing the exchange rate at parity with the US dollar by law (*Ley de Convertibilidad*) the new plan became known as the *convertibility regime*. With the new exchange rate arrangement the government prevented itself from issuing currency without a corresponding increase of foreign reserves. This helped to recover the confidence in the country leading to a successful control of inflation and large inflows of foreign capital. The programme was accompanied by a series of structural reforms including trade and financial liberalisation, deregulation of domestic markets, deepening of the privatisations of publicly-owned enterprises started by the previous government, and labour market reforms aimed at more flexibility in hiring and firing and lower labours costs (Beccaria 2003a; Heymann 2000).

The new regime had immediate success. Inflation was lowered to unprecedented levels and the economy reactivated. Between 1991 and 1998 total GDP increased 30%, employment levels rose consistently, government revenues increased as a result of the increase in activity, and investment and consumption also recovered as a result of the low inflation and the new availability of domestic and external credit. The initial years of euphoria coincided with a favourable international environment where prices of the exporting commodities improved and abundant capital – at cheap rates – was available. The continuous inflow of capital was fundamental for the sustainability of the regime, though they implied rising public

[2] For an analysis on the distributional effects of inflation see Ahumada, et al. (2000).
[3] Data correspond to Greater Buenos Aires, official figures. In September 1989 the poverty headcount reached its historical maximum, 41%. As it coincided with a peak in hyperinflation the measurement is sensibly excluded from most of the studies.

foreign debt[4].

**Figure 3.1. Basic macroeconomic variables. Argentina (1980 - 2002)**




NB: Based on author's calculations.

The main shortcoming of the regime was that the economy became extremely vulnerable and dependent on the inflow of foreign capital and hence, on the fluctuation of the external environment. At the end of 1994, when Mexico devalued its currency the economy experienced its first hit, with massive exit of capital and increase in interest rates. Nonetheless, and for some as a sign of strength of the programme, at the end of 1995 the economy was back on its feet and continued to grow at high rates. The recovery was driven by the reduction of international interest rates and the positive performance of exports, especially to Brazil (Beccaria 2003b). Nevertheless, the problem of financial vulnerability to external shocks was still there. With the Russian crisis (mid-1998), the Brazilian devaluation of the *real* (early 1999) and the substantial decline in private capital inflows ('*sudden stop*'[5]), Argentina entered a recession from which only recently, five or six years after, does it seem to be recovering.

A second major weakness, also central to the regime, was the continuous appreciation of the peso, which led to the loss of competitiveness of domestic goods. Imports increased throughout the decade, whereas exports grew more slowly. The trade balance, positive in the period 1982-1990, became negative and remained so for most of the 1990s (Frenkel and Gonzalez Rozada 2000; Heymann 2000). The loss of competitiveness became more evident with the devaluation of the real, given that Brazil was always one of the main commercial partners of Argentina. The correction of the trade balance came in 1998 when imports fell as a result of the recession. Between 1998 and 2001, total output went down by 5% (Table 3.1.).

[4] Foreign debt (public and private) rose from US$65.4 billions in 1991 to US$142 billions in 1998. See Heymann (2000).

[5] This point is emphasised particularly in Calvo (2003).

**Table 3.1. Argentina. Basic macroeconomic variables. 1974-2002**

| | CPI | GDP Index | Unemployment rate | Poverty Headcount (%) | Income Inequality | |
|---|---|---|---|---|---|---|
| | | | | | Gini coefficient | Decile 10/ Decile 1 |
| | (annual % variation) | (1991=100) | (Total cities, 28) | (Greater Buenos Aires) | | |
| 1,974 | | | 3.4 | | 0.345 | 8.0 |
| 1,980 | 84.0 | 97.9 | 2.5 | 8.0 | 0.391 | 10.9 |
| 1,990 | 1800.6 | 88.5 | 6.3 | 33.7 | 0.461 | 16.1 |
| 1,991 | 115.0 | 100.0 | 6.0 | 21.5 | 0.461 | 16.0 |
| 1,992 | 18.0 | 109.2 | 7.0 | 17.8 | 0.441 | 14.7 |
| 1,993 | 8.9 | 114.2 | 9.3 | 16.8 | 0.443 | 17.0 |
| 1,994 | 3.7 | 119.1 | 12.2 | 19.0 | 0.457 | 16.4 |
| 1,995 | 2.2 | 116.8 | 16.6 | 24.8 | 0.484 | 21.2 |
| 1,996 | 0.2 | 121.3 | 17.3 | 27.9 | 0.484 | 20.5 |
| 1,997 | 0.6 | 127.8 | 13.7 | 26.0 | 0.480 | 21.3 |
| 1,998 | 1.1 | 130.7 | 12.4 | 25.9 | 0.501 | 24.3 |
| 1,999 | -2.0 | 128.2 | 13.8 | 26.7 | 0.488 | 22.6 |
| 2,000 | -0.7 | 127.6 | 14.7 | 28.9 | 0.505 | 26.1 |
| 2,001 | -1.1 | 124.3 | 18.3 | 35.4 | 0.527 | |
| 2,002 | 38.5 | 115.8 | 17.8 | 54.3 | 0.538 | |

Source: GDP series: Beccaria (2003) *Revista Techint*. Gini coefficients: per capita household income, from Permanent Household Surveys (October). Rest: INDEC

Lastly, a key factor driving the collapse of the regime was the existence of macroeconomic policy inconsistencies (Blejer 2002). In particular, the currency board was not sustainable with the rapid increase of public debt observed in the second half of the decade. Between 1997 and 2001 public debt as a percentage of GDP augmented from 35% to 55%. The problem of the fiscal deficit, both federal and provincial, will impact unevenly the provinces. At the core of this were issues related to the crisis of the pension system, the distribution of federal resources to provinces and the decentralisation of central governmental activities to local governments (Centrángolo and Jimenez 2003).

In December 2001 President De La Rua, who succeeded Menem at the end of 1999, was forced to leave the government after demonstrating his inability to solve the politico-economic problems and with increasing discontent of the population which lead to social turmoil. Duhalde, the final caretaker of the presidency, immediately declared the end of the *convertibity plan*[6]. Pot-banging, queues in fronts of banks claiming their savings, *piqueteros* (road-block activists of organised unemployed workers) and *cartoneros* (impoverished, self-organized cardboard collectors and recyclers) characterise the time around and after devaluation. The exchange rate, which was initially set at a rate 1.4 peso per US dollar and then allowed to float, overshooted and later stabilised at 3$/1US$. Prices increased 38.5% in 2002, though not as much as the extent of the devaluation. During 2002 GDP felt by 7% (Table 3.1). The economy only started recovering at the end of 2002.

On the social front, the 1990s represented a period of continuous deterioration of labour market

[6] The default of all public debt (except for the multilateral debt) was declared only some weeks before by Rodriguez Saa, president for five days between De La Rua and Duhalde. As De La Rua, Rodriguez Saa was forced out of the government due to pressures of the population.

conditions and increase in income poverty and inequality levels. During the decade, not only did the unemployment rate triple (Table 3.1.) but so did involuntary underemployment and non-registration levels. In some provinces such as Salta or Santa Fe 40% of the economically active population was either unemployed or underemployed. Other, such as Santa Cruz, the proportion of workers with employment difficulties varied was less than 9%.

The changes in the labour market had a natural repercussion on the distribution of incomes among the population – as a result of job losses and/or deterioration of wage and non-wage revenues of those with a more precarious job. The Gini coefficient of per capita household income among individuals went from a level of 0.44 in 1991 to 0.52 in 2001 (Table 3.2). These results reflect partly the increasing levels of income poverty. In Greater Buenos Aires (GBA) the proportion of individuals below the poverty line increased from 21.5% in 1991 to 35.4% in 2001. For urban areas in 2001 the poverty headcount was 38% (Table 3.2)[7]. A number of papers show – using microeconomic decomposition exercises – that the increased concentration of incomes and poverty in the first years of the 1990s can be largely explained by the rise in unemployment levels. For the second half of the decade, however, it is rather the changes in the activity rates and returns to education explaining a significant proportion of the deterioration (Altimir *et al.* 2002; Gasparini 2002; Gonzalez Rozada and Menendez 2002).

**Table 3.2. Argentina, basic social indicators. 1991 and 2001.**

| | | 1991 | 2001 |
|---|---|---|---|
| Per capita household income (pesos, monthly) | | $190 | $177 |
| Unemployment rate (%) | | 6 | 18.3 |
| Gini coefficient for PCHI | GBA | 0.46 | 0.53 |
| | Main cities | 0.44 | 0.52 |
| Absolute Income Poverty (%) | GBA | 21.5 | 35.4 |
| | Main cities | NA | 38.4 |
| Life expectancy at birth (years) | | 72.0 | 74.1 |
| Infant Mortality Rate (per 1,000) | | 25.5 | 16.4 |
| Secondary enrolment rate (%) | | 59 | 64 |
| Proportion of adult population with at least complete primary education (%) | | 78 | 82 |

Source: author;'s calculation from Permanent Household Survey (October) and Population Censuses. *Life expectancy at birth* and *Infant Mortality rate*: based on Vital Statistics and Population Censuses 1991 and 2001. INDEC

In the strong swings of the economy's management and fortune, the regional aspect is clearly crucial, both in terms of impact and political economy, since the consequences of the regional distribution of social expenditure were important for welfare outcomes, and the regional political dimensions of fiscal policy were central to the dilemmas of macro management. As a step towards understanding this period, it therefore seems important to refine our ability to analyse the regional distribution of welfare.

In section 4 we compare the distribution of welfare across provinces with respect to income, health and

[7] The permanent household survey is done only on 28 agglomerates, representing 60% of the total population and nearly 70% of the urban. In 1991 and 2001 poverty lines were set at approximately $160 monthly per adult equivalent, hence 4US$ a day. Extreme poverty is approximately half of it, 2US$ a day. See Fiszbein, et al. (2002).

education. Between 1991 and 2001, the average level of household income per capita decreased (from $190 to $177 monthly), whereas life expectancy at birth rose by more than 2 years and infant mortality was significantly reduced (from 25.5 to 16.4 per 1,000) (Table 3.2). Educational attainments of the adult population also showed an improvement, following the trend of the last 30 years.

Nonetheless, the trend and magnitude of changes observed in these dimensions were not alike among provinces. The factors behind these differences are many and complex. Still, we should highlight the fiscal dimension and the dynamics of productive activities. The decentralisation of social services (particularly of schools and hospitals) was not accompanied by adequate funding, institutional reform and care for regional equity (Centrángolo and Jimenez 2003). The purpose was not to improve efficiency in production nor equity of the coverage; rather it was sought as a resource to improve federal accounts. Naturally, this affected the quality of the services provided, with the wealthier provinces being able to perform better. Also, the logic of distribution of federal resources to provincial governments was far too ad hoc and depended heavily on political reasons (more powerful jurisdictions relatively receiving more) (Centrángolo and Gatto 2002; Centrángolo *et al.* 2003). Furthermore, the restructuring of the state and privatisation of public services had a significant negative effect on employment, hence in poorer provinces, more dependent on public positions, the standard of living of its population was largely affected. In addition, the modernisation of the economy came together with the deterioration of labour conditions in the private sector, which also affected the regions unevenly. Not only did the worsening in employment have a direct impact on the incomes of workers left redundant or underemployed, but also on the health of their families given that most of the private health-care system is employment-based. Moreover, those previously in the formal sector who passed to the informal sector were no longer covered by the system (Altimir and Beccaria 1999b).

Table 3.3. highlights the 'best' and 'worst' performance provinces for 1991 and 2001 with respect to four selected indicators. These are unemployment rate, average per capita household income, life expectancy at birth, and percentage of adults with at least complete primary education. The letters in bold (C, S, NW, NE) indicate the geographical location of the provinces for Central, Southern, Northwestern and Northeastern regions, respectively. Some regional pattern is apparent in terms of levels. In general terms, Northern provinces present lower levels in all four indicators whereas jurisdictions in the Central and Southern regions have normally higher achievements. On the other hand, turning the attention to *changes* of levels – 'winners' and 'losers' – no clear regional pattern emerges. Both northern and southern provinces are among the best performers of the decades; such is the case of Catamarca (N) on income and life expectancy and Santa Cruz (S) on income and unemployment. Similarly, among the worst performers we find provinces of central, south, and northern regions. The dissimilarities observed across jurisdictions emphasise the need for a regional study of the distribution of welfare.

**Table 3.3. Summary of selected indicators for 'best' and 'worst' performing provinces.**
Argentina provinces, 1991 vs. 2001.

| | 1991 | | Perceptual change | |
|---|---|---|---|---|
| | *Worst* | *Best* | *Worst* | *Best* |
| **Unemployment rate** (%) | 11.4 Tucumán **NW**<br>10.9 T. del Fuego **S** | 2.7 La Pampa **C**<br>3.2 Sgo Estero **NW** | 491 Jujuy **NW**<br>463 La Pampa **C** | -32.4 Santa Cruz **S**<br>-10.5 Misiones **NE** |
| **PCHI** (monthly, 1991 prices) | $117 Corrientes **NE**<br>$119 Sgo Estero **NW** | $366 T. del Fuego **S**<br>$343 Capital Federal **C** | -22.2 T. del Fuego **S**<br>-18.7 Córdoba **C** | 23.3 Catamarca **NW**<br>21.7 Santa Cruz **S** |
| **Life Expectancy at birth** (years) | 69.4 Chaco **NE**<br>70.4 Salta **NW** | 75.3 T. Del Fuego **S**<br>74.3 Neuquén **S** | 0.9 Corrientes **NE**<br>1.3 Formosa **NE** | 6.3 Misiones **NE**<br>5.4 Catamarca **NW** |
| **Adults w.complete primary educ** (%) | 63.1 Misiones **NE**<br>59.9 Chaco **NE** | 93.1 Capital Federal **C**<br>89.1 Tierra Fuego **S** | 0.9 Capital Federal **C**<br>2.3 T. del Fuego **S** | 10.6 Entre Ríos **C**<br>10.6 Chaco **NE** |

Source: author's calculation.

# 3. Multivariate Distribution Methods

In the past decades specialists have designed a great number of analytical tools to compare distributions, some of them widely accepted and much studied. Extending the traditional definition of well-being to account for multiple dimensions requires extending also the existing techniques. This adaptation is not always straightforward and in the process certain value judgements are unavoidable.

Consider there are $k=1, 2, \ldots K$ dimensions of well-being and $i = 1,2, \ldots n$ units of analysis (individual, household, province). Each unit $i$ has a (non-negative) values $x_{ik}$ for each $k$ dimension.

Following Brandolini-D'Alessio (2001), multidimensional distribution techniques can be categorized in three groups, according to the extent to which they impose structure on the data[8].

The first of these routes (*item-by-item)* involves the study of each $K$ dimension separately, hence using similar techniques as standard income distribution analyses. In turn, these can be grouped between those that seek measurement (such as the Gini coefficient, General Entropy family of indices, Atkinson Index) on the one hand, and those based on orderings (first- and higher-order stochastic dominance conditions) on the other[9]. The analysis is complemented with studies of patterns of cross-correlation among attributes – "low correlation between functioning measures confirms the usefulness of broadening the analysis to non-economic factors" (Brandolini and D'Alessio 2001, 37). Nevertheless, no structure is imposed on the relation between dimensions. Therefore, the main criticism is precisely that of ignoring the

[8] We borrow the classification of strategies suggested by Brandolini and D'Alessio (2001) though not their complete grouping of techniques. In particular, we include 'multidimensional inequality indices' within aggregative strategies (not within non-aggregative). The reason is that it imposes as much structure to the data as other aggregative techniques, even if implicitly. In effect, Brandolini and D'Alessio notice that when a multidimensional index is additively separable across persons – as it is the case in here – the approach is "observationally equivalent to a fully aggregative strategy" (p. 18).

[9] For a fuller description of univariate techniques to inequality see Atkinson (1970), Cowell (2000), Litchfield (1999), Sen and Foster (1997).

multidimensionality of each of the individuals' well-being. On a more practical basis, when extending the number of dimensions to a sufficiently high number, this method might lack synthesis. Sen and Foster (1997) suggest taking an item-by-item strategy as a *supplementation strategy* to traditional measures of inequality, to be done in a less formal way. The proposed strategy can be used "to add to the partial illumination provided by the traditional measures in the income space" (Sen and Foster 1997, 214).

The remaining strategies to multivariate analysis follow also the same grouping (measurements and orderings) as found within the *item-by-item* approach.

The a*ggregative approach* aims at obtaining real-valued measurements summarising the information about the *K*-distribution of well-being. It involves deciding over distributional judgements, weighting structure, and functional form. Being the strategy which imposes more structure to the data, it gives a complete ordering of distributions. Several techniques have been proposed, with varying assumptions and levels of structure imposed. Additionally, value judgements can be made more or less explicit. All of them share, however, the feature of collapsing dimensions and utilising some inequality measure to derive complete orderings of distributions. The main advantage of an aggregative strategy "rests on its being operational and rather effective in summarising complex problems in a simple and comprehensive way for a general public" (Brandolini and D'Alessio 2001, 19). Then again, it has the problem of having to arrive at an agreement not only on the functional form of the inequality measure but also on the functional form to aggregate attributes. Even if there is such agreement, too much information might be lost in the process of aggregation. In the next subsection we explore two suggested indicators.

The third approach, *non-aggregative*, makes deliberate efforts to avoid condensation and works instead with *K*-dimensional distributions, seeking to order them according to pre-established criteria. As Brandolini (2001) argues, it attempts to retain the multidimensionality of the concept of well-being. This makes the analysis more complex and, most of the time, does not lead to unambiguous rankings of distributions. The basic treatment in this area comes from Kolm (1977), Atkinson and Bourguignon (1982) and Jenkins and Lambert (1993). The central idea is to specify dominance conditions (first, second, and higher-order) required to obtain an ordering of distributions without needing to specify precisely the form of the social welfare function (SWF). Ordinality, and not cardinality, is the ruling criterion. This approach will not be pursued here[10].

## Aggregative strategy

There are two distinct identified procedures within the aggregative strategies[11]: two-step approach and

[10] For sufficient stochastic dominance conditions for three-dimensional distribution of well-being see Muller and Trannoy (2003).

[11] Brandolini and D'Alessio (2001), Maasoumi (1999) argue that the equivalent income approach should be

multidimensional indices. In the former, the aggregation is done explicitly, arriving first at a single composite measure for each individual (household) expressed in some 'well-being unit'; applying, secondly, some inequality index. Multidimensional indices, on the other hand, have implicit in the inequality measure the valuation function of attributes.

Formally, the *two-step procedure* implies the following steps:

1. Obtain a unidimensional aggregate indicator (*S)* from the *K*-dimensional space of attributes, for each individual/household/province $S_i = S(x_{i1}, x_{i2}, \ldots x_{iK}) : \Re^K \rightarrow \Re$ for $i = 1, 2, \ldots n$.
   $S_i$ are distributed according to a given CDF $F(S_i) \in \Im$, where $\Im$ is the space of functions
2. Apply an inequality measure $I = I(S_1, S_2, \ldots, S_n) : \Im \rightarrow \Re$

*Multidimensional indices*, instead, do a similar procedure in a single step; i.e. from the *K*-variate distribution of attributes (*x*'s) to a real number:

1. Apply a multidimensional inequality measure $I = I[F(x_1, x_2, ..., x_K)] : \Im^K \rightarrow \Re$
   where $x_k$ is the vector of the *k*-th attribute across *n* individuals.

In both, decisions are made inevitably over (1) the *weighting structure* (the extent to which each dimension is assumed to contribute to individuals' well-being); (2) the *degree of substitution* between each pair of attributes; and (3) the *degree of inequality aversion* in the well-being space. The value of these parameters will depend, generally, on a set of desirable properties of the inequality index and the underlying SWF.

Let $s_{.k} = s(x_{.k})$ be an (increasing) index function of $x_{.k}$ with the same unit of measurement for all *k*. Frequently utilised index functions are the standardization and HDI (min-max) formulae.

Let $w_k$ represent the weight attached to the *k*-th attribute and $\sum_{k=1}^{K} w_k = 1$. Weighting can be done in three ways: (a) treating all dimensions equally – *equal weighting* ($w_1 = w_2 = \ldots = w_K$), "from an 'agnostic' attitude or from the lack of information about some kind of 'consensus' view" (Brandolini and D'Alessio 2001, 22) – ; (b) setting weights according to some *normative* criterion in which at least one $w_i \neq w_j$; (c) using *data-driven techniques*, i.e. multivariate procedures such as factor analysis, principal component or cluster analysis to derive weights. If market prices for all attributes were available, we can also use them as the basis for the weights. Clearly, for many of the dimensions included in any concept of well-being, market prices do not exist. Irrespectively of the criteria used, we could also follow Sen's recommendation to utilise a range of weights rather than a single set for robust results (Sen *et al.* 1987).

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considered within the *aggregative strategies methods*. Equivalence scales imply adjusting income according to demographic composition of the household, representing 'needs'. Welfare depends positively on income, and negatively on needs. It seems problematic though to interpret 'needs' as one of the dimensions of well-being, similar to life expectancy or educational attainments. Strictly speaking, equivalent income approach does not imply an *aggregation* of welfare dimensions, but merely an 'adjustment' of one of the dimensions, normally income. See Anand and Sen (1994).

For the aggregator function $S_i$ a standard assumption is additive separability[12] the existence of certain degrees of substitution between attributes. A common generalisation, used in both measures reviewed below, is given by the constant elasticity of substitution (CES) class of functions, with Cobb-Douglas for when $\beta = 0$.

$$S_{\beta i} = \begin{cases} \left[ \sum_k w_k s(x_{ik})^{\beta} \right]^{1/\beta} & \beta \neq 0 \\ \prod_k \left[ s(x_{ik}) \right]^{w_k} & \beta = 0 \end{cases} \qquad (1)$$

$s(.)$ is non-decreasing in $x_{ik}$. The parameter $\beta$ is related to the degree of substitutability between attributes and determines the shape of the contours for all pair of attributes. The elasticity of substitution is given by $\sigma = \frac{1}{1-\beta}$. The smaller the $\beta$, the smaller is the elasticity of substitution between attributes. In the limit, as $\beta \to -\infty$, $\sigma \to 0$ (i.e. no substitution between attributes) and the function is of Leontief type. When $\beta = 0$, $\sigma = 1$ and $S_{0i}$ is a Cobb-Douglas function. And when $\beta = 1$, $S_{1i}$ is a linear function of the $k$ attributes and $\sigma \to \infty$, that is, perfect substitute attributes. For $\beta \leq 1$, the elasticity of substitution is non-negative (thus, convex to the origin contours) and the function is quasiconcave with respect to the $x$s, with decreasing marginal returns[13]. UNDP's a measure of welfare (HDI) considers $w_k = w = \frac{1}{3}$ *for all* $k$ and $\beta = 1$[14].

Lastly, we choose the sensitivity of the inequality measure to different parts of the distribution, i.e. the inequality aversion parameter. Normally, desirable properties of the inequality index would favour those satisfying scale- and population-invariance properties, anonymity-symmetry in the space of well-being (as opposed to the space of the distinct dimensions), principle of transfers, decomposability, and transfer sensitivity. General Entropy (GE) family measures satisfy the above-mentioned requirements, with $\alpha$ being the indicator of 'inequality aversion' (with $\alpha<1$) measuring the concavity of the function.

## 3.1. Two-step procedure

The collapsing of dimensions into one is done in two separate steps. We follow here the approach explored by Maasoumi in a number of papers (Hirschberg *et al.* 1991; Maasoumi 1986; 1999; Maasoumi and Nickelsburg 1988).

Based on the idea that different indicators of economic welfare are distributed differently, Maasoumi

[12] Savaglio (2001), Tsui (1999) question this assumption.

[13] In the context of utility/welfare maximisation exercise, quasiconcavity of the objective function guarantees that the solution of the optimisation exercise is indeed a maximum and that the demand functions are well-behaved.

[14] The dimensions considered are 'decent standard of living', health and knowledge. Description of the methodology, discussion over its properties and implications, and criticisms can be found in Anand and Sen (1994), (2003)

suggests an index with distributions that most closely represents the *distributional information* in each attribute. In particular, he proposes a multivariate generalisation of the ***GE* measure of divergence** or closeness between the *K* densities and arrives to the 'optimal' aggregation functions described in (1).

For the second step, he utilises an inequality index of the GE family. Hence, Maasoumi's measure will be

$$I_M = \frac{1}{\alpha(1-\alpha)} \frac{1}{n} \sum_{i=1}^{n} \left[ 1 - \left( \frac{S_i\left(s_{ik};\beta;w_k\right)}{\overline{S}} \right)^{\alpha} \right] \qquad (2)$$

where $S_i$ is determined following (1) and $\overline{S}$ is the average of the $n$ well-being indices. $I_M$ measure is decomposable (when $\alpha - \beta = 0$), scale invariant (homogeneity), and 'vector-symmetric'. Also, for concave $S_i$ all $I_M$ for which $\alpha \leq 1$ satisfy the multidimensional version of the principle of transfers. When $\alpha - \beta = 0$, the SWF will be also individualist and specific[15].

## 3.2. Multidimensional indices [16]

Bourguignon (1999) rejects the two-step procedure while proposing a new multidimensional inequality measure, $I_B$.

$$I_B = 1 - \frac{1}{n} \frac{\sum_i \left[ \sum_{k=1}^{K} \left( w_k s_{ik}^{\beta} \right) \right]^{\alpha/\beta}}{\left[ \sum_{k=1}^{K} \left( w_k \mu_k^{\beta} \right) \right]^{\alpha/\beta}} \qquad (3)$$

where $\alpha$ is related to the degree of inequality aversion, and $\alpha$ is set to be less than 1. Again, a standard assumption would be that $\beta \leq 1$. In his paper, Bourguignon argues that $I_B$ satisfies the following properties: continuity, perfect equality when $I_B = 0$, anonymity, principle of transfer, and group-decomposability. It is not scale invariant though he argues this is might be in fact an interesting feature of the measure. Additionally, $I_B$ has the property that more correlation leads to less inequality only if the substitutability between attributes is below a certain level which increases with $\alpha$ (in particular, $\alpha - \beta \geq 0$ which is the condition for attributes to be in some sense complements – positive cross derivative)[17].

Bourguignon's index is related to the Maasoumi's but, at the same time, "significantly different". The $I_B$ –

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[15] Savaglio (2001) will argue that the requirement of additive separability imposed to the measure could be far too restrictive as "…does not always represent individuals' preferences (…) [and] it is in contradiction with the evaluation of individuals' welfare when there exist correlations about the personal attributes" (p.11).

[16] In Tsui (1995) the author offers two multidimensional inequality measures based on a additively separable SWF; in Tsui (1999) the measures are based on a non-separable SWF (multidimensional generalisation GE measure), still satisfying decomposability.

[17] The link between the sign of higher derivatives and the relation between the degree of inequality aversion and the degree of substitution was already pointed out in Atkinson and Bourguignon (1982).

incidentally a natural extension of Dalton's measure – has embedded an aggregator that is a distance function. In this respect, it is similar to $I_M$. However, in $I_B$ individual welfare is normalised using the value of the aggregator for the mean individual; i.e. the one endowed with mean attributes $\left[\sum_{k=1}^{K}(w_k\mu_k^{\beta})^{1/\beta}\right]^{\alpha}$, whereas in $I_M$ normalisation is done by the mean aggregator $\left[\sum_{i=1}^{n}\sum_{k=1}^{K}(w_k s_{ik}^{\beta})^{1/\beta}\right]^{\alpha} \Big/ n$.

We can express $I_B$ as a linear transformation of $I_M$.

$$I_B = \alpha(1-\alpha)\frac{n^{1-\alpha}\left[\sum_{i=1}^{n}\sum_{k=1}^{K}(w_k s_{ik}^{\beta})^{1/\beta}\right]^{\alpha}}{n\left[\sum_{k=1}^{K}(w_k\mu_k^{\beta})^{1/\beta}\right]^{\alpha}} I_M \qquad (4)$$

where $R = \frac{\sum_{i=1}^{n}\left(\sum_{k=1}^{K} w_k s_{ik}^{\beta}\right)^{\alpha/\beta}}{n\left(\sum_{k=1}^{K} w_k \mu_{ik}^{\beta}\right)^{\alpha/\beta}}$ is the 'corrective term' which is the ratio between the mean aggregator and the aggregator at the mean. Because of this term, Bourguignon argues that Maasoumi measure cannot be directly related to a social welfare function, "which makes it difficult to interpret" (Bourguignon 1999, 478).

# 4. Argentine provinces: distribution of welfare 1991 and 2001

This section presents a comparison of 1991 and 2001 distributions of well-being across Argentine provinces (22 provinces and 1 federal district[18]). It is assumed, quite restrictively, that the standard of living of the population can be appropriately described by three key dimensions: income, health, and education. The indicators utilised are *real per capita household income* (RPCHI), *life expectancy at birth* (LE), and the *proportion of the adult population with at least complete primary schooling* (as a proxy for adult literacy rate, hence LR), respectively[19].

Data is available at the provincial level. The exercise could be performed with or without weighting each observation by its population size. The choice depends, naturally, on the main interest of the analyst. If one is primarily concerned with the population living in each province, each jurisdiction should be weighted according to its number of inhabitants. But if so, we should also include some measure of

[18] One province, Río Negro, is excluded. The reason is that there is no information on household incomes since no PHS survey was done until after 2001.

[19] Dimensions and indicators were chosen following the UNDP -HDI. For a discussion of the variables, problems and advantages of combining 'ends' variable with 'means to other ends' indicators, and difficulties of using aggregate indicators see Anand and Sen (1994). We also analyse other indicators, such as the Infant Mortality Rate and achievements of adult population at different levels of education (incomplete primary and complete secondary). Results are consistent with the ones obtained in the present selection.

distribution between people within each province. If, instead, we want to focus on the provinces as such, we should weight them equally –i.e. one jurisdiction as one observation. In the present exercise, we follow the second approach; the units of analysis are the *provinces*. A brief description of the data is included in the Annex.

## 4.1. Item-by-item strategy

We utilise stochastic dominance criteria and well-known inequality measures so as to determine for each attribute whether one distribution (among provinces) dominates the other –1991 or 2001.

Between 1991 and 2001, average national per capita household income decreased slightly while life expectancy and the 'literacy rate' improved, even if not dramatically (Table A.1 Statistical Appendix). This is consistent with the observed continuous reduction in infant mortality rates and increased enrolment of children in the formal educational system.

All correlation values between the variables experienced a drop between 1991 and 2001. Pearson correlation coefficient between income and education variables is rather high in both years, though it decreased (from 0.83 in 1991 to 0.73 in 2001). The level of association between income and LE is lower, though it also declined (0.65 in 1991 and 0.42 in 2001). Finally, LE and LR correlation coefficient dropped from 0.52 to 0.46 (Table A.1 Statistical Appendix). It is particularly the lower correlation values between income and the other variables and their changes which suggest the importance of a multivariate analysis. If the attributes were highly correlated among them a univariate income study could be considered satisfactory.

### 4.1.1. Stochastic Dominance Criteria

Table 4.1.1 summarises the results obtained from testing (graphically) first- and second-order stochastic dominance conditions for each of the three attributes across provinces. First-order stochastic dominance implies comparing the CDFs for 1991 and 2001; if the curves do not cross, the CDF to the right (below) dominates. If, instead, the functions intersect at least once, we are not able to draw an unambiguous conclusion in ordering the distributions. We then utilise second-order conditions, by which we compare the first integral of the CDFs – which, incidentally, have a direct correspondence to Generalised Lorenz Curves[20] (Atkinson 1970). Again, if the curves GLC do not intersect at any point we are able to order the

[20] Lorenz Curves is invariant with respect to proportional shifts in the distribution, hence it satisfy scale independence. This is desirable when one is solely concerned with distribution, not levels of welfare.
LC and GLC for weighted distributions have a more clear interpretation than non-weighted distributions. These curves are based on the cumulative proportion of variable *y*, i.e. income or LE. In the case of weighted distributions of income, it represents on the *y*-axis the cumulative proportion of total income that the cumulative proportion of total population (*x*-axis) posses. That is, it graphs how total income of the country is distributed [?]among the population. For non-weighted distributions we would be accumulating mean per capita incomes, though this sum doesn't have a clear interpretation. The interpretation of LC and GLC for the educational indicator (proportion of population with at least complete primary schooling) becomes more problematic. Lorenz Curves are based on the

pair of distributions unambiguously; the curve above dominates.

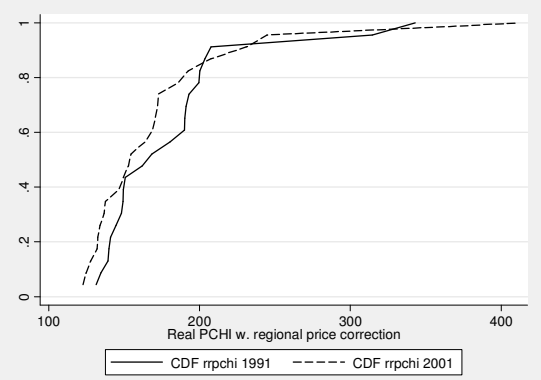
**Table 4.1.1. Indicators of well-being. Stochastic dominance conditions, 1st and 2nd Order.** Argentina provinces, 1991 vs. 2001.

| *Dimension* | Indicator | Ordering |
|---|---|---|
| *Income* | Per capita household income | 1991 $\succ$ 2001 (2nd Order) |
| *Health* | Life Expectancy at birth | 2001 $\succ$ 1991 (1st Order) |
| *Education* | % Adults at least complete primary | 2001 $\succ$ 1991 (1st Order) |

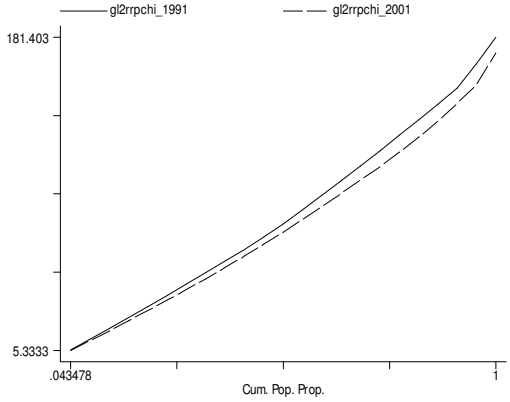
Source: author's calculations

In short, the 2001 distribution of health and education indicators dominates the 1991 one. In contrast, the 1991 distribution of per capita household income dominates the 2001 one (Figure 4.1-4.4.).

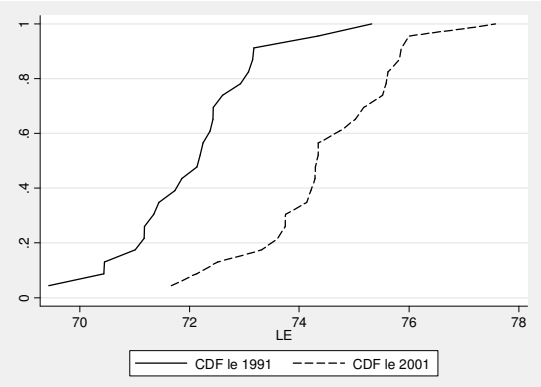
**Graph 4.1. CDFs,** Real per capita household income (monthly $).



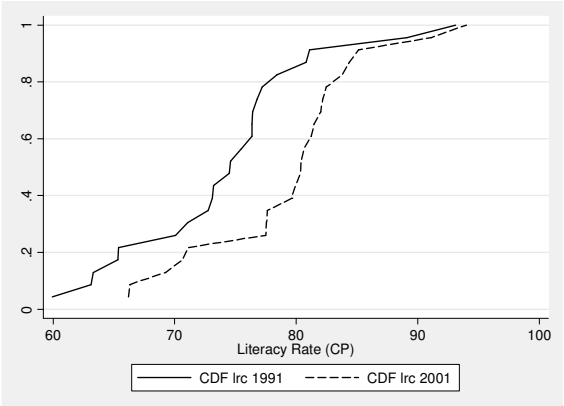

**Graph 4.2. Generalised Lorenz Curves**, Real per capita household income (monthly $).




**Graph 4.3. CDFs,** Life expectancy at birth (years).




**Graph 4.4. CDFs,** 'Literacy rate' (%).




## 4.1.2. Inequality measures

From the results on stochastic dominance we can anticipate the rankings of distributions we will obtain when utilising several inequality measures[21]. As an example, Table 4.1.2 includes measurements for each

cumulative proportion of rates! Still, they provide information on how educational attainments are distributed across provinces in the country.

[21] In fact, only for all inequality measures that have embedded any increasing SWF for those cases where FSD

dimension using the Gini coefficient and the two most common measures of the General Entropy family (Theil index, Theil log entropy measure). As expected, all indices indicate that income inequality is higher in 2001 than in 1991, while inequality of life expectancy and education are higher in 1991 than in 2001.

**Table 4.1.2. Selected inequality measures.** Argentina provinces, 1991 vs. 2001

| Dimension | Indicator | Inequality measures | | | | | |
|---|---|---|---|---|---|---|---|
| | | Gini | | GE $\alpha$=0 | | GE $\alpha$=1 | |
| | | 1991 | 2001 | 1991 | 2001 | 1991 | 2001 |
| *Income* | Per capita household income | 0.138 | **0.155** | 0.033 | **0.043** | 0.036 | **0.050** |
| *Health* | Life Expectancy at Birth | **0.010** | 0.010 | **0.000** | 0.000 | **0.000** | 0.000 |
| *Education* | % Adults at least complete primary | **0.056** | 0.047 | **0.005** | 0.004 | **0.005** | 0.004 |

Source: author's calculations

Two remarks are in place. Firstly, all measurements in Table 4.1.2 are extremely low, in particular when compared to values obtained for distributions across households[22]. In the case of income, most of Argentina's income inequality is within provinces, not between them. Using a similar sample but for distribution of PCHI across households, the Gini coefficient in 1991 is around 0.43 and in 2001 around 0.53 (Altimir and Beccaria 2001; Gasparini *et al.* 2002). In contrast, the estimated index for the distribution across provinces is 0.14 and 0.15, respectively. This point stresses the importance of including some measurement of intra-province inequality particularly when studying individuals' well-being.

Secondly, the positive performances during the decade of health and education indicators should be taken with care. Both life expectancy at birth and literacy rate are variables that tend to be rather stable and have a natural upward tendency. For a comprehensive understanding of achievements in these two dimensions we should complement the study with other indicators (e.g. avoidable deaths infant mortality rate, repetition and drop-out rates, assessment of education results). UNICEF (2002) opposes the improvements in IMR and life expectancy indicators with other less positive performances observed throughout the 1990s. In particular, the report emphasises the stagnation of the rate of reduction of the IMR, the constant high proportion of infant deaths that could be avoided though low cost interventions[23], and the increasing regional disparities of infant mortality rates (as measured by the ratio between the best and worst performer and the number of provinces with double the rate of the best performer). Within education achievements, school quality assessment tests show a decline in the performance of students in secondary education in the last five years of the decade[24].

In sum, 1991 dominates 2001 in terms of the distribution of incomes – with higher mean and lower inequality – while 2001 dominates 1991 in terms of the distribution of health and education – where

condition is satisfied, while increasing and concave SWF, for pairs of distributions for which SSD condition is satisfied but not FSD.

[22] In the case of income (the only survey based variable) we computed confidence intervals for the Gini Coefficient and the Theil entropy measure. In none of the cases differences were statistically significant, at 5%.

[23] Such as proper control during pregnancy, adequate birth care, and premature diagnosis and treatment of children.

[24] Unfortunately, these sorts of assessments were systematically performed in all provinces only since 1997.

national averages are higher and the distributions are less spread out. Differences in measurements are, however, significantly low.

## 4.2. Aggregative strategies

In this section we show results obtained utilising Maasoumi ($I_M$) and Bourguingon ($I_B$.) measures of multidimensional inequality.

Originally, real PCHI is measured in money units, life expectancy at birth in years, and 'literacy rate' in percentage points. Hence, the first step implies choosing a way of transforming all variables so as have the same unit of measurement. The manner in which the transformation is performed will affect the results of the analysis. Human Development Index relies on agreed goalposts (minimum and maximum) and arrives at indices that fall between 0 and 1 (UNDP 1995); others, such as Hirschberg *et al* (1991, 2001) prefer variable standardisation -using the variable mean and variance[25]. In the present exercise we use the HDI approach, i.e. a simple average of the three indices. We apply the following general formula:

$$S_{ik} = \frac{x_{ik} - \min x_{ik}}{\max x_{ik} - \min x_{ik}} \text{ with } i = 1, \ldots, 23 \text{ and } k = h, e, y$$

As the purpose is to compare 1991 and 2001 distributions, the goalpost will be identical for both distributions, chosen as the minimum and maximum values across both years. The minimum values of health and education indicators are achieved in 1991 and their maximum in 2001, while both minimum and maximum values of income are in 2001[26].

We use equal weighting ($w_1 = w_2 = w_3 = w_k = ⅓$) and degrees of substitution $\beta = [0; ⅓; ½; 1]$ so that the elasticity of substitution is always positive[27]. With respect to the level of inequality aversion, for $I_M$ we utilise $\alpha = (0; 1)$ and include also Gini coefficient. For Bourguignon measure we choose $\alpha = [0; ½; ⅓; 1]$. Later, we graph $I_B$ in the ($I_B$, $\alpha$) space for $\alpha \in (0,1)$. In both cases, α is chosen to satisfy the principle of transfer.

[25] Hirschberg, et al. (2001) opt for rescaling each attribute to have a mean of zero and a variance of one. No log transformation is made to income. This procedure of standardising the variables will result in indices for each dimension that have positive as well as negative values, which might be problematic when using inequality measures.

[26] The minimum value of life expectancy at birth is 68.4 years (Jujuy in 1991), the maximum value is 77.6 years (Buenos Aires DF, 2001); the minimum proportion of adult population with at least complete primary schooling is 59.9% (Chaco, 1991) while the maximum is 94% (Buenos Aires DF, 2001); the minimum of mean real per capita household monthly income is $122.7 (Corrientes, 2001) and the maximum is $411.8 (Buenos Aires DF, 2001).

[27] "There is an inescapably arbitrariness in the choice of [$\beta$]. The right way to deal with the issue is to explain clearly what is being assumed, as has been attempted here, so that public criticism of the assumption is possible" (Anand and Sen (2003), 218).

### 4.1.3. Two-step procedure

The following table summarises the graphs of comparisons of 1991 and 2001 CDFs for the four distinct well-being indicators, with differing degrees of substitution ($\beta$)[28].

**Table 4.2.1. Composite indices of well-being. Stochastic dominance conditions.** Argentina provinces, 1991 vs. 2001

| *Well-being Index* | Degree of substitution | Ordering |
|---|---|---|
| *SM1* | $\beta$= 1 | 2001 $\succ$ 1991 (1st Order) |
| *SM2* | $\beta$ = ½ | 2001 $\succ$ 1991 (1st Order) |
| *SM3* | $\beta$ = 1/3 | 2001 $\succ$ 1991 (1st Order) |
| *SM4* | $\beta$ = 0 | Ambiguous |

Source: author's calculations

For the first three well-being indicators considered, the 2001 distribution across provinces dominates 1991. First-order dominance conditions are satisfied[29]. We interpret this as, for a certain degree of substitutability between attributes, any inequality measure that is increasing in its arguments will produce higher measurements for 1991 than for 2001. On the other hand, when we assume a Cobb-Douglas representation of the welfare function ($\beta$ = 0) CDF and Generalised Lorenz curves cross at the lower end of the distribution, after which 2001 dominates 1991. Thus, we are unable to rank the distributions unambiguously.

Table 4.2.2 presents several measurements of inequality using inequality indices satisfying the above mentioned properties[30]. Again, all measurements (even for $\beta$ =0) indicate that inequality is higher in 1991 than in 2001, i.e. the same as the one we obtain from item-by-item analysis of health and education indicators, and thus, contrary to income distribution ordering[31].

**Table 4.2.2. Composite indices of well-being. Inequality measures**
Argentina provinces, 1991 vs. 2001 (in bold, lowest inequality measurement)

| **Index** | | **Inequality measures** | | | | | |
|---|---|---|---|---|---|---|---|
| | | Gini | | GE $\alpha$=0 | | GE $\alpha$=1 | |
| | $\beta$ | 1991 | 2001 | 1991 | 2001 | 1991 | 2001 |
| SM1 | 1 | 0.274 | **0.184** | 0.176 | **0.064** | 0.136 | **0.060** |
| SM2 | .1/2 | 0.294 | **0.225** | 0.234 | **0.090** | 0.156 | **0.086** |
| SM3 | .1/3 | 0.301 | **0.248** | 0.287 | **0.112** | 0.165 | **0.104** |
| SM4 | 0 | 0.315 | **0.306** | | | 0.180 | **0.171** |

Source: author's calculations

Additionally, as $\beta$ tend to zero inequality measurements increase. In other words, if we impose less substitution between attributes, for a given state of the world, we should accept higher values of inequality measurements. In a world of linear substitution between dimensions (when $\beta$ = 1) differences within them

[28] Graphs are available on request.
[29] For the weighted by population distributions the conclusion is reversed. We only arrive to unambiguous ranking of distributions when $\beta$=0.
[30] For the values of parameters selected here, only when both β and α equal unity the measure will be decomposable, individual, and specific.
[31] When $\beta$ = 0, given the normalisation method chosen, there is always at least one case with value 'zero', that is, the case with the minimum value in one of the attributes. Hence, GE(0) cannot be utilised.

might complement so that the measurement is lower.

### 4.1.4. Bourguignon's multidimensional index

We apply the multidimensional measure proposed by Bourguignon (1999).

**Table 4.2.3. Bourguignon measure**
Argentina provinces, 1991 vs. 2001 (in bold lowest inequality measurement)

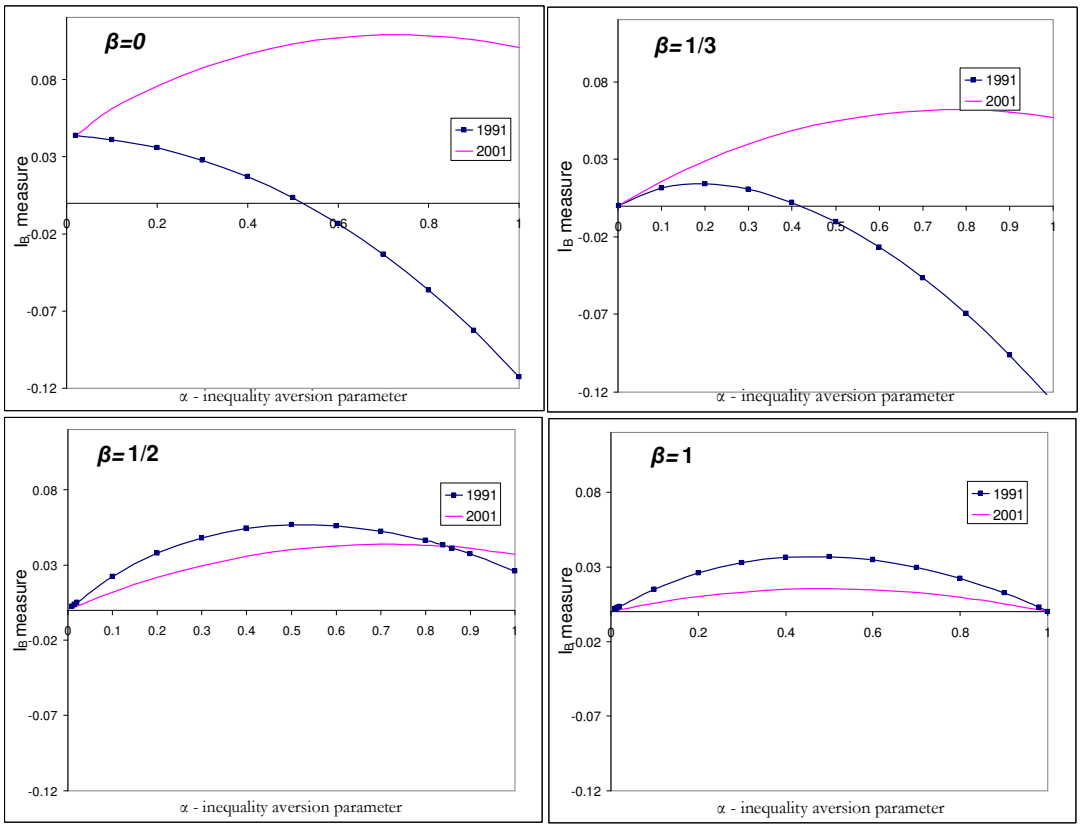
| | $\alpha = 0$ | | $\alpha = 1/3$ | | $\alpha = 1/2$ | | $\alpha = 1$ | |
|---|---|---|---|---|---|---|---|---|
| | 1991 | 2001 | 1991 | 2001 | 1991 | 2001 | 1991 | 2001 |
| $\beta = 1$ | 0.176 | **0.064** | 0.034 | **0.014** | 0.037 | **0.015** | 0.000 | 0.000 |
| $\beta = 1/2$ | 0.261 | **0.128** | 0.051 | **0.032** | 0.057 | **0.040** | **0.026** | 0.037 |
| $\beta = 1/3$ | **0.168** | 0.170 | **0.008** | 0.043 | **-0.010** | 0.055 | **-0.126** | 0.057 |
| $\beta = 0$ | - | **-** | **0.024** | 0.091 | **0.003** | 0.103 | **-0.113** | 0.101 |

Source: author's calculations

Table 4.2.3 does not give an unambiguous ordering of distributions across provinces. Multidimensional inequality measures are higher in 1991 than 2001 (as in $I_M$) when both the inequality aversion parameter is ½ or lower and the degree of substitutability between attributes is ½ or higher.

These results are best seen in the following graphs, in the ($I_B$, α) space with $\alpha \in (0,1)$. They depict the interesting relation between substitutability of attributes and degree of inequality aversion in determining the results of ordering of distributions.

**Figure 4.2.1. Bourguignon's measure as $\alpha$ changes.** Argentina provinces, 1991 vs. 2001




Source: author's calculation.

Once more, we reach consistent results to those from $I_M$ measure – i.e. 2001 dominates 1991 – unambiguously either when we assume that the attributes are related linearly in the welfare function ($\beta = 1$, perfect substitutability between attributes) or when $\beta = ½$ and $\alpha < 0.85$. In other cases, multidimensional inequality is everywhere higher in 2001 than 1991 hence 1991 distribution is preferred.

$I_B$ (as opposed to $I_M$ measure) satisfies a property emphasised by Bourguignon that when we assume that dimensions are in some sense complements, higher correlation between attributes will lead to lower inequality measurements. Restricting the analysis to these cases implies focusing on some parts of the previous graphs where the condition $\alpha - \beta > 0$ holds (we exclude $\beta = 1$). In these cases, 1991 is generally preferred to 2001, that is, contrary to the ranking derived from utilising $I_M$ – only for $\beta = ½$ and $\alpha = (0.5; 0.85)$ the opposite is true.

In sum, applying Bourguignon's multidimensional index of inequality to 1991 and 2001 distributions across Argentine provinces we arrive to ambiguous rankings, these dependant on the level of inequality aversion and degree of substitutability between attributes we are willing to impose. When we choose the parameters so that the measure satisfies a desirable property (in Bourguignon's view) 1991 distribution generally dominates 2001 distribution. That is, contrary to the ordering arrived utilising $I_M$ measure, while consistent with the income distribution result.

# 5. Conclusions and possible extensions

This paper provides an exploration into the distribution of well-being across Argentine provinces in 1991 and 2001, years representing the beginning and the end of the *convertibility regime*. The model left the Argentine provinces seemingly worse off in terms of income (on average and relative to one another) though better off with respect to basic health and education indicators. The fact that the orderings of provincial distributions differ suggest the relevance of moving towards a multidimensional analysis of welfare.

Using multivariate methods to compare the regional distributions in the two extreme points of the regime, we are not able to arrive to an unambiguous conclusion as to which situation is preferred without making explicit assumptions over essential parameters. More importantly, it is possible that the rankings obtained from the exclusive concentration of the distribution of income differ from those when other dimensions enter into the analysis. If we agree that these three dimensions are relevant components of welfare (as means or ends) these conclusions stress the importance of including them all in a comprehensive study of well-being.

In future work, we will extend the study both in terms of the indicators used and the methodologies

utilised to arrive at rankings. Among the former we should utilise other indicators for health and education dimensions. As mentioned, the nature of the indicators chosen here might be hiding the actual differences in achievements of the Argentine provinces in these dimensions. We can also include 'corrections' for within-province inequality of income if we concentrate on the distribution across individuals. In terms of the methods, we should explore other weighting structures, and other methodologies.

# Statistical Appendix

**Table A.1. Basic summary statistics of indicators used.**
Argentine provinces*, 1991 and 2001

| | Obs | Mean | Std. Dev | Min | Max |
|---|---|---|---|---|---|
| **year = 1991** | | | | | |
| RPCHI | 23 | 181.4 | 53.1 | 131.4 | 343.2 |
| LE | 23 | 72.1 | 1.3 | **69.4** | 75.3 |
| IMR | 23 | 25.0 | 5.6 | 15.2 | **33.2** |
| LRb | 23 | 95.4 | 2.3 | **89.4** | **99.0** |
| LR | 23 | 74.2 | 7.8 | **59.9** | 93.1 |
| LRd | 23 | 23.5 | 6.4 | **16.2** | 48.3 |
| **year = 2001** | | | | | |
| RPCHI | 23 | 172.7 | 61.7 | **122.7** | **411.8** |
| LE | 23 | 74.5 | 1.4 | 71.7 | **77.6** |
| IMR | 23 | 17.1 | 5.0 | **9.6** | 28.9 |
| LRb | 23 | 95.6 | 1.7 | 91.3 | 98.2 |
| LR | 23 | 79.4 | 7.0 | 66.2 | **94.0** |
| LRd | 23 | 30.9 | 7.5 | 21.2 | **58.9** |

**Pearson correlation coefficients**

| | RPCHI | LE | IMR | LRb | LR | LRd |
|---|---|---|---|---|---|---|
| RPCHI | 1.00 | | | | | |
| LE | **0.65** | 1.00 | | | | |
| IMR | -0.77 | -0.70 | 1.00 | | | |
| LRb | 0.67 | 0.60 | -0.57 | 1.00 | | |
| LR | **0.83** | **0.53** | -0.65 | 0.89 | 1.00 | |
| LRd | 0.85 | 0.46 | -0.57 | 0.69 | 0.84 | 1.00 |
| | RPCHI | LE | IMR | LRb | LR | LRd |
| RPCHI | 1.00 | | | | | |
| LE | **0.42** | 1.00 | | | | |
| IMR | -0.63 | -0.72 | 1.00 | | | |
| LRb | 0.59 | 0.59 | -0.61 | 1.00 | | |
| LR | **0.73** | **0.47** | -0.60 | 0.91 | 1.00 | |
| LRd | 0.88 | 0.38 | -0.51 | 0.73 | 0.85 | 1.00 |

where RPCHI: Real per capita household income (monthly, pesos$)
LE: life expectancy at birth (in years)
IMR: Infant Mortality Rate (per 1,000)
LRb: % adults with at least incomplete primary
LR: % adults with at least complete primary
LRd: % adults with at least incomplete secondary

*Excludes Rio Negro

# Annex . The Data

- **Income: *per capita household income* (RPCHI).** Average for each provincial capital city of all positive and complete incomes[32].
  Source: Permanent Household Survey, October spells.

  We adjust incomes for inflation. Unfortunately, it can only be done using the Greater Buenos Aires Consumer Price Index as no other option is available[33]. A more serious limitation of the present data is the lack of an index to adjust for regional price differentials. Indeed, different regions face different prices for goods and services, hence affecting individuals' ability to convert those incomes onto goods. Throughout the 1990s prices have not been systematically surveyed in all provinces but only in GBA. The 1996 National Household Consumption Survey provides a price index for a basket of goods and services for each of the country's six regions[34]. No other alternative is available at present and we apply it for both beginning and end of the period. Hence, we implicitly assume that the regional price differential in 1991 is the same as in 1997 and 2001, certainly a very questionable assumption.

- **Health: *Life expectancy at birth* (LE):** average number of years a newborn person is expected to live if he/she passes through life subject to the age-specific death rates of a given period. It is the sum of the mortality rates for all ages combined, expressed in years.
  Sources: life tables from Vital Statistics (Ministerio de Salud). Population per age groups form Population Censuses.

- **Education: *Literacy rate* (LR)**. Percentage of adult population (15 years and over) with at least complete incomplete secondary schooling – due to relative high rates in primary.
  Sources: 1991 and 2001 National Population Censuses.

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[32] We don't include household with incomplete or zero responses. This might bring some uncertainty as they are not distributed homogeneously across cities and has changed over time. In 1991, 22% of the households have incomplete incomes, while in 2001 the proportion is 12%., hence not only significant but also changing over time.
[33] Strictly speaking, comparisons of mean levels of incomes are relevant if the interest is on welfare instead of solely inequality. Scale independence of inequality measures is a desirable characteristic when studying inequality, i.e. invariant with respect to proportional shifts in the distributions.
[34] These are the regional price differentials used by the official institution to calculate regional poverty lines.

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