

Opportunity and Chance: The Introduction of Sampling Techniques in Portugal

Nuno Luís Madureira
ISCTE, Lisbon, Portugal
nuno.madureira@iscte.pt

Abstract

In the Republican State, the idea of social reform brought about new languages and new attitudes with respect to misery and poverty. Private situations became not only public problems but also social priorities. Sampling methods were adopted as a technique that allowed the transposition of particular situations to universal problems, abstracted from individuals and summarized in synthetic numbers. Sampling was a device for the acquisition of knowledge, with low information costs, but also for the conversion of knowledge into guidelines for government action. This paper examines the evolution of sampling techniques in Portugal considering four levels of analysis: the politics of government, the meaning acquired by statistical figures in the perception of society, the uses of numbers by social groups and class associations, and the innovations introduced by the development of mathematical statistics (Bowley, Fisher and Neyman) in applied science.

Keywords

Scientific culture and political culture, history of statistics, government techniques, social meaning of index numbers, disembodiment of knowledge, opportunity sampling and random sampling

Sampling techniques were used in government surveys undertaken at the beginning of the 20th century. Thanks to this innovation, data collection methodologies began to involve a choice not only of the type of facts to be recorded and the field of possibilities associated with those facts, but also of information extraction processes and “laboratory” control of results. The question of material survey conditions was subordinate to the question of the representativeness of the information obtained. The sense of things shifted from the honest search for occurrences to the search for representative occurrences. The reliability of surveys began to be relative not only to the situation in which the questions were asked, but also to the selection of respondents and the number of useful answers. These were changes in both accepted ways of thinking and of acting, to the knowledge of agents and the *modus operandi* of institutions. In such a context, it is particularly interesting to analyse the logic that came to serve as the justification for the sampling criteria: How were the political arguments and the scientific arguments weighted? What roles were played by institutional structures, political and administrative priorities and government objectives in the choice of what was taken to be representative? Could there be partial information extraction units, capable of suitably representing the social whole, without the legal recognition of the State? What was the role played by information costs in determining sampling methods?

In order to answer these questions, we shall examine the various stages in the diffusion of sampling procedures in Portugal, distinguishing between their first appearance, the phase of their consolidation and subsequent transformation.

Social Reform and Single Numbers

In March 1916, Germany's official declaration of war brought an end to the uncertainties of diplomacy and made it necessary for the Portuguese government to prepare for war in terms of its own logistical apparatus, as well as ensure social support. With the formation of the "Sacred Union" government, Afonso Costa and António José de Almeida sought to cement together a social block that was capable of guaranteeing stability for the country's participation in the First World War and reserving a place for Portugal at future peace negotiations. The "national" strategy did not, however, heal the wounds that had been opened earlier, and the government remained under fire from the unionist right, independent republicans, radical monarchist sectors and anarchist militants. Whilst a contingent of troops was being prepared for Flanders at Tancos, the working classes unfurled their anti-war banners and came out onto the streets to denounce the policy of using them as "cannon fodder," and to underline the class nature of the conflict. In an attempt to obtain the greatest possible consensus and to maximise social peace, Evolutionists and Democrats proposed the creation of a Ministry of Labour with clearly defined functions: to look after the food provisions for the poor, to deepen the charitable support provided to the more needy, and to guard against strikes. The government social welfare institutions were to serve as a buffer against difficulties, as well as set up a basic network of protection under the supervision of the government.

António Maria Lisboa, a leading figure in the Democratic Party, a mason and a member of the Carbonária, was called upon to coordinate the new ministry. The Ministry of Labour therefore had a reputation as one of the more left-wing sectors of the government, a tradition that was to be maintained in the future.¹ Besides guaranteeing the capacity of the Ministry to engage in dialogue with the militant radical workers, by virtue of his links with the Carbonária, António Maria Lisboa brought to the post the experience that he had previously accumulated in the civil service, in his capacity as the interim director of statistics and director general of the Post Office.

The economic and social crisis dictated priorities. The Ministry of Labour rapidly became a benchmark organisation in the collection of information about prices and mutual aid societies, supplanting the practices of social assistance engaged in by the Directorate-General of Trade and Industry. A new phase began to take shape in the contextualisation of the working class. The use of statistics for prevention and control gave way to more sophisticated techniques of planning, forecasting and calculation. The aim was no longer to disseminate norms and check patterns, but instead to allocate resources. "The work of the State is not to provide assistance, but to take providence," (*Boletim da Previdência Social* 1919: 376) said Andrade de Saraiva to his peers at the Ministry of Labour. The legacy of sociological paternalism lost its utility in light of the new challenges being placed before the "Modern State," making it responsible for managing the social question in a situation of crisis. In the same way, local surveys ceased to be of interest, for what mattered were national solutions.

In no other contemporary institution did there exist such close ties between the task of collecting information and legislative responsibility. The imbuing of knowledge into action presented new challenges to techniques of analysis: calculation became an instrument of governance with short-term [immediate?] effects. Reforms such as the compulsory social insurance payments of 1919 sought to attack the structural causes of the precariousness of the working classes, pledging the State to seeking to achieve joint solutions. The change from conceptions of social assistance to conceptions of social welfare brought with it major alterations in the object of study and in statistical methods, and raised new mathematical problems.

A carefully combined response to social problems was only possible by considering national figures. There had to be an idea of the mortality rate and the average salary to be able to minimally forecast the mathematical reserve of invalidity and old age pensions and the corresponding deduction

¹ António Maria Lisboa remained Minister of Labour from March 1916 to April 1917. He was replaced by the horticulturist Lima Basto, the former Mayor of Lisbon. With the revolution led by Major Sidónio Pais in December 1917, Major José Feliciano Costa Júnior, a member of the military Revolutionary Junta, occupied the post. The Unionist and mason, Manuel Forbes de Bessa, in turn, replaced him in March 1918.

rates. The change in the language and objectives of social policies required the transposition of statistics to another level of abstraction and synthesis. The other side of the coin was that the monographic study lost its immediate relevance. Increasing the knowledge of a community or a region was only of interest in order to draw conclusions that covered a larger area. Government activity was now conducted through summarised numbers and not through private networks of social interaction, as had previously happened with the Directorate-General of Trade and Industry. In this way, the community ceased to be the real object of study, and became a miniaturised universe, for what mattered was extracting data for normative calculation from limited series of observations. New questions were therefore raised at the methodological level: How to move from the particular to the general? What was the representativeness of the cases considered? What was the relationship between the parts and the whole? Under the scope of the Ministry of Labour's reformist policy, case studies gave rise to sampling studies.

With these techniques, a short cut was introduced in terms of the diversity of records, and greater economy was introduced into statistical procedures with a view to the calculation of summarised numbers. This need was felt even more deeply when civil servants had to forecast the consequences of the reforms and anticipate valid solutions for the whole country. Planning and prospective calculation were used to steer the services towards low-cost methodologies capable of revealing single numbers. Statistics were integrated into the recursive circuit of the action and the consequences of the action: decisions had to be justified; results of decisions had to be gauged.

The term "single numbers" is used to designate the statistical indicators that summarise quantitative data into one single value by means of a criterion of classification, a criterion for the aggregation of data or a ratio between variables. This definition is explicitly comprehensive and includes everything from arithmetical averages to more complex indicators such as the estimates of a country's Gross Domestic Product. The underlying methodology of calculation is here so important because of the social use that is given to these indicators. What characterises single numbers is precisely the fact that the values can be highlighted from amongst the concrete mathematical operations that gave rise to them and can be used as "things" that have their own intrinsic value, which circulate and create areas of objectivity. The initiative shown by State institutions in creating single numbers therefore ends up having collateral repercussions throughout society, since the strict aim of ensuring the governability of a given sector is rapidly overtaken by decentralised processes for the appropriation of information. These processes reinvent the function of indicators, as these are applied in different areas from those originally envisaged. Once they have been made public, single numbers begin to structure social interactions, for they make it possible to anticipate information about the actions of others.² The publication of a consumer price index, for example, by reducing the universe of possibilities and concentrating attention on a given value, changes an individual's expectations not only in relation to himself, but also in relation to the possible strategies of other agents, companies and the State.

The Introduction of Sampling Techniques

The question of the increase in the cost of living became one of the main themes of the working-class movement in the period of the First Republic. From 1913 onwards, the protests of class associations, and particularly of those that were influenced by the socialist movement, became much more aggressive. In Lisbon, a Trade Union Central Committee was formed with the aim of making propaganda against the high cost of living and encouraging the creation of local committees. Newspapers such as the *Voz do Povo* launched a campaign arguing that prices had doubled while salaries remained stationary.

² This explanation in terms of decentralized information effects is not incompatible with the explanation in terms of governmentalization of politics advanced by Rose Nikolas (1991). *Governing by numbers: figuring out democracy. Accounting Organizations and society*, 16 (7): 673-692.

Until then, the price of bread had been considered the main measure of the people's standard of living. With the increase in national income in the second half of the 19th century (a growth in the national product at a rate of 0.6% per year), the elasticities of demand changed and the range of food products was diversified. Rice, potatoes, beans, dried cod, fresh fish, *chouriço* and bacon, butter, sugar, soap, coal and oil began to represent a very significant share of the household budgets of working-class families and began to be widely advertised at grocer's shops, which sought to attract customers with attractive prices (Costa Junior 1917:195-199; Quintas 1988). In order to gain a more complete knowledge of the situation of the working class, it was necessary to establish a benchmark for the 20th century that was equivalent to that provided by bread for the 18th and 19th centuries. It was not enough to know the price of the different commodities, since it was not possible to draw any safe conclusions from these: what was needed was a single number that represented a synthesis of the evolution of the cost of living. The first author to attempt to represent the aggregate change in prices was Albino Vieira da Rocha, who resorted to the values of imported and exported goods, just as these were set out in the Trade Balances, in order to produce a single index based on different "proportions" of 38 commodities that entered into commercial trade (1913) (Rocha 1913). Using this methodology, it was confirmed that inflation had risen 20% since the beginning of the century. However, the impact that prices of imported and exported goods had on the shopping basket of household budgets remained to be explained: the statistical measurement related to goods included in the trade balance did not have sociological content.

With the disgraceful situation of the First World War, the problem of provisions once again encouraged discussion of the social question of the cost of living. The normal supply circuits experienced a serious crisis. There were wholesalers who took advantage of the circumstances to hoard products and in some cases it was even necessary to resort to the services of the army bakehouse to ensure the supply of bread at reasonable prices. The difficulties were exacerbated by the fall in national production, and the shortage of energy products and imported raw materials, which pushed prices upwards. This trend grew worse from 1916 onwards. At the recently created Ministry of Labour, the Economic Defence Department took on the task of combating speculation and the shortage of essential goods. As early as 1917, information began to be collected about the prices of commodities in the various districts of mainland Portugal. Influenced by the developments of the English statistics published by the Board of Trade and by the Australian survey, *Expenditure on living in Australia*, Aquino da Costa Júnior, the head of the Economic Defence Department at the Ministry of Labour, set to work constructing the first weighted cost of living index in Portugal. Transferred to the Ministry of Labour from the Directorate-General of Trade and Industry, this engineer combined his new position with his work as a mathematics lecturer at the Lisbon Science Faculty, where he was the most qualified statistical analyst.

How did the workers spend their salaries? This was the first problem to be investigated. Quite simply, the question was more complicated than it seemed. Consumption depends on disposable income and consequently on the worker's income level. However, it also depends on the household structure, the person's stage in the life cycle, the traditions of the region's material culture and its eating habits. In contemporary language, this complexity is captured by the multivariate analysis model, saying that the household structure, region and income level are variables that help to explain the behaviour of the dependent variable of consumption. Aquino da Costa Júnior felt the need to make the relationship between these components explicit, because he was not thinking of surveying all the households in the country. Instead, he wished to gather a significant sample of the working-class population. Now, if there were no control of sampling, there would be a danger that the conclusions might be distorted: just think, for example, what would happen if the data collected were to over-represent the proportion of families at advanced stages of the life cycle and if their children, by contributing to the household budget, were to push disposable income and consumption up to values above the mean for the population: "in order for the budgets of the working classes to be properly appreciated, we must take into account the relationship existing between their income and the number of children who work and do not work, without which apparently unreasonable conclusions might be drawn" (Costa Junior 1917:108).

Although the idea of delineating smaller sectors for observation was not new, discussing the social and demographic composition of a sample was an important scientific step in Portuguese

statistics.³ Thanks to this methodology, the doors were opened to low-cost data collection and selection processes, replacing interminable counts through laboratory modelling and through the mathematical analysis of the relationship between the estimates of the sample and the parameters of the population as a whole. Unfortunately, the initiative did not enjoy any continuity and the recourse to sampling procedures remained relatively unaltered in until the 1940s.

Aquino da Costa Júnior began by sending 7500 questionnaires to 350 of the country's class associations. In the accompanying circular letter, he considered the fact that science was the best possible ally of the working class, a view that clearly revealed his positive belief in the role of knowledge in transforming society: "Social science abroad has taken its researches to the point of determining man's economic value, establishing the equation between *what* his sustenance requires and *what* his work produces. This remarkable work of economic speculation, which has benefited from the help of the class associations, is responsible for most of the conquests achieved by the working classes in their claims, based on a greater equity in the relationship between capital and labour" (Costa Junior 1917:103).

Only 756 answers were received, a part of them being incorrectly filled in, and a new request had to be made, this time being issued through the local administrators. When it finally proved possible to amass a reasonable volume of surveys, he moved on to the next phase. The methodology presented by Costa Júnior was based on intuitive elements, without his putting forward any theoretical arguments to support them. The lack of any more profound justifications was probably due to the fact that the author followed in the footsteps of the mega-survey undertaken by the Board of Trade in 1906, which represented the first survey of household budgets amongst the working classes, simultaneously undertaken by various European nations. The consultation of this source of authority gave scientific credibility and legitimacy to the comparison of results in international statistics, curtailing the discussion of sampling techniques. The nub of the argument was centred on one single feature: showing that there were no spurious elements and that all social factors that might influence the results were subject to prior control.

A set of cross tables shows the distribution of the frequencies of household types by income classes, the number of children by income classes, and average income by region. Checking the reliability of these figures as a whole consists of showing that, if we divide the answers to the questionnaire into sub-samples, each of which is structured according to mutually exclusive criteria, we will obtain new distributions that are reasonably similar amongst themselves. In other words, the distribution of income classes does not significantly change when we consider families with fewer than 4 persons and families with 4 or more persons (Graph 1). It can therefore be deduced that this factor does not have any spurious influence on the results of household consumption.

An intuitive methodology was followed, without any mathematical confirmation of the conclusions and without any explicit formulation of the statistical hypotheses. However, even at this intuitive level, there are two ways of looking at things:

One is to consider the fundamental element of distinction to be the mean of the distributions. Not only is the mean an appropriate statistical indicator for filtering the random variations of social facts and showing their regularities, but the symmetrical nature of the (normal) distribution means that the deviations in one direction or the other cancel themselves out. On the other hand, in large aggregates, the concentration of frequencies around average values has a profound epistemic meaning, for it reveals that there are constant causes guaranteeing the stability of data. Conversely, any instability or difference between mean values proves that the aggregates are affected by different causes. Such a conceptualisation was the starting point for the notion of the "average man" developed by the French mathematician Jacques Quetelet (Hald 1998: 586-598). Now, as the two sub-samples of the survey undertaken by the Ministry of Labour present a household income distribution centred more or less on the same average values, decreasing thereafter

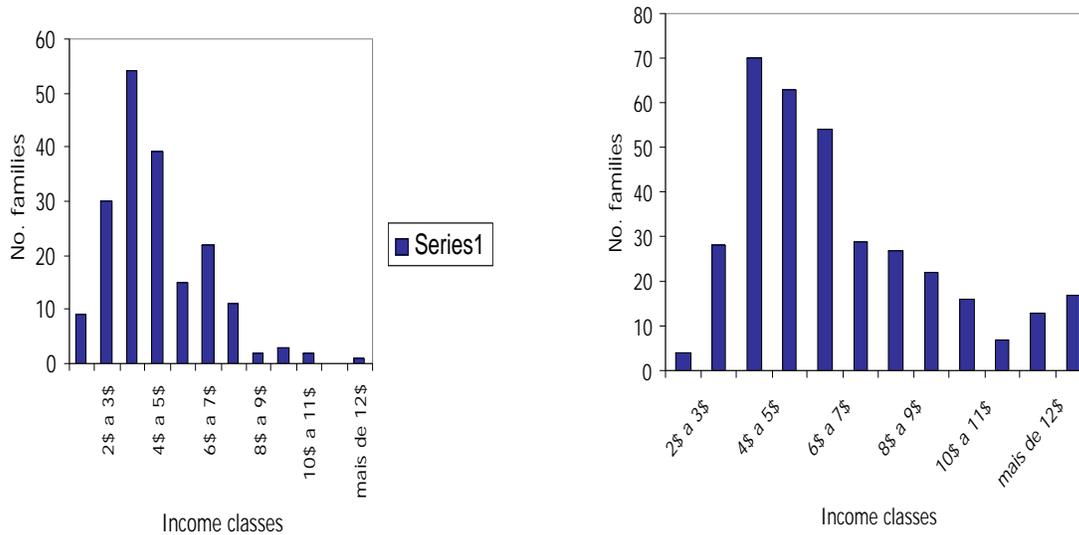
³ Aquino da Costa Júnior was the first author to discuss this problem when applied to economic and social areas. A first scientific introduction to the theory of sampling probability was, however, provided in a footnote by Luiz Feliciano Marrecas Ferreira, with the author making use of the methodologies developed by the mathematicians Laplace and Jacques Bernouilli. Marrecas Ferreira, Luiz Feliciano (1886). *Estudo sobre Montepios*, Lisbon:Tipografia da Viúva Sousa Neves: 9.

at the extreme values, it seems legitimate to conclude that they are similar. The similarity of the more frequent values in both sub-samples therefore functions as proof of the fact that there are no causes influencing one sample without also influencing the other. Our eyes are directed towards the fact that most people were situated in the income classes between 3\$00 and 5\$00 escudos, both in the sub-group of families with more than 4 members and in the sub-group of families with 4 members or fewer.

Graph 1

Classification of working-class families according to their average family income

2.1. Families with fewer than 4 members 2.2. Families with 4 or more members



Sources: (Costa Júnior 1917:103-109)

But there is another way of looking at the problem. The fundamental element of distinction between the two sub-samples is not the mean but the variation around the mean. The possibility of the distribution of the frequencies not having a symmetrical shape and therefore of the mean not representing the best estimate of the expected value is theoretically contemplated. Other parameters are needed that are capable of showing the variation at different moments of the distribution, both to the left and to the right. In the actual case under analysis here, the prospect of change directs our eyes towards the fact that the families “with 4 or more persons” show a distribution with a pronounced tail to the right, indicating that the larger households, probably those with children in active employment, have higher incomes. From this, it can be inferred that the two distributions are not exactly the same.

The succinct interpretation made by the Ministry of Labour did not suggest this latter hypothesis, and it was satisfied with the conclusion that there was a similarity in the distribution of incomes in different-sized families.⁴ Underlying this was the idea that “representativeness” is given by the concentration of sociological groups around a certain mean. The sense of order, position and functional group is transmitted through the concentration of the distributions at central values.

⁴ The statistical test for the differences of the means gives a result of -5.58, showing that there is a significant difference in the mean of the two distributions, which allows us to conclude that family size is effectively related to the variable of household disposable income, contrary to the view expressed by the Ministry of Labour.

Historically, this view was closer to Quetelet's Average Man theory, from the first half of the 19th century, than to the English biometry movement, from the end of the 19th century. This included the new discoveries of anthropometry and mathematical biology made by Galton, Pearson, Weldon and other authors, who centred their attention on the variability of individual cases and on ideas of variance, correlation and regression.⁵ The priority given to the study of groups, summarised by their mean, gave way to the analysis of the distribution of individuals and their comparative difference.

The idea of using what is known about the population as a whole in order to select small samples that represent the diversity of characteristics of the whole group only began to be noted in the mid-1920s. A. Jensen, the director of the Danish Department of Statistics, made a decisive contribution towards testing this methodology and demonstrating its efficacy (Hald 1998: 290-291). Aquino da Costa Júnior's view naturally did not have anything to do with these techniques of intentional selection. There were other concepts involved: the population of the sample was not a randomly chosen object, but there was also no deliberately determined pattern. For this reason, it would be difficult to speak of the existence of criteria for the extraction of data. And this meant that the notion of "representativeness" had to be constructed *a posteriori*, as a justification for the volume of answers that it was possible to obtain within the survey. We are therefore faced with a sample of opportunity, where the reliability of what is represented depends on a judgement about its capacity for revealing the average traits of a population⁶ without questioning the verisimilitude between the observations collected and the sector under analysis, between the sample and the population. The concept of a *sample of opportunity* thus describes the State's use of previously existing social groups and their recognition as suitable entities for building a sampling pool with low data collection costs.

In the international statistical world, the mathematician Arthur Bowley insists on criticising this type of survey, proposing a methodology for estimating "confidence intervals" for samplings. After the First World War, the question was firmly on the agenda. To counteract the proliferation of questionnaires, which lacked the formal mechanisms of standardisation and control, the International Statistical Institute approved a recommendation in 1925, in which it declared the need for finding a mathematical formulation for establishing the degree of accuracy of results, as well as providing an indication of its probability of error.⁷

In 1934, the mathematician Jerzy Neyman established a new paradigm for research in this area. Before an audience of specialists at the Royal Statistical Society, Neyman answered a fundamental question: how many observations must be collected for us to be able to replace the exhaustive analysis of the whole by the investigation of one of the parts. Thanks to this idea, statistical representativeness began to be gauged mathematically, subordinating the importance of sociological representativeness. The very concept of the confidence interval is also altered, ceasing to

⁵ Astronomy and navigational sciences from the end of the 19th century, (Pedro José da Cunha, Wills de Araújo, Júlio Milheiro and others), followed by criminal anthropology and the eugenics movement from the 1920s, were the first scientific areas in Portugal to introduce the analysis of the dispersion of distributions (standard deviation and probable error). This representation corresponds in the human sciences to an attitude of distrust in relation to the realistic grouping of individuals into classes, justified by the sociological sense of the normal distribution of the categories around a central trend. The prospect of individual variation becomes important and calls into question the aprioristic coherence of statistical categories, this being one of the features of the criticism levelled at the biological determinism of Lombroso (evident in the works of Roberto Frias, Basílio Freire, José Joyce) and the distancing from the social elitism of Darwinism (evident in the works of António Azevedo Castelo Branco, Júlio de Matos, Magalhães Lemos). Madureira, Nuno Luís, 2003. A estatística do corpo: antropologia física e antropometria na alvorada do século XX, *Etnográfica*, VII(2):283-303.

⁶ According to Desrosières, the 1906 survey of the Board of Trade, the benchmark for the Portuguese survey, as well as others of a similar nature undertaken in Europe at the beginning of the 20th century, were part of the mathematical theory of Quetelet's average man. On this subject, see Desrosières, Alain, (1998). *The Politics of Large Numbers*, Harvard: Harvard University Press (English translation).

⁷ This recommendation by the International Statistical Institute resulted from the insistence of A. Jensen and the Professor of Statistics at the London School of Economics, A. Bowley, who at that time was the scientist most evidently concerned with defining the conditions for a probabilistic assessment of sampling error. Hald, Anders, *A History of Mathematical Statistics...*, op. cit. (1998): 291-294.

be a result in order to become a flexible process, in which the researcher is called upon to intervene. The statistician becomes a decider for it is his responsibility to decide upon what would be the most suitable confidence interval: he can equally well choose an interval of 99.5% or one of 95%. The greater the level of confidence, the greater is the possibility of the real value of the parameter remaining within the intervals estimated by the sample.⁸ This contribution provides theoretical support for the adoption of random sampling techniques, freeing administrative techniques from prejudices against the uncertainty of results in random choices.

In the survey undertaken by the Ministry of Labour in 1917 on the “Portuguese proletariat,” the class associations and the ministry staff filtered the answers twice over: the associations because they were intermediaries in the choice of candidates; the ministry staff because it suppressed answers that were considered invalid or fanciful. Although the historical sources have not survived, it is legitimate to suspect that the less literate workers, those who had greater difficulties in calculating their consumption and those who were politically radical and refused to engage in any form of collaboration with the State (it should be remembered that we were at that time at the height of anarcho-sindicalist influence) did not contribute to the final results of the sample. Such circumstances profoundly changed the premises of random selection. If hypothetically we were to forget such a reality and took the sampling as a genuinely random act, Neyman’s theory would allow us to conclude that the 538 valid questionnaires (0.4% of the industrial workers identified in the 1917 census) effectively guaranteed a good estimate. Faced with the parameters of the distribution and basing ourselves upon a confidence interval of 95%, it could even be said that it would be enough to have access to roughly half of the answers collected (292 questionnaires) in order to already be able to obtain satisfactory results.⁹

Technical Legitimacy and Political Legitimacy of the Price Index

The next step in the construction of the index of the cost of living consisted in finding out how households managed their budgets. The quantities consumed were calculated on the basis of 52 weeks (1 year) and began to constitute what is now known in modern terms as the “consumer’s shopping basket” (Table 2). From this reference, the index was calculated by multiplying the average prices for a given year by the respective average consumptions. Subsequently, the total expenditure of the shopping basket was added up and a weighted average was obtained that fixed in one single number the impact of the price changes on the life of families.

The publication of the first studies making use of the price index was a source of great pride for the staff at the Ministry of Labour. The satisfaction came from the fact that Portugal introduced this statistical innovation before other European nations, more particularly before Spain and Germany. Not everyone shared in this enthusiasm, however. The globalising expression “cost of living index” gave an idea that did not correspond to reality because many household expenses were not included in the “shopping basket.” For technical reasons it was only possible for the Ministry of Labour to investigate the prices of food and the odd products used for hygiene and heating purposes.

Amongst the items omitted, clothing, linen and house rents were the most problematical, for they represented a considerable portion of household budgets (at least 25% according to the conclusions of the survey of workers’ consumption habits). In other circumstances, perhaps this technical lapse would have gone unnoticed. In the agitated atmosphere of the First World War, the

⁸ “Note that to Neyman, the probability associated with the confidence interval was not the probability that we are correct. It was the frequency of correct statements that a statistician who uses this method will make in the long run. It says nothing about how accurate the current estimate is.” Salzburg, David, (2001). *The Lady Tasting Tea. How Statistics Revolutionized Science in the Twentieth Century*, New York:W.H. Freeman and Company, 123.

⁹ A group of 292 surveys would make it possible to obtain a sample of working-class families with average incomes situated within a 95% range of confidence, in the interval between $8 - Z \alpha/2 \sigma \sqrt{n}$ and $8 + Z \alpha/2 \sigma \sqrt{n}$ and receiving 5\$69 and 5\$09, respectively. The average income of the survey of living conditions was 5\$39 per family per week.

deficient coverage of the index took on political overtones and became a subject of debate. Due to the shortage of essential commodities, the prices of food products and coal grew at a faster rate than all other types of goods and services. Furthermore, they were imperfectly measured by the official statistics, which did not capture the parallel evolution of the black market. The wave of robberies at grocer's shops and small trading establishments in the spring of 1917 was the most visible symptom of people's impatience with the bottlenecks in the market and the rising trend in prices. As the index only considered those essential goods where the effects of inflation were most severely felt, the official picture of the cost of living was higher than that which individuals experienced in their day-to-day life. If we further add to this factor a high level of social conflict, which continued until 1921 in the struggle for better salaries, in a defence of the 8-hour working day and in the fight against a reduction in work by the employers, then the ingredients were in place for the index to become part of the social unrest. An exaggerated measurement of the rise in the cost of living legitimised the workers' claims for an updating of their pay levels.

Table 2

Annual consumption of a working-class family (food, energy and hygiene) according to the 1917 survey

Product	Annual consumption of a 4-person family	Product	Annual consumption of a 4-person family
Bread	800 Kg	Eggs	40 dozen
Potatoes	250 Kg	Sugar	50 Kg
Beef	90 Kg	Lard	10 Kg
Lamb	20 Kg	Chouriço	12 Kg
Rice	30 Kg	Bacon	12 Kg
Dried cod	30 Kg	Wine	400 litres
Olive-oil	40 litres	Coke	250 Kg
Coffee	12 Kg	Charcoal	250 Kg
Beans + chickpeas	150 litres	Oil	50 litres
Milk	180 litres	Soap	100 Kg

Sources: (Costa Júnior 1917:106)

Working class associations expressed their discontent by comparing the increase in salaries with the increase in the prices of bread, dried cod, meat and other foodstuffs, resorting to disaggregated prices to draw their own conclusions. Against such a line of reasoning, the employers were unable to counteract with a valid argument; they could not invoke the single numbers of the cost of living, nor even wave the flag of scientific objectivity. The mathematics of the Ministry of Labour coincided with the arithmetic of the workers' associations. Faced with the adversity of the numbers, all that was left was to lead this debate to those places behind the scenes in which technical discussion was the order of the day, and to criticise the lack of credibility of the cost of living index: "Unfortunately, our offices where statistics are kept are not equipped to formulate the necessary data for the appreciation of the nation's different forms of economic life (...) At this moment, the working classes wish to be given impracticable rewards for their work, and the impossibility of satisfying such demands cannot be opposed with sufficiently convincing arguments, because of the lack of statistical data on which such opposition would have to be based." This text appears on the opening page of the Commercial and Financial Bulletin (*Boletim Comercial e Financeiro*), distributed free of charge in banking and financial circles. The writer of the article concludes his argument by requesting the compilation of a truly representative price index: "not only is it necessary to deal with the problem of food, clothing and accommodation, but it is also necessary, in addition to such essential needs, to

pay attention to the habits of social solidarity, the organisation of education and health, aspects of a recreational nature and others” (Boletim Comercial e Financeiro, 1921). Through an ironical twist of fate, Aquino da Costa Júnior’s visionary statement of science as the ally of most working-class “conquests” ends up being proven, although not in the sense envisaged by the author.

Against the background of galloping inflation, strikes and demonstrations for better salaries, and the snowball effect of the budget deficit, single numbers began to have strategic significance in the perception of the indicators of the economy and the State’s behaviour. In five, or possibly six years, things had changed so rapidly that the economic agents needed reference anchors in order to be able to understand what was happening.

Comparing data from 1913 with data from 1919 or 1920 became a common practice in all reflections upon this matter: in this interval was to be found the unknown measure of the war’s economically degenerative effects. Not only in Portugal, but throughout Europe, “index number mania” was invading the space of reflection, and the essayists came to use the aggregate information of these indicators as a platform for developing their ideas (Andrade 1925; Costa 1926; Valente undated).

This whole conjuncture gave a special impetus to the search for single numbers that were capable of reducing ambiguities and uncertainties. The cost of living index became highly relevant, for it was a tool that was already available to be used in measuring phenomena and in comparing them in order to establish a pattern. The trend towards extrapolation necessarily implied that the social meaning be decontextualised: what had previously been an instrument for helping the working class was transformed, by dint of circumstances, into a macroeconomic indicator that could be generalised and applied to the whole country. The cost of living of the working population was therefore transformed into an abstract rate of inflation. The first step was taken in 1922, when the Statistical Yearbook reproduced Aquino da Costa Júnior’s work in order to make a comparative estimate of the evolution of prices in that year. The aggregate indicators were presented as prices for the country as a whole and no longer just as measurements approximating the standard of living of the workers. In other words, the social significance of the aggregation faded away (this social significance was represented by the value of q in the calculation of $\sum pq$, which describes the sum total of the prices weighted in accordance with the quantities consumed).

In 1929, the Monthly Statistical Bulletin (Boletim Mensal de Estatística) issued by the National Statistical Institute continued with the initiative, updating all the information of the Ministry of Labour and establishing the prices of July 1914 as the 100 base of the index. During the period of the New State (Estado Novo), this indicator became the official one. The State formed by Salazar appropriated the republican initiative, stripping it of its social ideas and converting it into a technical device. Such a disembodiment of knowledge implies that the conclusions that were strictly valid in terms of sampling were later extended to cover the whole population.

The first attempts made by the regime to modernise the coefficients for the weighting of consumption were unsuccessful. In an attempt to solve the problem, the National Statistical Institute ended up resorting to the survey carried out by the Directorate-General of Health in 1937 in order to obtain data about household budgets. Once the index had been reformulated, the advances made in the coverage of expenditure were minimal and there continued to be only 21 items estimated in the shopping basket. The discourse was therefore prudent and cautious. To avoid falling into the controversies experienced by the former Ministry of Labour, it was stated that the country did not have a real cost of living index, but rather a “weighted index number of the cost of food and some articles of domestic consumption” (INE; 1940).

But not everything had to do with technical difficulties. Some products escaped the nets used for the collection of information simply because the informality of transactions did not allow for any standardisation of characteristics or comparison of prices. The selling of fruit and vegetables on farms, in the street, at temporary markets and stalls, based on the value of each unit, the circumstances of the moment and the general appearance of the customer, fell under this category. Obviously, where the economic rules of trade allowed themselves to be imbued with other factors, the analysis of prices was more complicated. In these first indexes, there was clearly some difficulty in capturing the evolution of perishable seasonal products such as vegetables and of those that

appeared on an irregular basis, such as fresh fish. The very size and scale of market relations limited the possibilities of statistics.

The main novelty in the updating of the index undertaken in 1938 was the appearance at such an early stage of an official mathematical notation of the formula proposed by the mathematician Laspeyres (1871).¹⁰ The price index of the Laspeyres type is still in use today in Portugal and in the other countries of the European Union,¹¹ and shows the variation in the cost of a shopping basket of articles in the current period (1), by comparison with the same shopping basket in the base period (0):

$$L = \frac{\sum_{i=1}^n p_{i1} q_{i0}}{\sum_{i=1}^n p_{i0} q_{i0}}$$

According to the economists Solow and Temin (Solow and Temin 1978:8), the Laspeyres index has an effect similar to that of a man who, on the basis of today's information, goes to bed trying to imagine what tomorrow's prices will be like. It is easily understood that the great disadvantage of this statistical indicator is that it does not accompany the trends of consumers when they choose to buy new products whenever there are advantages in replacing one good with another.

The statistics relating to inflation changed very radically after the Second World War. The age of radio advertisements, restaurants, entertainments, detergents, electricity, electrical household appliances and medicine substantially altered the consumption routines of the urban classes. Changes were now occurring at a much faster pace. From 1941 onwards, the Bank of Portugal also began to publish a price index on a regular basis, and in 1948 the National Statistical Institute finally presented a general consumer price index.

A substantial improvement was immediately noted in the coverage of the whole spectrum of household expenditure, particularly in the category of services that had been undervalued until then. Furthermore, the index now included those novelties that had caused such a stir in modern life: football and other entertainments, electricity, restaurants and cafés, personal hygiene, home furnishings and a fair sample of expenditure on clothing and footwear (12 items for men and 19 items for women). The main advance in this area, however, had to do with the inclusion of the price series of house rents, whose absence from earlier statistics called into question their reliability. Altogether, each month between 198 and 251 prices of goods and services were collected, five times more than previously, and a fairly up-to-date number if we consider that the Consumer Price Index for 1976 grouped together similar information (256 items excluding rents). The new advances made in statistical credibility only occurred during the 1980s, when the database increased to a total of 524 items (1983 Index) and then to 577 items (1991 Index).

Despite the post-war improvements, the fact of the matter is that the use of the sampling of the survey as the basis for the construction of the coefficients for the weighting of the index was far from able to represent the multiform reality of household expenditure in the different Portuguese

¹⁰ In the Monthly Statistical Bulletin of the Directorate-General for Statistics, INE, (1929) 3, a version had already been presented of the Laspeyres index with an early notation that used a capital "P" to indicate the current year's prices and a small "p" to refer to the prices of the base year:

$$L = \frac{100 \sum p q}{\sum P q}$$

¹¹ France and the United Kingdom used variants of chain indexes of the Laspeyres index to account for the permanent updating of consumer behaviour.

regions. The 56,215 individuals consulted in June 1948 were more a reflection of the “population of the regime” than the population of the country. The sampling criteria were drawn up from the corporate structure, using “official” trade unions, based in Lisbon, as their channel for the conveying of information. The overlapping between government and State, together with the centralism of capital, was able to produce scientific magic: a sample of 2.5% of the workers of each trade union in Lisbon ended up being representative of the country’s socio-professional universe. The reasons for the survey were grounded in the regime, serving simultaneously as official procedure, a legitimising demonstration and a motivating narrative.

Sampling Probability and Theory

Opportunity samples have the function of legitimising the mechanisms of representativeness created by the regime: political groups become statistically relevant groups, for it is in them that the very sap of social organisation is to be found. Yet the most important thing is to stress that, at that time (in the 1940s), new sampling techniques were being tested in Portugal for the first time, based on the paradigms of statistical inference. This scientific advance was to lead to the general acceptance of the methodologies of random sampling.

The new concepts were presented in a book published in 1938 by the scientist who had most distinguished himself in Portugal in the experimentation of mathematical statistics, the Coimbra University lecturer Euzébio Tamagnini (Tamagnini 1938). From the point of view of practical applications, it was in the field of agronomic studies that the first steps were taken. At the Alandroal Dryland Crops Experimental Station and the Sacavém National Agronomic Station, stratified samplings were developed, based on the geometrical division of the cultivated land into “causalised blocks ... with L strips, each with h possible sample units, of which only K are included in the sample” (Oliveira 1948: 208). Ronald Fisher’s variance analysis, which had also come into being at an experimental agronomic station in England, was the great theoretical influence upon these experiments. It should be noted that the methodology of artificially dividing the land into small experimental blocks transformed the statistical observations into a random selection of the set of possible measurements. The object of knowledge ceased to be the cultivated land and was centred on the samples taken from this land. Consequently, instead of having fixed parameters to describe the real distribution of the observations, we were left with estimates, “mere statistics” based on insufficient information, which might later be used to try and discover the parameters of the real distribution. By making the mathematical calculation dependent on the prior constitution of the series, the sampling became a logic for science to represent the world. The methodology for the construction of the observations was likened to a throw of the dice, and statistical facts therefore acquired the theoretical position of probable facts. The premise that there was a gap between the theoretical value of the parameters (mean, standard deviation, regression, etc.) and their estimated value led to the foundation of an epistemology that was to become known as statistical inference.

The adoption of these methods in Portuguese agronomy was associated with the activity of Manuel Zaluar Nunes at the Higher Agronomic Institute in Lisbon. His works on samples of cereal and potato crops at Sacavém and Alandroal were not in fact the only developments of the research. In the 1940s, mathematical applications of sampling techniques to the study of forests were also attempted to determine the volume of trees in eucalyptus woods, controlling the errors to which sample units are subject (Monteiro 1944:25-58), an activity that involved high costs in information collection by direct measurement.

Around this time, the secondary school teacher and psychologist, Rui Carrington da Costa, introduced an application of the significance tests (*student T-tests* and Fisher’s *z-Distribution*) to check the forecast of his students’ success at school, based on a small sample of 59 cases. As he said, it was a question of “assessing in terms of probability, the degree of confidence that can be attributed

to the calculations made... establishing the limits of the discrepancy between the constants or parameters of the sample and those corresponding to the population or sector” (Costa, 1941).¹²

The contrast between the agronomic experimentation and the estimative theory of school psychology, and the methodology of household budgets, is enormous. The demographic and sociological concerns of the First Republic resulted in surveys intended to confirm the political and administrative structure of the New State, whose reliability was based on the law of large numbers. Still missing, however, was an assessment of the degree of confidence in the results (Bowley, Neyman) and the probability of obtaining estimates in the samples that were different from the true mean of the population (Fisher).

Seen from a comparative historical perspective, the adoption of sampling methods, modelled by mathematicians, enjoyed a remarkable level of development in the American administration during the period of the New Deal. In several sectors of the Federal Government, namely in the Trade Department and the Labour Department, but also at the National Cancer Institute, a generation of young mathematicians replaced the routine statistics of the federal government with Fisher and Neyman’s methodologies, proving that small random samples were more accurate and rigorous than the exhaustive surveys that had been undertaken until then (Salzburg 2001:172-180).

Scientific Culture and Political Culture: an Impossible Compromise

The New State’s administrative opportunity statistics preferred to demonstrate in an overwhelming fashion the regime’s power of persuasion, gathering together tens of thousands of responses and encouraging the collaboration of the corporate trade unions. In fact, the idea that individuals can be drawn at random from a population and that they can be used to form an experimentally valid group transcends the scientific question to become a postulate that is politically incompatible with the basic principles of organisation of the New State.

Salazar’s regime ideologically justified authoritarianism and restrictions on freedom of expression with the argument that political representation in Portuguese society gave a voice to the natural groups and spontaneous forms of social structuring: the family, socio-professional organisations, local communities. This corporate base made it possible to go beyond the dilemma of the liberal model of the expression of individual interests, as opposed to the socialist model of the representation of class interests. Now, as the corporations were political realities and economic entities, they also took on the role of administrative units for the purposes of information collection (institutionally inserted in the data collection circuits of the National Statistical Institute from 1944 onwards). The regime established a representativeness prior to the statistical choices made about groups and political and administrative classification. In this way, however convincing the scientific arguments might be, there could not be any great sensitivity to the idea of random sampling, for this meant denying the representative logic of existing institutions and the constitutional philosophy of representation, not to mention the risk of obtaining results without any political control and opening the doors to the sociological questioning of the variance in household incomes. Establishing limits for the processes used for extracting information from structures that were bound to the regime was the way of controlling the outburst of randomness.

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¹² The significance tests had previously been introduced by Eusébio Tamagnini in the above-mentioned work published in 1938.

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