Efficiency Analysis of Social Protection Expenditure in the Italian Regions

Antonio Frenda [1], Enrica Sepe[2,3], Sergio Scippacercola[2,4]
[1]*Istat - Direction of Business Statistics – Structural statistics on businesses, governmental and non-profit organizations*
[2]*Department of Economics, Management, Institutions, Naples University "Federico II"*
[3] *Department of Law and Economics Sciences - Pegaso Telematic University*
[4]*INGV- OV Napoli*

Abstract

The attention and demand for greater social protection is increasing among the populations of all European countries. It is difficult to identify which of the structures and infrastructures, sectors and regional budgets are inefficient and/or negligent in respect of providing more social protection. In the political sphere the problem is examined from a qualitative point of view, because it is essential to have a valid decisional support system that provides useful information for structural and economic intervention programs devised to improve social protection**.** Regional spending on social protection is a fundamental component of individual well-being. This work is precisely aimed at assessing individual well-being in terms of technical expenses efficiency in the Italian Regions. Stochastic frontier analysis and a nonparametric deterministic model structure are the tools used to investigate the social protection determinants in the paper.

Keywords: *Data envelopment analysis, Stochastic frontier analysis, Technical Efficiency, Social protection expenditure.*

1. Introduction

In this period of a European economic crisis, the efficiency of social protection is an object of close attention because it weighs quite heavily on national resources. The main objectives of this paper are to evaluate the technical efficiency (TE) scores of Italian regions and to investigate determinants in the utilization of resources in terms of social protection, which the European Commission (2018a) describes as follows: *"Social security serves to protect people against the financial implications of social risks, such as ill health, old age or job loss, and contributes to preventing and alleviating poverty and social exclusion* [1]. Spending on social protection by macro area is, according to the authors, a fundamental component of individual well-being. Prompted by the work of the Stiglitz's Commission, the attention to the beyond-GDP measures has led to the inclusions of well-being indicators in the policy choices [2]. Testing for the time series approaches, such as dynamic factor models could be another important step forward, in particular to estimate the underlying component of the growth (e.g. Eurocoin Indicator) [2]. This work aims to evaluate individual well-being in terms of technical efficiency deriving from the investment policy for social protection.

In this paper we describe new developments in statistics applied to the evaluation of global social security expenditure: we will consider both "public social security" and the part of private social security concerning complementary pension funds [3].

Social protection is about redistribution and facilitating inter-temporal resource transfers, such as those facilitated through government pensions that also have a role to play. Some economists [4] outline how the state should seek to counter inequality that arises from factors that are beyond individual control: this is also expressed in terms of the Rawlsian philosophical *maximin* principle, *"according to which a just society should seek to maximise the minimum opportunities within the social system"* [5].

An exhaustive analysis of social security expenditure must consider the criteria established by the European system of integrated social protection statistics (*ESSPROS*). *ESSPROS* is a common framework that was developed by Eurostat and the EU Member States in the late 1970s in order to provide a coherent comparison between social benefits and their financing in European countries, thus making a comparison of national administrative social protection data possible [6]. ESSPROS is built on the concept of social protection, or the coverage of precisely defined risks and needs, which include health, disability, old age, family and unemployment. A part of the expenses incurred for social security, such as unemployment insurance, has never been provided by private insurers despite the obvious benefits to beneficiaries, largely because of the challenges concerning *information asymmetries* between potential insurance firms and insured individuals. The models differ in terms of who pays for the benefits and who is qualified to receive the benefits [7]. In Bismarck's model, benefits are available only to the families of those who work, and are paid for by employees. In Beveridge's model (which

[1] The views expressed in the article are those of the Author and do not necessarily reflect those of ISTAT.

includes the Italian case that we outline in this work), benefits are typically available to all, and are funded out of general taxation revenues.

Under Articles 8 and 9 of the *European Commission's Council Recommendation (2018b)*, *"Member States should ensure that workers have access to social protection by extending formal coverage on a mandatory basis to all workers, regardless of the type of their employment relationship":* this would cover sickness and healthcare benefits, maternity/paternity benefits, old age and invalidity benefits and benefits in respect of accidents at work and occupational diseases on a mandatory basis [1]. It is unsurprising, therefore, to discover (through the SFA and DEA analyses that follow) how pensions and health expenditure are the main inputs, together with the municipal expenditure for social protection, estimating "global spending on social protection", which refers to a particular area of economic and social activities through which a part of the sectorial and territorial process of income redistribution is realized: it traditionally corresponds to the three intervention sectors represented by health, social security and social care [8; 9].

The study is structured as follows: in the second section some methods for an efficiency analysis are briefly presented by the Stochastic Frontier (SFA) and the Data Envelopment Analysis (DEA). Additionally, in the second section, all the variables that could be candidates for the design of the two efficiency methods are shown and explained through descriptive analysis, while the main economic indicators for analysis of the Italian Social Security System are implemented. The third section illustrates the results obtained after realization of the SFA and DEA models. Subsequently, in the Fourth section, a discussion on the obtained results is reported. Conclusions and perspectives close the work.

2. Material and Methods

2.1 Stochastic Frontier Analysis

The Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) [10; 11; 12] are two alternative approaches to identifying the Technical Efficiency (TE). The DEA assumes a deterministic production frontier as the solution of a linear programming problem without taking into account possible random errors: any distance from the frontier is an evidence of inefficiency [13; 14; 15]. The SFA, instead, develops the production function by comparing it with all the examined production units: deviations from the frontier are interpreted as the sum of effects of the stochastic disturbance and technical inefficiency.

The SFA model relates the outputs (Y_i) of the *i-th* production unit (Data Making unit: *DMU*) to the process inputs (X_i), and estimates the parameters related to the distribution of residuals [16; 17]. The model, called the Stochastic Frontier of the production function, is [18]:

$$\ln Y_i = x_i'\beta + v_i - u_i \quad (i = 1,2, \ldots, I) \tag{1}$$

where β is a vector of $k+1$ parameters to be estimated, v_i includes random events that do not produce changes to the technical efficiency of the dependent variable y_i, u_i, non-negative random variable, evaluates the effect of random variables that affect the technical efficiency in the production process. The random variables v_i are assumed i.i.d. with zero mean and constant variance, independent from u_i, whose distribution can be half-normal or normal-truncated [19], and exponential or gamma [20].

The Technical Efficiency *(TE)* of *i-th* production unit is defined as the ratio of the realized output to the stochastic frontier:

$$\ln TE_i = \ln Y_i \quad - \ln Y_i^* = - u_i \quad (0 \leq TE \leq 1) \tag{2}$$

The stochastic frontier model allows the estimation of parameters by the usual hypothesis tests with traditional maximum likelihood techniques. To evaluate the need of the stochastic frontier, Battese and Corra [11] suggested the parameter $\gamma = \sigma_u^2/(\sigma_u^2 + \sigma_v^2)$ whose range is between zero and one: zero indicates that the deviations from the frontier are entirely due to random disturbances, whereas one indicates that the deviations are entirely due to technical inefficiency. If $\gamma = 0$ the model parameters are estimated with the classic OLS model [16]. For further details about the method, see [10;11].

2.2 Data Envelopment Analysis

The Data Envelopment Analysis, non-parametric model can be carried out using as deterministic as stochastic approaches. The classic DEA [21], is ascribed to the deterministic models, vice versa both DEA with Bootstrap [22] and Stochastic Dea [23] are part of the stochastic methods. To use Stochastic DEA it is necessary to

provide information about the expected values and variances of all variables, as well as probability levels at which feasibility constraints are satisfied [24; 17]. In this work we refer to classic DEA to identify the efficiency values of the Italian Regions each considered as DMU.

DEA consists of a new algorithmic method to the efficiency measurement of the Data Making Units for constant returns to scale (DEA CRS), where all DMUs are operating at their optimal scale. The DEA algorithm does not make any assumptions about the distribution of the data and moreover, unlike the stochastic frontier (SFA), it can calculate the efficiency values by making use of more input variables, obtaining also more output variables.

Banker, Charnes and Cooper (1984) [15] introduced variable returns to the scale efficiency measurement model, allowing the breakdown of efficiency into technical and scale efficiencies in DEA.

The DEA model aims to choose the input and output weighting system through a mathematical programming model input or output oriented. The input-oriented model, minimizes the input while at least satisfying the given output level; the output-oriented model, instead, maximizes the weighted sum of the outputs. "*In particular, for each DMU the input-oriented efficiency is the relationship between the ideal amount x and the actually applied x_j quantity. The output-oriented efficiency is the ratio between the y_j quantity output and the ideal amount of y that it should produce in conditions of efficiency."*[17].

In the DEA model, Technical Efficiency TE_j *(j=1,2, … , l)* is measured in terms of a proportional change among inputs and outputs:

$$TE_j(p,w) = \frac{\Sigma_{k=1,m} \quad w_k \quad y_{kj}}{\Sigma_{i=1,n} \quad p_i \quad x_{ij}} \tag{3}$$

where, x_{ij} *(i=1,2, … n)* is the input i.e. the amount of the input used by the DMU_j *(j=1,2, …, l)* ; p_i is the weight associated with the input; y_{kj} are the outputs *(k=1,2, …, m)* of the DMU_j; w_k are the weights associated with the outputs.

The objective function is to maximize the TE for DMU_j according to the weights of p and w:

$$\max \; TE(p,w) \tag{4}$$

The maximization, according to the weights of p and w, is subject to the following constraints:

- no DMU can operate beyond the production possibility set (6) meaning that the efficiency value for each unit is inferior to one:

$$\frac{\Sigma_{k=1,m} \quad w_k \quad y_{kj}}{\Sigma_{i=1,n} \quad v_i \quad x_{ij}} \leq 1 \quad (j = 1,2,\dots,l) \tag{5}$$

- the weights are non negative:

$$p_i, \qquad w_k \geq 0 \quad i = 1,2,\dots,n\,; k = 1,2,\dots,m \tag{6}$$

Making an inefficient unit efficient means identifying the resources with which to bring the efficiency units close to the efficiency border. The slacks values indicate the inefficiency of the DMU in the sense that if the resources used are reduced it would be possible to maintain the same level of production. If *TE = 1* it is difficult to determine to what extent the value of efficiency is due to the high level of efficiency or to the selection of the optimal structure of weights. For further details and a different version of the method, see [25; 26; 27].

The DEA algorithm does not make any assumptions about the distribution of the data and moreover, unlike the stochastic frontier (SFA), it can calculate the efficiency values by making use of more input variables, obtaining also more output variables.

2.3 Datasets

The following independent input variables for 2016 have been kept on the list of the potential determinants of technical efficiency and represent the main characteristics of the region with regard to social protection.

Concerning *infrastructural, environmental and management variables* for the Italian regions, the following were tested:

1. Number of residents in the region
2. Residential social welfare facilities
3. Public or private structure(s) that provide social-welfare and/or social-health type residential care services (assisted hospitality with overnight stays) for people in need. The recipients of the assistance, in ASI (2018) [8], are minors in need of protection or those with disabilities, disabled adults, self-sufficient and non-self-employed elderly, foreigners, Italian citizens temporarily lacking means of subsistence and in contingent situations of difficulty, hardship or abandonment
4. Beds in care facilities
5. Ordinary hospital beds

6. Guests in residential social welfare facilities
7. General practitioners
8. Nursery users
9. The ratio between the number of pensions and the resident population

The pension treatment represents the periodic and continuous cash benefit provided by public and private bodies after recipients satisfy the following criteria: attaining a certain age, contribution accrual, lack or reduction of work capability due to congenital and/or supervening impairment, death of the protected person and meritorious awards for services to the state. The number of received pensions may not coincide with the number of pensioners, because a single individual may be eligible for multiple benefits. In the case of indirect pensions in favour of multiple beneficiaries, many pensions are considered as service benefits. In 2016 Italian pension expenditure relative to GDP was more limited in the North-East, while expenditure in the South and Islands was higher than the national average [8; 9].

10. Retirement rate

The incidence of pension expenditure on GDP can be broken down into the product of the general retirement rate (TP) and the relative benefit index (IB): $IS_t = TP_t \times IB_t$ where the retirement rate is the ratio between the number of pensions relative to the entire population as of 31 December of year t and the relative benefit index is obtained from the ratio between the average amount of pensions and the GDP per inhabitant on the same date. The latter indicator therefore represents the share of GDP pro capita which, for a pensioner, derives from pension transfers.

The main statistics of the collected variables are shown in Table 1.

Table 1 - Statistics of the collected variables

Variable	Mean	Variance	Skewness	Kurtosis
Amount of social security contributions (in millions of euros)	11,957	1.89e+14	2.17	7.831
Coverage index for social protection	66.96	348.83	0.827	2.57
Global spending on social protection (in millions of euros) (Y)	18,226	2.52e+08	1.268	4.642
Guests present in the social welfare institutions	19,132	3.73e+08	1.715	5.779
General practitioners	2,213	3.07e+06	0.738	2.667
Expenditure for social security benefits (in millions of euros)	15,916.	1.86e+14	1.306	4.799
Expenditure for social security contributions (in millions of euros) (X3)	14,04.	1.47e+14	1.341	4.918
Expenditure of municipalities for social interventions and services (in millions of euros) (X2)	352	1.00e+17	1.344	5.011
Health expenditure (in millions of euros) (X1)	5,626	2.17e+11	1.22	1.890
Number of pensions	1,126,258	8,04e+11	1.076	4.160
Kindergarten users (units)	8,759	9.24e+07	1.450	3.997
Ordinary beds	19,534	3.78e+06	1.801	3.662
Regional GDP (in millions of euros)	84,428	7.62e+09	1.899	6.823
Resident population (units)	3,029,472	6.42e+12	1.033	3.747
Retirement rate	38.9	16.068	-.200	2.309

Concerning *Financial and economic variables (2016),* the following were tested for Italian regions:

1. Global spending on social protection

Social protection (SP) is first the responsibility of EU member states, but the EU has explicit authority in facilitating the free movement of workers, which is essential to an integrated labour market. SP is our output variable, also considered as the dependent variable in the analysis explained in this work. There are six branches of social protection that have been prominent in the discussion relative to the social protection of non-traditional workers and the self-employed [28]. These branches of social protection have been centre-stage in the analysis and the policy measures put forward by the European Commission; they are:

- Unemployment benefits;
- Sickness benefits;
- Maternity and equivalent paternity benefits;
- Invalidity benefits;
- Old age benefits; and
- Benefits in respect of accidents at work and occupational diseases.

2. Expenses for social security benefits on population

Social benefits represent current transfers paid to families by social security institutions in cash or in kind, in order to cover the costs deriving from specific risks, events or needs. Depending on the type of protection provided, social security institutions fall under the basic regime or the supplementary scheme. ISTAT (2018) [29] shows the results of an annual survey of social security institution balance sheets for the purpose of constructing the public administration income statement and the social protection income statement, compiled according to the criteria established by the European system of integrated social protection statistics (ESSPROS). Expenditure on social services and benefits managed by single and associated municipalities can be classified by the following

beneficiary categories: Family; Disability; Alcohol and drug addiction; Elderly; Immigrants and nomads; Poverty, social exclusion; Multi-purpose benefits [30; 9]

3. Amount of social security contributions

Social contributions collected by social security institutions Social security contributions, together with transfers that weigh on the state budget, finance social spending. These consist of direct or indirect payments that the insured personnel or their employers make to the social security institutions in order to purchase and/or keep the right to social benefits.

4. Amount of pensions in percentage with respect to the whole of Italy.

The social protection system in Italy is mainly related to pensions as outlined in ASI (2018) [8], ISTAT [9] and ASI (2019) [31]; pension treatment represents periodic and continuous cash benefits provided by public and private bodies in the following situations: attaining a certain age, contribution payment seniority, lack of or reduction in work capability for congenital and/or supervening health impairment, death of the protected person, and recognition of particular merit for services to the state. The pension expenditure as a percentage of GDP represents the share of the total income produced by the country redistributed to families in the form of pensions. The pension expenditure as a percentage of GDP represents the share of the total income produced by the country redistributed to families in the form of pensions. This is one of the explicative and significant variables used in both SFA and DEA analyses as follows.

5. Municipality welfare services expenditure.

In ASI (2018) [8] and ISTAT [9], Spending on interventions and social services of single and associated municipalities. These municipalities are tasked with interventions to guarantee social services for citizens, as foreseen by the Italian framework law on assistance (n.328/2000). Expenditure refers to the public component of socio-welfare expenditure provided at the local level by the municipalities and by various forms of association between neighbouring municipalities. At the accounting level, it is defined as annual current account expenditure, committed to the provision of social-assistance services and interventions in the reference year by municipalities and associations of municipalities, net of the sharing by users and the National Health Service. This is one of the explicative and significant variables used in the SFA and DEA analyses that follow.

6. Current public health expenditure per inhabitant

Public health spending refers to the expenditure incurred by public administration bodies (PA) to meet the individual and collective needs of the resident population. This expense is classified according to the ICHA classification as an expense incurred by the public administration (HF.1.1) and by compulsory contribution health insurance (HF.1.2). A distinction must be made between countries characterized by a Bismarck type health model system (France, Germany) and those characterized by a Beveridge type system (Italy, Spain, Portugal): the former are served by health systems originally founded on a decentralized, mutual-insurance type structure, the latter uses a system originally having a strongly centralized, publicly-oriented structure. This is one of the explicative and significant variables used in the SFA and DEA analyses that follow.

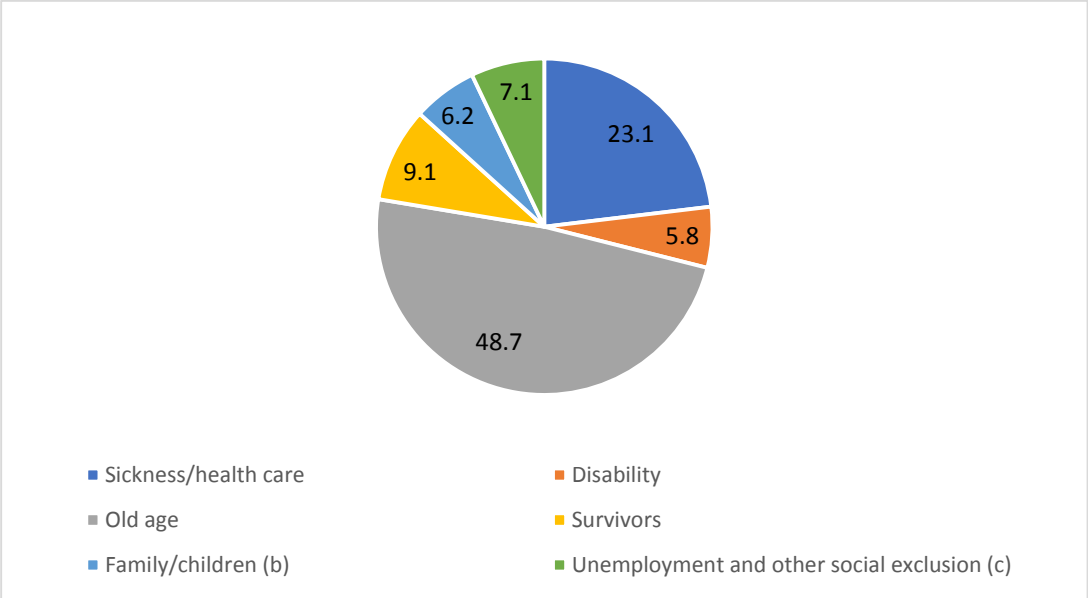
2.3.1 Social protection expenditure by function: a descriptive analysis of the Italian System

Data on social protection estimated by following [32] ESSPROS (European system of integrated social protections statistics, 2016 edition) cover the following aspects:

- expenditure by function (sickness/health care, disability, old age, survivors, family/children, unemployment, social exclusion and housing);
- receipts by type and sector of origin;
- number of pension beneficiaries by sex;
- net social benefits, namely social benefit expenditure less taxes and social contributions paid into them.

The main function of the social security system, which historically constitutes the central pillar of modern welfare systems, consists in withdrawing asset resources and transferring them to the unemployed, and in particular, the retired. Social security pensions (invalidity, old age, survivors) constitute both the main redistributive measure of the system and the main tools for transferring resources from active working people to the unemployed. Social protection expenditure [33] is an indicator linked with the adopted welfare as well as with the social composition and the income level: it is higher in countries when the population age is polarized on young and/or old age (figure 1).

Figure 1. Social protection expenditure in Italy by function. Year 2016 (percentage composition). Source: Elaboration on ISTAT data concerning Accounts of social protection.



In 2016, three quarters (75.7 per cent) of general government expenditure on social benefits was absorbed by cash pay-outs, mainly consisting of pensions, while the remaining 24.3 per cent by those in kind, such as education or health services: this share is 11.4 percentage points lower than the EU15 average (35.6 per cent)[2]. In Italy, over 90 per cent of benefits in kind refer to health services, while 2.6 are destined for families (EU15 values are 72.4 and 8.2 per cent respectively) [30].

Elaborating data from ASI [8] we observe that in the South and Islands in 2016 the social security coverage index was lower than the national figure, with Calabria having the lowest value; pensions expenditure to GDP (gross domestic product) was more limited in the North-east, while the South and the Islands were the only areas with a higher incidence than the national average.

In addition, if regional pension expenditures are different, age differences across the population may pertinent to explaining the phenomena.

As Agasisti et al. (2015) [34] describe, the spending review for social protection must be linked to its capacity to improve the efficiency of public administration by considering resident population characteristics in the municipal area.

In table 2 (elaboration from ISTAT data) we show the ageing index that is a composite demographic ratio, defined as the percentage between the elderly population (65 and over) and the young population (under 15). It is one of several demographic indicators (e.g. old age dependency index, average age, turnover index) that can be used to measure a population ageing level. We show also the percentage ratio between the annual amount income from pensions and the gross domestic product.

Table 2. Ageing index and Annual income from pension in Italy - Year 2016

Regions and Macro-areas	**Ageing index**	**Annual income from pension as a % of GDP**
Piemonte	193.7	18.4
Valle d'Aosta	166.7	15.3
Lombardia	155.7	13.6
Trentino-Alto Adige/Südtirol	130.8	11.8
Veneto	159.2	14.2
Friuli-Venezia Giulia	204.7	18.4
Liguria	246.5	19.4
Emilia-Romagna	175.6	15.3
Toscana	195.4	17.3
Umbria	192.4	22.0
Marche	183.9	18.5
Lazio	152.9	14.8

[2] General Italian government expenditure on social benefits in kind is slightly less than half that of Sweden (47.4), which allocates the greatest resources to transfers in kind

Abruzzo	180.1	18.4
Molise	201.4	22.1
Campania	117.3	18.9
Puglia	151.5	22.4
Basilicata	175.7	19.2
Calabria	150.8	23.2
Sicilia	141.4	21.3
Sardegna	187.9	22.1
North-West	**173.2**	**15.2**
North-East	**166.8**	**14.8**
Centre	**172.3**	**16.4**
South	**143.8**	**20.8**
ITALY	**161.4**	**16,6**

Considering only the regions included in North and Central Italy we can observe that the correlation coefficient between the two variables is equal to 0.8; alternatively, if we consider all regions, it is equal to 0.25. Data from table 2 shows that population age differences are relevant with regard to pension expenditure in the North and Centre when compared to the Southern regions where the ageing index is low and pensions represent a very high component of GDP relative to the Italian total. Many Southern areas are in fact characterised by a weak industrial structure, whose role is marginal and strongly dependent upon public budget, and the public-sector accounts for a significant share of regional employment.

2.3.2 Social security expenditure: an integrated analysis for the Italian System

Social security benefits are a component of the larger aggregate called social protection expenditure (sub-section 2.3.1).

The sources used in this section to outline the phenomenon of the Italian social security system containing pension expenditure, are:

- Main private and public Pension Funds Balance sheets;
- Annual ISTAT Survey on Italian social security Institution accounts;
- Annual Report of the Italian Supervisory Authority [35] on Supplementary Pension Funds (PF).

Supplementary funds include: Closed and Open PF; Individual New Pension Schemes; Old PF [36].

In the first part of this sub-section we show and analyse some of the main economic indicators to explore social security: estimates outlined by an ISTAT survey and based on ESSPROS framework and sample data, which are compared with those obtained by integrating the above indicated sources.

While the ISTAT survey only includes "public social security" and the part of funds - about 7,5% of all the supplementary Pension Funds (PF) expenditure outlined by Covip - to which it is possible to participate because the promoters are both workers and employers (e.g. BNL/BNP Paribas Italy PF), our integrated indicators also include the supplementary funds to which is possible to adhere regardless of one's work situation: we build and integrated and exhaustive aggregate of PF.

The main economic indicators outlined are the following:

Pro-capite pension deficit: measures the part of the social security deficit to be paid by each resident and is calculated using the ratio between the social security deficit and the resident population. The estimate of the social security deficit comprises the difference between contributions and social benefits, divided by the resident regional or national population.

It has been estimated in Table 3 below for each Italian geographic area, by aggregating data on social security concerning private and public Pension Funds from an ISTAT Survey with the other supplementary pension funds. We observe that supplementary funds (SF) are able to improve the pro capite pension deficit, particularly for the NE and NW.

Table 3 - Pro capite pension deficit in Italy

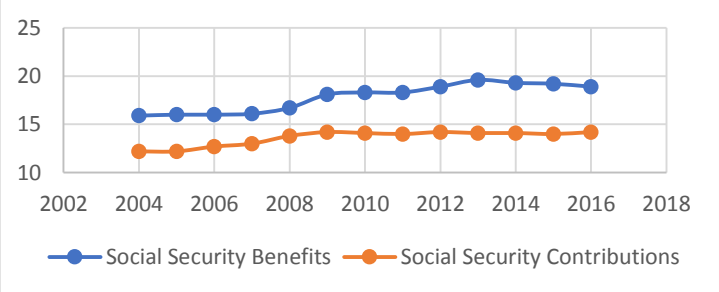
	ISTAT Survey	**Integrated approach***	**Δ**
North-west (NW)	-688	-540	149
North-east (NE)	-889	-729	160
Centre	-1.222	-1098	124
South+Islands	-2.069	-1991	78
Italy	-1.307	-1185	122

Social security coverage index (SSC): measures (Table 4) the portion of social security expenditure that is covered by contributions. It is calculated by using the percentage ratio between social contributions and social benefits: we observe that supplementary funds (SF) are able to improve SSC, particularly for the NE.

Table 4 - Social security coverage index for 2016

	ISTAT Survey	Integrated approach*	Δ
North-west	88.3	91.0	2.7
North-east	84.1	87.2	3.1
Centre	78.3	80.8	2.5
South + Islands	52.7	55.1	2.4
Italy	75.1	77.9	2.8

Figure. 2 – *Ratio between social security expenditure and GDP*



We observe (Figure 2) that supplementary funds strongly increase the relationship between social security contributions and GDP, which is estimated as «integrated» for 2016.

3. Results

The application of the Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis methodologies (DEA) into the economic field is difficult when considering the definition of production and the factors that can affect social protection processes. The first difficulty is to identify the output needed to define the result of the production process.

The effect of social protection is an unknown and latent variable that is difficult to associate. In this stochastic approach with the SFA and afterwards with DEA, we suggest *global spending on social protection* in the regional environment as the *output* variable of the complex production process directed towards social protection. The authors consider the variable of global spending on social protection as a useful component of "social well-being" induced by a set of expenditure variables, structures, infrastructures and environmental characteristics.

3.1 Results of SFA Model

We initially included all candidate variables in the model (Table 1), but many of them were later removed due to their being found insignificant. The choice of the model was founded on a Box-Cox transformation [37] with the choice of the functional form guided by the parsimony principle and the AIC criterion [38]. In this paper, we applied the Cobb-Douglas form [18] of the stochastic frontier production.

The model chosen is:

$$\ln Y_i = ß_0 \ln(X_{i1}) + ß_1 \ln(X_{i2}) + ß_2 \ln(X_{i3}) + v_i - u_i \quad (i=1,2, \ldots,l) \tag{7}$$

where i refers to the *i*-th Region, Y_i is the Global spending on social protection, X_{i1} is Health expenditure per inhabitants, X_{i2} is social welfare expenditure per number of inhabitants and X_{i3} is the municipality spending for social interventions and services per number of inhabitants; $\boldsymbol{v_i}$ and $\boldsymbol{u_i}$ represent the first and the second error component respectively, while the latter also measures the *technical inefficiency*.

The maximum likelihood (LR) estimation was performed after checking the asymmetry (-1.18) present in the OLS residuals. The presence of negative asymmetry is evidence that the sample residuals can be an object of the maximum likelihood process. We tested the dataset with half-normal, truncated normal and exponential

models. The log likelihood values and the test on $\mu = 0$, suggest the choice of the exponential model. Also, the exponential model was more significant regarding the coefficients as for the gamma value of (γ = .87) than was true for both the normal and the truncated normal distribution. The LR for σ_u, based on a mixed χ^2 distribution was 4.13 ($p \leq \chi^2 = 0.000$) [39]. The inefficiency is a significant of the total error, and SFA is appropriate for the analysis, the model is significant (Prob > $\chi^2 = 0.000$). The inefficiency is a significant part of the total error and the stochastic frontier model is suitable for the analysis conducted. Furthermore, the chosen model is significant (Prob> $\chi^2 = 0.000$).

The main SFA results are summarized in Table 5. In Table 6 the rank of the Regions, distinct for territorial area to which they belong, are shown.

Table 5 - Estimation Results of Frontier Production Functions with the dependent variable being Global spending on social protection (Wald $\chi^2(3) = 32.17$; Log likelihood = -23.279718 Prob > $\chi^2 = 0.0000$)

Input Variables/Parameters	**Coef.**	**Std. Err.**	**z**	**P>z**	**95% Confidence Interval**	
(X_1) Health expenditure per inhabitants	-15.02873	2.599249	-5.78	0.000	-20.12317	-9.934299
(X_2) Municipality expenditure for social interventions and services per inhabitants	.7336707	.33447687	2.19	0.028	.0781044	1.389237
(X_3) Expenditure for pensions per inhabitants	2.778626	1.341623	2.07	0.038	.1490922	5.408159
Constant	115.9429	18.3811	6.16	0.000	79.91662	151.9692
σ_v^2	.3307014	.1315613			.1516375	.7212161
σ_u^2	.8512527	.2533718			.4750091	1.52551
Wald $\chi^2(3) = 32.17$;	Log likelihood = -23.279718			Prob > $\chi^2 = 0.0000$		
LR test of $\sigma_u=0$	$\overline{\chi}^2(01)=4.13$			Prob>= $\overline{\chi}^2=0.021$		

Table 6 - Regions according to geographical distribution and ordered by Technical Efficiency with regard to Global spending for social protection (SFA Model)

North West	**North East**	**Center**	**South**	**Islands**
Lombardia	Emilia-Romagna	Toscana	Campania	Sicilia
Piemonte	Veneto	Lazio	Molise	Sardegna
Liguria	Trentino-A.A.	Marche	Puglia	
Valle d'Aosta	Friuli V.G.	Umbria	Calabria	
			Abruzzo	
			Basilicata	

3.2 Results of the DEA model

In this paper the CRS-Input Oriented DEA [14] has been utilized. The model results are shown in Table 7, while the results of all slacks for each DMU (Region) are in Table 8. The theta values and the Region Technical Efficiencies rank attributed by DEA are in Appendix A.

Table 7. CRS-INPUT Oriented DEA Efficiency Results (3 inputs and 1 output for 20 DMUs labeled 1 through 20)

North West	**North East**	**Center**	**South**	**Islands**
Lombardia	Veneto	Lazio	Campania	Sicilia
Piemonte	Emilia-Romagna	Toscana	Calabria	Sardegna
Liguria	Friuli V.G.	Marche	Puglia	
Valle d'Aosta	Trentino-A.A.	Umbria	Abruzzo	
			Basilicata	
			Molise	

Table 8. The results of slacks by DMU.

(DMU) Region	**islack: Expenditure**	**islack: Expenditur**	**islack: Health**	**oslack: Global spending on social**

	of municipalities for social interventions and services per inhabitants (in euros) (x_2)	e for social welfare per inhabitants (in euros) (x_3)	expenditure per inhabitants (x_1)	protection
Piemonte	.	.266906	.	.
Valle_d'Aosta	123.305	.	.586201	.
Liguria	.	.135232	.	.
Lombardia	.	.	0	.
Trentino-Alto_Adige/	163.428	.	304.128	.
Veneto	.	.0521001	.	.
Friuli-Venezia_Giulia	194.211	.0564136	.	.
Emilia-Romagna	105.096	.	129.954	.0010077
Toscana	.	.0643197	.	.0000333
Umbria	.	.141465	.	.
Marche	.	.0998224	.	.0001788
Lazio	246.943	.	104.356	
Abruzzo	.	.121467	.	
Molise	.	.0249916	103.417	.000054
Campania	.	0	0	
Puglia	.	.100081	.	.0005003
Basilicata	.	.0205697	.	.0000295
Calabria	.	187.718	776.772	.
Sicilia	.	.	121.539	.
Sardegna	213.687	.	597.349	.

4. Discussion

The results of the SFA Model (Table 6) show that the Health expenditure per inhabitants (X_1) variable has a negative impact on results, which indicates that it is a sensitive variable for improving efficiency: an increase in Health expenditure results in proportionally better social protection. The Municipality Expenditure on social interventions and services per inhabitants (X_2) and the Expenditure on social welfare per inhabitants (X_3) have positive and significant coefficients showing that an increase in these expenditures can produce a significant improvement in the Technical Efficiency relative to social protection in the Italian Regions. By dividing the main regions into five sectors as indicated in Table 6, we observe a possible classification of technical efficiency based on a stochastic type analysis.

On the basis of the variables we considered, it seemed accurate to compare Regions belonging to adjacent productive and social aggregates in order to take population displacements for work or health reasons into account, to get an idea of the overall efficiency of the "breakdown" aggregate and related subsets.

The main results that we have summarized in Table 6 and 7 above, can be explained by considering the significant variables used in the analysis (in euros), that are: municipality expenditure for social interventions and services per inhabitants expressed as a percentage with regard to total, expenditure for pensions per inhabitants and health expenditure per inhabitants.

Concerning the expenditure capacity for social security contributions to improve efficiency of social protection (SP) we observe that, at the regional level, the highest average pension amounts in 2016 are recorded in Lazio (€ 14,059) and in Lombardia (€ 13,667); the North-West is also the area that provides more social benefits (29.7 per cent). Calabria is the region where the per inhabitant spending by municipalities for social services is lower (23 euros); more generally, all the regions of the South are below the national average, together with Umbria and Marche for the Centre and Veneto alone for the North. SFA outline and confirm the main descriptive results, in particular the good performance of Lombardia in the North, the quite good performance of Lazio in the "central-division" and Calabria's problems in managing these resources.

DMU is considered efficient if its efficiency is equal to unity and all slack variables are zero. The presence of slack, in fact, indicates that the DMU is not efficient and would therefore be possible to maintain the same level of production by reducing the resources used (see Table 7). Table 7 gives a summary of the results for the DEA

model. The scores tell us that this model identifies a DMU efficient for Lombardia (TE* = 1 as indicated in Appendix A) and Campania. For example, the optimal solution of efficiency score (theta) for Piemonte is 0.477858; In other words, because Piemonte has an efficiency score of 48%, all inputs could be reduced by 52% without worsening any other input or output. Table 8 also gives the ranking for each county classified on the basis of presence of one or more slacks. The decreasing values of Theta indicate an increasingly inefficiency of the Region. For each region, DEA highlights the input variable that should be object of correction by the DMU (i.e. the region), with the presence of slacks different from zero, to reach the maximum efficiency level. Thus, Piemonte can be improved by subtracting 0,2669 units from input Expenditure for social welfare per inhabitants; Valle d'Aosta can be improved by eliminating 123.305 unit from the Expenditure of municipalities for social interventions and services per inhabitants input and 0,586201 unit from the Health expenditure per inhabitants input, whereas Trentino Alto Adige can be improved by subtracting 163.428 and 304.128 unit from the Expenditure of municipalities for social interventions and services per inhabitants variable and the Health expenditure per inhabitants variable. Another Region that needs efficiency improvement is Calabria with 187.718 and 776.772 unit from inputs. Yet, Sardegna can be improved by subtracting 213.687 units from Expenditure of municipalities for social interventions and services per inhabitants and 597.349 units from Health expenditure per inhabitants. Liguria, Basilicata, Puglia, Marche, Umbria, Toscana and Veneto improve by subtracting only the variable Expenditure for social welfare per inhabitants. In addiction Emilia Romagna, Toscana, Marche, Molise, Puglia and Basilicata can be improved by subtracting also output Global spending on social protection as shown in table 8.

With reference to the North-West division, DEA confirms the good performance of Lombardia, for which it does not appear necessary to reduce the relative expenses. For the northern regions with a special statute (Valle d'Aosta, Trentino, Friuli) the interpretation of the results appears to be complex, and they seem not particularly efficient elements with reference to the expenditure for social services of the municipalities. Healthcare expenditure in Calabria and Sardegna appears unbalanced, considering the objective of efficiency relating to global spending on social protection.

5. Conclusions

From the analysis carried out, Italy appears to be a country with quite high territorial variability with reference to the phenomenon of social protection, which is also influenced by the age composition. Health expenditure of citizens appears to be a fundamental component of social protection for reducing waste and improving efficiency, particularly in the South. Considering the other input variables, the expenditure for social services in the municipalities appears as another element to manage for increasing efficiency, in particular in the regions with special statute and in Lazio. On the other hand, social security spending receives an improvement in efficiency through the integration of compulsory and complementary social security.

The search for the model with both SFA and DEA was very difficult: many exit variables were tested: pro capite GDP, social security expenditure, the number of beds in residential facilities, the number of children enrolled in kindergartens, etc., but it was possible to achieve a parsimonious model with reliable estimates only by introducing global expenditure as an output variable and, as input variables, the Health expenditure, the Expenditure for municipality social services and the Expenditure for pensions per inhabitants: we have found evidence that by monitoring these variables it is possible to improve the technical efficiency of social protection.

This article has therefore examined the potential institutional drivers that can help improve Public sector efficiency with regard to social protection: this information is essential to improve Regional economic efficiency performance and to plan the necessary future budgets for public sector interventions. In all European governments the expenditure inputs still play a key role, but while the results of efficiency analyses are still excluded from the budget plans, they are slowly pushing public decision makers towards paying greater attention to the results. Today, decision makers and public opinion are both increasingly sensitive to methods that check whether government actions achieve results that increase efficiency.

Acknowledgements

The authors are grateful to two anonymous reviewers for their useful comments and suggestions.

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APPENDIX A

Table A.1 Results of Technical Efficiencies of Regions by DEA

Region	**rank**	**theta**	**Region**	**rank**	**theta**
Piemonte	8	.477858	Marche	12	.192988
Valle_d'Aosta	20	.0133914	Lazio	5	.613695
Liguria	14	.175509	Abruzzo	11	.221576
Lombardia	1	1	Molise	19	.0570364
Trentino-A.A.	18	.0614188	Campania	1	1
Veneto	7	.560519	Puglia	6	.603225
Friuli-V.G.	16	.132034	Basilicata	17	.0938011
Emilia-Romagna	9	.445917	Calabria	3	.814002
Toscana	10	.39318	Sicilia	4	.630571
Umbria	15	.133809	Sardegna	13	.176388

BIOGRAPHY OF ANTONIO FRENDA

Antonio Frenda studied at the Université Libre in Brussels and at the Univ. Federico II of Naples. He obtained a PhD in "Computational Methods for forecasting and decisions in Economics and Finance" at the Univ. of Bergamo. Researcher at ISTAT since 2000, he has been a member of the Eurostat task force on Business Registers. He began his university teaching activity in 2012: he is currently Contract Professor in Statistics and Economics; Referent for the ISTAT survey on the final balance sheets accounts of social security Institutions. His research activity falls primarily within three areas of Economics and Statistics: enterprise groups analysis; social security and business cycle estimation.

BIOGRAPHY OF ENRICA SEPE

Enrica Sepe is a PhD Fellow at the Department of Economics, Management and Institutions of University of Naples Federico II, Monte Sant'Angelo. Her research activity falls primarily within two areas, one focused on entrepreneurship and the other on quantitative methodology, in order to generate an interaction between different theoretical and applicative perspectives. She holds a PhD in Management with backgrounds in Entrepreneurship and Innovation. During the year 2015, she participated in the ESU doctoral program and the IES (innovation and society statistical methods for services assessment) international conference. She was a Visiting Scholar in 2016 at the EMLYON Business School.

BIOGRAPHY OF SERGIO SCIPPACERCOLA

Sergio Scippacercola is teacher of Computerized Data Management (with an annual appointment) at the Department of Economics, Management, Institutions (University of Naples Federico II). He has been Associate Professor in Statistics and Information Processing Systems. He is associated, for researches, to the National Institute of Geophysics. He is the author of numerous scientific publications in Statistics and Computer Science (Multivariate Analysis, Computational Statistics, Decision Support Systems). He is membership in International Societies and of SIS Working Group for Customer satisfaction and evaluation of services. He is a part of the Editorial Board of the EJASA DSS and the IJSINT review.

Credit Author Statement

Antonio Frenda: Conceptualization, Methodology, Investigation, Resources, Data Curation, Writing - Original Draft Preparation.

Enrica Sepe: Conceptualization, Methodology, Software, Data Curation, Writing - Review & Editing Preparation.

Sergio Scippacercola: Conceptualization, Methodology, Formal analysis, Visualization.