From persons to places: territorial redistribution by personal public expenditure programmes

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Abstract

Public expenditure programmes may address persons (personal programmes) or places (territorial programmes), the latter often pursue the territorial redistribution of resources, especially in countries characterised by a significant economic divide, different fiscal capacities and polarised levels of economic development. This paper is conversely interested in the territorial redistributive power of *personal* public expenditure programmes, that is of public programmes that allocate resources among individuals on the basis of "socio-demographic" features, as opposed to programmes allocating resources across territories according to "territorial" criteria. Methodologically, this paper develops a case study to better investigate this theoretical issue: it compares the degree of interregional redistribution accomplished in Italy in 1999-2010 by a selection of expenditure programmes with the one that would arise if those expenditure programmes were driven by socio-demographic criteria only. Making use of a regression approach, first we simulate the distribution of total expenditure for each programme across regional territories if these programmes were allocated neglecting territorial criteria. Further we use regional fiscal residua to contrast interregional redistribution accomplished by the public budget in two different scenarios. The first scenario is based on the actual distribution of public expenditure and receipt across regions, while the second makes use of a simulated territorial distribution of expenditure, under the hypothesis that only socio-demographic criteria are significant for the allocation of expenditure. Results show that overall interregional redistribution slightly declines when shifting from actual expenditure to the simulated personal distribution of expenditure, and that this result holds for most public programmes. However, results clearly disclose that even when resources are distributed according to socio-demographic criteria only, public programmes still produce a significant level of territorial redistribution (let aside personal redistribution) in a country characterised by a stark interregional economic divide, as Italy is.

Keywords: Redistribution, Fiscal residua, Regions
JEL : classification: H23, H50, H70

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1. Introduction

The public budget may transfer resources among different areas of a country through policies and programmes specifically designed for that purpose, such as interregional equalisation schemes. In addition resources may be redistributed across territories as a result of expenditure programmes explicitly directed to places, such as infrastructure investment programmes, whose allocation across different areas depends only on the "territorial structure" of places.

However, territorial redistribution may also be a by-product of public policies pursuing other targets, such as central government tax-financed social insurance systems, which are generally directed to individuals rather than territories or jurisdictions and redistribute among individuals on the basis of "personal" characteristics (age, state of health, professional status, and so forth). The territorial redistribution from these latter programmes is the result of the heterogeneous distribution across places of the individual features that inform the allocation among residents of public programmes' costs and benefits. That is, it results from the different "socio-demographic structure" of places. For instance, in a polarised country where the population of region A consists of aged people only and the population of region B is entirely made up of young, programmes of social support for the elderly financed through payroll taxes, would result in a net transfer from region B (net financer) to region A (net recipient) and therefore positive redistribution if average per capita GDP in region A were lower than in region B (negative redistribution in the opposite case). Territorial redistribution may therefore be the by-product of policies and programs targeting individuals rather than territories.

In this paper we focus on this latter kind of territorial redistribution, i.e. that stemming from expenditure programmes explicitly targeting individuals. Differences as regards the attributes of places where individual beneficiaries live are obviously neutral in this respect, as expenditure programmes are not driven by territorial features at all.

The paper aims at showing that personal programmes, that redistribute across individuals according to "socio-demographic" features, may well produce territorial redistribution. Intuitively, this happens when the personal features that drive the allocation of public expenditure are negatively correlated with income. This is of particular significance for countries characterised by stark economic differences, where personal programmes, besides redistributing across individuals, may also provide a significant contribution to accomplish the territorial redistributive objectives of public policies. In this paper, the investigation over this theoretical issue is pursued through the analysis of a case study of Italy, a country characterised by stark economic differences across territories, as well as by a polarisation of its socio-demographic structure. Due to data availability, the analysis will address the redistributive properties of public functions, conceived as a sum of public programmes, as defined in the COFOG – Classification of functions of government (e.g. education, health, social

security, justice, roads and transports,…). Therefore we shall conduct our analysis at a higher level of aggregation than individual public programmes.
The paper is organised as follows. Section 2 expands on the theoretical background relevant for our analysis, and in particular on territorial versus personal public expenditure programmes. Section 3 proposes a methodological approach to measure territorial redistribution by personal public expenditure programmes. This approach is structured in two steps: first personal and territorial programmes are defined, second a methodology to measure redistribution by personal programmes is introduced. Section 4 introduces the empirical analysis: it outlines an implementation of the proposed methodology to the case of Italy 1999-2010. Section 5 presents the case study of Italy. In this section the "personal" distribution of a selection of public function is reconstructed for the years 1999-2010, then the interregional redistributive effects of observed and "personal" public functions is measured. Section 6 concludes.

2. Conceptualising personal and territorial public programmes

Public expenditure may address persons (personal programmes) or places (territorial programmes). This classification may also be described as the existence of programmes pursuing different equity targets (Bordignon *et al* , 2006). In particular, territorial programmes often pursue the territorial redistribution of resources, especially in countries characterised by a significant economic divide, different fiscal capacities and polarised levels of economic development.
In federal countries this articulation of public programmes is often made explicit in federal grants that may be targeted either to States and local governments or to individuals (e.g. Kinkaid, 2011, on the USA; Dafflon, 2014, on Switzerland; Dept. of Finance – Canada, 2014; Ahmad and Thomas, 1996; Clemens and Veldhuis, 2013). For instance, Kinkaid (2011) classifies U.S. federal grants distributed to States and local governments into two groups. The first is aid to places, including grants for infrastructure, highways, economic development, criminal justice. The second is aid to persons, including grants for social welfare (Medicare, Temporary assistance for needy families,…), food stamps, social security (for senior citizens). Similarly, in Canada, Federal support to Provinces and Territories is structured into four main transfer programs: the Canada Health Transfer, the Canada Social Transfer, Equalization, and Territorial Formula Financing (Department of Finance, Canada, 2014; Clemens and Veldhuis, 2013). The first two are directed to persons, the latter two to places. As a last example, the recent reform of Swiss intergovernmental financial arrangements has identified three lines for Cantons financing by the Confederation: revenue equalization, expenditure equalization and cohesion fund. As regards the second line, expenditure equalization transfers from the Swiss Confederation to the Cantons are driven either by topo-geographic needs or by socio-demographic needs (Swiss

Confederation, 2007; Dafflon, 2014; Dafflon, 2004). Such a dichotomy mirrors the dualism between persons and places.

In the EU, regional policy is financed through the European Structural Funds, which encompass the European Social Fund (ESF) and the European Regional Development fund (ERDF). This structure well exemplify the dichotomy between persons and places as the targets of transfers. As for places, the ERDF supports programmes for regional development, economic restructuring, enhanced competitiveness and territorial co-operation, while the ESF targets persons: it focuses on increasing the adaptability of workers and enterprises, enhancing access to employment and participation in the labour market, reinforcing social inclusion. In addition, EU regional policy includes also the Cohesion Fund, which again targets places, by focusing on the environment and on trans-European transport networks (Evans, 1999).

The balance between programmes targeting persons and places as well as their overall dimension differ across countries and time. For instance, Kinkaid (2011, p. 14) shows evidence of a shift of federal aids from "places to persons" in the USA. After nearly thirty years of federal grants to places being financially bigger than federal grants to persons, in the late 1980s this relation has reversed and the percentage of federal grants to persons on overall grants in the USA is constantly increasing ever since. When the levels of economic development are highly polarised across the States (or regions) of a country, such a shift opens up the question of whether public programmes remain capable of achieving some degree of redistribution across regions, and, consequently, if they remain capable of reducing interregional economic disparities.

In other countries (e.g. Italy), due to fiscal decentralisation process, competencies are transferred from central to decentralised governments. Therefore, the number of programmes that the central government may use to pursue the interregional redistribution of resources inevitably decreases. When a territorial redistributive central government public programme is completely decentralised to regional governments, then the programme's interregional redistributive power inevitably becomes null. Therefore the overall degree of interregional redistribution by public policies lowers, unless a compensatory equalising system is introduced. For example in Italy the decentralization of social assistance, together with the retrenchment of the national equalizing fund in this sector, has brought about a growing differentiation in the level of service provisions across territorial areas.

3. Methodology

The definition of a methodology to measure territorial redistribution by personal public expenditure programmes is necessarily structured in two stages. First a formal definition of personal and territorial programmes needs to be introduced and an

approach to reconstruct the personal distribution of public expenditures has to be devised. As a second step, a methodology to measure redistribution by personal programmes is introduced.

3.1. personal public expenditure programmes

In this paper we investigate the territorial redistributive power of personal programmes. For our purposes, we distinguish between the revenue and expenditure side of public programmes, and focus on the expenditure side only.
On the expenditure side, each public programme may be conceived as an assignment rule that distributes either monetary or in kind benefits to beneficiaries (individuals; households, firms, public bodies such as regional or municipal administrations, and so forth). Formally, we may define *n = 1,…,N* the potential beneficiaries of each one of the existing *j=1,…,J* public expenditure programme.
Each recipient of public programmes is characterized by two attributes:

1) a territorial attribute, that is the relevant region for the recipient, such as the region where an individual or households reside, or where firms carry out their economic activity. For the *n-th* beneficiary, the relevant region is denoted by $r^n \in$ R*, the set of regions, with R*=(1,…,R).
2) a public benefit attribute, given by the amount of public resources assigned to the recipient by each public expenditure programme, denoted by g_j^n.

In more detail, g_j^n is a function of a set A of variables (in the following the "drivers"), which drive the allocation of public expenditure. The set A may include either personal features (age, state of health, employment status, family status, …) or attributes of the territory relevant for the recipient (structure of the economy, GDP, morphology, climate, transport connections, infrastructures,…).Therefore the set A of all drivers for the allocation of public expenditure may be divided in two subsets, P and T, where P includes all personal variables (personal "drivers") and T includes all territorial variables (territorial "drivers").The following proposition holds for the sets of "drivers" A, P and T:

Proposition 1. Given A, the set of all "drivers" of public expenditure, A is separable in two subsets P and T, including, respectively, the personal and the territorial "drivers" of public expenditure, for which the following properties hold:

1. $P = (p_1, p_2, \ldots, p_k) \subset A$
2. $T = (t_1, t_2, \ldots, t_w) \subset A$
3. $P \cap T = \varnothing$
4. $A = P \cup T = (p_1, p_2, \ldots, p_k, t_1, t_2, \ldots, t_w)$

Therefore the expenditure allocated to each recipient, g_j^n, may be defined as follows:

$g_j^n = g_j^n(p_1, p_2, ..., p_k, t_1, t_2, ..., t_w)$, for each *n =1, …, N,* for each *j = 1,…,J* (1)

It is worth noticing that not all the "drivers" in A are relevant for the distribution of expenditures under each programme. Conversely, for each programme *j*, only a subset A_j of "drivers" is relevant for the distribution of expenditure, where: $A_j = (P_j, T_j) \subseteq A$, and $P_j \subseteq P$, $T_j \subseteq T$.
In particular we can define:

a) *personal* programme: when $T_j = \varnothing$ and $P \neq \varnothing$;
b) *territorial* programme: when $P_j = \varnothing$ and $T_j \neq \varnothing$;
c) *mixed* programme if $P_j \neq \varnothing$ and $T_j \neq \varnothing$.

Now if we consider the common case of a mixed programme, we can resort to variable $r^n \in R^*$ to move from the distribution of public resources (stemming from each public expenditure programme) across recipients to the distribution across regions. As a matter of fact we can define the total amount of resources allocated to region *r* by the *j*-th expenditure programme as:

$$G_j^r = \sum_{n:r^n=r} g_j^n(p_1, p_2, ..., p_k, t_1, t_2, ..., t_w), \text{ for each } j=1,...,J,\ r=1, ..., R \quad (2)$$

The total amount of resources allocated to region *r* by all public expenditure programmes is given by:

$$G^r = \sum_{j=1}^{J} G_j^r = \sum_{j=1}^{J} \sum_{n:r^n=r} g_j^n(p_1, p_2, ..., p_k, t_1, t_2, ..., t_w), \text{ for each } r=1, ..., R \quad (3)$$

Therefore the following holds:

$$G^r = G^r(p_1, p_2, ..., p_k, t_1, t_2, ..., t_w) \quad (4)$$

That is, the total amount of public expenditure benefitting a given region is a function of a set of both personal and territorial "drivers".

Moreover, for each mixed expenditure programme we can derive from the distribution of public resources across recipients given by (1) the distribution that would result if the territorial drivers ($t_1, t_2, ..., t_w$) were totally neglected, that is:

$$\overline{g_j^n} = g_j^n(p_1, p_2, ..., p_k) \quad (5)$$

under the constraint that:

$$\sum_n \overline{g_j^n} = \sum_n g_j^n \qquad (6)$$

We denote the distribution (5) as a *personal* public expenditure programme, in addition to those that are already personal *ab origine* (case a) above.
Now, as before, if we move to the distribution of the personal programme across regions we get:

$$\overline{G_j^r} = \sum_{n:r^n=r} \overline{g_j^n} = \sum_{n:r^n=r} g_j^n(p_1, p_2, ..., p_k), \text{ for each } j=1,...,J \text{ and , } r=1, ..., R \qquad (7)$$

and summing across different expenditure programmes:

$$\overline{G^r} = \sum_{j=1}^{J} \overline{G_j^r} = \sum_{j=1}^{J} \sum_{n:r^n=r} \overline{g_j^n}(p_1, p_2, ..., p_k) \qquad (8)$$

Therefore by comparing the distribution of public resources across regions that is actually observed (equation (2) and (4) respectively for individual programme and for total public budget) with the distribution as if the territorial drivers ($t_1, t_2, ..., t_w$) were negligible (equation (7) and (8)), we can derive a measure of the territorial redistribution generated by personal public expenditures, that is the issue at the core of this paper.

3.2. A summary measure of territorial redistribution

The measurement of territorial redistribution by the public budget is the object of a number of empirical works (for a review of methodologies adopted, see Arachi *et al.*, 2010). Essentially, all studies regress a regional 'economic activity' variable (output or income) including net transfers from the public sector on the same regional variable before transfers.
Following the approach proposed by Bayoumi and Masson (1995), as later developed by Mélitz and Zumer (1998, 2002), applied to Italy by Decressin (2002) and partially modified by Arachi et al. (2010), a summary measure of interregional redistribution can be derived by an OLS regression of regional per-capita GDP after net transfers from the public sector on regional per-capita GDP before net transfers.
A common measure of net transfers from the public sector is provided by fiscal residua, defined as the difference between public expenditure in a given territory (*G*) and public revenues collected in that same territory (*E*). Fiscal residua may be computed for the total public budget or for a single public programme. For a given programme j, in year t and region r, fiscal residua are defined as follows:

$$FR_{jt}^{r} = G_{jt}^{r} - E_{jt}^{r} \quad (9)$$

Having defined fiscal residua, a summary measure of territorial redistribution by programme j may therefore be derived by running an OLS estimation of the following model:

$$\tilde{y}_{jt}^{r} = \alpha_j + \beta_j \tilde{x}_t^r + \eta_{jt}^r \quad (10)$$

where:

- r, j and t respectively denote the region, the programme and the year;
- η is the error term;
- $y_{jt}^{r} = \frac{Y_{jt}^{r}}{\sum_{k=1}^{R} Y_{jt}^{k}}$ and $x_t^r = \frac{X_t^r}{\sum_{k=1}^{R} X_t^k}$, (11)

  and X_t^r is per-capita GDP in region r and year *t*, while Y_{jt}^r, is given by X_t^r plus the corresponding fiscal residuum for programme *j*; all variables are divided by nationwide values to control for shocks that are common to all regions and may be absorbed via the national budget;
- tildes denote the regional trend component of y_{jt}^r and x_t^r over time, isolated by applying the Hodrick and Prescott (1997) filter.

The amount of redistribution is given by 1 – *β*. For example, if *β* =0.9, then a region with per-capita GDP 1 euro higher than the average, after net public transfers, ends up with disposable resources 90 cents higher than the average, implying a redistribution of 10% of GDP.

4. Empirical approach

The issue of the measurement of the territorial redistribution generated by personal public expenditures is dealt with in this paper by making use of a case study focused on Italy in the years 1999-2010. Italy is a country characterised by significant economic differences across its 20 regions, as well as by considerable interregional differences in its socio-demographic structure (table 2 below exemplifies these disparities, with reference to a selected number of indicators). In Italy territorial equalisation is a significant policy issue, and therefore the interregional redistributive properties of "personal" programmes may be a significant complement to explicit redistribution by territorial equalization schemes. This is of even higher relevance in the context of the ongoing fiscal decentralisation process. Therefore our analysis focuses on Italian regions as the terminus of public policies: regions are taken as the basic unit

benefitting from expenditures and contributing revenues. We limit our analysis to the 15 ordinary statute Italian regions (out of the overall 20), due to the specific revenue and expenditure competencies of the 5 special statute regions.
In the following, section 4.1. presents the data used, while section 4.2 applies the methodology developed in section 3 to measure territorial redistribution by personal public programmes in Italy in 1999-2010. This latter section introduces also some methodological adjustments, made necessary by the nature of the available data.

4.1. Data

Regional redistribution by public functions is the results of net transfers of resources among regions accomplished by the two sides of the public budget, namely revenue and expenditures. These net transfers are summarised by fiscal residua, i.e. the difference between revenue collected from and expenditure assigned to each region by the public budget. For our empirical analysis we use data from the Italian public budget for the years 1999-2010. The data source is the Conti pubblici territoriali (Territorial Public Accounts, TPA) produced by the Italian Ministry of Economy[1]. Based on general government budget, the TPA allocate on a cash basis public revenue and expenditure to the 20 Italian regions for the years 1996-2012. Fiscal flows are recorded for general government and distinctively for each level of government (central, regional, local, social security institutions). Expenditure are recorded by region, and disaggregated by economic classification and by function. Revenue are recorded by region and disaggregated by economic classification. For each level of government, revenue are allocated to the region that originated the fiscal flows, while expenditure are allocated to the region where the means of production for public services or investments are located ("expenditure principle").
For our purposes, that is, measuring fiscal flows and reconstructing the "personal distribution" of expenditure, we introduced four adjustments to the TPA database, primarily to obtain a regional distribution of expenditure that reflects the actual benefits accruing to each Italian region. This methodology is detailed in annex 1.
Out of the thirty public functions recorded in our dataset, for the purpose of this paper we selected the five major expenditure programmes in financial terms, namely: general administration, social assistance and charity, education, health, social protection and income support. These functions overall account for about 83% of total public expenditure in Italy. The distribution of per-capita public expenditure for the five selected functions across Italian regions, derived from the adjusted TPA, is depicted in table 1.

[1] Ministero dell'economia e delle finanze, http://www.dps.mef.gov.it/cpt/banca_dati_home.asp, last accessed June 2014.

Table 1 shows that per capita overall expenditure as well as per capita expenditure for the selected functions vary significantly across Italian regions. The overall coefficient of variation is 12%, but it varies from a minimum of 11% for education to a maximum of 22% for social protection and income support.

The regional distribution of expenditure for the five selected function is indeed different. In particular, table 1 shows a generally higher level of per capita expenditure in the southern regions for education and social assistance and charity, while the opposite holds for social protection and income support and for health expenditure. Overall (last two columns) the average per capita expenditure for all the selected five functions is higher in the Northern regions and lower in the Southern ones. With a minimum in Campania and a maximum in Liguria. This result is strongly affected by the distribution of social protection and income support per capita expenditures in these regions. Such expenditures have their maximum in Liguria and minimum in Campania, respectively the region with the highest percentage of elderly (as disclosed by variable "old" in table 2) and the region with the highest percentage of young in Italy (as disclosed by variable "young" in table 2). Finally, the high levels of expenditures in Lazio are partially due to the concentration of public sector activities in the capital city (Rome) which belongs to that region.

Table 1. Public expenditure by functions - per capita average values, 1999-2010 (constant prices, base year 2011)

	General services	Social assistance and charity	Education	Health	Social protection and income support	*Total*	*All functions*
Piemonte	460	466	876	1,671	5,849	9,323	*11,193*
Lombardia	387	478	845	1,749	5,327	8,785	*10,220*
Veneto	420	463	856	1,607	4,625	7,971	*9,441*
Liguria	647	619	821	1,630	6,767	10,484	*12,840*
Emilia Romagna	451	566	919	1,723	5,847	9,505	*11,110*
Toscana	477	565	1,019	1,670	5,628	9,360	*11,124*
Umbria	605	730	1,055	1,785	5,644	9,820	*12,124*
Marche	514	607	985	1,605	5,014	8,724	*10,340*
Lazio	384	724	1,046	1,600	6,306	10,060	*12,603*
Abruzzo	422	662	1,027	1,561	4,437	8,109	*9,948*
Molise	543	559	1,040	1,296	4,305	7,743	*10,406*
Campania	431	587	1,101	1,432	3,157	6,708	*8,496*
Puglia	314	526	980	1,496	3,690	7,006	*8,446*
Basilicata	499	556	1,131	1,578	3,714	7,478	*10,070*
Calabria	427	646	1,160	1,709	3,581	7,523	*9,865*
All regions (euro)	428	558	960	1,628	5,010	8,584	*10,378*
All regions (%)	4.1	5.4	9.2	15.7	48.3	83	*100*
Coefficient of variation	*0.19*	*0.14*	*0.11*	*0.08*	*0.22*	*0.14*	*0.12*

Source: our elaborations based on CPT, Ministero dell'Economia e delle Finanze

4.2. Implementation of the methodological approach

Following the methodological approach described in section 3, we proceed to measure the interregional redistribution by "personal" public functions through two successive stages:

1) In the first stage, the "variable construction phase", we contrast the actual territorial distribution of expenditure (equation (2) and (4)) with the distribution that would be observed if only socio-demographic criteria ("personal" drivers) were used to allocate expenditure across regions ((equation (7) and (8)).
2) In the second part, the "redistribution estimation phase", using the econometric model described by equation (10), we evaluate the territorial redistributive effects of public functions, under the two scenarios for expenditure: the observed one and the "reconstructed" one, that is the one where expenditure is only driven by socio-demographic criteria.

As for the "variables reconstruction phase", we use public budget data on expenditure aggregated by functions of government and assigned to regions according to the territorial distribution of benefits. As each public function includes a multiplicity of expenditure programmes, which differ in many respects, including the drivers for the allocation of benefits, the distribution across territories of benefits may be generally conceived as reflecting both territorial and personal features. We therefore develop a two-step empirical methodology to "neutralise" the territorial drivers of public expenditure and reallocate total expenditure across regions *as if* expenditure were only driven by personal features. This is what we refer to as the "personal distribution" of expenditure or, "personal" expenditure. At the end of this process, starting from actual expenditure, we end up with a distribution of expenditure across territories which only reflects the interregional distribution of the personal features of regions' residents.

The first step of this methodology comprises the assessment, for each function, of the relative role of territorial versus personal drivers in determining the total amount of expenditure in each territory. To do so, we use an econometric model where, for each function of government, the dependent variable is public expenditure in each territory and the regressors are a number of territorial and socio-economic variables.

In the second step, we assume that there are only differences in the socio-demographic structure, while the territorial structure is homogeneous across the country. We call this the process of "neutralisation" of territorial drivers' effect on expenditure's distribution across territories. This is done by imposing that territorial covariates are equal to their overall mean and that territorial dummies are equal to zero (i.e. there are no differences across territories). After this "neutralisation", we use our model to predict the "personal distribution" of total expenditure, that is a

distribution of expenditure that reflects only the interregional distribution of socio-demographic features.
Secondly, in the "redistribution estimation phase", using the econometric model described in equation (10), we evaluate the interregional redistributive effects of public functions. We first calculate fiscal residua for each function (i.e. the difference between expenditure accruing to a territory and the amount of revenue from that same territory used to finance each function). Fiscal residua are computed both using the actual (observed) distribution of public revenue and expenditure and using the "personal distribution" of expenditure, i.e. the distribution driven by socio-demographic criteria only. The first set of fiscal residua is used to estimate actual interregional redistribution. The second set conversely provides a measure of the degree of redistribution that would be produced by expenditures allocated according to personal criteria only ("personal distribution").
The comparison of the degree of redistribution generated by the two different sets of fiscal residua allows an evaluation of the relative role of territorial and personal features in driving the territorial distribution of expenditure and as a consequence the degree of territorial redistribution. Such a comparison allows the separation of the interregional redistributive effect of the public budget due to the personal component of expenditure programmes from that due to the territorial component. For a better understanding of the phenomenon we shall also measure redistribution by public expenditures only, and compare the degree of redistribution achieved by actual expenditures versus the "personal distribution" of expenditures.

5.Territorial redistribution by personal programmes in Italy

The methodology described above is applied to the selected five public functions (general administration, social assistance and charity, education, health, social protection and income support), in order to measure the degree of redistribution that would be accomplished by these functions if expenditure were driven by socio-demographic factors only. We then compare this level of redistribution with the actual one, accomplished by observed expenditures.

5.1. Estimating the "personal distribution" of public expenditure programmes

According to the definition given in section 2, public functions may be classified as "territorial", "personal" or "mixed" depending on the type of drivers that guide the allocation of expenditure across regions.

We therefore assume that for each one of the five functions the observed distribution of expenditure may be replicated by an econometric model that includes both "territorial" and "personal" explanatory variables, as described in equation 8:

$$G = \overline{\alpha} + \sum_{i=1}^{9} \beta P_i + \sum_{j=1}^{4} \gamma T_j + \delta YD + \lambda TD + \overline{\varepsilon} \qquad (12)$$

Where, for each function:

- G is the matrix of expenditure for each region (15 rows) and year (12 columns)
- P_i are the matrices for each of the nine personal explanatory variables (age structure, state of health, unemployment levels,…) for each region (rows) and year (columns)
- T_j are the matrices of territorial explanatory variables (per capita GDP, sector composition of the economy) for each region (rows) and year (columns)
- YD is the matrix of time dummies (years)
- TD is the matrix of territorial dummies (regions)

We estimate the model described by equation 12, using a set of personal and territorial explanatory variables described in Table 2. Table 2 reports average values for all the variables and also illustrates the marked structural and economic differences between Italian regions. These differences are to be found in a wide spectrum of regional features, ranging from surface area to population density and age composition, from average income to economic structure. This geographical dualism explains, inter alia, the particular concern for interregional redistribution in the Italian political and academic debate.

The estimation results for each of the five expenditure functions are reported in annex 2 (table A2). For each function the estimation procedure has gone through the iterated deletion of not significant regressors (90% significance level), so that five different models have been identified, one for each function. These models include as explanatory variables both a subset of personal drivers and a subset of territorial drivers. Therefore we may conclude that these functions are of a mixed nature, according to the definition provided in section 2.

Table 2. Explanatory variables for expenditure functions (average values, 1999-2010)*

			Demographic structure							Territorial structure			
	POP	POPDENS	YOUNG	OLD	POVR	UN	YUN	ONED	TWOD	PRIM	SEC	TERT	GDPPC
Piemonte	4,307,247	170	13.2	21.9	6.2	6.0	17.1	37.2	19.5	1.9	30.4	67.6	25.425
Lombardia	9,331,528	391	14.4	19.0	4.3	4.1	13.3	37.4	18.1	1.4	33.8	64.8	31.102
Veneto	4,673,578	254	14.6	18.9	4.6	4.4	11.6	37.8	18.0	2.4	34.3	63.3	27.582
Liguria	1,593,463	294	11.6	26.2	6.7	6.7	18.8	40.7	21.8	1.8	19.0	79.2	24.053
Emilia R.	4,127,856	187	12.9	22.6	4.1	3.6	11.9	40.9	20.8	3.0	32.3	64.8	29.735
Toscana	3,585,888	156	12.8	22.9	5.4	5.1	15.2	39.6	20.4	2.2	27.2	70.6	25.672
Umbria	854,597	101	13.4	23.1	8.2	6.2	16.1	41.7	22.9	2.9	27.7	69.4	22.185
Marche	1,509,149	156	14.0	22.1	6.2	5.1	14.4	38.3	20.1	2.5	31.8	65.7	23.913
Lazio	5,313,289	308	14.9	18.7	8.2	8.8	28.2	37.6	20.1	1.3	15.5	83.2	27.659
Abruzzo	1,293,114	120	14.7	20.8	15.1	8.4	25.6	39.7	22.1	3.3	31.9	64.8	19.934
Molise	321,212	72	14.8	21.5	21.6	9.8	27.2	37.8	21.2	4.6	25.1	70.4	17.396
Campania	5,761,930	424	19.2	14.8	23.6	15.6	40.3	32.8	18.8	3.0	18.2	78.7	14.604
Puglia	4,052,103	209	17.3	16.8	21.6	14.0	34.2	34.2	18.8	4.9	23.8	71.3	15.372
Basilicata	595,425	60	16.1	19.2	26.2	12.6	38.6	38.9	22.5	6.0	27.1	66.9	15.767
Calabria	2,011,489	133	17.1	17.7	26.4	15.1	39.2	39.7	23.9	5.4	16.1	78.5	14.614
*All regions***	*49,331,868*	*218*	*15.0*	*19.3*	*12.0*	*8.7*	*23.8*	*37.2*	*19.6*	*3.1*	*26.3*	*70.6*	*24.319*

** For a key to abbreviations and units of measurement used in this table, see annex 2 (table A1).*

*** Averages for all regions for POVR, UN, YUN, ONED, TWOD are reconstructed based on ISTAT data.*

Source: Istat

The reconstruction of the "personal distribution" of public expenditure is based on these models: the coefficients estimated from equation (12), $\hat{\alpha}, \hat{\beta}, \hat{\gamma}, \hat{\delta}, \hat{\lambda}$, are used to predict the level of expenditure that would be accomplished if there were no "territorial" differences across territories, that is, if territorial factors were neutral to the regional distribution of expenditure. In order to do so, the two matrices containing territorial regressors (T and TD) are modified in order to "neutralise" territorial differences. This is done by assuming that all regions are equal as far as territorial factors are concerned, and that these factors in all regions assume the same value, equal to the average across all regions. Therefore continuous "territorial" explanatory variables take the same value across regions year by year (and this value is given by their yearly mean across regions), so that each T_j matrix is transformed into T_j* (where each column contains only one, repeated, value). In addition territorial dummies are imposed to be equal to zero for all regions and years (TD becomes TD*, a null matrix). Equation 13 describes the new model:

$$\widehat{G} = \hat{\alpha} + \sum_{i=1}^{9} \hat{\beta} P_i + \sum_{j=1}^{4} \hat{\gamma} T_j^* + \hat{\delta} YD + \hat{\lambda} TD^* + \hat{\varepsilon} \qquad (13)$$

Table 3 reports per capita average general government expenditure by function for each Italian region, as derived from equation 13. Therefore it shows the amount of expenditure that would be observed if there were only personal drivers, i.e. what we referred to as the "personal distribution" of expenditure. For each function, table 3 shows also the difference, in percentage terms, between the reconstructed "personal distribution" of expenditure and the observed one.

As disclosed by table 3, the personal distribution of expenditure for the total of the five selected functions assigns generally higher per capita values to the Northern regions than to the Southern ones. This is the result of the composition of the different behaviours displayed by the five selected functions, but it is mainly driven by the pattern of the "personal distribution" of education, health and social protection expenditure, which are generally higher in Northern than in Southern regions.

Table 3 allows also a comparison between the observed and the "personal distribution" of expenditure. The two distribution display some differences. First, overall expenditure increases in Northern regions under the personal distribution as compared to the observed one, while overall expenditure decreases in Southern regions. Turning to the five functions, this pattern is also markedly clear for education, and to a lower extent also for social assistance and charity. Health expenditure under the personal distribution is generally lower in Southern regions than according to the observed one. A reverse pattern is displayed by general services: expenditure increases in Southern regions under the personal distribution as compared to the observed one. To a slight extent this same pattern is displayed also by social protection and income support.

Table 3. General government expenditure by function, personal distribution - per capita average values, 1999-2010 (euro, constant prices, base year 2011)

	General services		Social assistance and charity		Education		Health		Social protection and income support		Total	
	personal distribution	*% observed*	*personal distribution*	*% observed*	*personal distribution*	*% observed*	*personal distribution*	*% observed*	*personal distribution*	*% observed*	*personal distribution*	*% observed*
Piemonte	376	*82*	355	*76*	1219	*139*	1554	*93*	5785	*99*	9288	100
Lombardia	378	*98*	546	*114*	1202	*142*	1670	*95*	5322	*100*	9117	104
Veneto	431	*103*	567	*123*	947	*111*	1584	*99*	5192	*112*	8721	109
Liguria	571	*88*	1177	*190*	237	*29*	2282	*140*	6662	*98*	10930	104
Emilia Romagna	398	*88*	452	*80*	1118	*122*	1670	*97*	5919	*101*	9557	101
Toscana	395	*83*	404	*71*	1147	*112*	1616	*97*	5997	*107*	9558	102
Umbria	443	*73*	493	*67*	896	*85*	1635	*92*	6072	*108*	9539	97
Marche	458	*89*	601	*99*	792	*80*	1668	*104*	5782	*115*	9300	107
Lazio	450	*117*	691	*95*	840	*80*	1669	*104*	5065	*80*	8716	87
Abruzzo	439	*104*	472	*71*	901	*88*	1530	*98*	4681	*105*	8022	99
Molise	439	*81*	396	*71*	925	*89*	1494	*115*	4655	*108*	7910	102
Campania	518	*120*	880	*150*	469	*43*	1739	*121*	3317	*105*	6922	103
Puglia	426	*136*	357	*68*	1031	*105*	1373	*92*	3692	*100*	6879	98
Basilicata	420	*84*	279	*50*	1030	*91*	1316	*83*	3735	*101*	6781	91
Calabria	429	*100*	326	*51*	982	*85*	1342	*79*	3546	*99*	6625	88
Alll regions	428	*100*	558	*100*	960	*100*	1628	*100*	5010	*100*	8584	100

Source: our elaborations based on CPT, Ministero dell'Economia e delle Finanze

5.2. *Measuring the interregional redistributive effects*

We generate two sets of fiscal residua for each of the selected functions of government and for them all. The first set makes use of observed expenditure and the second uses the "personal distribution" of expenditure.
Recalling equation (9), for each function j and for each year t and region r, fiscal residua are given by:

$$FR_{jt}^{r} = G_{jt}^{r} - E_{jt}^{r} \qquad (9)$$

Table 4 displays the two sets of fiscal residua and reports the difference in percentage terms between them, for each selected function and for them all.
The distribution of observed fiscal residua across regions gives a preliminary picture of the main patterns characterising inter-regional fiscal flows in Italy for each function. First, there is substantial redistribution from the wealthier to the poorer jurisdictions (i.e. those with per capita GDP above or below the national average), the former generally in the North of the country, the latter in the South. In fact, with very few exceptions, both observed and "personal distribution" fiscal residua are positive in the South and negative in the Northern regions. Moreover, the size of the residua is to some extent negatively correlated with regions' surface area: they are generally higher in smaller regions (Liguria, Umbria, Marche, Molise, Basilicata). Moving from the observed to the personal distribution, overall fiscal residua generally display slight changes in Southern regions (little decreases or increases). Changes are conversely significant in Central Italian regions, while under the personal distribution, in Northern regions fiscal residua are generally less negative than observed ones. An analysis function by function of the differences between the two distribution, reveals that for general services, health and social assistance and charity, fiscal residua generally become more negative in the North than under the observed distribution. Conversely, fiscal residua for education in Northern regions are less negative under the personal than the observed distribution.

Table 4. G-T for expenditure functions (per capita average values 1999-2010, euro 2011)

	General services			Social assistance and charity			Education			Health			Social protection and income support			All functions		
	obs. [1]	pers. distr. [2]	diff. [(2-1)/1]	obs. [1]	pers. distr. [2]	diff. [(2-1)/1]	obs. [1]	pers. distr. [2]	diff. [(2-1)/1]	obs. [1]	pers. distr. [2]	diff. [(2-1)/1]	obs. [1]	pers. distr. [2]	diff. [(2-1)/1]	obs. [1]	pers. distr. [2]	diff. [(2-1)/1]
	Euro	euro	%	Euro	Euro	%	euro	euro	%	euro	euro	%	euro	euro	%	euro	euro	%
Piemonte	-30.2	-114.0	-277	-172.1	-283.1	-65	-222.6	120.1	154	-189.5	-307.3	-62	461.0	396.7	-14	-153.3	-187.7	-22
Lombardia	-202.3	-211.9	-5	-290.8	-222.4	24	-476.8	-119.4	75	-493.0	-572.5	-16	-1196.1	-1201.4	0	-2659.1	-2327.6	12
Veneto	-45.8	-34.8	24	-144.5	-40.3	72	-188.0	-97.1	48	-163.3	-186.5	-14	-877.2	-310.4	65	-1418.9	-669.0	53
Liguria	141.3	64.9	-54	-39.8	518.2	1401	-312.7	-896.3	-187	-292.6	360.2	223	1840.2	1734.8	-6	1336.4	1781.8	33
Emilia R.	-104.3	-157.3	-51	-157.3	-270.7	-72	-325.5	-126.9	61	-384.1	-437.8	-14	-255.6	-182.9	28	-1226.9	-1175.5	4
Toscana	-10.6	-92.7	-779	-68.7	-230.0	-235	-73.5	53.9	173	-179.6	-234.0	-30	458.7	827.2	80	126.2	324.4	157
Umbria	162.6	1.2	-99	155.3	-82.4	-153	65.0	-94.4	-245	107.9	-42.5	-139	1069.7	1497.2	40	1560.5	1279.2	-18
Marche	95.9	39.9	-58	64.3	58.4	-9	48.8	-144.0	-395	23.6	86.6	268	259.0	1026.2	296	491.5	1067.1	117
Lazio	-192.4	-126.2	34	-24.7	-57.5	-133	-244.5	-451.0	-84	-584.7	-515.2	12	200.6	-1040.1	-619	-845.7	-2190.0	-159
Abruzzo	62.9	80.2	28	193.7	3.5	-98	223.0	97.3	-56	195.6	163.9	-16	422.0	665.9	58	1097.2	1010.8	-8
Molise	222.2	118.7	-47	141.3	-21.3	-115	322.5	207.8	-36	77.4	274.6	255	860.7	1211.2	41	1624.0	1791.1	10
Campania	149.5	236.8	58	219.4	512.9	134	471.3	-161.5	-134	360.5	667.4	85	106.7	266.0	149	1307.4	1521.6	16
Puglia	33.3	145.3	336	159.6	-9.8	-106	350.5	401.5	15	425.8	302.9	-29	574.4	576.4	0	1543.6	1416.3	-8
Basilicata	213.2	134.9	-37	183.3	-93.6	-151	491.0	390.7	-20	490.9	228.8	-53	461.8	482.9	5	1840.2	1143.7	-38
Calabria	161.7	163.6	1	299.4	-20.2	-107	565.3	387.8	-31	697.4	330.1	-53	813.2	777.4	-4	2536.9	1638.8	-35
All regions	*-32.4*	*-32.4*	*0.0*	*-42.1*	*-42.1*	*0.0*	*-72.7*	*-72.7*	*0.0*	*-123.1*	*-123.1*	*0.0*	*-34.8*	*-34.8*	*0.0*	*-305.1*	*-305.1*	*0.0*

Source: our elaborations based on CPT, Ministero dell'Economia e delle Finanze

Regional fiscal residua provide qualitative insights on the distribution of net benefits from public functions across Italian regions. However, to reach a conclusive judgement on the redistributive properties of the selected public functions and on the differences between redistribution by observed expenditures and by the "personal" distribution of expenditure, we resort to a summary measure of interregional redistribution. We take per-capita regional GDP as a measure of economic "activity" before net benefits from the public sector. Following the approach presented in section 2, , a summary measure of interregional redistribution is given by the complement to 1 of the coefficient β estimated by OLS from equation (10):

$$\tilde{y}_{jt}^{r} = \alpha_j + \beta_j \tilde{x}_t^r + \eta_{jt}^r \qquad (10)$$

Table 5 presents the results on redistribution under the two different distribution of expenditures: observed and "personal", by displaying the summary measures of redistribution obtained under the two scenarios.

Table 5. Redistribution through fiscal residuals (percentages, 1999-2010)

		General services	Social assistance and charity	Education	Health	Social protection and income support	Total selected functions
N.observations		*180*	*180*	*180*	*180*	*180*	*180*
Observed	R^2	0.9987	0.9983	0.9968	0.9991	0.9776	-
	Redistribution	1.83	2.63	5.49	5.62	6.11	21.68
Personal distribution	R^2	0.9999	0.9988	0.9979	0.9992	0.9735	-
	Redistribution	2.11	1.59	2.95	5.17	7.14	18.96
% difference	Redistribution	15%	-40%	-46%	-8%	17%	-13%
Observed - expenditure only	R^2	0.9992	0.9988	0.9982	0.9995	0.9854	-
	Redistribution	1.53	2.13	4.28	5.00	1.81	14.74
Pers. distrib. – expenditure only	R^2	0.9980	0.9933	0.9982	0.9986	0.9857	-
	Redistribution	1.79	1.20	2.12	4.58	3.05	12.75
% difference	Redistribution	17%	-44%	-50%	-8%	69%	-14%
Pers. distrib. expenditure only/ Pers. distrib. fiscal residua	Redistribution	85%	76%	72%	89%	43%	67%

Source: our elaborations based on CPT, Ministero dell'Economia e delle Finanze

The first section of table 5 (row 3-7) reports the degree of regional redistribution accomplished by observed fiscal residua and by fiscal residua obtained using the "personal distribution" of expenditure. The second section (row 8-12) compares the degree of regional redistribution accomplished by observed expenditure and by

expenditure according to the "personal distribution". The last section (row 13) compares redistribution by expenditure only and by fiscal residua under the "personal" distribution of expenditure.

The first section shows that, for each of the selected functions of government, and for them altogether, both observed fiscal residua and fiscal residua obtained using the "personal distribution" of expenditure generate a redistributive impact, that is they generate a positive flow of resources from the richer (Northern) regions to the poorer (Southern) ones. This was anticipated by data reported in table 4, where positive residua in the South suggested that these territories are net beneficiaries of public programmes.

The second section shows that while expenditure is always redistributive, when shifting from observed data to the "personal" distribution of expenditure, total redistribution decreases for the five functions altogether and for three of them (Social assistance and charity, education, health) but it increases for two functions (general services and social protection and income support).

The third section discloses that under the "personal" distribution of expenditure, redistribution by fiscal residua is always higher than that from expenditure only. Therefore revenue have a redistributive power too.

Turning to results reported in the first section of table 5, although both observed fiscal residua and fiscal residua obtained using the "personal distribution" of expenditure generate a redistributive impact, there are however differences between the degree of redistribution generated by the two sets of fiscal residua. For the explanation of these differences, obviously revenue are "neutral" (they are unaltered in the two alternative scenarios: they are unchanged when we calculated either "observed" fiscal residua or "personal distribution" fiscal residua). Therefore the observed differences in the degree of redistribution accomplished by observed and "personal distribution" fiscal residua are exclusively due to the changes made to the distribution of expenditure across regions.

In addition, when the behaviour of each of the five functions is analysed separately, two different patterns emerge as regards the changes from the observed to the "personal distribution" scenario. For three functions, Health, Social assistance, Education, as well as for the total selected functions, results show that the "personal distribution" of expenditure generates a lower degree of interregional redistribution than observed expenditure. Therefore, in a country characterised by a polarised distribution of socio-demographic features, we may conclude that these features alone generate a significant degree of redistribution, but not as much as is achieved when the territorial distribution of programmes' expenditures is also driven by territorial features.

This pattern is better explained turning to data reported in section 2 of table 5. Row 12 in particular shows that redistribution by public expenditure only decreases when

shifting from observed expenditure to expenditure according to the "personal distribution". These functions are: Social assistance, Education and Health. It is rather significant, though, the result obtained for the remaining two functions of government: General services and Social protection. For these functions the "personal distribution" of expenditures generates a higher degree of interregional redistribution than the observed one.

Our analysis therefore shows that there are two patterns when we move from observed to "personal distribution" fiscal residua. In pattern 1, the latter are less redistributive than the former, and this is the case for Health, Social assistance and Education, as well as for the total selected functions. The opposite holds for pattern 2, detected for General services and Social protection. Going back to table 3 we may see that for pattern 1 functions, in Southern regions expenditure according to the "personal distribution" is lower than observed expenditure. Conversely, in southern regions the "personal distribution" of expenditure is higher than the observed one for pattern 2 functions.

This result seemingly suggests that for some functions (pattern 1), the omitted territorial drivers for the allocation of public expenditure have a significant redistributive role, as they increase the concentration of expenditure in the southern (poorer) regions. In contrast, for pattern 2 functions, the omitted territorial drivers do not play a significant redistributive role.

Given these results we may only try to infer the causes beneath such different patterns. We may first observe that for two functions in pattern 1 group, namely Health and Education, citizenships rights should play a significant role in the distribution of expenditure across regions. Therefore if the omitted territorial factors generate higher levels of expenditure in southern regions, this may be due to higher inefficiencies in Southern regions, where guaranteeing the same citizenship rights as in the north becomes "more expensive". Further, for some functions in pattern 1 group, the higher observed redistribution (due to the inclusion of territorial drivers) may be also explained if we assume that these programmes embed some implicit retributive mechanisms (for instance, income support for southern regions, as the one produced by a higher concentration of assistant teachers in southern regions) which yield a higher concentration of expenditure in poorer regions.

If these intuitions are sound, we may then conclude that these mechanisms are apparently less operating for pattern 2 functions.

6. Final remarks

Public expenditure and public transfers may address persons (personal programmes) or places (territorial programmes), the latter often pursue the territorial redistribution

of resources, especially in countries characterised by a significant economic divide, different fiscal capacities and polarised levels of economic development. This paper, through a case study of Italy in 1999-2010, investigated the territorial redistributive power of personal public expenditure programmes, that is of public programmes that allocate resources among individuals on the basis of "socio-demographic" features, as opposed to programmes allocating resources across territories according to "territorial" features.

For this purpose we compared the observed interregional redistribution by major expenditure functions with the one that would arise if those expenditure functions were driven by socio-demographic criteria only. Results show that overall interregional redistribution slightly declines when shifting from actual expenditure to the simulated personal distribution of expenditure, and that this result holds for most public programmes. However, results clearly disclose that even when resources are distributed according to socio-demographic criteria only, public programmes still produce a significant level of territorial redistribution (let aside personal redistribution) in a country characterised by a stark interregional economic divide, as Italy is.

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Annex 1. Database construction

For the purpose of measuring fiscal flows and reconstructing the "personal distribution" of expenditure, we introduced four adjustments to the Conti Publbic Territoriali (Territorial Public Accounts, TPA) database, produced by the Italian Ministry of the economy.

First, we netted out interest spending and government deficit. The former is not consistent with our focus on territorial versus personal expenditures, so we simply considered total expenditure net of interests. The latter has an intertemporal nature which again is not consistent with the aim of our analysis, so we netted it out by imposing a balanced budget: we reduced overall expenditure and proportionally, its regional distribution.

Secondly, as we are interested in the "territorial" versus the "personal" distribution of expenditure, we also devised a specific approach for central government expenditures for public goods. Indeed, central government public goods benefit all citizens equally, regardless of where the expense is located, therefore the territorial distribution of benefits from national public goods reflects only the population of each region, not the "socio-demographic" features of territories and even less their "territorial structure". Therefore, central government expenditure for pure public goods has a peculiar nature, and our criteria for territorial vs personal distribution of benefits cannot be applied to it. For this reason this expenditure was netted out from our database. Conversely, decentralised governments expenditure for local public goods was included because, net of externalities, this expenditure equally benefits all citizens of the jurisdiction where it is introduced, and the expenditure amount may reflect either the jurisdiction's "territorial" or "personal" structure. As for central government mixed public goods, a specific procedure was applied, as described below.

The third adjustment to the regional allocation of expenditure was introduced in order to achieve the territorial location of benefits from public expenditure (according to the "benefit principle") departing from the available data, distributed according to the "expenditure principle". This is relevant for central government expenditure, while for decentralised government expenditure, the allocation according to the benefit or the expenditure principle generally coincide (net of externalities). In principle, for central government expenditures, consistency between the two principles depends on the nature of the publicly provided goods. For pure national public goods, public intervention benefits all citizens equally, so the regionalisation of financial flows according to the expenditure principle does not coincide with that according to the benefit principle, however expenditure for pure national public goods was already expunged from the dataset (see above). For publicly provided private goods, conversely, it may be presumed that the expenditure principle largely matches the benefit principle. Accordingly, in the case of publicly provided pure private goods, the regionalisation of the TPA was retained. Finally, in the case of central government

mixed goods, featuring both public and private characteristics, our rule-of-thumb was to expunge 50% of expenditure (the public good "quota", for the reasons described above) and keep the reminder 50% (the "private good" quota) without altering its regional distribution (parallel to the approach used for pure private goods).

Finally, the TPA also needed revision with reference to regional governments' health services expenditure (which accounts for nearly 80% of total regional budgets). These flows, regionalised according to the expenditure principle, were attributed entirely to the regional jurisdiction responsible for the expenditure (where the services are provided), regardless of where the patients actually reside. This distinction proves to be significant in Italy, where there is considerable inter-regional mobility of National Health Service patients (especially from southern to northern regions). To measure the real benefits of health care to residents in each jurisdiction, the raw data on regional expenditures were adjusted for net expenditures for inter-regional patient mobility, determined, for each region, as expenditures for services to non-residents less expenditures by other regions for services to the region's own residents.The result of these adjustments is a distribution of general government expenditure by function across regions which should reflect the regional distribution of benefits. This is the first step in order to measure fiscal residua and interregional redistribution.

Annex 2. Modelling expenditure functions

Each public expenditure function allocates resources across regions according to differing parameters or, as we called them, according to different "drivers" of public expenditure. As derived in section 2, public functions may be classified as "territorial", "personal" or "mixed" depending on whether the drivers for the allocation of expenditure across regions are, respectively, only topo-geographical (i.e. "territorial"), only socio-demographic (i.e. "personal"), or both.
In principle, therefore, the observed distribution of expenditure by each function may be replicated by an econometric model that includes both "territorial" and "personal" explanatory variables, as described in equation 12 above, that is:

$$G = \overline{\alpha} + \sum_{i=1}^{9} \beta P_i + \sum_{j=1}^{4} \gamma T_j + \delta YD + \lambda TD + \overline{\varepsilon} \quad (12)$$

Where, for each function:

- G is the matrix of expenditure for each region (15 rows) and year (12 columns)
- P_i are the matrices for each of the nine personal explanatory variables (age structure, state of health, unemployment levels,…) for each region (rows) and year (columns)
- T_j are the matrices of territorial explanatory variables (per capita GDP, sector composition of the economy) for each region (rows) and year (columns) YD is the matrix of time dummies (years)
- TD is the matrix of territorial dummies (regions)

Obviously, for territorial functions, P_i is a null matrix for each *i*, while for personal functions, T_i is a null matrix for each *i*. The nine personal explanatory variables and the four territorial explanatory variables are described in Table 2 above, while Table A1 below lists all explanatory variables (with keys to measurement units and abbreviations used in this paper).
For each one of the five selected Italian public functions (general administration, social assistance and charity, education, health, social protection and income support) we estimate the model described by equation 12, using this set of personal and territorial explanatory variables. For each function, the estimation procedure has gone through the iterated deletion of not significant regressors (90% significance level), so that five different models have been identified, one for each function. All these models include as explanatory variables both a subset of personal drivers and a subset of territorial drivers. Therefore these functions are of a mixed nature. The estimation results are reported in Table A2 below.

Table A1. Explanatory variables: keys to measurement units and abbreviations

Demographic structure		
Variable	*Abbreviation*	*Measurement unit*
Population	POP	units
Square population	POPQ	thousand billions
Population density	POPDENS	inhabitants/sq.km
Population under 16 years	YOUNG	share of total population
Population 65 years and over	OLD	share of total population
Relative poverty	POVR	share of families
Unemployment	UN	share of labour force
Youth unemployment	YUN	share of unemployed youth (15-24 years) over youth labour force
Population with at least one chronic disease	ONED	share over similar population
Population with at least two chronic diseases	TWOD	share over similar population

Territorial structure		
Variable	*Abbreviation*	*Measurement unit*
Primary sector	PRIM	share of total added value
Secundary sector	SEC	share of total added value
Tertiary sector	TERT	share of total added value
Per capita GDP	GDPPC	thousand euro

Source: Istat

Table A2 - General administration expenditure: estimation results

Number of obs = 180
F(18, 161) = 40.92
Prob > F = 0.0000
R-squared = 0.7260
Root MSE = .0561

Dependent variable: per capita general administratione expenditure

	Coefficient	Robust std. error	t	P>|t|	[95% Conf.	interval]
pop	-0.0000000353	0.00000001	-5.020	0.000	0.000	0.000
popdens	0.001	0.000	4.210	0.000	0.000	0.001
pilpc	0.014	0.003	4.030	0.000	0.007	0.021
sec	1.935	1.052	1.840	0.068	-0.141	4.012
terz	1.937	1.103	1.760	0.081	-0.241	4.115
terr3	-0.165	0.055	-3.010	0.003	-0.273	-0.057
terr5	-0.118	0.034	-3.490	0.001	-0.185	-0.051
terr8	-0.073	0.033	-2.200	0.029	-0.139	-0.008
terr10	0.139	0.025	5.670	0.000	0.091	0.187
terr12	-0.197	0.035	-5.670	0.000	-0.266	-0.129
terr14	0.179	0.027	6.730	0.000	0.126	0.231
terr17	0.209	0.022	9.460	0.000	0.166	0.253
terr18	0.134	0.032	4.200	0.000	0.071	0.198
year5	-0.026	0.014	-1.880	0.062	-0.054	0.001
year9	0.040	0.013	2.940	0.004	0.013	0.066
year10	0.024	0.011	2.220	0.028	0.003	0.045
year11	0.023	0.013	1.800	0.073	-0.002	0.048
trend	-0.012	0.002	-6.690	0.000	-0.016	-0.009
_cons	-1.676	0.958	-1.750	0.082	-3.568	0.217

Source: our elaborations based on CPT, Ministero dell'Economia e delle Finanze and Istat.

Table A2 - Social assistance and charity expenditure: estimation results

Number of obs = 180
F(26, 153) = 182.49
Prob > F = 0.0000
R-squared = 0.9332
Root MSE = .02728

Dependent variable: per capita social assistance and charity expenditure

	Coefficient	Robust std. error	t	P>|t|	[95% Conf.	interval]
pop	-0.0000000857	0.0000000126	-6.790	0.000	-0.0000001	-0.0000001
popdens	0.003	0.000	7.530	0.000	0.002	0.003
giov	-2.635	0.608	-4.330	0.000	-3.837	-1.434
dis	-0.007	0.004	-1.780	0.077	-0.014	0.001
disgiov	0.002	0.001	2.110	0.036	0.000	0.004
pilpc	0.008	0.003	2.630	0.009	0.002	0.014
year6	-0.079	0.009	-8.900	0.000	-0.096	-0.061
year7	-0.023	0.006	-3.720	0.000	-0.036	-0.011
year8	-0.023	0.006	-3.870	0.000	-0.035	-0.011
year9	-0.042	0.006	-6.880	0.000	-0.054	-0.030
year10	-0.048	0.007	-7.170	0.000	-0.061	-0.035
year11	-0.028	0.007	-4.090	0.000	-0.041	-0.014
year13	-0.028	0.008	-3.580	0.000	-0.043	-0.012
year14	0.050	0.010	4.920	0.000	0.030	0.070
terr1	0.177	0.030	5.980	0.000	0.118	0.235
terr7	-0.267	0.059	-4.510	0.000	-0.383	-0.150
terr8	0.169	0.016	10.710	0.000	0.138	0.200
terr9	0.238	0.026	9.040	0.000	0.186	0.290
terr10	0.367	0.025	14.870	0.000	0.318	0.416
terr11	0.149	0.016	9.210	0.000	0.117	0.181
terr12	0.167	0.018	9.250	0.000	0.131	0.202
terr13	0.332	0.034	9.780	0.000	0.265	0.400
terr14	0.306	0.043	7.160	0.000	0.221	0.390
terr16	0.319	0.048	6.600	0.000	0.224	0.415
terr17	0.404	0.055	7.320	0.000	0.295	0.513
terr18	0.467	0.053	8.770	0.000	0.362	0.573
_cons	0.354	0.103	3.450	0.001	0.151	0.556

Source: our elaborations based on CPT, Ministero dell'Economia e delle Finanze and Istat.

Table A2 - Education expenditure: estimation results

Number of obs = 180
F(25, 154) = 134.77
Prob > F = 0.0000
R-squared = 0.9396
Root MSE = .03243

Dependent variable: per capita education expenditure

	Coefficient	Robust std. error	t	P>|t|	[95% Conf.	interval]
pop	0.00000071	0.00000012	5.770	0.000	0.00000046	0.00000095
popdens	-0.016	0.003	-6.170	0.000	-0.022	-0.011
giov	1.708	0.515	3.320	0.001	0.691	2.725
pilpc	-0.034	0.010	-3.580	0.000	-0.053	-0.015
sec	1.069	0.316	3.390	0.001	0.446	1.693
terr1	-4.000	0.671	-5.960	0.000	-5.326	-2.673
terr3	-3.808	0.709	-5.370	0.000	-5.209	-2.407
terr5	-2.891	0.495	-5.840	0.000	-3.868	-1.914
terr8	-3.425	0.594	-5.760	0.000	-4.600	-2.251
terr9	-3.528	0.614	-5.740	0.000	-4.742	-2.314
terr10	-2.603	0.456	-5.710	0.000	-3.504	-1.702
terr11	-2.236	0.382	-5.850	0.000	-2.991	-1.481
terr12	-2.056	0.401	-5.130	0.000	-2.848	-1.264
terr13	-2.775	0.475	-5.840	0.000	-3.714	-1.836
terr14	-2.873	0.496	-5.790	0.000	-3.853	-1.893
terr15	-0.983	0.231	-4.260	0.000	-1.439	-0.527
terr16	-3.424	0.577	-5.940	0.000	-4.564	-2.284
terr17	-3.286	0.575	-5.720	0.000	-4.422	-2.151
terr18	-2.990	0.534	-5.600	0.000	-4.044	-1.935
year5	0.032	0.010	3.140	0.002	0.012	0.051
year6	0.162	0.020	8.120	0.000	0.123	0.202
year7	0.060	0.012	5.170	0.000	0.037	0.083
year8	0.149	0.011	13.090	0.000	0.126	0.171
year9	0.097	0.009	10.370	0.000	0.079	0.116
year10	0.057	0.009	6.100	0.000	0.039	0.076
year11	0.089	0.008	11.600	0.000	0.074	0.105
year13	0.044	0.007	6.220	0.000	0.030	0.057
year14	0.072	0.007	10.690	0.000	0.059	0.085
trend	0.017	0.005	3.640	0.000	0.008	0.026
_cons	4.742	0.672	7.060	0.000	3.415	6.070

Source: our elaborations based on CPT, Ministero dell'Economia e delle Finanze and Istat.

Table A2 - Health expenditure: estimation results

Number of obs = 180
F(16, 163) = 25.17
Prob > F = 0.0000
R-squared = 0.6504
Root MSE = .12088

Dependent variable: per capita health expenditure

	Coefficient	Robust std. error	t	P>|t|	[95% Conf.	interval]
pop	-0.0000000524	0.0000000213	-2.460	0.015	-0.0000000946	-0.0000000103
popdens	0.002	0.001	4.390	0.000	0.001	0.004
vec	5.388	1.182	4.560	0.000	3.053	7.723
pilpc	0.019	0.005	4.030	0.000	0.010	0.028
terz	-0.458	0.251	-1.830	0.069	-0.953	0.037
terr1	0.153	0.042	3.620	0.000	0.069	0.237
terr7	-0.492	0.126	-3.900	0.000	-0.741	-0.243
terr9	0.101	0.036	2.840	0.005	0.031	0.171
terr10	0.262	0.047	5.550	0.000	0.169	0.355
terr13	0.157	0.061	2.570	0.011	0.036	0.277
terr16	0.355	0.070	5.090	0.000	0.217	0.492
terr17	0.462	0.068	6.780	0.000	0.328	0.597
terr18	0.643	0.094	6.840	0.000	0.457	0.828
year6	0.073	0.042	1.720	0.087	-0.011	0.156
year14	0.067	0.032	2.050	0.042	0.002	0.131
trend	0.007	0.004	1.770	0.079	-0.001	0.015
_cons	-0.114	0.297	-0.380	0.702	-0.700	0.473

Source: our elaborations based on CPT, Ministero dell'Economia e delle Finanze and Istat.

Table A2 - Social protection and income support expenditure: estimation results

Number of obs = 180
F(19, 160) = 507.13
Prob > F = 0.0000
R-squared = 0.9773
Root MSE = .17238

Dependent variable: per capita social protection and income support expenditure

	Coefficient	Robust std. error	t	P>|t|	[95% Conf.	interval]
vec	19.262	1.172	16.440	0.000	16.947	21.576
povr	-0.047	0.005	-9.690	0.000	-0.056	-0.037
pilpc	-0.037	0.009	-4.020	0.000	-0.055	-0.019
prim	-9.729	2.497	-3.900	0.000	-14.661	-4.798
terr1	0.597	0.053	11.180	0.000	0.492	0.702
terr3	0.716	0.052	13.850	0.000	0.614	0.818
terr7	0.652	0.111	5.870	0.000	0.432	0.871
terr8	0.628	0.063	10.000	0.000	0.504	0.752
terr9	0.188	0.053	3.510	0.001	0.082	0.293
terr11	-0.296	0.058	-5.100	0.000	-0.411	-0.182
terr12	1.806	0.080	22.640	0.000	1.649	1.964
terr14	-0.202	0.075	-2.700	0.008	-0.349	-0.054
terr15	-0.214	0.088	-2.420	0.016	-0.388	-0.040
year6	-0.193	0.049	-3.970	0.000	-0.289	-0.097
year9	-0.179	0.043	-4.180	0.000	-0.264	-0.095
year10	-0.309	0.043	-7.240	0.000	-0.393	-0.224
year11	-0.378	0.051	-7.470	0.000	-0.478	-0.278
year12	-0.357	0.038	-9.320	0.000	-0.433	-0.281
year13	-0.278	0.054	-5.170	0.000	-0.384	-0.172
_cons	2.598	0.344	7.540	0.000	1.918	3.278

Source: our elaborations based on CPT, Ministero dell'Economia e delle Finanze and Istat.