

REGIONAL REDISTRIBUTION AND RISK SHARING IN ITALY:
THE ROLE OF DIFFERENT TIERS OF GOVERNMENT

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Regional redistribution and risk sharing in Italy: the role of different tiers of government

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Abstract

This paper provides estimates of the redistribution and risk sharing across regional jurisdictions accomplished by the public sector in Italy. In this analysis the multi-level structure of the Italian government and the financial relations which link the different layers of government are explicitly considered. Using panel data for the period 1996-2002 we found that public policies in Italy significantly reduce differences in per-capita GDP across regions. On the other hand, public budget, far from providing insurance against idiosyncratic shocks, greatly emphasize income fluctuations across regions.

Keywords: Fiscal policy, Redistribution, Risk sharing, Inter-governmental relations, Regions

JEL classification: E62, H23, H50, H70, R10

1. Introduction

Fiscal measures for redistributing income and mitigating asymmetric shocks across different regions of a national state or across states forming a federation have received increasing attention in recent theoretical and empirical literature. Much of this interest was sparked by the preparation of the European Monetary Union during the '90s. At single-nation level, most empirical studies have focused on the cases of the US and Canada, while providing limited evidence for other countries.

However this literature seems not to adequately investigate the role of different institutional arrangements of the public sector on redistribution and risk sharing. In particular, in the countries with a multi-level government structure territorial jurisdictions are interconnected in terms of financial flows by the way of different schemes of transfers generally involving the Central government budget and are aimed both to transfer resources between different levels of government and to reduce fiscal disparities between regions. The risk sharing and redistributive properties of those components should be distinctively considered.

This perspective is developed in this paper with reference to the case of Italy, that is a country where the public sector institutional structure is particularly complex and the inter-governmental relations are ruled by a number of different tax-sharing and grant arrangements. Moreover, Italian regions are characterized by stark contrasts in terms of dimension, population structure and level of economic development and by a distinctive polarization between northern and southern areas. Finally, during the last decade the Italian system of intergovernmental fiscal relations has been involved in a radical process of reform that is still under way. Therefore, there is a scope for analyzing whether these reforms have affected the risk sharing and redistributive properties of the public budget.

This paper is organized as follows. Section 2 reviews the relevant literature and critically discusses the limits of the existing studies. Section 3 sketches the main features of the Italian institutional framework with particular reference to the system of inter-governmental fiscal relations. The data are presented in Section 4 whereas Section 5 discusses the specification of the econometric model used to derive a summary measure of the redistribution and risk sharing accomplished by the fiscal system. The results of the estimations are presented in Section 6. Section 7 concludes.

2. Literature review

The extent of redistribution and stabilisation – or risk sharing – across regions accomplished by the fiscal system has been analysed by a number of empirical works, initially concerned with the degree of income equalization and smoothing in the framework of currency unions. Early studies focused on the United States and Canada (Sala-i-Martin and Sachs, 1992; Von Hagen, 1992; Goodhart and Smith, 1993; Bayoumi and Masson, 1995; Asdrubali et al., 1996). Later, the concern for future prospects of EMU member states fostered comparative studies on European countries, such as Germany, France, United Kingdom, Italy and Sweden, and between some of these countries and the United States or Canada (Decressin, 2002; Dedola et al., 1999; Italianer and Pisany-Ferry, 1992; Melitz and Zumer, 2002; Obstfeld and Peri, 1998).

The first wave of empirical studies raised a number of methodological issues as they reached quite contrasting results on the degree of redistribution and stabilisation in the United States despite a fairly similar econometric strategy. Estimates of stabilisation

across States in the United States range from 10-15% (Von Hagen, 1992; Italianer and Pisani-Ferri, 1992; Asdrubali et al., 1996; Mélitz and Zumer, 1998) to 30-40% (Sala-i-Martin and Sachs, 1992; Bayoumi and Masson, 1995). Mélitz and Zumer (2002) argued that these discrepancies can be due to the different accounting criteria adopted to select the data used in the regression analysis. Essentially all studies regress a regional “activity” variable (output or income) after net transfers from the public sector on the same regional variable before net transfers. The first crucial choice concerns the “activity” variable, which is in some cases measured by personal income while in others is taken to be equal to gross product. The latter is obviously more comprehensive as it includes items (e.g. depreciation) which are not covered by the definition of personal income. The second option relates to the definition of net transfers from the public sector. Again, the choice is between “narrow” measures, that associate net transfers just with direct taxes and money transfers to households, and “wider” measures that may include transfers in kind, public consumption and investments. As further illustrated by Melitz (2004), different choices on the two above-mentioned criteria significantly influence the estimated size of redistribution and risk sharing. Specifically, the combination of a “narrow” measure of net transfers (e.g. money transfers net of taxes) and of a “wide” measure of regional activity (e.g. gross product) leads to underestimate the degree of stabilisation, whereas the opposite combination may bring about an overestimation. From these remarks it follows that it is critical to choose the criteria in a consistent manner: a narrow (wide) measure of regional activity must be coupled with a narrow (wide) measure of net transfers.

As to the measure of net governmental transfers, Decressin (2002) has convincingly argued that the public sector impact cannot be adequately captured by direct taxes and money transfers alone. A relevant component of redistribution and stabilisation carried out by the public sector comes from transfers in kind, public consumption and investments. Therefore we follow Decressin (2002) in defining the measure of net transfers by a specific level of government as the difference between total public expenditures (net of public debt interests and of all transfers to other levels of government) and total revenues (net of all transfers from other levels of government).¹ Having adopted a “wide” notion of net transfers, we refer consistently to GDP as the measure of economic activity.

Beside the measurement of the overall impact of public policies, the literature has investigated the differential role played by specific instruments (direct taxes, social insurance, transfers and grants) in redistribution and risk sharing across regions. The studies which focus on direct taxes and money transfers usually find that redistribution is mainly driven by direct taxation while social insurance, transfers and grants play a minor or negligible role (Sala-i-Martin and Sachs, 1992; Von Hagen, 1992; Bayoumi and Masson, 1995). A noteworthy exception is Melitz and Zumer (2002) that find the opposite result by analysing the United States and Canadian data. Decressin (2002), that applies a broader definition of net government transfers by taking into account public consumption and investment as well as subsidies to firms and indirect taxes, shows that

¹ Interest expenditures on public debt have been excluded in order to obtain comparable results with the existing literature, which usually do not apportion interest expenditures on a regional basis given the arbitrariness of the criteria used.

in Italy most of inter-regional redistribution is brought about by public expenditure, while the estimated contribution of revenue to redistribution seems to be modest.

The results are rather mixed as to the composition of the stabilisation effect. Sala-i-Martin and Sachs (1992) and Von Hagen (1992) based on US data, and Andersson (2004) referred to Sweden, find that most of income smoothing across regions is due to the tax system while the role of transfers is minor. In contrast, Bayoumi and Masson (1995) and Melitz and Zumer (2002) provide evidence, based on US and Canadian data, that transfers are the largest component in stabilisation. With reference to Italy Decressin (2002) finds an even different picture where public consumption plays the most important role in risk sharing and, in contrast with the rest of the literature, fiscal revenues (and also public investment) amplify the effects of regional shocks on economic activity.

However the existing literature seems to suffer a major drawback in so far it fails to adequately investigate an important institutional profile: the role of the different tiers of government in providing inter-regional redistribution and risk sharing. This is somewhat surprising as some of the existing studies suggest that the distribution of powers among different layers of government may be relevant for the amount of fiscal flow that takes place for risk-sharing purposes (Bayoumi and Masson, 1995; Andersson, 2004). Regional and Local governments taxes and expenditures are clearly irrelevant for assessing inter-regional redistribution and risk sharing when each single government has an autonomous budget. Yet, in most countries the budget of these governments are interdependent by the way of different schemes of transfers which in general involve the Central government budget but sometimes are directly connect different units within each of the levels of government. In this framework public policies implemented by Regional and sub-regional governments may have an inter-regional dimension.

This point is partially acknowledged by Buettner (2002) that analyses the income smoothing effect of the German system of fiscal equalization across Western German States (Länder). He finds that almost half of the risk sharing accomplished by the public sector is due to the transfers carried out by the system of fiscal equalization. However, we do not find the approach by Buettner entirely satisfactory for two reasons. First, the distinction between own taxes, tax sharing and transfers in the budget of sub-regional governments is not really relevant if the aim is to measure the amount of resources which are transferred from one region to another. For example, consider a country where sub-national governments do not have any taxing power and are entirely financed by transfers from the Central government. If a tax is devolved to them by the Central government with a reduction in transfers which exactly matches the yield of the newly introduced tax, region by region, there will be no real change in the allocation of resource across territories. Second, there is an important difference, which is overlooked in Buettner's paper, between inter-regional flows aimed to offsetting respectively vertical or horizontal fiscal imbalances. Vertical fiscal imbalance refers to the difference between expenditures and revenues at different layers of government; hence transfers usually from the Central government fill an overall fiscal imbalance at the sub-national level of government. On the contrary, horizontal fiscal imbalance refers to the differences between revenues and expenditures levels by different regions within a particular tier of government. In the latter case the transfers operate even if such level of government is balanced budget in the aggregate.

Vertical and horizontal imbalances are addressed by different policy instruments in different countries. In few cases (as in Germany) each imbalance is corrected by separate policy measures: the vertical imbalance is resolved by tax-sharing or grants arrangements from the centre, whereas horizontal imbalances are resolved by transfers from regions with higher fiscal capacity to poorer regions. More frequently (as in Australia, Canada and Italy) both vertical and horizontal imbalances are dealt with simultaneously through an integrated system of equalization transfers from the Central government. In these cases a transfer from the Central government to sub-national governments can be always broken up into a vertical component, which allows to reach the desired total amount of resources for the sub-national governments in the aggregate, and an horizontal one, which redistributes across sub-national jurisdictions.

For these reasons we follow a different approach. First, we provide a breakdown of public intervention by calculating regional fiscal residua referred to expenditures and fiscal revenues distinctively implemented by each level of government. Then, we break down these inter-regional fiscal flows into a vertical and an horizontal component and we measure the role of each component in providing redistribution and risk sharing across regions.

3. The Italian institutional framework

Italy is a unitary country with strong attributes in terms of territorial and functional decentralization, at least on the side of the expenditure tasks. Public sector in Italy is organized into three main layers of territorial government (Central government, Regional governments, which include Regions and Local health firms, and Local governments, which include Provinces plus Municipalities) and the Social security system, which operates mandatory pensions and unemployment insurance on a nationwide jurisdiction. In particular, sub-national governments includes 15 Ordinary Statute Regions, 5 Special Statute Regions, 102 Provinces, and more than 8,000 Municipalities ranging in size from a small village to a large city.

Italy is a country marked by stark structural and economic contrasts across different areas. Table 1 shows that regional territories greatly differ in terms of extension (a relevant feature for economies of scale in public productions) and both density and age structure of the population (in Southern regions the population is substantially younger than in Northern ones with obvious impacts on health care and pension expenditures). On the ground of economic development, regional disparities are considerably more pronounced than in other European countries (Sinn 2001). Moving from northern to southern areas, GDP in per-capita terms reduces to a half and this obviously implies large disparities in fiscal capacity. This marked north-south dualism explains, inter alia, the particular emphasis put on redistributive issues across the country in the Italian political debate.

Given the articulated structure of public sector in Italy, it is not easy to describe the assignment of expenditure responsibilities and taxing powers across the above-mentioned levels of government and the financial relations across those layers. A summary outlook can be given by Table 2 which reports revenues, expenditures and deficits of General government and its main components (Central government, Sub-

national governments, Social security institutions) in 2002.² In Italy the size of the public sector is, in an international comparison, quite large. When figures including inter-governmental transfers are considered, the Table shows that little short of half of both expenditures and revenues can be imputed to Central government whereas the other half is roughly equally shared between sub-national governments and Social security institutions. Budgets for all the levels of governments are near to be balanced. However, when inter-governmental transfers are netted out, the general picture dramatically changes. Sub-national governments and Social security institutions clearly shows their expenditures greatly exceeding own revenues (by respectively 5.7 and 4.0 in terms of GDP)³, whereas the opposite happens for the Central government. This means that the vertical fiscal imbalance affecting Sub-national governments and Social security institutions is substantially filled by the inter-governmental transfers flowing from Central government with the consequence that, in this way, the formation of fiscal deficit is almost completely centralized. Moreover, given the absence in Italy of any explicit scheme of transfers directly linking different jurisdictions at the same sub-national level of government (Regions, Provinces or Municipalities), transfers from the centre also aim at reducing horizontal fiscal imbalances across regions at any level of government.

Some additional details about the inter-governmental fiscal relations in Italy are given by Table 3 which reports the percentage composition of public expenditures financing (gross of inter-governmental transfers) by different fiscal instruments (taxes, social security contributions, transfers, others revenues, deficit) for each level of government. With reference to total revenues of sub-national governments (Regions, Provinces and Municipalities) and of Social security institutions, this Table provides evidence that the share of grants from other levels of government still remains relevant even after the massive decentralization process promoted by the reforms implemented in the nineties.⁴ Moreover, it is clear the limited degree of Local governments hierarchical dependency from the Regional level: the bulk of transfers that Provinces and Municipalities receive stems directly from Central government.

When assessing the role of fiscal system in providing inter-regional redistribution and risk-sharing, it should be stressed that the inter-governmental grants paid by the Central government at least partially result from the operation of equalizing mechanisms. Basically fiscal equalization, both in the case of Regions and of Local governments, consists in redistributing the yield stemming from central taxes in order to fill for each Region and Municipality the gap between expenditures needs and own tax capacity. The relevant role of inter-governmental transfers may suggest to investigate the role of public budget to redistribution and income smoothing by looking directly at taxes, contributions and expenditures levied/carried out by the Central government and the Social security institutions (which operate on a supra-regional jurisdiction) together with the inter-governmental transfers (Buettner 2002). Nonetheless this approach would yield to misleading results, as explained in Section 3, since a number of reforms

² Data are for 2002 since this is the last year in the data-set used in the empirical Section of this paper.

³ Note, however, that the reforms of the financing mechanisms of Regions and Municipalities adopted during the nineties have almost halved in size this vertical fiscal gap between expenditures and own revenues.

⁴ See Arachi and Zanardi (2004).

implemented in Italy in recent years have replaced transfers from the Central government with own taxes (or contributions) assigned to sub-national governments or to the institutions of the pension system. Thus, we will look to the budgets of each single level of government, by considering corresponding revenues and expenditures net of all transfers received from/payed to other levels of government, and will recover the actual “vertical” and “horizontal” flows across regions through the methodology which will be presented in Section 4.

4. The data

Following Decressin (2002) redistribution and risk sharing provided by each tier of government can be evaluated by analyzing fiscal residua. As mentioned before, the fiscal residuum is defined as the difference between total public expenditures of a specific tier of government (net of public debt interests and of all transfers to other levels of government) and total revenues (net of all transfers from other levels of government). A positive residuum means that the residents in a given jurisdiction benefits from resources from the rest of the economy (the expenditures paid out in that jurisdiction exceed the revenues collected from its residents), whereas a territory that gives up part of its resources to finance expenditures of other jurisdictions displays a negative residuum.

The dataset is taken from the Territorial public accounts (*Conti pubblici territoriali*) produced by the Italian Ministry of Economy. These data provide the allocation of revenues and expenditure flows collected/paid by each level of government (Central government, Regional government, Local government, Social security institutions) included in the General government among 20 Italian Regions for the period 1996-2002.

Beside the time period there are two main differences between the dataset used in this paper and the one analysed by Decressin (2002). The first regards the criteria used to regionalize revenues and expenditures pertaining to each tier of government. In the dataset used by Decressin the expenditure of Central government and Social security institutions is regionalized essentially according to the territorial location of payments to the means of production used for the provision of public services and investments (e.g. for education essentially teachers' compensations and cost of buildings). This criterion is inconsistent with our aim to evaluate the effect of net transfers on the individuals living in a certain jurisdiction since the location of means of production does not always coincide with the location of benefits stemming from public expenditures programs. This is true, in particular, for pure national public goods (e.g. defence), which may be produced in a specific area, but nonetheless benefit in principle all citizens equally, irrespective of their jurisdiction of residence. A similar problem raises in the case of the regionalisation criteria adopted by the Territorial Public Accounts with reference to the expenditures of Regional governments, particularly in the health care sector (which represents nearly 80% of total expenditure of Regional governments). These financial flows are entirely attributed to the jurisdiction corresponding to the Regional government responsible for the expenditure (where health services are provided), irrespective of where the beneficiaries of the health services provided actually reside. The result may be potentially misleading given the high inter-regional mobility of National Health Service patients. For all these reasons, we partially revised the data

from Territorial Public Accounts to provide a dataset which is suitable for our purposes. Details are provided in the appendix.

A second difference is that the Territorial Public Accounts record actual cash flows while the Accounts for public administrations used by Decressin (2002) are compiled on an accrual basis. By definition there can not be a systematic divergence between the values of the fiscal residuum calculated on a cash flow or a accrual basis: if in year t the fiscal residuum on a cash flow basis is higher than the one calculated on an accrual basis there will be in the future a year $t+n$ where the opposite will occur. As a consequence average values over a sufficient long period of time cannot differ significantly. This implies, for reasons that will be apparent in the next Section, that the difference between the two accounting standards should not affect the estimates of the inter-regional redistribution carried out by the public sector. It may be relevant, in contrast, in the estimation of the stabilisation effect where annual changes of the fiscal residua come into play. We cannot provide a direct measure of the differences as the two series do not overlap. However, the data available for the Italian general government suggest that they may be significant: Bank of Italy has calculated that in the period 1998-2005 the difference between the budget-deficit calculated on an accrual basis and the deficit calculated on the basis of actual cash-flows has been close or higher than 0.5% of GDP in five years. In this framework we believe that our data are better suited to measure risk sharing as they reflect actual (not just accrued like in Decressin 2002) cash-flows among territories.

We generate two different series. In the first one the fiscal residuum is calculated for each tier of government by taking the difference between its total public expenditures (net of public debt interests and of all transfers to other levels of government) and its total revenues (net of all transfers from other levels of government). Average values for the period 1996-2002 in per-capita terms are reported in Table 4. The General government as a whole displays a significant primary surplus, amounting to 825 euro per-capita. This surplus is due to the above discussed exclusion of interest on public debt from our definition of public expenditures. General government surplus results from the combination of the considerable surplus of Central government (about 3.500 euro per-capita) and the deficits of all other tiers of government (Regional government, Local government, Social security institutions). This peculiar pattern of fiscal residua clearly shows the most relevant characteristic of the Italian system of inter-governmental relations already stressed in Section 3: notwithstanding the decentralisation process experienced in the last decade, most of the public revenues are collected by Central government and subsequently assigned to the other tiers of government through different systems of inter-governmental transfers. The comparison of fiscal residua across regional jurisdictions gives a preliminary picture of the main patterns characterizing the inter-regional fiscal flows in Italy. The first one is the strong redistribution from the wealthy jurisdictions to the poor ones (with per-capita GDP respectively above/below national average). Moreover, the size of fiscal residua seems to some extent to be correlated to territorial extension of single jurisdictions: fiscal residua are generally higher in smaller regions (Liguria, Umbria, Marche, Molise,

⁶ On the base of Ravn and Uhlig (2002) and Maravall and del Rio (2001) we set the penalty parameter equal to 7.

Basilicata). Finally, sizeable financial transfers occur from Ordinary Statute Regions to Special Statute Regions (Valle d'Aosta, Trentino Alto Adige, Friuli Venezia Giulia, Sicilia, Sardegna) irrespective of their level of GDP.

The second series generated here refers to the distinction between “horizontal” and “vertical” financial flows, which is a key feature of our analysis. As mentioned in Section 2, “horizontal” flows take place across territories within each single level of government. On the contrary, “vertical” flows result from transfers across territories through different levels of government (primarily from Central government). In order to separate “horizontal” from “vertical” financial flows the following approach has been applied. “Horizontal” flows have been isolated by reducing (or increasing) the original fiscal residua as to reach a nationwide balanced budget for each tier of government. In practice this means that Central government fiscal residua have been reduced in order to cancel out the overall surplus while fiscal residua of Regional, Local governments and Social security have been increased to eliminate their overall deficits. In particular, as far as Central government is concerned, the revenues corresponding to each region have been proportionally reduced so that total revenues equal total expenditures for the aggregate of the 20 regional territories. The ensuing new residua represent the horizontal flows of resources resulting from public policies implemented by Central government, net of resources collected and then transferred to other levels of government. Formally, let T_C^i and G_C^i respectively Central government fiscal revenue and expenditure in region i . The corresponding fiscal residuum is defined as:

$$R_C^i = G_C^i - T_C^i$$

The fiscal residua that measure horizontal flows through the Central government are defined then as:

$$RH_C^i = G_C^i - \alpha T_C^i$$

$$\text{where } \alpha = \frac{\sum_{i=1}^{20} G_C^i}{\sum_{i=1}^{20} T_C^i}.$$

As to the remaining tiers of government, which benefit from transfers from the Central government, the procedure is the reverse. In order to isolate the redistribution (and risk-sharing) resulting from the public programmes that these levels of government can autonomously finance, their expenditures have been reduced so to achieve a balanced budget over the sum of the 20 regions. The new residua for government level j are defined as:

$$RH_j^i = \beta_j G_j^i - T_j^i$$

$$\text{where } \beta_j = \frac{\sum_{i=1}^{20} T_j^i}{\sum_{i=1}^{20} G_j^i}.$$

Finally we defined the fiscal residua due to “vertical” flows as those associated with the portion of expenditure programs that sub-national governments and Social Security institutions finance by means of revenue collected by the Central government. Therefore, in this case fiscal residua RV^i are given by the difference between, on the one hand, the total amount of expenditures taken off from the budget of sub-national governments and, on the other hand, the total amount of reductions applied to Central government revenues in order to isolate “horizontal” flows:

$$RV^i = \sum_j (1 - \beta_j) G_j^i - (1 - \alpha) T_C^i.$$

Table 5 reports the results from this analysis. When considering “horizontal” flows alone, data show a strong redistributive impact of Central government: apart from Lazio, all regions with above-average GDP transfer resources to regions whose GDP is below the average. Evidence of horizontal redistribution emerges even in the case of Regional governments and Local governments. The horizontal redistribution by Social Security institutions results to be extremely polarised, with only 5 financing regions. Finally, the last column of Table 5 shows that a relevant part of inter-regional redistribution results from those fiscal policies managed by sub-national governments and Social Security institutions but financed by Central government transfers.

5. *Econometric model specification*

In the existing literature redistribution is usually related to public programs aiming at offsetting long-run regional income differentials, whereas stabilisation refers to public policies providing short-term relief from cyclical and asymmetric shocks. We believe that this partition may be useful for analysing the effect of public policy, despite its theoretical tenuousness, as redistribution may be simply seen as risk sharing over a longer time span (Obstfeld and Peri, 1998; Decressin, 2002, Varian 1978)

The literature has followed basically two approaches in the econometric specification. The first one, proposed by Obstfeld and Peri (1998) and implemented on Italian data by Decressin (2002), is based on the estimation of a bivariate VAR. The amount of redistribution is recovered from the estimated steady state relationship between the “activity” variable minus net transfers from the public sector (which will be denoted by y from now on) and the same regional variable gross of net transfers (denoted by x) while risk sharing is measured by the contemporary response of y to x or from the impulses responses of y and x (Decressin, 2002).

In the alternative approach the degree of redistribution and the degree of risk sharing are estimated separately with two different regressions.

With reference to redistribution, Von Hagen (1992) proposed to regress annual values of taxes and transfers in levels on annual values of incomes. However, a more common specification is the one suggested by Bayoumi and Masson (1995) that resorted to long-run average levels:

$$\overline{y}_i = \alpha_1 + \beta_1 \overline{x}_i + \eta_i \tag{1}$$

where overlined variables denote averages taken across time. The amount of redistribution is given by $1 - \beta_1$: a region with a 1 euro higher-than-average income or product x ends up with $1 - \beta_1$ euro higher-than-average disposable (i.e. plus net

transfers from the public sector), implying a redistribution on the order of $\beta_1\%$ of income or product.

Regarding the evaluation of stabilisation, a widely used functional specification is the one proposed by Von Hagen (1992):

$$\Delta y_{it} = \theta_i + \gamma_1 \cdot \Delta x_{it} + \varepsilon_{it} \quad (2)$$

where x_{it} and y_{it} refer to income or output of region i at time t , respectively before and after net public transfers, and Δ denotes first differences at time t . Melitz and Zumer (2002) showed that (2) is equivalent to

$$y_{it} - \bar{y}_i = \gamma_2 (x_{it} - \bar{x}_i) + v_{it} \quad (3)$$

when θ_i is equal to zero (where \bar{y} and \bar{x} denotes average values across time). Furthermore the same authors highlight that equations (1) and (3) can be summarised in one single equation yielding the same estimates for the relevant parameters:

$$y_{it} = \alpha_1 + \beta_1 \bar{x}_i + \gamma_2 (x_{it} - \bar{x}_i) + \zeta_{it} \quad (4)$$

As for redistribution, the degree of risk sharing will be measured by $1 - \gamma_1$ or $1 - \gamma_2$.

In this paper we follow this second approach. Thus we separately estimate redistribution and stabilization. However we believe that the specification based on (1) and (2) or (3) is not entirely satisfactory when analysing data, like those in our dataset, which display regional trends. To illustrate this point, we first formally define our variables. As explained in Section 2 we take a broad measure of economic activity, namely regional per-capita GDP. To wash out the effect of national evolutions we standardize all variables by dividing for countrywide values. Therefore we have:

$$x_{it} = \frac{X_{it}}{\sum_{i=1}^{20} X_{it}}, \quad y_{it} = \frac{Y_{it}}{\sum_{i=1}^{20} Y_{it}}$$

where X_{it} is the per-capita GDP in region i and year t , while Y_{it} , is given by X_{it} plus the fiscal residuum.

Figure 1a shows the values of x for the largest northern region, Lombardia. On average over the estimation period per-capita GDP in Lombardia was 30% higher than the national mean. However, this variable displays a neat downward trend. Figure 1b shows the same data for a large southern region, Campania. Here we get the reverse picture: per-capita GDP is on average 35% lower than the national mean but is characterized by a neat upward trend. In both cases there is no reason to pick-up the average as the reference point for distinguishing between redistribution and risk sharing as there is no evidence that regional GDP would converge to that value in the long run. For this reason we propose a variant of the Melitz and Zumer (2002) approach where in equations (1) and (3) the averages of y and x are substituted by their trends. In order to isolate the trend and the cyclical component we applied the Hodrick and Prescott (1997) filter, region by region, both to the x and to the y series.⁶ Then we run the following two regressions to estimate respectively the redistributive and risk sharing effects of public intervention:

$$\tilde{y}_{it} = \alpha_2 + \beta_2 \tilde{x}_{it} + \mu_{it} \quad (5)$$

$$y_{it} - \tilde{y}_{it} = \gamma_3 (x_{it} - \tilde{x}_{it}) + v_{it} \quad (6)$$

where trend components are denoted by tildes. As for equation (1) and (3), these two equations may be summarised in one single equation:

$$y_{it} = \alpha_2 + \beta_2 \tilde{x}_i + \gamma_3 (x_{it} - \tilde{x}_i) + \xi_{it} \quad (7)$$

6. Results

The regression results are shown in Table 6. The upper part reports the coefficients estimated when fiscal residua are calculated without separating “vertical” from “horizontal” flows of resources (see Table 4). The lower part presents the regression results when “horizontal” and “vertical” flows have been distinguished and the fiscal residua are those described in Table 5. In order to measure the impact of each tier of government, various regressions have been run – adopting both definitions of fiscal residua – starting with one level of government (Central government) and then sequentially adding to the dependent variable the fiscal residuum of an additional level of government. We also provide a decomposition of the fiscal residua by considering first, as endogenous variable, per-capita GDP minus revenue and subsequently per-capita GDP minus revenue plus expenditure (i.e. per-capita GDP plus the fiscal residuum).

6.1 Redistribution

Columns (1) and (2) of Table 6 show the degree of inter-regional redistribution measured by estimating equation (5) through OLS. Results from the estimation of equation (1) are omitted as they are not significantly different.

The estimates for inter-regional redistribution carried out by the General government as a whole equals to 27.6% of GDP (column 2, row 4) which is remarkably similar to the value of 24.5% found by Decressin (2002) for the period 1983-1992 using specification (1). The dataset used in this paper allows to extend Decressin’s analysis by isolating the contribution of each tier of government to total redistribution carried out by the General government. The first row in column (2) reports the value of the estimated coefficient when the dependent variable is per-capita GDP plus the Central government fiscal residuum. Therefore, this coefficient provides a measure of the degree of redistribution attained by this level of government alone. In the second row the Regional government fiscal residuum has been added to the dependent variable. The difference between the coefficient in the first and that one in the second row measures the redistributive effect of policies by the Regional government. Adding one by one the fiscal residua of the additional tiers of government, the redistribution by Local government and Social Security can be measured.

Examining first the upper part of the Table (where “horizontal” and “vertical” flows are jointly considered), the estimated coefficients show that all levels of government but the Regions positively contribute to income redistribution. As a matter of fact, the estimated value of $1 - \beta_2$ raises when both the Local governments and the Social security fiscal residua are added in turn, suggesting that these layers of government redistribute income across territories, whereas the coefficient falls as the fiscal residuum of the Regional governments is added, implying that the overall impact of Regional government intervention is regressive. However, the contributions of those levels of government are rather limited. Most of the redistribution is due to Central government: this level alone redistributes 25.7% of per-capita GDP.

Turning to fiscal residua calculated by separating “horizontal” from “vertical” flows (lower part of Table 6), OLS estimates show that most of inter-regional redistribution is accomplished through “horizontal” flows, which redistribute 25.1% of GDP. “Vertical” flows account for only 2.5% of GDP (that is the difference between the “horizontal”

flows contribution and the overall redistribution carried over by the General government), which corresponds to about 9% of the total redistributive effect. When the single levels of government are distinctively considered, the effects of “horizontal” flows are not significantly different from the case of total flows (“vertical” plus “horizontal”): most of the inter-regional redistribution results from the policies of the Central government which redistributes 19.4% of GDP. Again, Local governments and Social security institutions play a limited role and Regional governments policies are somewhat regressive.

Further insights may be provided by the analysis of the relative contribution of revenues and expenditures to inter-regional redistribution. Column (1) reports the coefficients estimated when the endogenous variable is defined by per-capita GDP minus revenues. Those coefficients provide a measure of the redistributive impact of taxes and contributions levied by the different layers of government. The difference, row by row, between the values of column (1) and those in column (2) measures of the redistribution brought about by public expenditures. The inspection of the upper part of Table 6 shows that taxes and contributions levied by the Central government (row 1) play a limited role (5.9% of GDP) in redistributing resources across territories. The bulk of the redistribution carried out by Central government is accomplished by public expenditures. Revenues always contribute positively to redistribution at each level of government. In contrast the redistributive impact of expenditures by the other layers of government different from the Central one results rather limited, or even regressive as in the case of Regional governments.

These remarks may help to interpret the results reported in the lower part of Table 6. Recollect that the inter-regional “horizontal” flows enacted by the Central government have been identified through a proportional reduction of revenues accruing to that level of government, as illustrated in Section 4. This explains why the degree of redistribution attributed to taxes and contributions levied by the Central government is more than halved, from 5.9% in row (1) to 2.3% in row (5), when “horizontal” flows are considered in isolation. The same argument accounts for the fact that the overall redistributive impact of the Central government (and, eventually, of the General government) remains high when the focus is on “horizontal” flows (row 5 column 2): the main redistributive component of public policies (i.e. expenditures) is still entirely included in the fiscal residuum.

The result that public expenditure is a relevant channel for inter-regional redistribution in Italy is in line with the findings of Decressin (2002). What is novel in our analysis is the evidence of a strong role played by taxes and contributions (15.4% of GDP), especially when levied by Regional and Local governments and by Social security institutions, and the regressive effect of public expenditure managed by Regional governments.

6.2 Risk sharing

Columns from (3) to (8) of Table 6 report the estimated coefficients under the three different specifications discussed in Section 5. The Melitz and Zumer (2002) approach, based on equation (3) yields an estimate for the overall degree of risk sharing provided by the General government equal to 35.4% which is considerably higher than the values derived by Decressin (2002), which range from 8% to 15% for the period 1983-1992. However, the most interesting result is that the other two specifications lead to the

opposite conclusion. The fixed effect estimate of equation (2) gives a value of γ_1 greater than one, implying that public intervention has an overall pro-cyclical effect on the economy. The size of the effect is even more surprising: idiosyncratic shocks are amplified by about 40%. The OLS estimate of equation (6) confirm the pro-cyclical impact of public policies even if the measure of the effect is smaller, around 30%.

The reason for such a striking variance in the estimates is to be found in the trends in regional variables discussed above. As explained in Section 5, with no regional trends in the data, equation (3) and (2) would yield the same estimates, while if the data show regional trends equation (3) is mis-specified and the estimates are biased. It is worth emphasising this point as Melitz and Zumer (2002) strongly argued that “[...] that employing levels or first differences makes no difference at all” and provided supporting evidence based on data for the U.S., Canada, France and U.K. Melitz and Zumer may have reached a conclusion opposite from that of this paper probably due to the different time span of the sample. They use data which contains observations for at least 16 years. Given that x and y have been normalized to the national values it is unlikely that they may display regional trends over a long period of time. As a matter of fact the relevance of the treatment of regional trends when the time dimension is small can be also shown using the evidence provided by Decressin (2002) which considers a 9 year-long dataset. Using equation (3) Decressin estimates a degree of risk sharing equal to 13.3%. The value drops to 8% when he allows for regional trends through the estimation of equation (2). Once stressed that regional trends must be taken into account for the analysis of our dataset, we now focus on the specification given by equation (6) which, for the reasons discussed in Section 5, provides a better identification of the stabilization effect of public policies over the business cycle.

First of all we may remark that the comparison between columns (7) and (8) shows that the pro-cyclical behaviour of the General government fiscal residua stems from the dynamics of revenue: the estimated coefficient in row (4) falls from -45.7% to -30.2% when public expenditures are added to the per-capita GDP minus revenue. This result confirms the results by Decressin (2002) who provide evidence of a pro-cyclical effect of taxes and contributions, even if on a smaller scale than derived here.

The breakdown of stabilization effects across different layers of government (upper part of Table 6) shows that Central government and Social security institutions follow the same pattern as the General government, i.e. strongly pro-cyclical revenues and mildly counter-cyclical expenditures, while Regional and Local governments show the opposite behaviour by providing insurance through taxes and amplifying regional shocks (in the case of Regions) through their expenditures.

The overall picture is rather complex and it is not easy to find a consistent explanation for all these findings. One reason for the pro-cyclical effect of General government revenue may be the limited share of direct taxation in Italy, which accounts for just one third of total revenues. The other two main sources of revenues, indirect taxes and social contributions, are not directly correlated with income (hence they may remain fairly stable after a shock) and somewhat regressive. It is more difficult to provide a rationale for the risk sharing provided by Regional and Local governments' revenues. The case of Local governments is particularly puzzling as the taxes levied by this level of government are essentially on wealth (the main one is ICI – a municipal tax on real estate), and their base is relatively unaffected by the economic cycle. As for Regional governments some insights about the revenue dynamics can be given by the reforms

implemented in the period 1996-2002 which assigned this level of government new taxes (mainly IRAP, a value-added business tax) and introduced a new system of inter-regional transfers (Arachi and Zanardi 2004). The last surprising result to be explained is the strong pro-cyclical impact of expenditures by the Regional governments. Regions spend about 80% of their budget in financing the National Health System. In principle, health expenditure should be unrelated to the cyclical component of regional GDP providing some insurance against idiosyncratic shocks. One way to reconcile theory and empirical evidence may be to consider the several attempts made by the Italian government in recent years to curb health expenditure. These measures may have hit Regions asymmetrically with the probable outcome of emphasising negative shocks. The lower part of Table 6 highlights the relative contribution of “horizontal” and “vertical” flows. While redistribution is mainly driven by “horizontal” flows, “vertical” flows play the main role in the risk sharing analysis. These are highly pro-cyclical as they are represented by fiscal residua computed as the difference between a share of public expenditure of Regional and Local government and Social security (the first pro-cyclical, the latter counter-cyclical) and a share of Central government revenue (highly pro-cyclical).

7. Conclusions

The aim of this paper is to measure redistribution and risk sharing across Italian regional jurisdictions as carried out by the public sector. In this analysis the multi-level structure of the Italian government and the financial relations (in terms of tax-sharing and grant arrangements) which link the different layers of government are explicitly considered. This allows to break down the redistributive and income-smoothing effects of public policies according to the institutional units that those policies have accomplished.

Using panel data for the period 1996-2002 we found that taxes and expenditures in Italy significantly reduce differences in per-capita GDP across regional jurisdictions: a region with 1 euro higher(lower)-than-average per-capita GDP ends up, after public intervention, with about 72% higher(lower)-than-average per-capita GDP. Most of the redistributive impact is due to Central government, while the contribution of Local government and Social security institutions is minor, or even, in the case of Regions regressive. “Horizontal” flows of resources across territories, brought about by just one level of government, accounts for about 90% of total redistribution. Just 10% is due to “vertical” flows, that is expenditures by sub-national governments financed by transfers from the Central government. As for the relative effects of specific fiscal instruments, the bulk of the redistribution can be ascribed to public expenditures carried out by the Central government, whereas public spending of the other levels of government results to be roughly distributionally-neutral or even regressive. Relative to the total redistribution accomplished by each level of government public revenues plays a role much stronger in the case of Regional and Local governments and Social security institutions than in that of Central government.

As for risk sharing, our findings show that public budget in Italy has no smoothing effects on regional economies hit by asymmetric, region-specific shocks, but on the contrary public policies greatly emphasize the variance of annual GDP across regions by about 30.2%. This pro-cyclical effect is mainly driven by the revenues of the Central government, that is only partially offset by the income-smoothing behaviour of

expenditures by Social Security expenditures. The role played by Regional and Local government is, even if in opposite directions, rather limited. Finally, our estimates point out a sharp contrast between the risk sharing properties of “horizontal” and “vertical” flows. Whereas the effects of the former are relatively minor and counter-cyclical, the impact of the latter is prominent and strongly pro-cyclical.

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Table 1: Regional indicators (2002)

Regional territories	Surface (Sq km)	Population	Population density	Population <15 years (%)	Population >64 years (%)	GDP (millions of euro)	Per-capita GDP (thousands of euro)	Per-capita GDP (index)
Piemonte (a)	25,399	4,270,215	168	12.0	21.3	106,200	24.9	1.14
Valle d'Aosta (a)	3,262	122,040	37	12.9	19.5	3,374	27.6	1.27
Lombardia (a)	23,857	9,246,796	388	13.2	18.2	255,086	27.6	1.27
Trentino-Alto Adige (a)	13,619	962,464	71	16.0	17.1	27,284	28.3	1.30
Veneto (a)	18,364	4,642,899	253	13.5	18.3	112,520	24.2	1.11
Friuli-Venezia Giulia (a)	7,845	1,198,187	153	11.4	21.6	29,683	24.8	1.14
Liguria (a)	5,416	1,577,474	291	10.6	25.4	37,855	24.0	1.10
Emilia Romagna (a)	22,123	4,080,479	184	11.6	22.3	110,659	27.1	1.25
Toscana (b)	22,992	3,566,071	155	11.7	22.3	84,942	23.8	1.09
Umbria (b)	8,456	848,022	100	12.3	22.6	17,458	20.6	0.95
Marche (b)	9,694	1,504,827	155	12.9	21.8	32,364	21.5	0.99
Lazio (b)	17,203	5,205,139	303	14.1	17.7	130,012	25.0	1.15
Abruzzo (b)	10,794	1,285,896	119	13.9	20.5	23,753	18.5	0.85
Molise (c)	4,438	321,697	72	14.2	21.4	5,512	17.1	0.79
Campania (c)	13,595	5,760,353	424	18.7	14.2	84,597	14.7	0.68
Puglia (c)	19,348	4,040,990	209	16.8	15.8	60,057	14.9	0.68
Basilicata (c)	9,992	597,000	60	15.7	18.7	9,261	15.5	0.71
Calabria (c)	15,080	2,011,338	133	16.7	17.2	27,752	13.8	0.63
Sicilia (c)	25,708	5,003,262	195	17.4	16.7	73,475	14.7	0.67
Sardegna (c)	24,090	1,643,096	68	13.9	16.1	27,594	16.8	0.77
<i>(a) Northern Italy</i>	119,885	26,100,544	22	12.8	20.2	682,660	26.2	1.20
<i>(b) Central Italy</i>	69,139	11,124,059	161	13.1	20.4	288,528	25.9	1.19
<i>(c) Southern Italy</i>	112,251	20,663,632	184	16.7	16.7	288,249	13.9	0.64
<i>Italy</i>	301,277	57,888,245	192	14.3	18.9	1,259,437	21.8	1.00

Source: Istat

Table 2: General government: expenditures, revenues and deficits by different levels of government (% GDP, 2002)

	General government	Central government		Sub-national governments		Social security institutions	
		gross of transfers from/to other public institutions	net of transfers from/to other public institutions	gross of transfers from/to other public institutions	net of transfers from/to other public institutions	gross of transfers from/to other public institutions	net of transfers from/to other public institutions
Total expenditures	47.4	27.4	16.9	14.7	14.7	16.1	15.9
Total revenues	44.5	24.4	24.2	13.9	8.1	17.1	12.4
Deficit	-2.8	-3.0	7.3	-0.8	-6.5	0.9	-3.5

Source: Istat - Conti ed aggregati economici delle Amministrazioni pubbliche, SEC95 series

Table 3: Public sector: financing of total expenditures by institutional levels (% total expenditures, 2001)

	Taxes	Social security contributions	Transfers from						Other revenues	Deficit
			(1)	(2)	(3)	(4)	(5)	(6)		
Central government (1)	78.3	0.2	0.0	0.5	0.0	0.0	0.0	0.1	10.7	10.2
Social security institutions (2)	0.0	70.1	27.4	0.0	0.0	0.0	0.0	0.4	2.0	0.0
Regions (3)	40.9	0.0	53.0	0.0	0.0	0.0	0.2	0.3	4.9	0.8
Local health firms (4)	0.0	0.0	0.0	0.0	90.2	0.0	0.2	0.3	8.3	1.1
Provinces and Municipalities (5)	28.5	0.0	21.9	0.0	13.2	0.0	0.0	1.3	33.5	1.6
Other public institutions (6)	3.6	0.2	52.0	4.7	12.6	0.0	3.4	5.1	18.6	-0.2
Duplicative items	0.0	0.0	57.7	1.2	33.5	0.0	0.6	1.6	5.5	-0.1
Public sector	58.3	23.6	24.2	0.5	14.0	0.0	0.2	0.7	11.5	6.6

Source: RGSEP, Vol. III, Tab. Appendice SP.1 (dati Ministero dell'Economia e delle Finanze)

Table 4: Fiscal residua for different levels of government (per-capita average values 1996-2002, euro 2002)

	GDP	General government	Central government	Regional government	Local government	Social security
Piemonte	25,206	-2,100	-4,671	678	495	1,397
Val D'Aosta	28,223	3,397	-5,682	6,046	1,421	1,612
Lombardia	28,239	-4,893	-6,430	806	264	466
Trentino Alto Adige	29,008	631	-5,604	4,581	1,298	356
Veneto	24,835	-2,841	-4,467	815	377	434
Friuli Venezia Giulia	25,078	-727	-4,519	1,534	659	1,599
Liguria	24,112	232	-4,131	955	583	2,824
Emilia Romagna	27,782	-3,180	-5,664	750	425	1,309
Toscana	24,290	-1,049	-4,107	857	589	1,612
Umbria	21,130	797	-2,865	799	945	1,918
Marche	21,999	-538	-3,330	929	565	1,298
Lazio	25,405	-2,252	-4,289	740	434	863
Abruzzo	18,816	779	-1,920	856	567	1,277
Molise	17,201	2,471	-897	1,363	718	1,287
Campania	14,838	1,927	-729	1,069	712	875
Puglia	14,941	1,689	-974	932	477	1,253
Basilicata	15,501	2,923	-286	1,299	891	1,018
Calabria	13,809	3,440	-106	1,514	711	1,321
Sicilia	14,797	2,846	-838	1,605	875	1,203
Sardegna	16,920	2,617	-1,377	1,894	924	1,176
<i>Italy</i>	<i>22,098</i>	<i>-825</i>	<i>-3,499</i>	<i>1,053</i>	<i>553</i>	<i>1,068</i>

Fiscal residuum = expenditure net of all transfers to other levels of government - revenue net of all transfers from other levels of government

Public expenditures exclude interest payments

Source: our calculations on Ministero dell'Economia e delle Finanze, Conti pubblici territoriali and Istat, Conti territoriali

Table 5: Vertical and horizontal flows in fiscal residua (per-capita average values 1996-2002, euro 2002)

	General government	Horizontal flows				Vertical flows
		Central government	Regional government	Local government	Social security	
Piemonte	-2,100	-673	-215	-18	136	-1330
Val D'Aosta	3,397	-1,287	1,363	547	290	2484
Lombardia	-4,893	-1,562	-187	-429	-703	-2012
Trentino Alto Adige	631	-1,262	1,288	350	-699	955
Veneto	-2,841	-615	-92	-89	-564	-1482
Friuli Venezia Giulia	-727	-481	246	9	240	-741
Liguria	232	-260	11	-83	1,327	-763
Emilia Romagna	-3,180	-1,119	-280	-176	-19	-1586
Toscana	-1,049	-335	-249	-30	367	-803
Umbria	797	353	-341	263	671	-148
Marche	-538	68	-91	9	176	-700
Lazio	-2,252	58	-136	-166	-546	-1462
Abruzzo	779	873	-36	101	299	-458
Molise	2,471	1,362	260	227	364	258
Campania	1,927	1,424	141	255	170	-63
Puglia	1,689	1,215	86	127	463	-204
Basilicata	2,923	1,713	155	355	229	471
Calabria	3,440	1,797	367	302	542	432
Sicilia	2,846	1,241	354	388	447	416
Sardegna	2,617	1,143	426	373	306	369
<i>Italy</i>	-825	0	0	0	0	-825

Fiscal residuum = expenditure net of all transfers to other levels of government - revenue net of all transfers from other levels of government

Public expenditures exclude interest payments

Source: our calculations on Ministero dell'Economia e delle Finanze, Conti pubblici territoriali and Istat, Conti territoriali

Table 6: Degree of redistribution and risk sharing through fiscal flows (1996–2002)

	<i>Redistribution</i>		<i>Risk sharing</i>					
	Eq. (5)		Eq. (3)		Eq. (2)		Eq. (6)	
	$1 - \beta_2$		$1 - \gamma_2$		$1 - \gamma_1$		$1 - \gamma_3$	
Number of observations	140		140		120		140	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Endogeneous variable	GDP minus revenue	GDP plus fiscal residuum	GDP minus revenue	GDP plus fiscal residuum	GDP minus revenue	GDP plus fiscal residuum	GDP minus revenue	GDP plus fiscal residuum
<i>Total flows ("horizontal" plus "vertical")</i>								
(1) Central government	0.059	0.257	-0.284	-0.040	-0.468	-0.338	-0.450	-0.341
	(0.009)	(0.007)	(0.032)	(0.055)	(0.075)	(0.103)	(0.061)	(0.084)
(2) (1)+Regional governments	0.079	0.210	-0.337	0.251	-0.288	-0.437	-0.176	-0.356
	(0.010)	(0.032)	(0.114)	(0.156)	(0.332)	(0.445)	(0.198)	(0.291)
(3) (2)+Local governments	0.105	0.232	-0.351	0.341	-0.266	-0.407	-0.109	-0.330
	(0.011)	(0.037)	(0.127)	(0.160)	(0.392)	(0.454)	(0.236)	(0.291)
(4) (3)+Social security inst.	0.154	0.276	-0.550	0.354	-0.724	-0.403	-0.457	-0.302
	(0.020)	(0.036)	(0.187)	(0.161)	(0.571)	(0.437)	(0.351)	(0.285)
<i>"Horizontal" flows</i>								
<i>Horizontal flows</i>								
(5) Central government	0.023	0.194	-0.108	0.071	-0.158	-0.054	-0.155	-0.073
	(0.003)	(0.004)	(0.012)	(0.043)	(0.024)	(0.082)	(0.022)	(0.065)
(6) (5)+Regional governments	0.037	0.188	-0.146	0.438	0.005	0.012	0.083	0.099
	(0.006)	(0.010)	(0.091)	(0.095)	(0.263)	(0.145)	(0.154)	(0.127)
(7) (6)+Local governments	0.056	0.209	-0.148	0.493	0.041	0.031	0.151	0.127
	(0.006)	(0.014)	(0.099)	(0.108)	(0.311)	(0.161)	(0.185)	(0.139)
(8) (7)+Social security inst.	0.082	0.251	-0.251	0.514	-0.224	-0.044	-0.044	0.084
	(0.011)	(0.015)	(0.137)	(0.099)	(0.423)	(0.152)	(0.255)	(0.144)

Source: our calculations on Ministero dell'Economia e delle Finanze, Conti pubblici territoriali

Robust standard errors in parentheses pertain to b or g, respectively.

Regional constants are omitted. The designated equations, to which b_2 , g_1 , g_2 and g_3 refer, are as follows:

$$\text{Equation (2): } \Delta y_{it} = \theta_i + \gamma_1 \cdot \Delta x_{it} + \varepsilon_{it}$$

$$\text{Equation (3): } y_{it} - \bar{y}_i = \gamma_2 (x_{it} - \bar{x}_i) + v_{it}$$

$$\text{Equation (5): } \tilde{y}_{it} = \alpha_2 + \beta_2 \tilde{x}_{it} + \mu_{it}$$

$$\text{Equation (6): } y_{it} - \tilde{y}_{it} = \gamma_3 (x_{it} - \tilde{x}_{it}) + v_{it}$$

Figure 1a: Standardized per-capita GDP in Lombardia

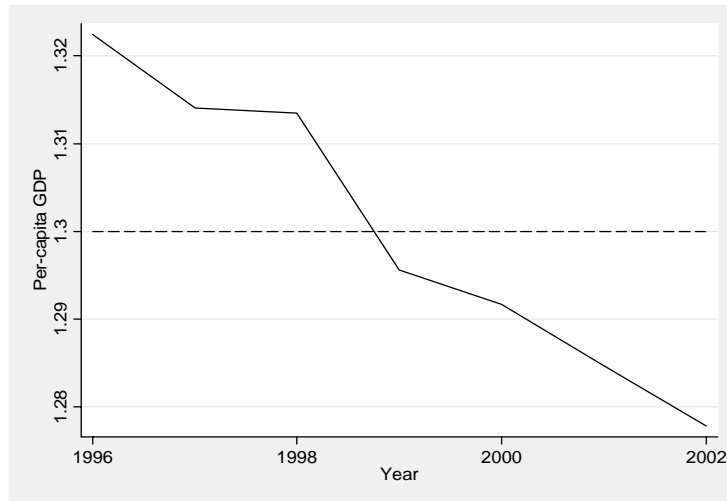


Figure 1b: Standardized per-capita GDP in Campania

