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The Municipal Bond Market in Italy:

an Empirical Analysis of the Determinants of Yields and Credit Ratings

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Abstract

This PhD thesis investigates the sub-sovereign financial market in Italy, specifically focusing on the municipal bond market and on local government credit ratings. This research aims to identify empirically the economic and financial variables which affect bond yields and credit ratings of Italian local governments, and to understand the role of such variables in explaining the differences in interest costs paid by different bond issuers (or paid by the same issuer at different times) and the differences in the rating judgments assigned by the major international rating agencies.

The Italian local government finance system is characterized by the several tiers of sub-sovereign governments (regions, provinces and cities) being differently linked to the central government finances, and by the central government itself conveying a non-negligible sovereign financial risk. The three local government tiers have a different institutional nature, while cities and provinces (jointly defined as local authorities) possess a similar status and are subject to the same legislation, regions are characterized by a greater independence and by a significantly higher degree of financial autonomy. These facts should affect the investors' evaluation of local government credit risk and, therefore, one of the aims of this research is to analyze the determinants of sub-sovereign bond yields and credit ratings in this institutional framework.

Credit ratings are investigated under a dual perspective, beyond the analysis on the factors driving the determination of credit ratings, this research also aims to study the role played by ratings in affecting local bond yields. First, testing if the purchase of a rating is rewarded by lower yields, i.e. if rated issuers pay lower yields than their unrated peers, and then if the specific creditworthiness assessment assigned by rating agencies is considered by investors when they price a municipal bond, i.e. if a AAA-rated issuer pays less than a BBB-rated one.

This work is organized in two parts. Part I provides the research framework, rationale and background, including the research planning, a description of the local government finance system in Italy and the review of the literature. Part II is dedicated to the empirical analysis, presenting the empirical methodology and results.

Keywords: Municipal bonds, credit ratings, local government finance, bond yield premia, default risk.

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Part I

Research Framework, Rationale and Background

Chapter I

Research Planning

This chapter outlines the rationale and design of the piece of research undertaken in the following Part II of the thesis. Section I.1 provides some preliminary information about the financial market for local governments in Italy and about the existing research on the subject, Section I.2 describes the research questions and Section I.3 introduces the general research approach.

I.1 Introduction

The financial market for local governments in Italy has grown significantly in the last fifteen years. The introduction of a new regulation in the mid-1990s has boosted recourse to bond financing by Italian cities, provinces and regions.[1]

The bond market for local administrations has increased from 6 pilot issues in 1996, for a total amount of € 227 million, to a long-term average, before the recent sovereign financial crisis, of 150-200 issues per year for a total amount of € 5-7 billion per year. By the end of December 2014, the overall amount of municipal outstanding bonded debt was around € 25 billion (accounting for a quarter of the whole local sector debt), with a peak of 85 sub-sovereign governments which, before the recent sovereign financial crisis, possessed a credit rating assigned by the major international agencies.[2]

A vast empirical literature regarding municipal bonds and ratings exists, but almost entirely on the US market. However a few studies cover some European sub-sovereign bond markets such as Spain and Germany, and despite the increasing importance of the Italian municipal bond market in the last fifteen years, no empirical research has been carried out on the large but quite new Italian market.[3] Similarly, also the empirical research on local governments' credit ratings has mainly focused on the United States, even if the recent production has begun covering the European markets, including one paper on the Italian market.[4]

[1] Law no. 724/1994, section 35 and Ministerial Decree no. 420/1996.
[2] Sources: Benvenuti and Calò (2000); Bank of Italy, *Indicatori monetari e finanziari: Mercato finanziario* (1999-2014); Bank of Italy, *Indicatori monetari e finanziari: Debito delle amministrazioni locali* (2004-2014); Dexia-Crediop, "Le Emissioni Obbligazionarie degli Enti Territoriali Italiani (1996-2002)", *Public Finance* (September 2003); Italian Government, Treasury Department, *Indebitamento degli Enti Locali e Territoriali* (December 2014); Dexia-Crediop, *La congiuntura finanziaria degli Enti Territoriali* (July 2011).
[3] Schulz and Wolff (2008), Schuknecht et al. (2009).
[4] Venneri (2013).

The Italian constitutional system is very different from the US federal model and, even after the constitutional reform in 2001 which granted several new powers to sub-national governments, Italy still represents a unitary state model with devolved powers.[5] Therefore, the well established findings on the US market may not be directly applicable under Italy's institutional framework. The relationship between Italian central and local governments must be addressed and, particularly, its role in affecting sub-sovereign bond yields and credit ratings must be formally analyzed.

I.2 Research questions

This research aims to analyze the determinants of bond yields and credit ratings of Italian local governments, as well as the interaction between ratings and yields. Moreover, also the role of the interrelation between central and local governments in affecting yields and ratings is studied. Lastly, the informational power of credit ratings and the disciplinary power of financial markets are tested. The main questions addressed in this research are:

i. Which are the economic/financial factors determining Italian municipal bond yields?

ii. Which are the economic/financial factors determining Italian sub-sovereign credit ratings?

iii. Is the specific creditworthiness of an Italian local government relevant in influencing its bond yields?

iv. Is the specific creditworthiness of an Italian local government relevant in influencing its credit rating?

v. Does Italy's sovereign financial risk affect sub-sovereign bond yields?

vi. Does Italy's sovereign credit rating affect sub-sovereign credit ratings?

vii. Do the bond yields of the different tiers of sub-national governments unanimously react to changes in Italy's sovereign financial risk?

viii. Do the credit ratings of the different tiers of sub-national governments unanimously react to changes in Italy's credit rating?

[5] Constitutional law no. 3, 18 October 2001.

ix. Are the ratings released by the three major international rating agencies driven by the same set of economic/financial variables?

x. Do investors in Italian municipal bonds price differently rated and unrated issues?

xi. Do the specific rating assessments (i.e. AAA, AA-, BBB+, etc.) attributed to Italian sub-national governments affect the Italian municipal bond yields?

xii. Do the credit ratings attributed to Italian sub-national governments possess any additional informational role beyond the information obtainable from publicly available financial and economic data?

xiii. Is the financial market able to impose debt discipline on the Italian local governments?

I.3 Research approach

This research is characterized by a rigorous empirical methodology. The precondition of the empirical analysis, the review of the literature, is the subject of Chapters III, while the core empirical analysis is undertaken in Part II (Chapters IV and V).

First, the relevant literature on both municipal bonds and credit ratings is critically reviewed. The existing research on these subjects has been analyzed in order to address the issues relating the methodology applied, the data collection, the construction of indicators and variables best suitable for the research goals, and the understanding of the results.

The empirical analysis is introduced in Part II. Chapter IV and Chapter V present the empirical analysis relating, respectively, the Italian municipal bond market (Chapter IV) and the Italian local governments' ratings (Chapter V), including the description of the data, the analytic derivation of the estimated models and the results of the analyses.

Chapter II

Local Government Finance in Italy

This chapter is divided into three sections, the first section describes the Italian local public finance system, while the second and the third provide a brief picture, respectively, of the municipal bond and of the rating market.

II.1 The local public finance system

This section contains a brief introduction to the Italian local public finance system, including the elements of the institutional framework and the features characterizing the interrelation between central and local governments finances. The following description is not meant to be exhaustive, as it serves the purpose of highlighting the aspects relating the pricing of municipal bonds and the assessment of credit ratings.

II.1.1 Institutional framework

The Italian Constitution, as amended by constitutional law no. 3/2001 which introduced fiscal federalism, reserves to the central government exclusive powers to act in the areas of international relations, justice, defence and national security, foreign trade and economic, monetary and energy policies. The central government also has powers to act in other areas, such as public works, water resources, railways and transportation. Except for the powers expressly reserved to the central government, legislative and executive powers are exercised in certain matters at local level.[6]

The Italian Constitution defines four levels of sub-national government: *regioni* (regions), *province* (provinces), *città metropolitane* (metropolitan cities) and *comuni* (municipalities).[7] As of December 2014 the Italian administration is organized in 20 *regioni*, 110 *province*, 8092 *comuni* and 14 *città metropolitane*.

Regions exert both legislative and executive powers according to their statutes. Of Italy's 20 regions, 15 operate under an ordinary degree of regional autonomy and are referred to as ordinary-statute regions, while five regions (Friuli-Venezia Giulia, Sardinia, Sicily, Trentino-Alto Adige and Valle d'Aosta) are regulated by special statutes which provide these regions with greater autonomy and wider legislative powers, classifying them as special-statute regions or autonomous regions. The region Trentino-Alto Adige consists of two autonomous provinces

[6] Constitutional law no. 3, 18th October 2001.
[7] Constitution of the Italian Republic, section 114.

(Trento and Bolzano) whose powers, including legislative, correspond to those of a region. The constitutional law no. 3/2001 significantly increased the powers attributed to ordinary-statute regions, while only slightly increased the legislative powers of special-statute regions, which were already broad.

Provinces exert administrative functions and regulatory powers within their territories, and coordinate inter-municipal planning. According to the Legislative Decree No. 267/2000 (the Local Authorities act), the matters under the provinces' responsibility include: environment, water, energy, road network and education. The law no. 56/2014, transformed the Italian provinces into second-level institutional bodies, formed by members of the constituent municipalities and with no elected council. This modification of provinces' nature is the first step of the process for their complete abolition.

Municipalities represent the basic local authorities' level in the Italian system. The Italian Constitution attributes the administrative functions in the first place to municipalities, according to the principle stating that the management of public functions should be attributed to the entities which are the nearest to the citizens and therefore in the best position to grant them the most efficient services.[8]

The above cited law no. 56/2014, on the 7th April 2014, activated the first 10 metropolitan cities for ordinary-statute regions. The 4 metropolitan cities belonging to special-statute regions, at the time of writing, have not been activated yet.

II.1.2 Local governments' revenues and financial autonomy

The constitutional law no. 3/2001 provides several principles relating the financial autonomy of Italian local governments. The new Section 119 of the Italian Constitution states that regions, provinces, metropolitan cities and municipalities are financially autonomous regarding revenues and expenditures.

They are entitled to establish and collect their own taxes and revenues in accordance with the national public finance principles and taxation system, and they are entitled to receive a portion of the central government taxes collected within their territory. The redistribution of resources from richer to poorer areas is to be effected by an equalisation fund, and the above mentioned revenues must be sufficient to finance all local government's functions and activities. In order to promote economic development and social cohesion the central government may allocate additional resources or carry out special actions in

[8] Constitution of the Italian Republic, section 118.

support of specific municipalities, provinces, metropolitan cities and regions. Local governments may incur debt only to finance investment expenses and their indebtedness is not guaranteed by the central government.

The items of revenues collected by Italian local governments are specific to the different tiers of government.

The regions' main tax revenues are: the regional tax on productive activities, the additional income tax on individuals and the contribution on value added tax. The regional tax on productive activities, of which regions have the power to determine the tax rate within a range defined by the central government, is based on the net production value of enterprises and professionals. The additional income tax on individuals entitles regions to impose an additional amount on the national income tax, within a range defined by the central government. The contribution on value added tax is a portion, defined by the central government, of the national value added tax collected in a specific region which is transferred to the same region. Other less significant sources of income for regional governments are the automobile tax, the fuel tax and other minor taxes.

The taxes that provinces are empowered to levy are: the car registration tax, the additional tax on electric power consumption, the tax on vehicle insurance and an environmental tax. Provinces are also entitled to a contribution on the national income tax on individuals defined by the central government.

The municipal sources of tax revenues are principally represented by the property tax and by the municipal service tax. Municipalities are also entitled to apply an additional income tax on individuals, within a range defined by the central government. Other less significant sources of income for municipalities include a tax for the utilization of public areas and a public advertisement tax.

Local governments also benefit from non-tax revenues, which include incomes derived from a variety of sources such as charges for public services, rents from property management, investment yields and profits on public owned firms.

The ongoing fiscal federalism process has been transforming the financial relationship between central and local governments, granting greater financial autonomy and financial responsibility to the lowest tiers of public administration. This has resulted and will continue to result in a reduction of transfers by the central government as increased revenue generating powers are passed to the periphery. Transfer payments are also granted by regions to municipalities and provinces, according to each regions' specific program.

II.1.3 Distinctive traits of the Italian local public finance system

The Italian local public finance system is characterized by several idiosyncratic legal, market and procedural features. These distinctive traits of the system, which are briefly described below, affect the credit risk of a local government and must be taken into account when interpreting the results of the empirical analysis.

Local governments in Italy are required to effect all payments and collect all revenues through one or more agent banks acting as their treasurer. The treasurer also intermediates funds between the local government and the Bank of Italy, which acts as the treasurer for the central government. The central government treasury system (*Tesoreria Unica*) requires the local governments' treasurers to deposit cash into (and withdraw funds from) an account at the local branch of the Bank of Italy, according to the regulation in force for the different types of local government.

Local governments' loans and bonds may be supported by a irrevocable payment delegation (*Delegazione di Pagamento*), which compels the treasurer to allocate appropriate funds to meet the payment of the scheduled interest and principal on debt. Funds are allocated having recourse to the local government revenues and are paid with absolute priority with respect to other payment obligations. A payment delegation does not constitute a security interest in favour of the payee and, accordingly, creditors who receive the benefit of a payment delegation should be considered common unsecured creditors for the benefit of whom certain funds have been allocated in order to support the repayment obligations.[9]

The Italian system has a special procedure for local authorities in financial distress (*Dissesto Finanziario*), similar to the private sector bankruptcy procedure, under which municipalities are subject to the rigorous control of an external committee which manages the financial position while the local authority's management keeps the ordinary operations running.[10] Although the Italian Constitution forbids any explicit central government guarantee on local government debt,[11] to date, every financial distress procedures benefited from the intervention of the central government which granted dedicated funds for distressed local authorities.[12] Moreover, central government intervention has

[9] Law no. 843, 21 December 1978, section 3. Law no. 724, 23 December 1994, section 35. Legislative decree no. 267, 18 August 2000, section 206.
[10] Legislative decree no. 267, 18 August 2000, sections 244-269.
[11] Constitution of the Italian Republic, section 119.
[12] Recent examples involving large municipalities include the Euro 590 million fund allocated in 2012 for, among others, the cities of Naples, Reggio Calabria and Alessandria (Government

happened also outside financial distress procedures, as in a recent case (September 2008), involving a provincial capital, where the City of Catania was about to default and was subsequently bailed out by the central government with a € 140 million transfer.[13] It must be understood that the above mentioned financial distress regulation is not applicable to regions, as it is specifically aimed at local authorities only (municipalities and provinces).

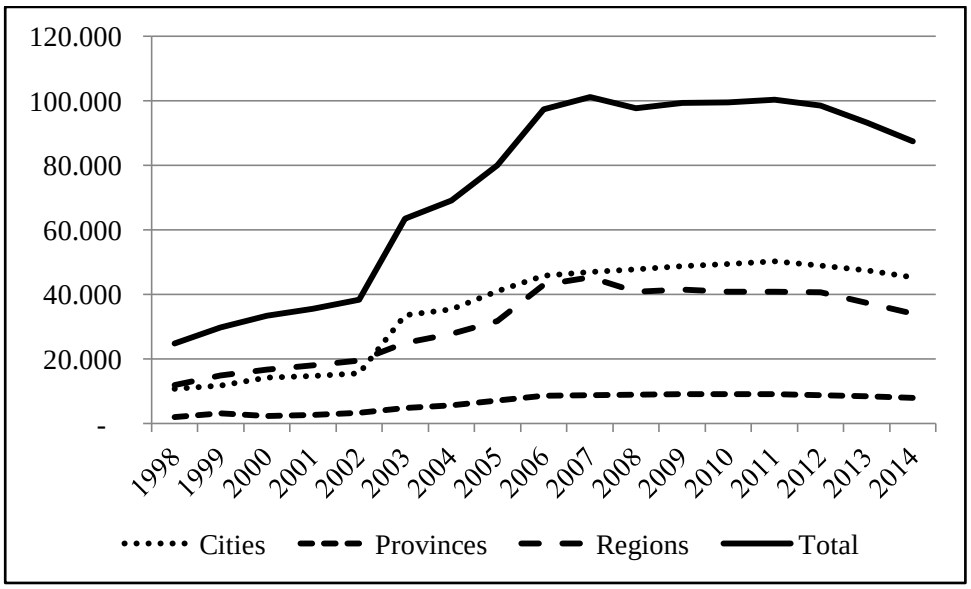
Furthermore, the local government debt market is dominated by a local government funding agency, *Cassa Depositi e Prestiti* (CDP), funded by postal savings and under central government control. CDP, which accounts for a share of 45% of the whole sub-national lending market, finances local infrastructure projects and represents the main competitor of bond and loan markets.[14]

Lastly, the law which introduced local government bonds in Italy, and still in force, states that municipal bonds' gross yields at issue cannot exceed the average gross yield of the corresponding Italian Government bonds plus 1%.[15]

II.2 Italian municipal bond market at a glance

As described in Graph II.1 below, the overall indebtedness of Italian sub-national tiers of government boosted after the above mentioned constitutional reform in 2001 which granted a higher financial autonomy to local governments.

Graph II.1 - Local government debt per government type (€ millions)



decree no. 174, 10 October 2012) and the Euro 150 million fund granted to the City of Taranto in 2007 (Government decree no. 159, section 24, 1 October 2007).

[13] C.I.P.E. (Interministerial Committee for Economic Planning) resolution n. 92, 30 September 2008.

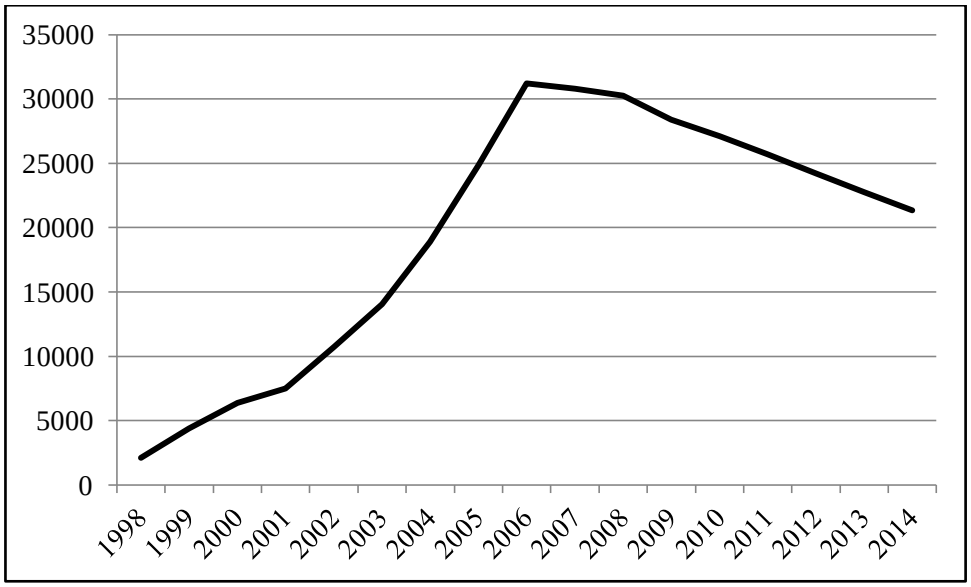
[14] Cassa Depositi e Prestiti SpA, *Relazione Finanziaria Semestrale Consolidata*, 30 June 2013.

[15] Law no. 724, 23 December 1994, section 35.

As reported in the graph above, the total amount of sub-sovereign debt grew from around € 35 billion in 2001 to an average of around € 100 billion along the 2000s. Looking at the distribution between government types, it can be noted the regions and cities represent the higher shares of outstanding debt, while provinces account for less than 10% of the market.

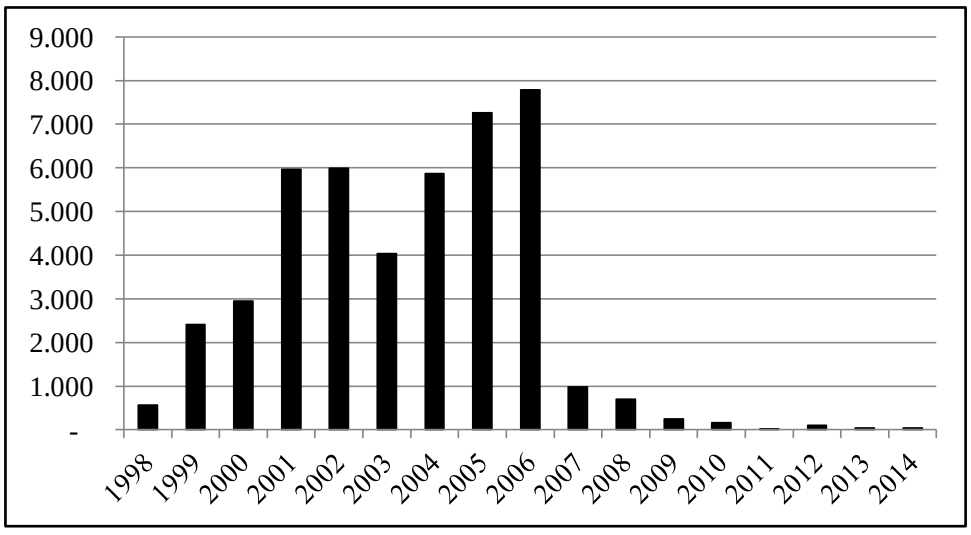
Considering the part of local government debt represented by bonds, Graph II.2 shows that outstanding bonded debt reached a peak of more than € 30 billion between 2006 and 2008, and then experienced a contraction during the sovereign financial crisis.

Graph II.2 - Outstanding municipal bonds (€ millions)



The effect of the financial crisis on municipal bond issuance is clearly represented in the following Graph II.3, which reports the amount of municipal bonds issued per year.

Graph II.3 - Municipal bond issues per year (€ millions)

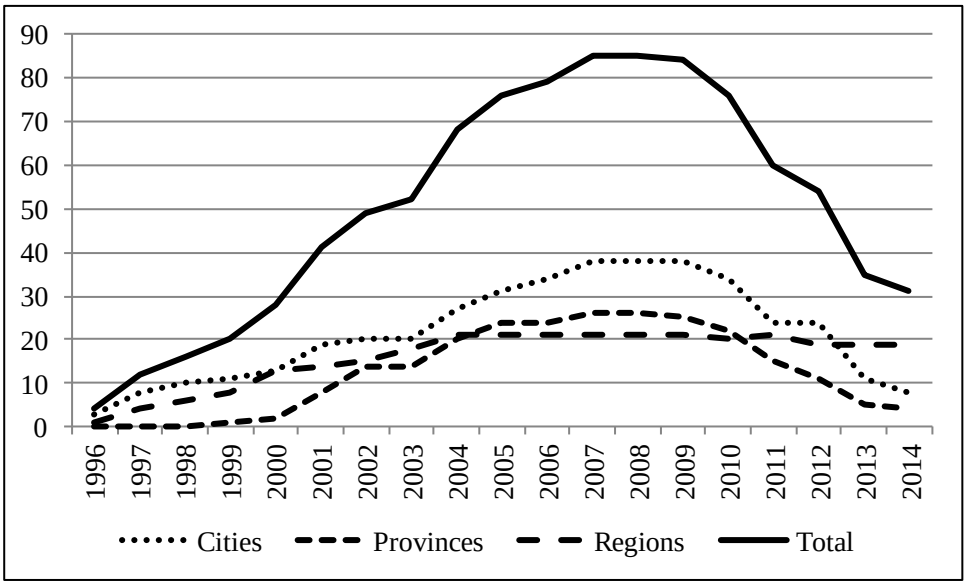


Graph II.3 shows how municipal bond issuance increased steadily from late 1990s to 2006, where it reached the maximum of almost € 8 billion in a year. Starting 2007 the yearly amount decreased to around € 40 million in 2014.

II.3 Italian Public Sector Rating Market at a Glance

Although a relatively new market, with the earliest rated local governments dating in the mid-1990s, the Italian public sector rating market has significantly developed along the 2000s. As detailed in the following Graph II.4, the number of rated local governments grew from the first 4 entities in 1996 to a peak of 85 (38 cities, 26 provinces and 21 regions) in 2007 and 2008.[16] Subsequently, as shown in the graph, the rating market eventually experienced a significant contraction in conjunction with the sovereign financial crisis characterizing the last five years. At the end of 2014 the total number of rated local governments decreased to 31, with only the regions maintaining a number (19) close to the pre-crisis period, while both cities and provinces underwent a dramatic drop (to 8 and 4 respectively).

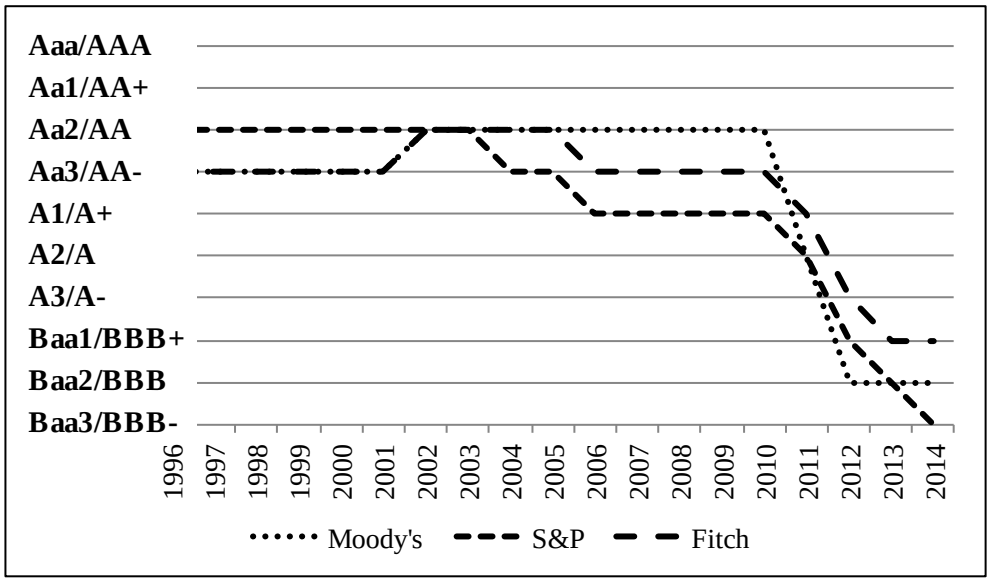
Graph II.4 - Number of rated entities per year and per government type



Now, in order to have a picture of the evolution of the credit risk involving the Italian public sector, the following Graph II.5 depicts the rating history of the central government. The graph reports the credit ratings assigned to the Republic of Italy by the three major rating agencies (Moody's, Standard & Poor's and Fitch) by the end of each year between 1996 and 2014.

[16] The number of regions includes the two Autonomous Provinces of Trento and Bolzano.

Graph II.5 - Italy's rating history



Observing Graph II.5 it can be noticed how, after 15 years of stability, the three rating agency have applied a sudden series of downgrades, starting in 2011, following the recent euro-zone sovereign-debt crisis. By the end of 2014 Italy's ratings have moved from the highest categories to the edge of the investment grade threshold, with the lowest rating assigned by S&P (BBB-), followed by Moody's (Baa2) and Fitch (BBB+).

Chapter III

Review of the Literature

"No person of sound mind would lend on the personal security of an individual of doubtful character and solvency, and on mortgage over a valuable estate, at the same rate of interest. Wherever there is risk, it must be compensated to the lender by a higher premium or interest." [17]

As stated around two centuries ago by the Scottish economist J.R. McCullough, scholars and practitioners have traditionally agreed on the fact that the interest rate paid on a loan depends on the risks borne by the lender. When the borrower is a local government, i.e. an authority which raises revenues by collecting taxes on a territory, receiving transfers from the central State and selling services to the public, several factors must be considered in order to assess its capability to duly service its debt.

This chapter divides the relevant literature on the subject into four paragraphs. The first paragraph focuses on the studies which have identified and tested the significant factors in determining municipal bond yields, the second deals with the studies which have analyzed the role played by credit ratings in affecting yields, the third reviews the empirical publications analyzing the factors determining sub-sovereign ratings and the fourth critically addresses the issues concerning the empirical methodologies applied in the reviewed literature.

III.1 Factors determining yields

The relationship between risk and yields in the government bond market has been the object of the work of Bernoth et al. (2006, 2012), which developed a portfolio model of bond yield differentials based on financial theory, specifying basic settings such as investors' preferences and market functioning. Afterwards, the model has been adapted to the case of local government bonds as in Booth et al. (2007) for Canadian provincial bonds and in Schuknecht et al. (2009) for German *Lander*'s bonds and Spanish provincial bonds.

Bernoth et al. (2006, 2012) consider a risk-averse investor, optimising in a mean-variance space, in a market with two assets: a risk-free bond and a bond subject to default risk, both denominated in the same currency. After portfolio optimization and market clearing, the model defines the yield spread (between the risky and the risk-free bond) as a function of three factors: default risk,

[17] J.R. McCullough, *The Principles of Political Economy: with a Sketch of the Rise and Progress of the Science* (Edinburgh: William and Charles Tait, 1825).

liquidity risk and market risk. Therefore, the total yield premium, i.e. the compensation for the total risk borne, can be decomposed into three distinct parts: default risk premium, liquidity premium and market risk premium. To estimate empirically the risk-return relationship in their model, the authors employ a set of economic, fiscal and financial variables such as debt, deficit, business cycle, liquidity of the issue, maturity of the issue etc. Also, since the theoretical model states the influence of investors' risk aversion on yield differentials, Bernoth et al. (2006, 2012) use yield spread between low grade US corporate bonds (BBB-rated) and benchmark US government bonds as an empirical proxy for global risk aversion. Testing their model on a sample of EU and US central government bonds, Bernoth et al. (2006, 2012) find that yield spreads are affected by default and liquidity risk. The default risk premium is positively affected by debt and debt service ratios of the issuer country, while the liquidity risk premium is lower in countries with larger market shares.

Booth et al. (2007) employ the theoretical model developed by Bernoth et al. (2006, 2012) and adapt it to the Canadian sub-sovereign bond market. The authors derived an empirical specification of the model designed to estimate the impact of Canadian provinces' fiscal and financial condition on their bond yields. The model specification, which adopts debt, deficit and employment as explanatory variables, is tested on a panel-data set of Canadian provincial government bonds issued between 1981 and 2000. The results clearly show that provincial fiscal positions, debt and deficit, significantly affect yield spreads between provincial and central government bonds. Moreover, Booth et al. (2007) examine the relationship between corporate and provincial yield spreads. They find that provincial bonds behave similarly to corporate bonds since during recessions their yields increase compared to the federal government ones, therefore experiencing the well known "flight to quality" phenomenon. However, provincial debt responds in a less pronounced way to general economic conditions than corporate debt, implying that provincial bonds may be weak substitutes for corporate bonds.

Schuknecht et al. (2009) study the risk premia paid by sub-national governments in Europe and Canada. They also analyze, with respect to European countries, how the risk premia were affected by the introduction of the Euro. They design an empirical model, derived from the above cited model of Bernoth et al. (2006, 2012), for the analysis of yield premia between sub-sovereign and sovereign governments and apply it to a sample of bonds issued by German *Landers* (federal states) and by Spanish and Canadian provinces. The authors find that, after controlling for variables related to the credit quality, sub-sovereign governments paid positive interest differentials compared to their respective central governments. They argue that lower levels of government are

perceived as riskier by the market because of their smaller and more volatile tax base, and are therefore requested a positive spread, over the central government yield, to compensate for the higher risk. Interestingly, the authors show that spreads between sub-sovereign and sovereign bonds narrowed in Germany and Spain after the introduction of the Euro, as a consequence of the mitigation of liquidity risk. Moreover, Schuknecht et al. (2009) assert that, before the introduction of the Euro, the risk premia paid by German *Landers*, especially those receiving transfers under the German fiscal equalization system, did not respond to fiscal balances, possibly because of the expectations of a bailout by the central government. This special condition seems to have disappeared with the start of the EMU, which imposed more fiscal discipline on German states. In contrast, Spanish provinces paid risk premia related to their fiscal balances both before and after the introduction of the Euro. Furthermore, they also find that Canadian provincial governments pay a significant risk premium related to their fiscal performance unless they belong to the group of net recipients under the Canadian fiscal equalization system, meaning that markets do not penalize provinces that consistently receive transfers for running large deficits. This infers that markets expect the Canadian government to provide financial assistance to the governments of these provinces should a financial crisis occur, a result which is similar to their findings for German states before the start of the EMU.

The findings in Bernoth et al. (2006, 2012), Booth et al. (2007) and Schuknecht et al. (2009) identify the risk factors expected to determine municipal bond yields and propose a set of observable variables meant to capture the effect of such factors. The three risk factors highlighted in the above-cited papers (default risk, liquidity risk and market risk) have been measured by different variables and indicators which can be grouped into three categories: characteristics of the issuer; macroeconomic and market variables; characteristics of the security. Hence, the following three subsections analyze the empirical literature on the subject, identifying the adopted variables and explaining their relevance in quantifying the risk factors and, therefore, their relevance in explaining local government bond yields.

III.1.1 Characteristics of the issuer: financial, fiscal, socio-economic

This category includes those issuer-specific characteristics able to measure the creditworthiness of a local government. This includes: financial indicators such as debt load and debt service; fiscal variables such as fiscal balances and financial autonomy; socio-economic indicators such as local income, unemployment and population.

One of the most important variable affecting the default risk of an issuer is the existing debt load of the issuing local government. Clearly, the higher the debt burden the higher the portion of future revenues absorbed by payments due to principal and interest, so the lower the ability to pay in case of a decline in revenues. One of the earliest studies on the subject, Hastie (1972), using a cross-sectional regression analysis on a sample of US municipal bonds, is one of the first studies analyzing yields as a function of default risk. He obtains that default risk indicators, including the debt load, are able to explain a large share of the differences in municipal bond yields and finds a positive relationship between debt burden and yields. Following studies, including influential papers such as Liu and Thakor (1984), Capeci (1991 and 1994), Booth et al. (2007) and Schuknecht et al. (2009), have applied this indicator as a ratio over a measure of income (overall debt/GDP), revenues (overall debt/total revenues, overall debt/current revenues) or in per capita terms. However, Robbins and Simonsen (2012) highlight the possible endogeneity issue between outstanding debt and interest rates (if local governments reduced debt responding to increases in interest rates), and suggest the use of instrumental variables to avoid it. Another measure of the sustainability of a local government's debt, used among others by Capeci (1994), is debt service. While the debt load measures the existing stock of debt, debt service (often expressed as a ratio over revenues) accounts for annual expenses in interest and capital repayment and therefore is affected by the debt structure and interest rates of existing loans.

Also, fiscal balances (deficits/surpluses) are extremely important in assessing the financial condition of a local authority. Especially the current balance (difference between current revenues and current expenditures) indicates if the local government is generating or absorbing cash from its operating activities, cash which can be used for debt repayments and therefore the higher the current surplus the higher the probability that the issuer will be able to cope with debt service in the near future. The first study to examine the degree of association between measures of budget performance and yield differentials on new issue municipal bonds was Wilson (1983), finding that fiscal performance indicators are significant in explaining local governments' credit risk. More recently, Benson and Marks (2007), in their study on the factors affecting the borrowing costs of US state governments (with specific attention to the impact of state fiscal imbalances), find that the interest costs determined in the market for state municipal securities do reflect estimates of state structural deficits, with states which exhibit greater structural deficits paying higher interest costs than states facing lower or no structural deficits. Other studies, including Capeci (1994), Booth et al. (2007) and Schuknecht et al. (2009), have included a fiscal balance indicator in the empirical specification of their models supported by a

fiscal or financial autonomy indicator, a ratio meant to describe the level of own revenues compared to the transfers from the central government.

Moreover, Capeci (1994) analyzes how a local government's fiscal policies affect the default risk premium on its borrowing cost. Focusing specifically on the endogeneity issue possibly arising between local fiscal policy and municipal bond yields, he asserts that causality is not unidirectional. Because, beyond the evidence that budget decisions affect the interest rate paid by the local authority, it is also likely that the same budget policies are affected by the borrowing cost. For example, a high interest rate might discourage the recourse to deficit spending through debt financing. Using a two-stage least squares model with instrumental variables employed to correct for endogeneity, he finds that treating fiscal variables as exogenous delivers biased estimators. Furthermore, Capeci observes that endogeneity is strictly related to asymmetric information between investors and issuers. His regressions' results change dramatically when current variables (known only to the issuer) are substituted by lagged ones (publicly observable), proving that the cost of borrowing affects the fiscal policy decisions of a local authority but also that the borrowing cost itself is determined by the market as a function of observable fiscal variables. Similarly, Poterba and Rueben (1999) analyze the impact of fiscal institutions on municipal bond yields. As in Capeci (1994), they acknowledge the issue of endogeneity (which in their study is between fiscal institutions and fiscal policy) and address it by employing a set of instrumental variables, which proxy for fiscal institutions without being affected by fiscal policy, in a simultaneous equations model. Their results point out that fiscal institutions affect the required return on municipal bonds. Local governments subject to expenditure and borrowing limitations face lower borrowing costs, *ceteris paribus*, compared to local authorities which are not imposed this kind of fiscal constraints.

Lastly, socio-economic variables have also proved to be relevant in explaining the variance in municipal bond yields. For instance local income, used among others by Liu and Thakor (1984) and Capeci (1991), is an important indicator (usually specified as local GDP per capita) of the economic base over which local taxes are levied, because the richer a territory the higher the taxes that can be collected on it. Similarly, unemployment, usually expressed as a percentage rate as in Johnson and Kriz (2005) and Booth et al. (2007) among others, helps assessing the economic strength of a territory, with weakness in the labour force employed always associated with higher interest rates. Also, population, a common measure for the size of a local authority, measured by the number of people on which it exercises its powers, has proved to be empirically significant in influencing local government's interest rates. To this end, Simonsen et al. (2001) asserts that smaller local authorities often lack staff

with financial-management capacity, and this would affect the terms of the bond issue. Testing a sample of US municipal bonds they find that, after having controlled for a set of other variables likely to affect yields, the population size of a local government has a significant impact on interest rates and, specifically, that local authorities with a population below ten thousands citizens pay higher interest rates.

III.1.2 Macroeconomic and market variables

Given a certain creditworthiness of an issuer, other factors, external to the issuer but common to the market or the economy as a whole, are likely to affect the yield of a local bond issue.

For example, Benson et al. (1981) examine the existence of a systematic variation in yield spreads for municipal bonds focusing specifically on the business cycle. The authors employ as explanatory variables, together with other variables used in previous studies (rating, size of the issue etc.), two business cycle indicators such as GDP change and a consumer sentiment index. They find that yield spreads (interest rate differentials between the analyzed bonds and a AAA-rated municipal bond index) widen during an economic downturn and narrow during an economic expansion, with a greater effect for lower-rated bonds than for higher-rated bonds.

Moreover, Schulz and Wolff (2009) perform a quantitative analysis on the determinants of the yield differential between bonds issued by German *Landers* (federal states) and the *bund* (the German Government bond). Employing a panel-data regression model, the authors find that yield spreads between central and state government bonds are mainly driven by international risk aversion. Where risk aversion in international markets is proxied by the yield differential between a US BBB-rated corporate bond index and US government's treasury bonds. Schulz and Wolff (2009) assert that sub-sovereign *Lander*'s bonds are not perceived by investors as substitute for the federal government's *bund*, and that differences in yields remain even after having controlled for issuer's and issue's characteristics, since these characteristics have only a negligible effect on German state bonds.

III.1.3 Characteristics of the security

The empirical literature on the subject has traditionally included in the model specification a set of provisions stated in the bond issue agreement. Since early studies, variables such as amount of the issue, maturity, coupon structure and, more recently, sale type have consistently been included in empirical

estimations. These features affect yields independently of the creditworthiness of the issuer.

For example maturity and coupon structure influence the duration of the bond, duration increases with the maturity of the bond and decreases with the frequency of coupons payments and with the size of coupon rate.[18] Since duration is the main indicator of interest rate risk and in a normal upward sloping term structure of interest rates we expect a positive relationship between duration and rates, maturity is expected to raise yields while coupon frequency and size are expected to lower yields. Moreover, the amount of the bond issue can be seen as a proxy for liquidity or marketability, given the fact that the larger the issue the higher the number of intermediaries and investors involved and the less the impact of transaction costs. Hence, we expect lower yields for larger issues. Tanner (1975), for instance, investigates the effect of credit risk, underwriter competition, maturity date, and size of issue, among other variables, on interest costs of new municipal debt. He obtains that, besides the other relevant variables identified in other studies, also the time to maturity of a bond (with longer maturities paying higher interest rates) affect the interest costs of new bond issues. Also, Broaddus and Cook (1981), in their comprehensive regression analysis of the determinants of municipal bond yields, find that, in addition to the variables identified by previous research, also the specific provisions of the bond indenture such as the early redemption clause (call option) and the coupon structure affect municipal bond yields.

Moreover, also the specific sale method chosen to float a municipal bond has been proven to influence its yield. To this end, Simonsen et al. (2001) explore the influence of bond's sale type (competitive or negotiated sale) on municipal interest rates. The authors study the effects of bond's sale type on yields, testing if there is any significant interest rate differential between bonds sold through competitive and negotiated sale. Testing a sample of US municipal bonds they find that, after having controlled for a set of variables likely to affect yields (amount of the issue, maturity, callable option, market interest rates and rating), the bond's sale type is found to be relevant. Bonds sold through competitive sale are characterized, *ceteris paribus*, by slightly lower yields compared to bonds sold through negotiated sale. From another perspective, Peng and Brucato (2003) examine the method of sale of municipal bonds as a certification mechanism, and analyze its impact on the borrowing cost of debt issues. They argue that the sale method can be viewed as a certification

[18] Duration or Macaulay duration is a measure of a bond price sensitivity to changes in interest rates. Duration is defined as the weighted average term to maturity of a security's cash flows, where the weights are the present values of each cash flow as a percentage to the security's price. This indicator was first proposed by Macaulay (1938).

mechanism as issuers self-select themselves into either competitive or negotiated groups based on their perception of the underlying degree of information asymmetry. Their findings demonstrates that local governments choose the method of sale according to the degree of information asymmetry between the issuer and investors. Where the information asymmetry is more severe, the negotiated sale method is chosen. After controlling for this self-selection bias, they found that competitive bidding has, as in Simonsen et al. (2001), a slight cost advantage over negotiated sale.

III.2 Role of credit rating in affecting yields

The relationship between ratings, economic indicators, and yields of municipal bonds has been a traditional subject of interest for both academics and practitioners. For instance, Jantscher (1970) analyzes the differences in interest rates between local governments which have maintained a constant credit rating and issuers which have been downgraded, has been the first author to study the relationship between ratings and municipal bond yields. He finds that yield differentials between local authorities with different ratings are partly explained by the rating assessments from rating agencies and partly by the independent credit analysis done by investors, which Jantscher called “market rating”. Later on, Rubinfeld (1973) applied a two-stage regression model where local governments’ bond yields are explained by credit ratings and a set of indicators aimed to quantify the creditworthiness of the issuer (Jantscher’s market rating). He first obtained a rating score variable (to convert the letter assessments Aaa, Aa, Baa etc. into numerical values) and then regresses it together with a set of financial, socio-economic and market variables. He obtains that published credit ratings have an independent effect beyond the market’s evaluation of the financial status of the rated municipality, meaning that the credit assessments provided by rating agencies carry additional information with respect to the independent market evaluation based on the publicly available observable variables. Also, Ingram et al. (1983) examined the information content of municipal bond rating changes by evaluating municipal bond price adjustments during the period surrounding a rating change. Testing a sample of US municipal bonds, they find that rating changes do have an impact on yields during the month of the change. As expected, upgraded bonds experience a decrease in yields while downgraded ones face a yield rise.

The early studies described above have examined the role of credit rating in affecting yields, but they lacked in econometric rigour. The first study to formally address the issue of the contemporaneous estimation of the effects of the credit ratings assigned by rating agencies and of the observable economic/financial

variables relating a local government was Liu and Thakor (1984). Liu and Thakor (1984) develop an empirical model for the determination of the relationship between ratings, economic indicators, and yields of municipal debt, aimed to quantify the impact that credit ratings have, *per se*, on the interest rates paid by local governments. The authors assert that ratings have an independent effect beyond the observable characteristics of the issue, because ratings' *raison d'être* is that they carry information that is not publicly available. That is, rating can be seen as a screening instrument *à la* Stiglitz (1975) and its acquisition by borrowers represents a signalling mechanism through which high standing issuers differentiate themselves from low quality ones, avoiding the "average quality pricing" phenomenon described by Akerlof (1970). Liu and Thakor acknowledge that an empirical model with both ratings and issuer's economic characteristics as independent variables is exposed to serious multicollinearity problems. Because a bond's yield depends on both the credit rating and the economic characteristics of the issuer, but the rating itself is affected by the same economic characteristics. The authors deal with the multicollinearity issue by adopting a two-stage regression model which employs an orthogonal rating indicator in order to avoid multicollinearity issues. Their results show that three variables (total debt, per-capita debt and unemployment), plus the rating, significantly affect municipal bond yields. Moreover, credit rating has an independent and significant effect on yields, meaning that it carries additional information beyond the credit analysis done by investors upon observable variables (Jantscher's market rating).

Also, in his paper published in 1991, Capeci examines the channels through which a municipality's credit quality affects its borrowing rate, considering both the direct effect of changes in credit quality on changes in borrowing rates and the indirect effect that operates through changes in credit ratings. He employs the same econometric model proposed by Liu and Thakor, but, while the former used cross-sections, he applies it to a panel data set in order to assess the impact of changes in the credit quality on borrowing costs. Capeci (1991) asserts that changes in ratings need to be analyzed together with changes in the underlying economic variables, because, since ratings are influenced also by public information, changes in yields due to changes in ratings could be actually determined directly by the publicly available information. Employing a random effects GLS estimation applied to first differences in a panel data set (an alternative way of facing the multicollinearity issue already addressed by Liu and Thakor), he obtains results which confirm the influence on yields of the economic and financial characteristics of the issuer as found in previous studies, but present a rating's independent effect which is less significant compared to what was found by Liu and Thakor.

A different approach to the issue has been followed by Liu and Seyyed (1991). This study define and statistically estimate a model designed to evaluate the effect of socio-economic characteristics, and credit ratings, of a municipal bond issuer on its borrowing cost. They develop an empirical model for the analysis of the yield differential between a risky local bond and a risk-free Treasury bond as a function of: bond structure (maturity and coupon), socio-economic variables (income, tax revenues, debt, unemployment and population) and the credit rating released by Moody's. Liu and Seyyed acknowledge, as Liu and Thakor (1984) and Capeci (1991), the issue of multicollinearity between socio-economic variables and rating. They consider that multicollinearity doesn't bias the estimated coefficients but only amplify the related standard errors, therefore making the conventional t-stats useless. In this respect, they propose a forward inclusion technique in a stepwise regression in which the rating variable enters after all socio-economic variables are included, with the statistical significance measured by an F-test. To assess the independent contribution of credit ratings to the yield equation, beyond the effect of socio-economic variables, they suggest to look at the significance of the F-stat after the rating variable is included in the stepwise regression. According to their methodology, a non-significant F-stat would imply that risk premia are only affected by socio-economic variables and that ratings would not provide additional information. Testing their model on a sample of US municipal bonds, Liu and Seyyed (1991) obtain that including the rating variable in the estimated equation significantly improve the explanatory power of the model and, therefore, they conclude that credit ratings have an independent effect on yields beyond the socio-economic characteristics of the issuer.

The approach of the Liu and Thakor model has been strongly criticized by Stover (1991). In his study, Stover claimed that Liu and Thakor methodology would not be able to decompose the relationship between economic characteristics and yields, of a municipal bond issuer, into direct and indirect effects. Hence, he proposes a path analysis model aimed at quantifying the direct effect of observable variables on bond yields and the indirect effect which is exerted by the same variables through credit ratings. Applying his model to the same dataset used by Liu and Thakor (1984), he obtains conflicting results with respect to the latter study. Particularly, in Stover's results the direct effect of the observable economic variables on yields is irrelevant, while the same variables are significant in explaining credit ratings and, therefore, they would affect yields only indirectly through their impact on ratings. Nevertheless, with its findings, Stover is negating any role for an investors' independent evaluation on the creditworthiness of the issuer (Jantscher's market rating). He asserts that only credit ratings are relevant in municipal bond pricing, contradicting what was

generally and almost unanimously found in the previous research on the subject.

The role played by asymmetric information in municipal bond pricing has been further studied by Hsueh and Liu (1993). As in Liu and Thakor (1984), they see credit rating as a signalling instrument *à la* Akerlof which allows high-quality issuers to reveal their credit standing to the market. This reduces the agency costs between the issuer and investors, contributing to set market prices (yields) which reflect the credit quality of the issuers. Specifically, Hsueh and Liu are interested in testing if high-standing municipal borrowers which choose not to purchase a bond rating are penalized, in terms of interests paid, with respect to same quality issuers possessing a credit rating. They employ a probit model, based on maximum likelihood estimations, to predict the credit quality of unrated issues in order to analyze yields differentials between rated and unrated bonds with comparable creditworthiness. Applying their model to a sample of US municipal bonds, they found that, after having controlled for the credit quality, unrated issuers are penalized by paying a higher yield. However, they also prove that investors correctly price the differences in the credit quality of unrated issues, and that the issuers most likely to forgo a credit rating are the smaller ones which aim at local markets. The authors conclude that this type of issuers (high-standing borrowers who choose not to purchase a rating), whose small size bonds are mainly marketed to regional banks, operate efficiently because the cost of acquiring a credit rating would exceed the benefit of having it.

From another perspective, Johnson and Kriz (2005) investigate the impact of fiscal institutions on local government borrowing costs as in Poterba and Rueben (1999), but including in the analysis also the indirect effect on yields through the impact exerted by fiscal institutions on rating. Specifically they focus on the influence that fiscal rules relating borrowing, revenues and expenditure have on default risk and consequently on ratings and borrowing costs. The authors employ three empirical models. An ordered probit model (suitable to deal with the ordinal nature of credit ratings) to estimate the effect of fiscal institutions on ratings, OLS to estimate the effect on borrowing costs and path analysis to identify direct and indirect effects. Controlling for a set of variables among the most used in the empirical literature (amount of the issue, maturity, callable option, local income and unemployment, revenues, debt burden and sale type), Johnson and Kriz find a significant direct effect of revenue limits on yields (with the presence of revenue limits increasing yields) but no role for the same variable on ratings, whereas both expenditure and borrowing limits have a positive effect on ratings (with the presence of expenditure and borrowing limits

corresponding to higher ratings) and, as a consequence, a negative (lower cost) indirect effect on bond's yields.

An interesting test on the relationship between ratings and municipal bond yields, examining specifically whether the choice of forgoing a bond rating causes an interest cost penalty to the issuer, has been carried out by Allen et al. (2009). They criticize the previous research on the subject for being unable to determine, for unrated issues, which rating category would have been assigned if a rating had been requested. The authors argue that higher yields on unrated issues may reflect, as broadly considered, the higher uncertainty due to lesser information, but, on the other hand, may reflect the correct assessment of a higher default risk characterizing those issuers which forgo the rating because they expect a low valuation by rating agencies. Using a proprietary database containing a set of unpublished ratings for a sample of municipal issuers, they are able to compare yields of publicly rated bonds with yields belonging to unrated bonds which would have received the same rating, if a rating had been purchased by the issuer.[19] They find that, after correcting for self-selection bias, there is no significant difference between yields of rated and unrated bonds, so they conclude that issuers that forgo to obtain a rating behave rationally. First because all the municipalities in their proprietary database received a low rating (most a non-investment grade one), and second because most of the issuers which don't request a rating are small municipalities whose small and infrequent issues are generally marketed to local banks who know the creditworthiness of the issuer and are able to price correctly the bonds. So to this type of issuers incurring the costs of a rating would be irrational, given that obtaining a rating would not change the credit assessment of investors and therefore would not lower the interests paid on the bond.

III.3 Factors determining sub-sovereign ratings

Whilst a widely covered research subject for the US municipal market, local government credit ratings outside the US have been academically studied only starting in the mid-1990s, following the growth in the number of ratings assigned to non-US sub-national governments by the major international agencies.[20] However, despite the increasing importance of the local government market in the last twenty years, only one study, at the time of writing, has analyzed empirically Italian sub-sovereign ratings.

[19] The authors commissioned a project to Moody's, which applied the same procedures normally used for solicited ratings. The analysts who worked on the assessment didn't know that the ratings they produced were unsolicited and aimed at academic purposes, so they worked under standard informational conditions.
[20] See Liu and Tan (2009).

III.3.1 US research

The main empirical studies on US municipal rating market date back to the early studies in the 1960s and 1970s. For example, the relevance of variables such as population and debt ratios was already demonstrated in the seminal study of Carleton and Lerner (1969), which developed a prediction model, applied to a set of US municipal bonds, aimed at duplicating Moody's local government ratings. Later on, the above cited Liu and Thakor (1984), estimating their non-linear numerical transformation of ratings against a set of economic and financial variables, found that debt ratios and unemployment were able to explain a high percentage of the sample variance of ratings. However, Moon and Stotsky (1993) tested the differences in the determinants of municipal ratings for Moody's and S&P and found significant discrepancies. While Moody's ratings determinants confirmed previous studies results, with the strong significance of per capita income and debt ratios, Standard & Poor's ratings were characterized by different significant variables and an overall lower relevance of socio-economic and financial variables.

On the other hand, some studies asserted that fiscal and financial variables are not the key determinants of credit ratings. As an instance, Loviscek and Crowley (1988), applying a linear probability model to a set of city and county ratings, found that variables measuring economic base diversification (i.e. population growth and energy endowment) were more accurate than accounting and financial variables in explaining ratings. Moreover, Lipnick et al. (1999), analyzing Moody's methodology, highlighted the importance of management and administrative factors in addition to economic and financial indicators.

III.3.2 Non-US international research

The academic research on local government credit ratings outside the US still amounts to a limited production. The first non-US empirical study on the subject is Cheung (1996). The author, applied an ordered probit model to estimate the relationship between the ratings released by Standard and Poor's to Canadian Provinces and a set of economic and financial variables. The results highlighted the relevance, beyond variables already identified in previous studies such as debt to GDP, local GDP and unemployment, of the financial autonomy of the provinces, measured by the ratio of federal transfers to total revenues.

More recently, Gaillard (2009) investigated Moody's ratings for non-US local governments. Gaillard, adopting an ordered probit model, demonstrated that sub-sovereign ratings are essentially constrained by their respective sovereign rating. Moreover, adopting an ordered probit model, he also found that three

variables (sovereign default history, local per-capita GDP and local debt-to-revenues ratio) were able to explain up to 80% of sub-sovereign ratings.

III.3.3 National research

The only empirical study to cover the Italian sub-sovereign rating market, at the time of writing, is Venneri (2013). Venneri, following Gaillard (2009), applied an ordered probit model to the ratings released by Moody's, Standard and Poor's and Fitch, between 2004 and 2008, to a sample of Italian provinces and cities. The interpretation of Venneri's findings, except for the significance of per capita GDP, is not straightforward since some of the significant variables appeared with the unexpected sign and, contrary to theoretical expectations and evidences from the literature, indebtedness indicators are never statistically significant. Venneri's ambiguous results can be explained on technical bases, pointing out to multicollinearity issues due to the adoption of possibly redundant explanatory variables and to the small sample properties of the estimation method.

III.4 Methodological issues

The estimation of the effects of economic, fiscal and financial variables on municipal bond yields does not present particular problems *per se*. The large majority of the studies on the subject have adopted standard OLS cross-section and panel data models. However, several issues on the empirical methodology must be addressed.

One major issue to be taken into account when estimating the impact of economic, fiscal and financial variables on yields is endogeneity. Endogeneity happens when one or more of the explanatory variables are correlated with the error term of a regression, causing the estimated parameters to be biased. In our setting, the main source of potential endogeneity is reverse causality, or the inability to discern the correct direction in a cause-effect relationship. For instance, Robbins and Simonsen (2012) warn about the possible endogenous relationship between outstanding debt and interest rates and suggest to estimate the model using two-stage least squares with instruments for the outstanding debt. The authors point out that as interest rates may rise in response to an increase in the debt load of a local government (because of the augmented credit risk), it might also happen that debt is cut back because interest rates have risen (because of the increased cost of borrowing). It needs to be specified, however, that the endogeneity problem between debt and interest rates can be avoided by using the risk premium (difference between the

municipal bond yield and a risk-free rate) as the dependent variable as done, among others, by Bernoth et al. (2006, 2012), Booth et al. (2007) and Schuknecht et al. (2009). Moreover, endogeneity has been highlighted also between fiscal policy and local bond yields. For example, Poterba and Rueben (1999), analyzing the impact of fiscal institutions on municipal bond yields, proposed the use of instrumental variables in a simultaneous equations setting to avoid the endogeneity issue between budget rules and fiscal policy. Furthermore, reverse causality is strictly connected to simultaneity. As remarked by Capeci (1994) in his study on the effect of local fiscal policy on bond yields, the simultaneous estimation of bond yields and fiscal variables may lead to endogenous explanatory variables. Since, for example, high interest rates might discourage the recourse to deficit spending through debt financing, this means that interest rates might affect budget decisions and so the direction of the causality is not unambiguous. Linking the issue of endogeneity to the existence of information asymmetries between issuers and investors, Capeci (1994) proved that this type of endogeneity can be addressed by substituting current explanatory variables with lagged ones, the latter being publicly available to investors while the former are known to the issuer only.

Another major issue in analysing the role of economic, financial and fiscal variables in the same model is multicollinearity. Multicollinearity refers to a high degree of correlation, or linear dependence, among regressors and commonly occurs when a large number of independent variables are incorporated into a regression model. Given the wide range of economic, financial and fiscal indicators available, it is very likely that many of them measure the same phenomena, therefore showing cross-correlations. Multicollinearity affects the estimation of regression's parameters, leading to a wrong assessment of statistical significance and erratic changes in the coefficients' estimates. The variables suspected to affect estimates can be identified by measuring the variance inflation factor (VIF), as in Benson and Marks (2007). The variance inflation factor measures how much the variance of an estimated regression's coefficient is increased by linear dependence, it is obtained by regressing an explanatory variable against all the other regressors and computing the R-squared of such a regression. Although none of the reviewed papers have, in addition to the calculation of single variable cross-correlations and VIFs, also the whole covariance matrix of the explanatory variables should be tested. The standard test for ill-condition of a matrix is the condition number (or condition index) which, by considering the magnitude of the eigenvalues, gives a measure of the overall multicollinearity of a regression.

Multicollinearity and endogeneity are also extremely relevant issues when an empirical model uses as regressors both credit ratings and observable variables

(fiscal, economic, financial etc.) simultaneously, as bond yields may depend on both the rating and observable variables, but the rating itself is likely to be affected by the same set of fiscal, economic and financial observable variables. The first study to address the issue of multicollinearity between rating and observable characteristics has been Liu and Thakor (1984). The authors deal with the multicollinearity issue by adopting a two-stage regression model: first the relationship between credit ratings and economic variables is estimated, then the residuals' vector from this regression is inserted as a regressor in an equation (with yield spreads as the dependent variable) which employs also the same set of economic variables used in the first estimate. The residuals from the rating regression are orthogonal by construction with respect to the explanatory variables (so any correlation issue is avoided) and carry that part of the rating score which is not explained by the economic variables, so the corresponding coefficient gives a measure of the marginal impact of the credit rating assessment on yields beyond the effect of the other observable variables in the model. Furthermore, beyond multicollinearity issues, a single equation model including both ratings and financial/economic information simultaneously, as exogenous variables, may be affected by an additional potential estimation problem. As noted by Reiter and Ziebart (1991), a single equation model of this kind is likely to suffer from endogeneity bias if an explanatory variable (i.e. the credit rating) is determined by other explanatory variables in the model (i.e. the economic and financial characteristics of the issuer). To tackle the possibly endogenous nature of the credit rating variable, Reiter and Ziebart (1991) adopt a system of two simultaneous structural equations (one for the yield and one for the rating), estimated through a two-stage generalized least squares model. One limit of the Reiter and Ziebart (1991) approach can be seen in the dated estimation technique adopted, specifically in the choice of the weight matrix in the optimization algorithm. A more generalized approach, to the same type of system modelling, can be obtained by employing the generalized method of moments (GMM) estimation.

Appendix III

Table APP.III.1 - Table of reviewed papers in chronological order

Author	Scope	Methodology	Data	Results
Carleton and Lerner (1969)	Duplicate Moody's ratings.	Statistical scoring.	US municipal bond ratings issued in 1967.	Variables such as population and debt ratios are relevant in predicting ratings.
Jantscher (1970)	Analyze the differences in interest rates paid by local governments with different credit ratings.	-	-	Yield differentials partly explained by credit rating and partly by the investors' independent credit analysis (market rating).
Hastie (1972)	Analyze municipal bond yields as a function of default risk and marketability.	OLS cross-sections.	US municipal bonds issued between 1957 and 1967.	Indicators such as debt burden, default history, economic base, population, outstanding debt and block size explain a large share of municipal bond yields.
Rubinfeld (1973)	Study the role of credit ratings in affecting municipal bond yields.	OLS cross-sections. Two-stage procedure to obtain rating scores estimates.	US municipal bonds issued in 1970. Ratings assigned by Moody's.	Published credit ratings have and independent effect beyond the market's evaluation of the financial status of the rated municipality.
Tanner (1975)	To investigate the effect of risk, underwriter compensation, maturity date, and size of issue, among other variables, on interest costs of new municipal debt.	OLS cross-sections.	US municipal bonds issued between 1971 and 1972.	The time to maturity of a bond and the number of bids in the underwriting process affect the interest costs of new bond issues.
Benson et al. (1981)	Examine the existence of a systematic variation in yield spreads for municipal bonds.	OLS cross-sections.	US municipal bonds issued between 1966 and 1975.	Yield spreads widen during an economic downturn and narrow during an economic expansion, with a greater effect for lower-rated bonds than for higher-rated bonds.
Broaddus and Cook (1981)	A comprehensive regression analysis of the determinants of municipal bond yields.	OLS cross-sections.	US municipal bonds issued between 1977 and 1978.	The specific provisions of the bond indenture, such as the early redemption clause (call option) and the coupon structure, affect municipal bond yields.
Wilson (1983)	Examine the degree of association between measures of budget performance and yield differentials on new issue municipal bonds.	OLS cross-sections.	US municipal bonds issued between 1978 and 1981.	Financial performance indicators such as current operating deficit and general fund deficit are important factors in analyzing local governments' credit risk.
Ingram et al. (1983)	Examine the information content of municipal bond rating	OLS regressions.	US municipal bonds issued between 1976	Rating changes have an impact on yields during the month of the change.

Table APP.III.1 - Table of reviewed papers in chronological order

Author	Scope	Methodology	Data	Results
	changes by evaluating municipal bond price adjustments during the period surrounding a rating change.		and 1979.	Upgraded bonds experience a decrease in yields, while downgraded ones face a yield rise.
Liu and Thakor (1984)	Empirical determination of the relationship between the ratings, economic indicators, and yields of municipal debt.	Two-stage regression model: first the relationship between credit ratings and economic variables is estimated; then the residuals' vector from this regression is inserted as a regressor in an equation with the economic variables.	US municipal bonds issued in 1977. Ratings assigned by Moody's.	Three variables (total debt, per-capita debt and unemployment), plus ratings, significantly affect municipal bond yields. Credit rating has an independent and significant effect on yields.
Loviscek and Crowley (1988)	Testing the relevance of variables measuring economic base diversification in determining municipal ratings.	Linear probability model.	Ratings assigned to US cities and counties in 1970 and in 1981.	Variables measuring economic base diversification more accurate than accounting and financial variables in explaining ratings.
Capeci (1991)	Examine the channels through which a municipality's credit quality affects its borrowing rate, considering both the direct effect of changes in credit quality on changes in borrowing rates and the indirect effect that operates through changes in credit ratings.	A random effects GLS estimation applied to first differences in a panel data set.	US municipal bonds issued in 1982 and in 1987. Ratings assigned by Moody's.	The influence of the economic and financial characteristics of the issuer on yields is confirmed. The independent effect of ratings is less significant compared to what was found by Liu and Thakor.
Liu and Seyyed (1991)	Define and statistically estimate a model to analyze how the socio-economic characteristics and the credit rating of a municipal bond issuer affect its borrowing cost.	Forward inclusion technique in stepwise regression in which the rating variable enters after all socio-economic variables are included.	US municipal bonds issued between 1981 and 1983. Ratings assigned by Moody's.	Including the rating variable in the estimated equation significantly improve the explanatory power of the model. Therefore credit ratings have an independent effect on yields beyond the socio-economic characteristics of the issuer.
Reiter and Ziebart (1991)	Analyze the relative roles of credit ratings and economic/financial information in the determination of bond yields.	System of simultaneous structural equations, estimated through a two-stage generalized least squares model.	US public utility bonds issued between 1981 and 1984. Ratings assigned by Moody's and S&P.	Both ratings and financial information are relevant in determining bond yields. Also, financial information is important in explaining yield differences for bonds belonging to the same rating category.
Stover (1991)	Design an empirical model to decompose the relationship	Path analysis model with maximum likelihood estimation.	US municipal bonds issued in 1977, 1984 and	The direct effect of the observable economic variables on yields is

Table APP.III.1 - Table of reviewed papers in chronological order

Author	Scope	Methodology	Data	Results
	between economic characteristics and yields of a municipal bond issuer into direct and indirect effects.		1985. Ratings assigned by Moody's.	irrelevant. The economic variables affect yields only indirectly through their impact on ratings
Hsueh and Liu (1993)	Study the role played by asymmetric information in municipal bond pricing, and examine why a non-negligible percentage of high-standing municipal borrowers choose not to purchase a bond rating.	Probit model with maximum likelihood estimation for the credit rating prediction, and OLS for bond interest cost estimation.	US municipal bonds issued between 1981 and 1986. Ratings assigned by Moody's.	Unrated issuers are penalized by paying a higher yield. Investors correctly price the differences in the credit quality of unrated issues. The issuers most likely to forgo a credit rating are the smaller ones which aim at local markets.
Moon and Stotsky (1993)	Test the differences in rating determinants for Moody's and Standard & Poor's.	Simultaneous equations estimated through maximum likelihood estimation.	US municipal bond ratings issued in 1981.	S&P's ratings characterized by different significant variables and an overall lower relevance of socio-economic and financial variables.
Capeci (1994)	Analyze how a local government's fiscal policies affect the default risk premium on its cost of borrowing.	Two-stage least squares with instrumental variables employed to correct for endogeneity.	US municipal bonds issued between 1975 and 1977.	The instrumental variables results suggest that there is an endogeneity issue between a municipality's financial variables and the interest rate paid on a bond.
Cheung (1996)	To estimate the relationship between the S&P provincial credit ratings, and a number of economic variables.	Ordered probit methodology.	Canadian provincial ratings released by S&P from 1969 to 1995.	Relevance of the financial autonomy of the provinces, measured by the ratio of federal transfers to total revenues.
Lipnick et al. (1999)	Analyzing Moody's rating methodology.	-	-	Importance of management and administrative factors in addition to economic and financial indicators.
Poterba and Rueben (1999)	Analyze the impact of fiscal institutions on municipal bond yields.	Instrumental variables in a simultaneous equations setting to avoid the endogeneity issue between budget rules and fiscal policy.	US municipal bonds issued between 1973 and 1995.	Fiscal institutions affect the required return on municipal bonds. Local governments subject to expenditure and borrowing limitations face lower borrowing costs.
Simonsen et al. (2001)	Explore whether a local authority's financial-management capacity and the bond's sale type (competitive or negotiated sale) influence municipal interest rates.	OLS cross-sections.	US municipal bonds issued between 1994 and 1997.	Smaller jurisdictions pay an interest cost penalty in the municipal bond market, and competitive sales result in slightly lower interest rates compared to negotiated sales.
Peng and Brucato (2003)	Examine the method of sale of municipal bonds as a certification	Probit model and OLS regressions.	US municipal bonds issued in 1998.	Local governments choose the method of sale according to the degree of

Table APP.III.1 - Table of reviewed papers in chronological order

Author	Scope	Methodology	Data	Results
	mechanism, and its impact on the borrowing cost of debt issues.			information asymmetry. Competitive bidding has a slight cost advantage over negotiated sale.
Johnson and Kriz (2005)	Investigate the impact of fiscal institutions on local government borrowing costs.	Ordered probit model to estimate the effect on ratings. OLS to estimate the effect on borrowing costs. Path analysis to identify direct and indirect effects.	US municipal bonds issued between 1990 and 1997.	Positive direct effect of revenue limits on yields. Expenditure and borrowing limits have a positive effect on ratings. Negative indirect effect on bond's yields.
Bernoth et al. (2006, 2012)	Study bond risk premia among EU government bonds as a function of default risk, liquidity risk and market risk.	Portfolio model of bond yield differentials based on financial theory. OLS regressions and instrumental variables.	EU and US central government bonds issued between 1993 and 2005.	Yield spreads are affected by default and liquidity risk. The default risk premium is positively affected by the debt and debt service ratios. The liquidity risk premium is lower in countries with larger market shares.
Benson and Marks (2007)	Study the factors affecting the borrowing costs of US state governments, with specific attention to the impact of state fiscal imbalances.	OLS cross-sections.	US state bonds issued in 1999 and 2000.	Interest costs reflect estimates of state structural deficits. States which exhibit greater structural deficits pay higher interest costs than states facing lower or no structural deficits.
Booth et al. (2007)	Estimate the impact of Canadian provinces' fiscal and financial condition on their yield spreads over Canadian central government bonds.	Bernoth et al. (2006, 2012) theoretical portfolio model. Panel-data regressions.	Canadian provincial government bonds issued between 1981 and 2000.	Provincial fiscal positions (debt and deficit) significantly affect yield spreads between provincial and federal government bonds. Provincial bonds respond to changes in economic conditions in a similar way to corporate bonds.
Allen et al. (2009)	Investigate whether the choice of forgoing a bond rating causes an interest cost penalty higher than the cost of the rating.	Probit and switching regression models.	US municipal bonds issued between 1999 and 2000. Proprietary data-base containing unpublished ratings.	No significant difference between yields of rated and unrated bonds. Issuers that forgo to obtain a rating behave rationally.
Gaillard (2009)	Investigate Moody's ratings' determinants for non-US local governments.	Ordered probit model.	Non-US municipal ratings released by Moody's in 2005.	Sub-sovereign ratings are constrained by sovereign rating. Three variables (sovereign default history, local per-capita GDP and local debt-to-revenues ratio) able to explain 80% of sub-sovereign ratings.
Schuknecht et al. (2009)	Study risk premia paid by sub-national governments in Germany, Spain, and	Bernoth et al. (2006, 2012) theoretical portfolio model. Cross-section	German, Spanish and Canadian sub-national government	Sub-sovereign governments paid positive differentials compared to their respective central

Table APP.III.1 - Table of reviewed papers in chronological order

Author	Scope	Methodology	Data	Results
	Canada. Analyze how the risk premia were affected by the introduction of the Euro.	regressions.	bonds issued between 1991 and 2005.	governments. Spreads between sub-sovereign and sovereign bonds narrowed in Germany and Spain after the introduction of the Euro. Fiscal equalization schemes affect the credit risk of sub-national governments.
Schulz and Wolff (2009)	Quantitative analysis on the determinants of the yield differential between bonds issued by German *Landers* (federal states) and the *bund* (the German Government bond).	Panel-data regressions.	German federal states' bonds issued between 1992 and 2007.	Yield spreads between central and state government bonds are mainly driven by international risk aversion.
Robbins and Simonsen (2012)	Investigate the effect of debt levels on the borrowing costs of US states.	Two-stage least squares and OLS.	US state bonds issued between 2001 and 2006.	The market does not extract an interest cost penalty for increasing debt loads. Municipal debt has increased unabated throughout the sample period, while states have maintained nearly uniformly high bond ratings.
Venneri (2013)	Investigate the determinants of ratings assigned by Moody's, S&P and Fitch to Italian local governments.	Ordered probit model.	Ratings released by Moody's, S&P and Fitch to Italian local governments between 2004 and 2008.	Some variables appeared with the unexpected sign and debt indicators are never statistically significant.

Part II

Empirical Analysis

Chapter IV

Determinants of Municipal Bond Yields

This chapter develops extensively the empirical analysis on Municipal Bond Yields. The analysis is elaborated through five sections. Section IV.1 focuses on the relationship between risk and municipal bond yields. Section IV.2 illustrates the theoretical model and its empirical specification. Section IV.3 describes the dataset. Section IV.4 analyzes the basic regression analysis on the determinants of yields. Section IV.5 investigates the role of credit rating in affecting yields.

IV.1 The relationship between risk and municipal bond yields

As highlighted in Chapter III, the academic literature on municipal bond pricing has mostly focused on the relationship between the borrower's risk and the lender's required yield.

When the borrower is a local government, i.e. an authority which raises revenues by collecting taxes on a territory, receiving transfers from the central State and selling services to the public, several factors must be considered in order to assess its capability to duly service its debt. The vast empirical literature on the subject has adopted a wide set of variables and indicators, which can be summarized in 3 classes: characteristics of the issuer, market and macroeconomic factors and characteristics of the security.

IV.1.1 Characteristics of the issuer

According to the existing research, the first class, characteristics of the issuer, can be divided into 3 categories: accounting and financial variables, fiscal variables and socio-economic variables.

The first category, accounting and financial variables, includes:

- debt load (Liu and Thakor, 1984; Capeci, 1991; Capeci, 1994; Booth et al., 2007; Schuknecht et al., 2009; Venneri, 2013), probably the most important variable affecting the default risk of an issuer, this indicator for the existing debt has mainly been used as a ratio over a measure of income (overall debt / GDP), revenues (overall debt / total revenues, overall debt / current revenues) or in per capita terms;

- debt service (Capeci, 1994; Venneri, 2013), while the debt load measures the existing stock of debt, this indicator (often expressed as a ratio over revenues) accounts for annual expenses in interest and capital repayment and therefore is affected by the debt structure and interest rates of existing loans;

- current and capital balances (Capeci, 1994; Booth et al., 2007; Schuknecht et al., 2008; Venneri, 2013), this type of variable is extremely important to assess the financial condition of an administration, especially the current balance (difference between current revenues and current expenditures) indicates if the local government is generating or absorbing cash from its operating activity, cash which can be used for debt repayments and therefore the higher the current surplus the higher the probability that the issuer will be able to cope with debt service in the near future.

The second category, fiscal variables, accounts for:

- tax revenues (Liu and Thakor, 1984; Capeci, 1991; Venneri, 2013), mainly expressed in per-capita terms, is clearly the most important source of revenues for a local government;

- degree of fiscal autonomy (Capeci, 1991; Capeci, 1994; Schuknecht et al., 2009; Venneri, 2013), a ratio meant to describe the level of own revenues compared to the transfers from the central government.

The third category, socio-economic variables, consists of:

- local income (Liu and Thakor, 1984; Capeci, 1991; Venneri, 2013), usually specified as local GDP per capita, indicators of local income are important to evaluate the economic base over which local taxes are levied, because the richer a territory the higher the taxes than can be collected on it;

- population (Liu and Thakor, 1984; Capeci, 1991; Capeci, 1994), the size of a local administration, measured by the number of people on which it exercises its powers, has always proved to be significant when inserted in an empirical model, with smaller administrations usually paying higher interest rates compared to their larger peers, this can be explained by the fact that larger administrations have better management abilities, greater autonomy and are more familiar with financial markets;

- unemployment (Liu and Thakor, 1984; Booth et al., 2007; Venneri, 2013), this indicator, expressed as a percentage rate, helps assessing the economic strength of a territory, with weakness in the labour force employed always associated with higher interest rates.

IV.1.2 Market and macroeconomic factors

Given a certain creditworthiness of an issuer, other factors, external to the issuer but common to the market or the economy as a whole, are likely to affect the yield of a local bond issue.

For example, early studies such as Benson et al. (1981), focused on the relationship between municipal bond yields and the business cycle. Using as explanatory variables, together with several issuer specific variables listed in section IV.1.1, two indicators such as national GDP growth rate and a consumer sentiment index, they observed that spreads over the risk-free rate (in every rating category) widened during economic downturns and narrowed during economic expansions.

Moreover, Shultz and Wolff (2008), analysing the determinants of yield differentials between German state bonds issued by Länder and bund issued by the federal government, found that the yield spreads between state and federal bonds were mainly explained by international risk aversion, proxied by the yield spread between US corporate bonds rated BBB and treasury bonds issued by US government.

IV.1.3 Characteristics of the security

The empirical literature on the subject has traditionally included in the model specification a set of provisions stated in the bond issue agreement. Since early studies, variables such as amount of the issue (Hastie, 1972), maturity (Tanner, 1975) and coupon structure (Broaddus and Cook, 1981) have consistently been included in empirical estimations. These features affect yields independently of the creditworthiness of the issuer.

For example maturity and coupon structure influence the duration of the bond, duration increases with the maturity of the bond and decreases with the frequency of coupons payments and with the size of coupon rate.[21] Since duration is the main indicator of interest rate risk and in a normal upward sloping term structure of interest rates we expect a positive relationship between duration and rates, maturity is expected to raise yields while coupon frequency and size are expected to lower yields.

[21] Duration or Macaulay duration is a measure of a bond price sensitivity to changes in interest rates. Duration is defined as the weighted average term to maturity of a security's cash flows, where the weights are the present value of each cash flow as a percentage to the security's price. This indicator was first proposed by Macaulay (1938).

The amount of the bond issue can be seen as a proxy for liquidity or marketability, given the fact that the larger the issue the higher the number of intermediaries and investors involved and the less the impact of transaction costs. Hence, we expect lower yields for larger issues.

IV.2 A model for the analysis of municipal bond yields

The risk-return relationship can be based on financial theory, specifying basic settings such as investors' preferences and market functioning. Once a theoretical model is obtained, the specific observable variables able to act as proxy for the underlying factors must be chosen from a wide set of possible candidates.

IV.2.1 Theoretical framework

The equation to be estimated can be easily derived from a simple portfolio model of bond yield differentials, as in Bernoth et al. (2006, 2012), Booth et al. (2007) and Schuknecht et al. (2009). Bernoth et al. (2006, 2012) considers a risk-averse investor, optimising in a mean-variance space, in a market with two assets: a risk-free bond and a bond subject to default risk, both denominated in the same currency. After portfolio optimization and market clearing the model delivers the following pricing equation:[22]

$$\text{(IV.1)} r_{i,t} - r_{f,t} = \pi(x_t)\left(1 + r_{i,t} - \beta_t\right) + \gamma_t + S_t\pi(x_t)(1 - \pi(x_t))\left(1 + r_{i,t} - \beta_t\right)^2\varphi^{-1},$$

where

$r_{i,t}$ is the yield of the risky bond,

$r_{f,t}$ is the yield of the risk-free bond,

$\pi(x_t)$ is the default probability of the risky bond (a function of x_t, which represents a set of variables affecting this probability),

$\beta_t \in [0,1]$ is the fraction of the par value of the risky bond received by the investor in the event of default,

γ_t is the transaction cost for trading the risky bond (with transaction costs of the risk-free bond normalized to zero),

S_t is the total supply of the risky bond,

[22] The notation used here follows the equation specification in Booth et al. (2007).

φ is a measure of investors' risk tolerance (the inverse of the relative risk aversion).[23]

This model defines the yield spread (between the risky and the risk-free bond) as a function of three factors: default risk, liquidity risk and market risk.

The first term on the right hand side, $\pi(x_t)\left(1 + r_{i,t} - \beta_t\right)$, reflects the *default risk premium*. It depends positively on the default probability of the risky issuer, $\pi(x_t)$, and negatively on the fraction of repayment the investor receives in case of default, β_t. Since β_t ranges between 0 and 1 the default risk premium is always positive.

The second term, γ_t, is the *liquidity premium*, identified by the transaction cost (relative to the transaction cost of the risk-free bond, which has been normalised to zero). Clearly, the more liquid the risky bond, the smaller the premium. Given the fact that the risk-free asset is represented by highly liquid government bonds, this premium is non-negative.

The third term, $S_t\pi(x_t)(1 - \pi(x_t))\left(1 + r_{i,t} - \beta_t\right)^2\varphi^{-1}$, represents the *market risk premium* which is affected by the total debt issued by the risky issuer, S_t, by the variance of the return on the risky security, $\pi(x_t)(1 - \pi(x_t))\left(1 + r_{i,t} - \beta_t\right)^2$, and by investors' risk tolerance, φ, represented in the formula by its inverse, φ^{-1}, the investors' risk aversion.[24] The more investors care about the variance of their future wealth (the larger the risk aversion term), the larger will be the interest rate differential between the risky and the risk-free asset. Furthermore, the market risk premium clearly increases with the total supply of risky debt and with the variance of the risky security, as both the total debt and the variance amplify the effect of risk aversion. Since all three terms S_t, $\pi(x_t)(1 - \pi(x_t))\left(1 + r_{i,t} - \beta_t\right)^2$ and φ are positive by assumption, the market risk premium in the pricing equation is strictly positive.

This general model can be adapted to the case of local government bonds as done by Booth et al. (2007) with Canadian provincial bonds and by Schuknecht et al. (2009) with German Lander's bonds and Spanish provincial bonds.

IV.2.2 Empirical specification

[23] The *Arrow-Pratt* measure of relative risk aversion (RRA) is $\frac{cU''(c)}{U'(c)}$. Pratt (1964).

[24] The derivation of the variance of the risky bond can be found in Bernoth et al. (2012), page 986.

Once the theoretical model has been outlined and the risk factors have been identified, the observable variables can be selected, among the categories detailed in section IV.1, in order to proxy for the underlying risk factors.

The empirical model to be estimated, with the yield differential between a risky municipal bond and a risk-free bond as the dependent variable, can be outlined as:[25]

(IV.2) $r_{i,t} - r_{f,t} = \alpha + \beta'_{\mathrm{ISS}}\mathrm{I_{i,t}} + \beta'_{\mathrm{MKT}}\mathrm{M_{i,t}} + \beta'_{\mathrm{SEC}}\mathrm{S_{i,t}} + \varepsilon_{\mathrm{i,t}}$,

Where $r_{i,t}$ is the yield of the risky municipal bond, $r_{f,t}$ is the yield of the risk-free bond, α is a scalar intercept, β'_{ISS}, β'_{MKT} and β'_{SEC} are row vectors of coefficients, $\mathrm{I_{i,t}}$, $\mathrm{M_{i,t}}$ and $\mathrm{S_{i,t}}$ are column vectors of, respectively, characteristics of the issuer, market/macroeconomic variables and characteristics of the security. The description of the variables is detailed in the following table.

Table IV.1 - Description of variables

Variable	Symbol	Description	Formula	Measure	Exp. sign
Accounting and financial variables					
Current Balance	A_01_curr_bal	Current revenues (CR) minus current expenditures (CE), over current revenues (CR).	(CR – CE) / CR	Ratio	-
Total Balance	A_02_tot_bal	Sum of current revenues (CR) and capital revenues (CaR) minus the sum of current expenditures (CE) and capital expenditures (CaE), over the sum of current revenues (CR) and capital revenues (CaR).	((CR + CaR) – (CE + CaE)) / (CR + CaR)	Ratio	-
Debt to Revenues	A_03_debt_rev	Total outstanding debt (D) over the sum of current revenues (CR) and capital revenues (CaR).	D / (CR + CaR)	Ratio	+
Per capita Debt	A_04_pc_debt	Total outstanding debt at constant prices* (Dcp) over population (P), log-transformed.	Ln(Dcp / P)	Ratio (log)	+
Debt Service	A_05_debt_serv	Sum of debt reimbursement (DR) and interest payments (I) over current revenues (CR).	(DR + I) / CR	Ratio	+
Interest Coverage	A_06_int_cov	Current revenues (CR) minus gross current expenditures (CE – I), over interest payments (I).	(CR – CE + I) / I	Ratio	-
Current Expenditures	A_07_curr_exp	Current expenditures (CE) over the sum of current expenditures (CE) and capital expenditures (CaE).	CE / (CE + CaE)	Ratio	+
Personnel Expenses	A_08_pers_exp	Personnel expenses (PE) over current expenditures (CE).	PE / CE	Ratio	+
Current Rigidity	A_09_curr_rig	Sum of personnel expenses (PE) and debt reimbursement (DR) over current revenues (CR).	(PE + DR) / CR	Ratio	+
Fiscal variables					

[25] As detailed in section IV.3, the risk-free rate has been proxied by the 10-year German government treasury bond yield.

Table IV.1 - Description of variables

Variable	Symbol	Description	Formula	Measure	Exp. sign
Per capita revenues	F_01_pc_rev	Sum of current revenues (CRcp) and capital revenues (CaRcp) at constant prices, over population (P), log-transformed.*	Ln((CRcp + CaRcp) / P)	Ratio (log)	-
Net revenues	F_02_net_rev	Current revenues (CR) minus debt reimbursement (DR) and interest payments (I), over current revenues (CR).	(CR – DR – I) / CR	Ratio	-
Financial Autonomy	F_03_fin_aut	Sum of tax revenues (TR) and other revenues (OR) over current revenues (CR).	(TR + OR) / CR	Ratio	-
Tax Autonomy	F_04_tax_aut	Tax revenues (TR) over current revenues (CR).	TR / CR	Ratio	-
Socio-economic variables					
Unemployment	E_01_unem	Unemployment percent rate (U)**.	U	%	+
Population	E_02_pop	Number of residents (P), log-transformed.	Ln(P)	Log	-
Per capita Income	E_03_pc_inc	Local per capita added value (LAVpc) over national per capita added value (NAVpc)**.	LAVpc / NAVpc	Ratio	-
Market and macroeconomic variables					
BTP-BUND Spread	M_01_btp_bund	Difference between 10-year Italian Government bond yield (BTP) and 10-year German Government bond yield (BUND).	BTP - BUND	%	+
Rating Italy	M_02_rat_ita	Credit rating assigned to the central Italian Government (RATIta) by Moody's, S&P and Fitch***.	RATIta	***	-
Risk Aversion	M_03_baa_gov	Difference between long term Moody's Baa US corporate bond yields (Baa) and 10-year US Government bond yield (Gov).	Baa – Gov	%	+
Economic Sentiment	M_04_econ_sen	Italy's monthly economic sentiment indicator (ES) published by Eurostat.	ES	Scaled to 100	-
GDP Change	M_05_gdp_cng	Italy's GDP growth rate compared to the same quarter of previous year, published by OECD.	GDP	%	-
Bond issue's characteristics					
Maturity	I_01_mat	Bond maturity at issue in years.	Mat	Years	+
Average Life	I_02_avg_life	Weighted average of the times (t) of the principal (P) repayments of the bond at issue.	$\sum_{i=1}^{n} \frac{P_i}{P} t_i$	Years	+
Size	I_03_size	Amount of the issue in Euros (Size), log-transformed.	Ln(Size)	Log	-
Dummy variables					
Fixed Rate	D_01_fixed	Takes value 1 if the bond coupon is fixed, 0 otherwise.	-	1,0	+
Rated Issuer	D_02_rated	Takes value 1 if the issuer is rated by at least one rating agency, 0 otherwise.	-	1,0	-

Table IV.1 - Description of variables

Variable	Symbol	Description	Formula	Measure	Exp. sign
Southern Italy	D_03_south	Takes value 1 if, according to the European Union NUTS classification (Nomenclature of Territorial Units for Statistics), the issuer belongs to the ITF group (Abruzzo, Basilicata, Calabria, Campania, Molise, Puglia) or to the ITG group (Sardegna and Sicilia), 0 otherwise.	-	1,0	+
Sovereign Crisis	D_04_crisis	Takes value 1 if the bond has been issued from 4 March 2008 onwards (day in which the BTP-BUND spread crossed the 50 basis point threshold for the first time since the introduction of the Euro), 0 otherwise.	-	1,0	+

* Base year: 1999.
** For the cities in the sample, since data at city level are unavailable, these indicators refer to the figures of the corresponding provinces.
*** The calculation methodology for rating scores is explained in section IV.3.

IV.3 Data

The empirical analysis includes 399 bond issues, issued by 122 Italian local governments between 2000 and 2011.[26] Of which 198 bonds issued by 56 cities, 156 bonds issued by 50 provinces and 45 bonds issued by 16 regions. The list of local governments in the sample and the details on the bonds issued are given in Appendix IV.1 at the end of this chapter.

IV.3.1 Data description

The sub-sample relating the cities has been formed by cities (*Comuni*) possessing the status of Provincial Capital (*Capoluogo di Provincia*), therefore excluding the smallest and less significant local authorities, widely diversified across eighteen out of the twenty Italian regions as detailed in Appendix IV.1.[27]

The yield spread has been divided into two categories: fixed coupon bonds (192 out of 399 bonds) and floating rate bonds (207 out of 399 bonds). For the first one the yield spread has been calculated as the difference between the bond's yield at issue and the yield of the 10-year German Government's bond

[26] The observation period has been chosen to avoid exchange rate issues and therefore allows the use of German government Bund as the reference risk-free rate in the analysis. Given the fact that starting January 1999 Italy has adopted the Euro currency, all financial and statistical documents have been reported in Euro from that year. The bond sample starts in year 2000 because the analysis requires previous year accounting and statistical figures for each issue.
[27] The two missing regions are *Trentino-Alto Adige* and *Val d'Aosta*.

(generally referred to as the "Bund") on the pricing date of the bond.[28] For the second category the yield spread is the margin, expressed as annual percentage rate, over the base rate stated in each bond's prospectus.[29]

183 out of 399 bonds in the sample are rated by one (or more) of the three major international rating agencies, Moody's Investors Service, Standard & Poor's Financial Services and Fitch Ratings, with the details on ratings assigned by the three agencies given in Table IV.2. In order to perform tests about the influence of ratings on bond yields, since credit ratings are expressed by letters, a conversion into numerical values was necessary. The rating score has been calculated following Liu and Thakor (1984). First, out of sample (US market) yield differentials between rating classes have been calculated, then a value proportional to the yield differentials has been assigned to each rating category, with the highest score assigned to the Aaa/AAA class and a value equal to zero assigned to the Baa2/BBB category (no bond in the sample has a rating below Baa2/BBB).[30]

Table IV.2 - Number of bonds in each rating category

Rating category	Rating agency			Total
	Moody's	S&P	Fitch	
Aaa/AAA	-	-	-	**-**
Aa1/AA+	-	-	-	**-**
Aa2/AA	34	13	6	**53**
Aa3/AA-	41	17	52	**110**
A1/A+	11	27	15	**53**
A2/A	7	12	4	**23**
A3/A-	1	2	1	**4**
Baa1/BBB+	-	1	-	**1**
Baa2/BBB	-	-	-	**-**
Total	**94**	**72**	**78**	**244***

* The number of rated bonds in the sample is 183, 57 of which have two ratings and 2 have three ratings, hence the total number of 244.

[28] Fixed rate bond's yield has been calculated as the internal rate of return (IRR) of the bond's cash flows at the issue date, expressed as an annual percentage rate. The IRR is defined as the discount rate that makes the net present value of all cash flows from an investment equal to zero.

[29] For all floating rate bonds in the sample the base rate is the Euribor rate. Euribor stands for Euro Inter Bank Offered Rate and represents the reference rate for floating rate loans and bonds in the European Monetary Union. For bonds issued under or above par, the reported margin would not be a good measure of a bond yield differential. In these cases an interest rate correction has been applied in order to account for the extra (positive or negative) yield deriving from the premium or discount in the price of the bond. In this study only 3 out of the 207 floating rate bonds in the sample were not issued at par.

[30] The bond yields for every rating class have been taken from "BofA Merrill Lynch US Corporate Bond Effective Yield" indexes, as the average of the period 01/01/2000 – 31/12/2011. The rating scores for each rating category are: Aaa/AAA = 1.50, Aa1/AA+ = 1.46, Aa2/AA = 1.37, Aa3/AA- = 1.23, A1/A+ = 1.03, A2/A = 0.80, A3/A- = 0.55, Baa1/BBB+ = 0.28, Baa/BBB = 0. The rating scores have been calculated as average yield differentials between a given rating category and the lowest Baa/BBB category, with yields' averages computed on daily data over the period 01/01/2000-31/12/2011. E.g. the 1.37 score assigned to the Aa2/AA category is equal to the absolute difference between the Aa2/AA average yield (4.84) and the Baa/BBB average yield (6.21).

Table IV.2 shows that credit ratings are almost equally spread among the three rating agencies, with a slightly higher number of ratings released by Moody's. Interestingly, all bonds in the sample were rated as investment grade and the large majority of rating assessments falls into high categories (with two thirds of ratings ranging between Aa2/AA and Aa3/AA-).

IV.3.2 Data analysis

Table IV.3 reports the descriptive statistics of the dependent and independent variables used in the empirical analysis. For each variable in the sample are reported the average of the pooled sample together with those of the six sub-samples relating to: cities (198 observations), provinces (156 observations), regions (45 observations), rated issues (183 observations), bond issued by issuers located in southern regions (69 observations), bond issued during the financial crisis (51 observations).[31]

Table IV.3 - Descriptive statistics

Variable	Symbol	Total Avg	Cities Avg	Provinces Avg	Regions Avg	Rated Avg	South Avg	Crisis Avg
Dependent variables								
Fixed Rate Spread	01_fix_spread	0.52	0.49	0.54	0.57	0.44	0.60	0.82
Floating Rate Spread	02_float_spread	0.15	0.14	0.16	0.15	0.12	0.26	0.34
Rating Score	03_rating	1.15	1.16	1.09	1.17	-	0.94	1.20
Accounting and financial variables								
Current Balance	A_01_curr_bal	0.08	0.05	0.13	0.09	0.08	0.07	0.08
Total Balance	A_02_tot_bal	-0.10	-0.07	-0.14	-0.09	-0.09	-0.19	-0.03
Debt to Revenues	A_03_debt_rev	0.83	0.89	0.94	0.20	0.72	0.86	0.87
Per capita Debt *	A_04_pc_debt	719	1,190	167	562	923	441	854
Debt Service	A_05_debt_serv	0.16	0.20	0.15	0.03	0.15	0.19	0.17
Interest Coverage	A_06_int_cov	3.85	2.03	3.91	11.66	5.40	3.34	2.40
Current Expenditures	A_07_curr_exp	0.65	0.67	0.59	0.78	0.69	0.64	0.64
Personnel Expenses	A_08_pers_exp	0.27	0.33	0.27	-	0.23	0.26	0.32
Current Rigidity	A_09_curr_rig	0.40	0.46	0.33	-	0.41	0.47	0.40
Fiscal variables								

[31] According to the European Union NUTS classification (Nomenclature of Territorial Units for Statistics), in this study the southern region category includes the ITF group (Abruzzo, Basilicata, Calabria, Campania, Molise, Puglia) and the ITG group (Sardegna and Sicilia). Moreover, in this chapter for financial crisis is intended the sample period from 4 March 2008 (day in which the BTP-BUND spread crossed the 50 basis point threshold for the first time since the introduction of the Euro) to 31/12/2011.

Table IV.3 - Descriptive statistics

Variable	Symbol	Total Avg	Cities Avg	Provinces Avg	Regions Avg	Rated Avg	South Avg	Crisis Avg
Per capita revenues *	F_01_pc_rev	1,020	1,350	191	2,440	1,444	807	1,043
Net revenues	F_02_net_rev	0.84	0.80	0.85	0.97	0.85	0.81	0.83
Financial Autonomy	F_03_fin_aut	0.69	0.75	0.60	0.76	0.73	0.57	0.70
Tax Autonomy	F_04_tax_aut	0.54	0.49	0.54	0.73	0.55	0.48	0.45
Socio-economic variables								
Unemployment	E_01_unem	6.18	5.72	6.42	7.30	6.04	13.71	4.04
Population *	E_02_pop	669K	204K	692K	2,635K	1,030K	770K	313K
Per capita Income	E_03_pc_inc	1.06	1.08	1.05	1.01	1.07	0.71	1.17
Market and macroeconomic variables								
BTP-BUND Spread	M_01_btp_bund	0.33	0.38	0.30	0.23	-	-	1.02
Rating Italy	M_02_rat_ita	1.30	1.30	1.30	1.31	-	-	1.21
Risk Aversion	M_03_baa_gov	2.45	2.48	2.45	2.33	-	-	3.94
Economic Sentiment	M_04_econ_sen	101.29	100.54	101.62	103.43	-	-	90.47
GDP Change	M_05_gdp_cha	0.98	0.83	1.04	1.46	-	-	-1.98
Bond issue's characteristics								
Maturity	I_01_mat	20.27	18.68	21.97	21.4	-	-	-
Average Life	I_02_avg_life	12.12	10.71	12.84	15.80	-	-	-
Size *	I_03_size	54.8M	33.6M	18.9M	272.5M	-	-	-

* These indicators have been computed in log form for the regression analysis but displayed in standard measures in this table for an easier interpretation of the data.

Looking first at the dependent variables, we can notice that there are no significant differences in the averages between cities, provinces and regions. Also, the yield spreads are slightly lower on average for rated bonds, slightly higher for bonds issued by southern issuers and much higher for those bonds issued during the financial crisis. We can also notice that rating scores are lower for southern issuers and higher for issues floated during the crisis.

Moving to the several sets of independent variables (accounting, financial, fiscal and socio-economic), we can notice that, with exception of socio-economic indicators, there are significant differences between the averages of cities, provinces and regions, with the main variance occurring for regional governments. Moreover, we can see that average values for rated issues do not differ systematically from those relative to the full sample.[32] On the other hand, for southern issuers many indicators (for an evident example: unemployment and per-capita income) show a worse economic condition for this sub-sample. Lastly, looking at the average values for the cities and provinces which have issued bonds during the financial crisis (no region has issued during the

[32] More precise statistical tests will be carried in the next section.

financial crisis), we can notice that they are characterized by higher socio-economic figures and by similar accounting and fiscal indicators.

To sum up, first of all, we can conclude that the three tiers of local government are characterized by different levels particularly in issuer-specific indicators such as fiscal and financial variables. Besides, it seems that rated issuers pay lower interest rates while their economic, accounting and fiscal characteristics are not (on average) different from those related to the full sample. Moreover, southern cities show lower ratings and this seems justified by their weaker economic condition. Also, bonds issued during the crisis show much higher spreads, compared to the full sample, even if rating and overall indicators are better or at least not worse. The latter result leads to two considerations: first, we are facing a market selection issue where only high standing cities in strong economic and financial condition went to the bond market during the crisis; second, higher spreads paid by local governments during the crisis are driven by national and international market factors (all five market and macroeconomic variables in Table IV.3 show worse average levels for this sub-sample) and are not affected by the creditworthiness of the issuer.

These impressions derived by the observation of the descriptive statistics will be formally tested in the following sections.

IV.3.3 Data sources

All the data used in this study have been collected from official sources, such as the national institute of statistics, the Italian Government, the Italian stock exchange, Eurostat and OECD, as detailed below.[33] These databases allowed a wide set of indicators (listed in Table IV.1 above) to be used to measure the three risk factors highlighted in section IV.1: default risk, liquidity risk and market risk.[34]

Bond prospectuses have been provided by Monte Titoli SpA (the Italian custody and settlement bank belonging to the Italian Stock Exchange) which allowed special access to its proprietary database for the purposes of this research.

Accounting data of each *Comune* and *Provincia* in the sample have been obtained from the local finance database of the Italian Government. While data for the *Regioni* have been obtained from each regional government website or

[33] Each source website is reported in the References section.
[34] Due to lack of data it hasn't been possible to build a property value indicator, often used as a tax base indicator for property tax. This is a minor drawback since the Italian property tax in force during the sample period, I.C.I. (*Imposta Comunale sugli Immobili*), was not directly linked to the property value but depended on the size, use (business, residential etc.) and the area where the estate is located.

provided directly by regional administration offices, because accounting data for regions are not included in the local finance database.

Socioeconomic data at territorial level such as local income, population, unemployment etc. have been obtained from Istat's "Sitis" data-warehouse.[35] Economic data at national level such as GDP, price indices, economic sentiment etc. have been obtained from Istat, Eurostat and OECD.

Financial data for German and Italian Government bond yields have been obtained by Bloomberg Professional Service, data for Euribor rates from the European Money Markets Institute, data for US Government and Corporate bond yields from the Federal Reserve Bank of St. Louis.

Credit ratings assigned to each rated issuer have been provided by Moody's Investors Service, Standard & Poor's Financial Services and Fitch Ratings.

IV.4 Basic model estimation

This section deals with the estimation issues involving the basic empirical model, aimed at understanding the role of the different factors expected to affect municipal bond yields. The statistical procedure for selecting the actual variables to be inserted in the final version of the empirical model is illustrated in sub-section IV.4.1, and the results of the regression analysis are presented in sub-section IV.4.2.

A further deeper analysis on the role of credit ratings in influencing sub-sovereign yields is carried out in Section IV.5.

IV.4.1 Choice of variables

As first pointed out by Liu and Thakor (1984), a major issue in analysing the role of economic, financial and fiscal variables in the same model is multicollinearity. Given the wide range of indicators that can be used to assess the default risk of an issuer, it is very likely that many suitable variables show cross-correlation or linear dependence and therefore affect the estimation of regression's parameters, which may lead to a wrong assessment of statistical significance and erratic changes in the coefficients' estimates. The sets of indicators described in Table IV.1 include many interchangeable variables. Clearly, as an example, the issuers located in a wealthy area (high per-capita income, E_03)

[35] Istat is the Italian national institute for Statistics. "Sitis" (*Sistema di Indicatori Territoriali*) is a system of economic, demographic, social and environmental indicators referring to geographical areas, regions, provinces and cities.

should face low unemployment (E_01) and are likely to benefit from high per-capita revenues (F_01), therefore showing a higher financial autonomy (F_03) compared to issuers in worse economic condition. Similarly, a local government with a high debt compared to its revenues (A_03) is likely to show high debt figures also in per-capita terms (A_04). Also, badly managed local governments have all expenditure-quality indicators such as current expenditures (A_07), personnel expenses (A_08) and current expenditure rigidity (A_09) pointing out the same condition. Moreover, also market indicators are evidently interrelated, since as international risk-aversion (M_03) increases so does the sovereign risk indicator (M_01), which is, by the way, also affected by Italy's GDP growth rate (M_05). Hence, the first step of this empirical analysis is to select the best variables in terms of the efficiency and effectiveness of the empirical model.

The variables most likely to affect estimates have been identified by measuring the variance inflation factor (VIF), the condition index related to the variance-covariance matrix of regressors, together with the pair wise correlations of both variables and regression coefficients. The details of the selection procedure for the elimination of the inefficient variables are given in Appendix IV.2. After the variable selection procedure, the following variables have left: two accounting variables (A_01, A_03), one socio-economic variable (E_03), one market variable (M_01), one issue-related variable (I_02) and two dummy variables (D_01, D_02). As detailed in Appendix IV.2, the model show a condition index of 21, extremely low VIFs and no cross-correlation above 25%. The cross-correlations (for both the variables and the coefficients) are displayed in Table IV.4.

Table IV.4 - Correlation matrix (coefficients' correlations in parentheses)

Variable	A_01	A_03	E_03	M_01	I_02	D_01	D_02
A_01_curr_bal	1						
A_03_debt_rev	0.14 (-0.15)	1					
E_03_pc_inc	0.15 (-0.16)	-0.04 (0.05)	1				
M_01_btp_bund	-0.04 (0.07)	0.06 (-0.04)	0.16 (-0.19)	1			
I_02_avg_life	0.02 (-0.04)	-0.04 (0.03)	-0.14 (0.13)	-0.12 (0.08)	1		
D_01_fixed	-0.04 (0.02)	0.10 (-0.08)	-0.10 (0.14)	0.22 (-0.23)	-0.05 (0.04)	1	
D_02_rated	-0.01 (-0.02)	-0.24 (0.24)	0.06 (-0.06)	-0.05 (0.05)	0.02 (-0.01)	-0.03 (-0.01)	1

The final set of indicators comprises a wide range of regressors able to detect the three risk factors (default risk, liquidity risk and market risk) identified in section IV.2. It includes: a measure of the current deficit/surplus (A_01), a debt burden indicator (A_03), a major economic condition indicator such as the per-capita income (E_03), the sovereign-risk indicator (M_01) meant to assess how

national and international financial factors affect local government yields, a technical indicator able to detect the exposure of the bond to interest rate risk (I_02), and two dummy variables. The first dummy (D_01) has a technical function as it accounts for the difference in scale between fixed and floating rate bonds, while the second (D_02) is meant to identify any significant difference, in terms of yield, between rated and unrated bonds. For convenience, Table IV.5 below reports the same information contained in Table IV.1 (description, formulas, measure and expected sign) but only for the variables which are going to be used in the regression analysis.

Table IV.5 - Description of the variables used in regression analysis

Variable	Symbol	Description	Formula	Measure	Exp. sign
Accounting and financial variables					
Current Balance	A_01_curr_bal	Current revenues (CR) minus current expenditures (CE), over current revenues (CR).	(CR – CE) / CR	Ratio	-
Debt to Revenues	A_03_debt_rev	Total outstanding debt (D) over the sum of current revenues (CR) and capital revenues (CaR).	D / (CR + CaR)	Ratio	+
Socio-economic variables					
Per capita Income	E_03_pc_inc	Local per capita added value (LAVpc) over national per capita added value (NAVpc)*.	LAVpc / NAVpc	Ratio	-
Market and macroeconomic variables					
BTP-BUND Spread	M_01_btp_bund	Difference between 10-year Italian Government bond yield (BTP) and 10-year German Government bond yield (BUND).	BTP - BUND	%	+
Bond issue's characteristics					
Average Life	I_02_avg_life	Weighted average of the times (t) of the principal (P) repayments of the bond at issue.	$\sum_{i=1}^{n} \frac{P_i}{P} t_i$	Years	+
Dummy variables					
Fixed Rate	D_01_fixed	Takes value 1 if the bond coupon is fixed, 0 otherwise.	-	1,0	+
Rated Issuer	D_02_rated	Takes value 1 if the issuer is rated by at least one rating agency, 0 otherwise.	-	1,0	-

* For the cities in the sample, since data at city level are unavailable, these indicators refer to the figures of the corresponding provinces.

Another important concern in choosing the empirical specification is endogeneity. As Capeci (1994) asserted in his study on the effect of local fiscal policy on bond yields, treating the explanatory variables as exogenous when analysing the simultaneous relationship between fiscal variables and borrowing costs might lead to biased estimations, as the direction of the causality is not clear (fiscal variables affect interest rates but also interest rates affect budget decisions). Capeci links the issue of endogeneity to the existence of information

asymmetries, as he noted that the endogeneity bias disappears when current variables are substituted with lagged ones, the latter being publicly available and known to investors when they price new bond issues. In this study all accounting, fiscal and socio-economic variables refer to previous year (with reference to the issue date) financial statements and statistics, with only market and macroeconomic data taken as simultaneous (as endogeneity is clearly excluded).[36]

IV.4.2 Regression results

Throughout this section the dependent variable used in the regression analysis is the bonds' yield spread. As detailed in the previous section IV.3, the yield spread is calculated differently for the two bond coupon types, fixed rate and floating rate. For the fixed rate bonds in the sample the yield spread is represented by the yield differential between a municipal bond and the German 10-year Bund, while for the floating rate bonds is represented by the margin over the Euribor base rate (corrected for bonds issued under or above par).

The first step of the regression analysis is a poolability test. Since the descriptive statistics in Table IV.3 show a possible different behavior for the variables relating to the different categories of issuers (cities, provinces and regions), the poolability of the three categories has been formally tested. The first half of table IV.6 reports the results of two tests, called Poolability 1 and Poolability 2. The former tests whether there is a structural difference in the intercept and slopes of the regression model for the regions. A dummy variable taking the value 1 in case the issuer is a region (and 0 otherwise) and four interaction terms have been employed and tested both individually and jointly. One significant interaction term (E_03, per-capita income) and the joint F-test around 5% detect a difference in the behavior of the group of bonds issued by regions compared to the remaining group of cities and provinces. Moreover, Poolability 2 does the same type of test between cities and provinces. Here, unlike regions, no interaction term is significant and the joint F-test is above 55%, meaning that no structural difference between cities and provinces is detected.[37] These results, given the institutional nature of the three sub-national governments considered, are not quite surprising. Since, while cities and

[36] The 30th of April of each year is taken as a cut-off date to assume all information to be publicly available, (i.e. a bond issued on the 1st of May 2010 refers to data at 31st December 2009, while a bond issued on the 30th of April 2010 refers to data at 31st December 2008). Such a cut-off date has been chosen because Italian law compels local authorities to approve their annual financial statements no later than the 30th of April of each year and because socio-economic statistics are usually released soon after the first quarter of each year.

[37] This result has been confirmed by the two individual regressions run on cities and provinces separately.

provinces possess a similar status and are subject to the same legislation, Italian regions (which are not considered local authorities) are more independent, have some legislative powers and a higher fiscal autonomy. Therefore, in the following analysis, regions will be studied separately while cities and provinces will be pooled together and jointly identified under the term "Local Authorities" (*Enti Locali* in Italian).

The different behavior of regions is confirmed by the direct comparison of regressions 1 and 2 in Table IV.6, the first is run on the sample consisting of regions alone and the second on the sample consisting of cities and provinces altogether (local authorities). Two evident differences immediately arise, the role of per-capita income (E_03) which is significant only for regions, and the effect of BTP-BUND spread (M_01) which, vice versa, is significant only for cities and provinces. These results indicates that, while yields paid by local authorities are strongly linked to the yields paid by the Italian central government, the yields paid by regions are not. This means that the market perception of sovereign risk directly affects the pricing of local authorities' bonds but it's not affecting the bonds issued by regions. Moreover, Regression 2 shows that for local authorities none of the variables related to default risk (A_01 current balance, A_03 debt-revenue ratio and E_03 per-capita income) is significant (individually and jointly). For local authorities, around 60% of the variance in yield spreads is explained by market risk (M_01) and interest rate risk (I_02), together with the two dummy variables. On the other hand, Regression 1 shows that for regions the socio-economic variable (E_03 per-capita income) it is significant at 5% level and it appears with the expected sign, meaning that wealthier regions are charged lower interest rates compared to their poorer peers, once the characteristics of the bond have been controlled for (by variables I_02 and D_01).

Looking at the remaining regression's results, it can be observed that all significant variables enter with the correct expected sign. Also, the two dummies, the fixed coupon dummy (D_01) and the rated dummy (D_02), have very significant coefficients. The former is extremely important in this model because the dependent variable consists of both fixed and floating rate bonds' spreads, therefore this dummy is essential to correct for the different scale existing between the yields of the two bond types. The rated dummy (D_02) is extremely significant and has a negative sign, this means that (after having controlled for all the variables in the model) rated bonds pay, on average, 9 basis points less than their unrated counterparts.[38] Lastly, since both

[38] Regression 1 does not report a coefficient for the rated dummy D_02 because all bond issued by the regions in the sample are rated. An analysis on the role of credit ratings will be carried in the next section.

heteroschedasticity and serial correlation have been detected, White test and LM test have been run for each regression and robust standard errors computed accordingly. Test type and standard error's correction is reported in each regression's table together with standard regression output information.

Table IV.6 - Poolability tests (robust t-stats in parentheses)

Explanatory Variables	Poolability 1 Regions	Poolability 2 Provinces	Regression 1 Regions	Regression 2 Local Authorities
A_01_curr_bal	-0.11 (-0.45)	-0.77 (-1.52)	-0.09 (-0.30)	-0.12 (-0.47)
A_03_debt_rev	0.02 (0.61)	-0.01 (-0.14)	-0.04 (-0.12)	0.02 (0.54)
E_03_pc_inc	-0.03 (-0.54)	0.02 (0.33)	**-0.56**** **(-2.65)**	-0.03 (-0.56)
M_01_btp_bund	**0.41***** **(8.26)**	**0.41***** **(8.04)**	0.19 (0.56)	**0.41***** **(8.53)**
I_02_avg_life	**0.02***** **(7.35)**	**0.02***** **(7.52)**	**0.01**** **(2.59)**	**0.02***** **(7.41)**
D_01_fixed	**0.31***** **(11.74)**	**0.30***** **(10.22)**	**0.43***** **(5.48)**	**0.29***** **(10.78)**
D_02_rated	**-0.09***** **(-2.99)**	**-0.07**** **(-2.03)**	-	**-0.09***** **(-2.97)**
C	**-0.15**** **(-2.07)**	**-0.19*** **(-1.87)**	0.46 (1.59)	**-0.18**** **(-2.35)**
Observations	399	354	45	354
Adj. R2	-	-	63.60%	59.80%
F-test (prob.)	-	-	0.00%	0.00%
Wald F-test (prob.)	-	-	88.52%	70.84%
Condition index	-	-	26.14	21.07
White test (prob.)	0.00%	0.00%	0.47%	0.00%
Serial correlation LM test (prob.)	0.00%	0.00%	12.88%	0.00%
S.E. correction	Newey-West	Newey-West	White	Newey-West
Poolability diagnostics				
Reg_dummy	0.42 (1.60)	-	-	-
A_01_curr_bal x Reg_dummy	-0.18 (-0.47)	-	-	-
A_03_debt_rev x Reg_dummy	0.30 (0.99)	-	-	-
E_03_pc_inc x Reg_dummy	**-0.45*** **(-1.93)**	-	-	-
M_01_btp_bund x Reg_dummy	0.16 (0.43)	-	-	-
Prov_dummy	-	0.04 (0.29)	-	-
A_01_curr_bal x Prov_dummy	-	1.12 (1.54)	-	-
A_03_debt_rev x Prov_dummy	-	0.03 (0.44)	-	-
E_03_pc_inc x Prov_dummy	-	-0.16 (-1.60)	-	-
M_01_btp_bund x Prov_dummy	-	0.06 (0.48)	-	-
Joint F-test interactions (prob.)	5.40%	55.74%	-	-

* Significant at 10% level.
** Significant at 5% level.
*** Significant at 1% level.

Now, after having detected the differences between regions and local authorities, a second test is necessary. Since all regional bonds in the sample have been issued before the financial crisis, the differences detected between the two groups could also be due to a possible structural break between the two periods before and during the financial crisis. Therefore, a similar test as above have been run on the local authorities' sample and the results displayed in Table IV.7. A dummy variable taking the value 1 in case the bond has been issued during the financial crisis (and 0 otherwise) and four interaction terms have been employed and tested both individually and jointly. As reported under the Structural break 1 regression in the table, a weakly significant interaction term has been found (the BTP-BUND spread M_01) but the joint F-test failed to reject the null hypothesis. Therefore, two separate regressions have been run and compared, one consisting of bonds issued before the financial crisis (Structural break 2) and one consisting of bonds issued during the crisis (Structural break 3). Comparing the two regressions it can be noticed that M_01 and D_01 have different coefficients and this is clearly explained by the general widening of yields spreads which has characterized the financial crisis. But what is most important in this test is that no creditworthiness related variable (A_01, A_03 and E_03) is significant in any of the two test regressions, particularly the E_03 indicator which was significant in the regions' sample. Hence, the irrelevance of issuer specific characteristics, in favor of market and bond characteristics indicators, is not due to the shock brought by the crisis but is intrinsic in the standard pricing of Italian local authorities' bonds. For a more convenient comparison, Table IV.7 includes also Regression 2 already reported above.

Table IV.7 – Financial crisis structural-break tests (robust t-stats in parentheses)

Explanatory Variables	**Str. break 1 Full sample**	**Str. break 2 Pre-crisis**	**Str. break 3 Crisis**	**Regression 2 Local Authorities**
A_01_curr_bal	-0.10 (-0.62)	-0.13 (-0.77)	0.29 (0.27)	-0.12 (-0.47)
A_03_debt_rev	0.03 (1.04)	0.03 (1.11)	-0.24 (-1.44)	0.02 (0.54)
E_03_pc_inc	**-0.09*** **(-1.77)**	-0.08 (-1.63)	1.09 (1.69)	-0.03 (-0.56)
M_01_btp_bund	**0.62***** **(3.77)**	**0.57***** **(3.58)**	**0.33***** **(5.95)**	**0.41***** **(8.53)**
I_02_avg_life	**0.02***** **(7.13)**	**0.02***** **(7.64)**	**0.04**** **(2.40)**	**0.02***** **(7.41)**
D_01_fixed	**0.28***** **(10.52)**	**0.25***** **(10.13)**	**0.51***** **(3.98)**	**0.29***** **(10.78)**
D_02_rated	**-0.07**** **(-2.36)**	**-0.11***** **(-5.21)**	0.22 (1.37)	**-0.09***** **(-2.97)**
C	**-0.17**** **(-2.12)**	**-0.13*** **(-1.67)**	**-1.60*** **(-1.81)**	**-0.18**** **(-2.35)**
Observations	354	303	51	354
Adj. R2	-	56.61%	32.75%	59.80%
F-test (prob.)	-	0.00%	0.08%	0.00%

Table IV.7 – Financial crisis structural-break tests (robust t-stats in parentheses)

Explanatory Variables	Str. break 1 Full sample	Str. break 2 Pre-crisis	Str. break 3 Crisis	Regression 2 Local Authorities
Wald F-test (prob.)	-	8.53%	22.72%	70.84%
Condition index	-	20.98	54.08	21.07
White test (prob.)	0.00%	0.00%	0.00%	0.00%
Serial correlation LM test (prob.)	0.00%	0.00%	9.53%	0.00%
S.E. correction	Newey-West	Newey-West	Newey-West	Newey-West
Structural-break diagnostics				
Crisis_dummy	-0.31 (-0.66)	-	-	-
A_01_curr_bal x Crisis_dummy	0.48 (0.46)	-	-	-
A_03_debt_rev x Crisis_dummy	-0.13 (-1.36)	-	-	-
E_03_pc_inc x Crisis_dummy	0.53 (1.46)	-	-	-
M_01_btp_bund x Crisis_dummy	**-0.32*** **(-1.82)**	-	-	-
Joint F-test interactions (prob.)	16.72%	-	-	-

* Significant at 10% level.
** Significant at 5% level.
*** Significant at 1% level.

Now, lastly, an analysis on the sensitivity of regression coefficients to changes in the sample composition will be performed. The full sample analyzed above, in order to use the most information available and to not intervene arbitrarily on the data, included all bonds in the data set without any adjustment. The major issue with this sample is that is not balanced, as shown in Appendix IV.1 some issuers have floated several bonds while some others only one, some years have seen a large number of bond issues while some others only a few or no issue at all. So, in order to test if regression's coefficients are stable, two adjustments have been applied to the full sample available.

First, a single year cross-section has been selected. The year chosen is 2005 given the highest number of observations available and the relative stability of market and macroeconomic indicators. The bonds in this sub-sample include all bonds issued by cities and provinces from 1st May 2005 to 31st December 2005, so that the same information set applied (financial report year, socio-economic statistical releases etc.). This sub-sample consists of 76 bonds, almost equally divided between cities and provinces, almost equally divided between fixed and floating rate and of which 27 bonds possess a credit rating. The rationale of the choice of this sub-sample relies on testing bonds issued under similar market and macroeconomic conditions, and on avoiding the problems involving those entities with a high number of issues over the full sample period 2000-2011. Specifically, the aim of this test is to check if the relevance of issuer-specific characteristics (A_01, A_03 and E_03) have been dominated by the effect of the sovereign risk indicator (M_01) over the full sample period. As reported in

Table IV.8 under Regression 3, the BTP-BUND spread is, as expected, non-significant, but even in this scenario none of the three default risk indicators are significant either. So this means that, even when the dominance of market factors is excluded, the characteristics of the issuing local government are not taken into account by investors when they price an Italian municipal bond. Also, the other significant variables in Regression 3 confirm almost identical coefficients and statistical significance as in the full sample, the R-squared is quite high (above 70%) and the serial correlation in the errors vanished as stated by the LM test.

The second adjustment applied to the data set consisted in building a more balanced sample of bonds, correcting for the possible bias due to the fact that some issuers have floated many bonds during the sample period 2000-2011 while some others have issued only once over the same period, and increasing the sample size compared to the single year cross-section. Hence, in the new balanced sample a maximum of two bonds per issuer have been allowed, with only one bond belonging to same coupon type (one floating rate and one fixed rate bond per issuer). The priority has been given to the earliest bonds floated by a single issuer, assuming that investors exerted a deeper analysis when a local government approached the bond market for the first time. This second sub-sample consists of 135 bonds, almost equally divided between cities and provinces, almost balanced between fixed and floating rate and of which 41 bonds possess a credit rating. The results relating this second sub-sample are reported under Regression 4 in Table IV.8. As expected, the problems due to serial correlation have been significantly reduced as confirmed by the LM test (around 14%) and the overall result has not changed compared to the full sample (Regression 2).

Table IV.8 - Local authorities' sample sensitivity analysis (robust t-stats in parentheses)

Explanatory Variables	Regression 2 Full sample	Regression 3 Cross-section (2005)	Regression 4 Balanced sample
A_01_curr_bal	-0.12 (-0.47)	-0.20 (-1.23)	-0.26 (-1.04)
A_03_debt_rev	0.02 (0.54)	-0.01 (-0.03)	0.07 (1.49)
E_03_pc_inc	-0.03 (-0.56)	-0.04 (-0.62)	-0.02 (-0.27)
M_01_btp_bund	**0.41***** **(8.53)**	-1.29 (-1.08)	**0.49***** **(5.50)**
I_02_avg_life	**0.02***** **(7.41)**	**0.02***** **(4.10)**	**0.02***** **(4.67)**
D_01_fixed	**0.29***** **(10.78)**	**0.26***** **(9.01**	**0.31***** **(9.12)**
D_02_rated	**-0.09***** **(-2.97)**	**-0.10***** **(-3.75)**	**-0.08**** **(-2.46)**
C	**-0.18****	0.18	**-0.18****

Table IV.8 - Local authorities' sample sensitivity analysis (robust t-stats in parentheses)

Explanatory Variables	Regression 2 Full sample	Regression 3 Cross-section (2005)	Regression 4 Balanced sample
	(-2.35)	(0.57)	**(-2.03)**
Observations	354	76	135
Adj. R2	59.80%	70.85%	62.33%
F-test (prob.)	0.00%	0.00%	0.00%
Wald F-test (prob.)	70.84%	44.21%	33.80%
Condition index	21.07	63.89	17.53
White test (prob.)	0.00%	0.00%	0.00%
Serial correlation LM test (prob.)	0.00%	65.60%	13.68%
S.E. correction	Newey-West	White	White
* Significant at 10% level.			
** Significant at 5% level.			
*** Significant at 1% level.			

Summarizing the results obtained in this section, several interesting findings can be identified. First, it seems that investors price differently bonds issued by regions compared to those issued by cities and provinces. While local authorities' yields are closely linked to central government's ones, this doesn't happen with yields paid by regions, as these are mainly driven by the economic strength of the issuer. Also, the results show that none of the default-risk indicators are significant in local authorities' regressions, implying that the market does not discriminate yields according to borrower's risk, applying a sort of average pricing to the whole category of issuers. This surprising result has been confirmed as robust by several tests on the sample, and even in the single year cross-section (which excluded sovereign risk by construction) there was no role for issuer-specific characteristics. Moreover, another interesting finding is that possessing a credit rating matters. In every sample version rated issuers paid in interests, ceteris paribus, less than their unrated peers, with the benefit ranging from eight to ten basis point per year. A deeper analysis on the role of credit ratings is the subject of the next section.

IV.5 Role of credit rating

The regression output presented in Table IV.8 shows that rated issuers benefit from a credit rating compared to their unrated peers. The coefficient for the rated dummy (D_02) was extremely significant in the full sample (Regression 2) and in the adjusted samples (Regression 3 and Regression 4) and showed a value between -0.08 and -0.10, this means that *ceteris paribus*, after having controlled for all the variables in the model, rated issuers on average had a yield spread between 0.08% and 0.10% (in annual percentage rate) lower than their unrated counterparts, i.e. they paid in interest 8-10 basis points less on average

for any given level of the other (financial, economic, market etc.) variables in the model.

To this end, Liu and Thakor (1984) asserted that ratings have an independent effect beyond the observable characteristics of the issuer, because ratings' *raison d'être* is that they carry information that is not publicly available. That is, rating can be seen as a screening instrument *à la* Stiglitz and its acquisition by borrowers represents a signalling mechanism through which high standing issuers differentiate themselves from low quality ones, avoiding the "average quality pricing" phenomenon described by Akerlof.[39] Other studies, as Hsueh and Liu (1993), confirmed the view of credit rating as a signalling instrument through which high-quality issuers can reveal their true creditworthiness to the market, reducing the agency cost between the issuer and the investor and therefore increasing the information content of market prices.

Once the positive effect of possessing a rating has been demonstrated in section IV.4.2, the impact of the rating assessment must be addressed (i.e. if, for example, a AA rated issuer pays less interests than a BBB one). Now, a model that uses as regressors both the rating and the other observable variables (accounting, economic, market etc.) simultaneously is seriously exposed to multicollinearity problems, because bond yields depend both on the rating and on the other variables, but the rating itself is affected by the same set of accounting, fiscal, economic and market variables.

Moreover, as pointed out by Reiter and Ziebart (1991), the use of a single equation including both ratings and financial/economic information simultaneously as exogenous variables can raise an additional potential problem in the estimation. Such a model is likely to suffer from endogeneity bias if an independent variable (i.e. the credit rating) is determined by other independent variables (i.e. the economic and financial characteristics of the issuer) in the single equation specification.

Therefore, two different models have been estimated, tested and compared. A single equation two-stage regression model adopting an orthogonal rating indicator in order to avoid multicollinearity issues, and a system of simultaneous structural equations adopting a set of instrumental variables to address endogeneity problems. The two methods are illustrated in section IV.5.1 and V.5.2 respectively.

IV.5.1 Orthogonal rating residuals

[39] Stiglitz (1975). Akerlof (1970).

Following the Liu and Thakor (1984) methodology, a two-stage regression model is adopted, first the rating score (calculated as described in section IV.3.1) is regressed against the same set of variables used to analyze the yield spreads, then the residuals from this regression are inserted as an additional regressor in the original model.[40] The residuals from the rating regression are orthogonal (by construction) with respect to the explanatory variables (so any collinearity issue is avoided) and carry that part of the rating score which is not explained by the model, so the corresponding coefficient gives a measure of the marginal impact of the credit rating assessment on yields beyond the effect of the other observable variables in the model.

The following analysis has been conducted separately on the rated sub-sample of local authorities (138 observations) and on regions (45 observations), therefore the rated dummy (D_02) has been dropped from the variables' list and alternatively replaced by the rating score and by the orthogonal rating residuals as displayed in the following tables.

Table IV.9 reports the results of four regressions for the local authorities' sample: Regression 5, the standard model (without the rated dummy) applied to bonds possessing a credit rating; Regression 6, the standard model plus the rating score variable; Regression 7, the standard model plus the orthogonal rating residuals; Regression 8, a model excluding the three default-risk variables (A_01, A_03 and E_03) replaced by the rating score. Firstly, it can be noticed that Regression 5 has analogous results compared to Regression 2 in previous section, meaning that the findings of the full sample are also valid for the rated sub-sample. Moreover, simply adding the rating score variable (Regression 6) to the standard model alters, as expected, both coefficients and standard errors due to the multicollinearity issues explained above. So, applying the Liu and Thakor procedure, the residuals from the rating regression are used as an additional regressor in the standard model (Regression 7). The coefficient of the rating residuals in Regression 7 appears with the expected negative sign (the higher the rating the lower the spread) but is not statistically significant.[41] Lastly, Regression 8 prove that even when the rating-related issuer specific variables are dropped from the model still the rating variable remains non-significant.

Table IV.9 - Analysis on ratings - Local Authorities (robust t-stats in parentheses)

[40] For the bonds possessing more than one credit rating, the average of the ratings scores assigned by the different agencies has been adopted.

[41] To be noted that, as pursued by the Liu and Thakor methodology, the rating score in Regression 6 shows the same coefficient and significance as found for the Liu and Thakor residuals in Regression 7 (clearly all other variables' coefficients and significance in Regression 6 are altered).

Explanatory Variables	Regression 5 Rated sample	Regression 6 Rating score	Regression 7 Orthogonal	Regression 8 Rating only
A_01_curr_bal	0.21 (0.25)	0.08 (0.10)	0.21 (0.25)	-
A_03_debt_rev	-0.08 (-0.70)	-0.11 (-0.91)	-0.08 (-0.71)	-
E_03_pc_inc	0.02 (0.13)	0.16 (0.76)	0.02 (0.13)	-
M_01_btp_bund	**0.47***** **(5.87)**	**0.47***** **(5.76)**	**0.47***** **(5.76)**	**0.46***** **(5.92)**
I_02_avg_life	**0.03***** **(5.97)**	**0.03***** **(5.65)**	**0.03***** **(5.92)**	**0.03***** **(5.42)**
D_01_fixed	**0.23***** **(3.95)**	**0.25***** **(3.97)**	**0.23***** **(3.99)**	**0.21***** **(4.20)**
Rating score	-	-0.26 (-1.58)	-	-0.12 (-1.37)
Orthogonal rating residuals	**-**	**-**	-0.26 (-1.58)	**-**
C	**-0.30**** **(-2.26)**	-0.09 (-0.49)	**-0.30**** **(-2.28)**	-0.16 (-1.43)
Observations	138	138	138	138
Adj. R2	51.32%	51.82%	51.82%	51.65%
F-test (prob.)	0.00%	0.00%	0.00%	0.00%
Wald F-test (prob.)	37.63%	21.11%	21.11%	n.a.
Condition index	22.20	28.98	22.20	20.18
White test (prob.)	0.00%	0.00%	0.00%	0.00%
Serial correlation LM test (prob.)	0.00%	0.00%	0.00%	0.00%
S.E. correction	Newey-West	Newey-West	Newey-West	Newey-West

* Significant at 10% level.
** Significant at 5% level.
*** Significant at 1% level.

By the results in Table IV.9 we can conclude that, even if section IV.4.2 demonstrated that possessing a rating reduces spreads, it seems that the rating assessment assigned to a local authority doesn't affect yields. So that, for example, a BBB issuer doesn't suffer an interest rate penalty compared to a AA one, but both of them get a benefit from having a credit rating in comparison with an unrated issuer. These results confirm the findings in previous sections, where, for the local authorities' sample, the creditworthiness of the issuer was found to be irrelevant in the determination of the yield of a municipal bond.

Also, this fact questions the reason of the lower yields observed for rated local authority bonds. If investors do not take into account the credit quality of a specific local authority, it is unlikely that they price rated bonds differently because having a rating signals, as asserted by Liu and Thakor (1984), higher quality. So, what probably makes rated bond different is their marketability in the secondary market, with the possession of a rating making easier the possibility of selling back the security with no (or with a lesser) discount with respect to its fair value. As stated by Amihud and Mendelson (1991): "ratings provide investors with more information on the bond, increasing its liquidity and

helping to reduce required yield".[42] Hence, the reason for this pricing discrimination can be attributed to liquidity risk, and not to default risk.[43]

Now, the same procedure described above has been applied to the regions in the sample. As already stated, all 45 regional bonds in the sample possess a credit rating. Table IV.10 reports the results of four regressions for the regions' sample, similarly to the previous analysis for local authorities: Regression 1, the standard model (without the rated dummy); Regression 9, the standard model plus the rating score variable; Regression 7, the standard model plus the orthogonal rating residuals; Regression 8, a model excluding the three default-risk variables (A_01, A_03 and E_03) replaced by the rating score.

As expected, Regression 9 shows altered coefficients and standard errors, particularly for the per-capita income indicator (E_03), because of the multicollinearity issue due to the presence of the rating score in this specification. This is confirmed by the higher condition number and by the lower probability of the Wald test which includes per-capita income in the joint F-test. Also, it can be noticed that, in Regression 10, the Liu and Thakor rating residuals don't affect the other regression coefficients as these are identical to those in Regression 1. The rating score and the rating residuals, respectively in Regression 9 and 10, show the correct negative sign but are not statistically significant. Moreover, it is interesting to notice that when the issuer-specific characteristics (A_01, A_03 and E_03) are removed and substituted by the rating score (regression 11), the latter become extremely significant and with the correct negative sign (the higher the rating the lower the yield spread).

Table IV.10 - Analysis on ratings - Regions (robust t-stats in parentheses)

Explanatory Variables	Regression 1 Regions	Regression 9 Rating score	Regression 10 Orthogonal	Regression 11 Rating only
A_01_curr_bal	-0.09 (-0.30)	-0.07 (-0.24)	-0.09 (-0.30)	-
A_03_debt_rev	-0.04 (-0.12)	-0.07 (-0.21)	-0.04 (-0.12)	-
E_03_pc_inc	**-0.56**** **(-2.65)**	-0.52 (-1.51)	**-0.56**** **(-2.61)**	-
M_01_btp_bund	0.19 (0.56)	0.20 (0.56)	0.19 (0.55)	0.32 (0.79)
I_02_avg_life	**0.01**** **(2.59)**	**0.01**** **(2.59)**	**0.01**** **(2.57)**	**0.01***** **(2.82)**
D_01_fixed	**0.43***** **(5.48)**	**0.43***** **(5.31)**	**0.43***** **(5.48)**	**0.41***** **(5.45)**
Rating score	-	-0.05 (-0.19)	-	**-0.42***** **(-2.86)**
Orthogonal rating residuals	**-**	**-**	-0.05 (-0.19)	**-**

[42] Amihud and Mendelson (1991).
[43] For other studies on the relationship between bonds' ratings and liquidity see: Chen et al. (2007) and Ederington et al. (1987).

Table IV.10 - Analysis on ratings - Regions (robust t-stats in parentheses)

Explanatory Variables	Regression 1 Regions	Regression 9 Rating score	Regression 10 Orthogonal	Regression 11 Rating only
C	0.46 (1.59)	0.49 (1.68)	0.46 (1.57)	0.35 (1.49)
Observations	45	45	45	45
Adj. R2	63.60%	62.64%	62.64%	62.19%
F-test (prob.)	0.00%	0.00%	0.00%	0.00%
Wald F-test (prob.)	88.52%	8.19%	95.62%	n.a.
Condition index	26.14	39.92	26.14	21.59
White test (prob.)	0.47%	2.54%	2.54%	0.00%
Serial correlation LM test (prob.)	12.88%	14.45%	14.45%	28.69%
S.E. correction	White	White	White	White
* Significant at 10% level.				
** Significant at 5% level.				
*** Significant at 1% level.				

In conclusion, the results in this section confirm the findings of the previous section IV.4.2. Investors price differently the bonds issued by regions from those issued by local authorities. Whereas all issuer default-risk related variables, including rating, are irrelevant in the pricing of local authorities' issues, this is not true for the pricing of regional bonds. Beyond the previously demonstrated role of the major economic indicator (E_03, per-capita income), also the credit rating of a region affect bond yields. Specifically, what emerged by the comparison of the several regressions estimated in this section is that the default risk of a region matters, either measured by the economic indicator or by the credit rating. But when the two variables, credit rating and per-capita income, are included in the same regression the former becomes irrelevant, meaning that credit ratings are not adding new information to investors beyond the information already obtainable by the analysis of publicly available economic indicators.

IV.5.2 System of simultaneous equations

To address the possible endogenous nature of the credit rating variable, a model consisting of a system of two structural equations, one for the yield spread and one for the credit rating, is estimated trough Generalized Method of Moments (GMM). The system specification is:

(IV.3) $r_{i,t} - r_{f,t} = \alpha + \beta'_{\mathrm{ISS}}\mathrm{I}_{\mathrm{i,t}} + \beta'_{\mathrm{MKT}}\mathrm{M}_{\mathrm{i,t}} + \beta'_{\mathrm{SEC}}\mathrm{S}_{\mathrm{i,t}} + \beta_{\mathrm{RAT}}\mathrm{RAT}_{\mathrm{i,t}} + \varepsilon_{\mathrm{i,t}}$;

(IV.4) $\mathrm{RAT}_{\mathrm{i,t}} = \gamma + \delta'_{\mathrm{ISS}}\mathrm{I}_{\mathrm{i,t}} + \mathrm{u}_{\mathrm{i,t}}$.

The equation for the yield spread (IV.3) is the standard model plus the rating score variable (RAT). The equation for the rating score (IV.4) includes the three issuer specific characteristics (A_01, A_03 and E_03) previously adopted and a

constant (γ). In order to deal with the endogenous formulation of the system, a set of instrumental variables must be used as instruments for the rating variable. The chosen instrumental variables must be exogenous (uncorrelated with the error term), correlated with the issuer-specific explanatory variables (A_01, A_03 and E_03) and possibly non correlated with each other to avoid collinearity issues. The selection procedure detailed in appendix APP.IV.3 has delivered two sets of instrumental variables, one for the Local Authorities' sample and one for the Regions' sample. The lists of instrumental variables will be included in the results tables for every estimated system.

The first sample to be analyzed is the Local Authorities'. Table IV.11 reports the estimation results of three different systems: System 1, the full model described by equations IV.3 and IV.4; System 2, the full model excluding the rating variable in equation IV.3; System 3, the full model excluding the three issuer specific characteristics (A_01, A_03 and E_03) but including the rating variable in equation IV.3. Since the analysis in section IV.4.2 detected both heteroskedasticity and serial correlation in the Local Authorities' sample, an heteroskedasticity and autocorrelation consistent (HAC) covariance matrix has been adopted for the GMM estimation, with the parameters reported in the table.

Table IV.11 - System of simultaneous equations - Local Authorities (t-stats in parentheses)

Explanatory Variables	System 1 Full model	System 2 No Rating	System 3 Rating only
Yield equation			
A_01_curr_bal	-0.62 (-0.83)	-0.43 (-0.48)	-
A_03_debt_rev	-0.32 (-1.45)	-0.30 (-1.23)	-
E_03_pc_inc	0.19 (0.63)	0.04 (0.22)	-
M_01_btp_bund	**0.48***** **(5.15)**	**0.49***** **(5.05)**	**0.42***** **(6.06)**
I_02_avg_life	**0.03***** **(2.94)**	**0.03***** **(3.79)**	**0.02***** **(5.93)**
D_01_fixed	**0.26***** **(3.48)**	**0.27***** **(3.49)**	**0.22***** **(4.84)**
Rating score	-0.27 (-0.55)	-	-0.24 (-1.36)
C	0.12 (0.34)	-0.09 (-0.54)	0.06 (0.31)
Rating equation			
A_01_curr_bal	0.03 (0.05)	-0.05 (-0.09)	-0.13 (-0.26)
A_03_debt_rev	0.05 (0.39)	0.05 (0.39)	0.05 (0.37)
E_03_pc_inc	**0.55***** **(2.95)**	**0.54***** **(3.03)**	**0.48***** **(3.05)**
C	**0.50**** **(2.24)**	**0.51**** **(2.43)**	**0.58***** **(2.97)**

Table IV.11 - System of simultaneous equations - Local Authorities (t-stats in parentheses)

Explanatory Variables	System 1 Full model	System 2 No Rating	System 3 Rating only
Observations	138	138	138
No. of parameters	12	11	9
No. of moments	19	19	19
Initial weight matrix	Unadjusted	Unadjusted	Unadjusted
GMM weight matrix	HAC	HAC	HAC
Kernel option	Bartlett	Bartlett	Bartlett
Bandwidth	Newey-West	Newey-West	Newey-West
Hansen's J-test (prob.)	11.25%	15.13%	19.37%
Instrumental variables Yield equation: A_02, A_06, A_07, F_01, F_02, F_04, E_01, M_01, I_02, D_01.			
Instrumental variables Rating equation: A_02, A_06, A_07, F_01, F_02, F_04, E_01.			
* Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level.			

The results in Table IV.11 are almost identical to those in Table IV.9, meaning that the GMM estimation of the system of simultaneous equations confirms the findings of the OLS single equation estimation. Again, all three issuer specific characteristics (A_01, A_03 and E_03) are non-significant, while the BTP-BUND spread (M_01), the average life of the bond (I_02) and the fixed coupon dummy are extremely significant in every system formulations. Also, as in the previous section, the credit rating variable is non-significant even when the issuer-specific variables are excluded (System 3). Therefore, the irrelevance of default-risk indicators in favour of market and issue-related variables has been confirmed for the Local Authorities' sample. Moreover, the rating equation shows only one significant variable, the per-capita income E_03, which has the correct positive sign (the higher the income the higher the rating) and is significant at 1% level. Lastly, the Hansen's J-test confirms the validity of the model's over-identification restrictions for all the three system formulations.

Now, the same systems of simultaneous equations are estimated for the Regions' sample. Since the analysis in section IV.4.2 detected heteroskedasticity but no serial correlation in this last sample, an heteroskedasticity consistent (White) covariance matrix has been adopted for the GMM estimation, whose parameters are reported in Table IV.12.

Table IV.12 - System of simultaneous equations - Regions (t-stats in parentheses)

Explanatory Variables	System 1 Full model	System 2 No Rating	System 3 Rating only
Yield equation			
A_01_curr_bal	0.38 (0.74)	0.16 (0.67)	-
A_03_debt_rev	-0.57 (-0.88)	-0.31 (-1.28)	-
E_03_pc_inc	-0.54 (-0.54)	**-0.99***** **(-6.58)**	-
M_01_btp_bund	0.19	0.04	0.37

Table IV.12 - System of simultaneous equations - Regions (t-stats in parentheses)

Explanatory Variables	System 1 Full model	System 2 No Rating	System 3 Rating only
	(0.55)	(0.14)	(1.08)
I_02_avg_life	**0.01***** **(2.83)**	**0.01***** **(3.80)**	**0.01***** **(2.92)**
D_01_fixed	**0.42***** **(5.87)**	**0.43***** **(6.83)**	**0.34***** **(5.02)**
Rating score	-0.46 (-0.43)	-	**-0.81***** **(-4.75)**
C	**1.08**** **(2.43)**	**0.99***** **(4.97)**	**0.86***** **(3.25)**
Rating equation			
A_01_curr_bal	**0.32*** **(1.85)**	**0.30*** **(1.79)**	**0.44***** **(4.84)**
A_03_debt_rev	**-0.64***** **(-4.12)**	**-0.63***** **(-4.24)**	**-0.60***** **(-5.25)**
E_03_pc_inc	**0.88***** **(11.23)**	**0.89***** **(12.50)**	**0.93***** **(14.29)**
C	**0.40***** **(4.24)**	**0.39***** **(4.44)**	**0.33***** **(4.14)**
Observations	45	45	45
No. of parameters	12	11	9
No. of moments	19	19	19
Initial weight matrix	Unadjusted	Unadjusted	Unadjusted
GMM weight matrix	White	White	White
Hansen's J-test (prob.)	67.81%	66.53%	57.07%
Instrumental variables Yield equation: A_02, A_04, A_06, F_02, F_03, E_01, E_02, M_01, I_02, D_01.			
Instrumental variables Rating equation: A_02, A_04, A_06, F_02, F_03, E_01, E_02.			
* Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level.			

The results in Table IV.12, again, confirm the findings of Section IV.4.2. As above, Regions show a different behaviour compared to Local Authorities. First, the sovereign risk (M_01, the BTP-BUND spread) is not significant in any of the three systems, confirming that Regions are perceived as less dependent on the central government compared to Local Authorities. Also, when the credit rating is excluded from the model (System 2), the per-capita income (E_03) becomes extremely significant and appears with the correct negative sign (the higher the income the lower the spread). Similarly, when the three issuer specific variables (A_01, A_03 and E_03) are replaced by the rating variable (System 3), the latter becomes extremely significant and as well with the correct negative sign (the higher the rating the lower the spread). However, when the credit rating is estimated together with the three default-risk related variables (System 1), both the rating and the per-capita income appear with correct negative sign but are not statistically significant. Moreover, the issue-related variables (I_02 and D_01) show, as usual, an extreme statistical significance, a stable coefficients' magnitude and a correct sign. Furthermore, the rating equation is characterized by all three explanatory variables being significant and with the expected sign.

Lastly, the Hansen's J-test largely confirms the validity of the model's over-identification restrictions for all the three system formulations.

Interestingly, the system formulation of the model allows to account for the direct and indirect (through the credit rating) effects of the issuer-specific characteristics, and specifically of the per-capita income. The direct effect of per-capita income on yields is given by the coefficient in the yield equation of System 1 (-0.54), while the indirect effect of the per-capita income through the rating is given by the product of the rating coefficient in the yield equation of System 1 (-0.46) by the per-capita income coefficient in the rating equation of System 1 (0.88). So, the indirect effect can be quantified in -0.40 (-0.46 X 0.88) and the direct effect in -0.54, where the sum of the two effects (-0.94, the total effect) is very close to the estimated coefficient for per-capita income in the yield equation of System 2 (-0.99). Unfortunately, given the statistical non-significance of both the per-capita income and the rating coefficients in System 1, it is not possible to assess which, between the direct and indirect, effect dominates the other. As obtained in the previous section, it has been confirmed that default risk matters in regional bond pricing, either measured by economic indicators (System 2) or by credit ratings (System 3). However, it has not be detected any additional informational role for credit ratings beyond the information obtainable from publicly available financial and economic data.

Appendix IV

APP.IV.1 Details on local governments and bonds in the sample

For the cities in the sample, the list of issuers and the number of bonds issued is given in Table APP.IV.1.

Table APP.IV.1 - Number of bonds in the sample per city and per year

City	Year													Rating
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	
Alessandria	-	-	1	-	-	-	-	-	-	-	-	-	1	Yes
Ancona	-	-	1	1	1	3	-	-	-	-	-	-	6	No
Avellino	-	-	-	-	-	-	1	-	-	-	-	-	1	No
Bergamo	-	-	1	-	-	-	-	-	-	-	-	-	1	No
Biella	-	-	-	-	-	1	-	-	-	-	-	-	1	No
Cagliari	-	-	-	-	-	1	-	-	-	-	-	-	1	Yes
Campobasso	-	-	-	-	1	-	-	-	-	-	-	-	1	No
Carrara	-	-	-	-	-	-	1	-	-	-	-	-	1	Yes
Caserta	1	-	-	-	-	-	-	-	-	-	-	-	1	No
Catania	-	1	-	1	-	-	-	-	-	-	-	-	2	No
Cesena	-	-	-	-	-	-	-	-	-	-	1	-	1	No
Chieti	-	-	-	-	-	1	-	-	-	-	-	-	1	No
Como	-	-	-	-	-	1	-	-	-	-	-	-	1	No
Cosenza	-	-	-	-	1	-	-	-	-	-	-	-	1	No
Fermo	-	-	-	-	-	1	-	-	-	-	-	-	1	No
Ferrara	-	-	2	2	-	1	1	-	-	-	-	-	6	No
Firenze	-	2	-	-	-	1	-	-	-	-	-	-	3	Yes
Foggia	-	-	-	-	-	-	1	-	-	-	-	-	1	Yes
Forlì	-	-	-	-	-	1	1	2	3	2	1	-	10	No
Genova	1	-	2	2	2	1	2	1	2	-	-	-	13	Yes
Grosseto	-	-	-	-	-	2	-	-	-	-	-	-	2	No
L'Aquila	-	-	-	-	2	-	-	-	-	-	-	-	2	Yes
La Spezia	-	-	-	-	1	-	-	-	-	-	-	-	1	Yes
Lecce	-	-	-	-	-	1	-	-	-	-	-	-	1	Yes
Lecco	-	-	-	-	-	-	1	-	-	-	-	-	1	Yes
Mantova	-	-	-	-	-	2	-	-	-	-	-	-	2	No
Massa	-	-	-	1	-	-	-	-	-	-	-	-	1	No
Messina	-	-	-	-	-	-	1	-	-	-	-	-	1	No
Milano	-	-	-	-	-	1	-	-	-	-	-	-	1	Yes
Modena	1	-	-	-	1	1	-	-	-	-	-	-	3	No
Napoli	-	-	-	-	1	-	-	-	-	-	-	-	1	Yes
Parma	-	-	-	1	1	1	1	1	3	2	1	-	11	No
Perugia	1	1	1	1	1	2	-	-	-	-	-	-	7	No
Pescara	-	1	-	-	1	1	-	-	-	-	-	-	3	No
Piacenza	-	-	-	-	-	1	1	-	-	-	-	-	2	No
Pisa	-	-	-	1	-	-	-	-	-	-	-	-	1	Yes
Potenza	-	-	-	-	-	1	-	-	-	-	-	-	1	No
Prato	-	-	-	1	2	-	1	-	-	-	-	-	4	Yes
Ravenna	1	1	-	-	-	1	1	-	1	-	-	-	5	No
Reggio E.	2	1	1	1	1	2	-	-	1	-	-	-	9	No
Rimini	-	-	-	1	2	4	1	1	2	2	-	-	13	Yes
Roma	-	-	-	1	-	-	-	-	-	-	-	-	1	Yes
Rovigo	-	1	-	-	-	-	-	-	-	-	-	-	1	No
Salerno	-	-	-	-	1	-	-	-	-	-	-	-	1	No
Sassari	-	-	-	-	-	1	-	-	-	-	-	-	1	No
Savona	-	-	-	-	-	-	1	-	-	-	-	-	1	No

Table APP.IV.1 - Number of bonds in the sample per city and per year

City	Year													Rating
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	
Siena	1	-	-	5	6	5	3	3	3	2	3	2	33	Yes
Taranto	-	-	-	-	1	-	-	-	-	-	-	-	1	No
Teramo	-	-	1	-	-	1	-	-	-	-	-	-	2	No
Terni	-	-	-	1	-	2	1	-	-	-	-	-	4	No
Torino	3	1	-	-	-	-	-	-	1	-	-	-	5	Yes
Trieste	-	-	-	-	1	2	-	-	-	-	-	-	3	Yes
Udine	-	-	1	1	-	-	-	-	-	-	-	-	2	Yes
Venezia	-	-	2	1	1	1	2	1	1	3	-	-	12	Yes
Verona	1	-	1	1	-	-	1	-	-	-	-	-	4	Yes
Viterbo	-	-	-	-	-	1	-	-	-	-	-	-	1	No
Total	**12**	**9**	**14**	**24**	**28**	**45**	**21**	**9**	**17**	**11**	**6**	**2**	**198**	**22**

For the provinces in the sample, the list of issuers and the number of bonds issued is given in Table APP.IV.2.

Table APP.IV.2 - Number of bonds in the sample per province and per year

Province	Year													Rating
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	
Alessandria	-	-	-	-	-	1	-	-	-	-	-	-	1	No
Ancona	-	1	1	-	-	-	-	-	1	-	-	-	3	Yes
Arezzo	-	-	-	-	1	-	-	-	-	-	-	-	1	Yes
Ascoli	-	-	-	-	-	2	2	-	-	-	-	-	4	No
Belluno	-	-	1	-	-	-	-	-	-	-	-	-	1	No
Biella	-	-	-	-	-	2	-	-	-	-	-	-	2	No
Bologna	-	-	-	-	-	-	-	1	-	-	-	-	1	Yes
Brescia	-	-	-	1	-	-	1	-	-	-	-	-	2	Yes
Chieti	-	-	-	1	-	-	-	-	-	-	-	-	1	Yes
Cosenza	-	-	-	1	-	-	1	-	-	-	-	-	2	No
Crotone	-	-	-	-	-	2	-	-	-	-	-	-	2	No
Forlì-Cesena	-	-	-	-	-	-	3	1	2	-	-	-	6	No
Frosinone	-	-	-	-	-	1	-	-	-	-	-	-	1	No
Genova	-	-	-	-	1	2	1	-	1	-	-	-	5	Yes
Imperia	-	-	-	-	-	1	-	-	-	-	-	-	1	No
Lecce	-	-	-	-	1	3	2	-	-	-	-	-	6	Yes
Lecco	-	-	-	-	-	-	1	-	-	-	-	-	1	No
Macerata	-	-	-	-	-	1	-	-	-	-	-	-	1	No
Mantova	-	1	1	-	-	-	1	-	-	-	-	-	3	No
Massa	-	1	-	-	-	-	-	-	-	-	-	-	1	No
Milano	-	-	1	1	-	1	-	-	-	-	-	-	3	Yes
Modena	-	-	-	-	1	2	2	3	3	1	-	-	12	No
Padova	-	-	1	-	-	1	2	1	3	-	-	-	8	No
Palermo	-	-	-	1	1	1	-	-	-	-	-	-	3	Yes
Parma	-	-	-	-	1	-	-	-	-	-	-	-	1	No
Pavia	-	-	-	-	-	1	-	-	-	-	-	-	1	No
Perugia	-	-	-	1	-	-	1	1	-	-	-	-	3	Yes
Pesaro	2	2	2	1	1	1	-	-	2	-	-	-	11	No
Pescara	1	-	1	-	-	1	-	-	-	-	-	-	3	No
Pisa	-	-	-	-	-	-	-	1	-	-	-	-	1	No
Potenza	-	-	-	1	1	-	-	-	1	-	-	-	3	No
Prato	-	-	-	1	1	-	1	-	-	-	-	-	3	Yes
Ravenna	-	-	-	-	-	2	1	2	-	-	-	-	5	Yes
Reggio E.	-	1	1	1	1	-	-	-	-	-	-	-	4	No
Rimini	2	1	-	-	-	-	-	-	1	-	-	-	4	No

Table APP.IV.2 - Number of bonds in the sample per province and per year

Province	Year													Rating
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	
Roma	-	-	-	-	1	-	-	-	-	-	-	-	1	Yes
Salerno	-	-	-	-	1	2	1	-	-	-	-	-	4	No
Savona	-	-	-	-	-	1	-	-	-	-	-	-	1	Yes
Siracusa	-	1	-	-	-	1	-	-	-	-	-	-	2	No
Taranto	-	-	-	-	-	1	-	-	-	-	-	-	1	No
Teramo	-	1	1	2	-	1	-	-	-	-	-	-	5	No
Torino	-	-	1	-	-	1	-	-	-	-	-	-	2	Yes
Trapani	-	-	-	-	1	-	-	-	-	-	-	-	1	No
Treviso	-	1	1	-	1	-	-	-	-	-	-	-	3	Yes
Udine	-	-	-	1	-	-	-	-	-	-	-	-	1	Yes
Varese	1	-	-	1	-	-	1	2	1	1	-	-	7	Yes
Venezia	-	1	-	-	1	-	-	-	-	-	-	-	2	Yes
Verona	1	1	-	2	3	2	1	1	-	-	-	-	11	No
Vibo Val.	-	-	-	-	-	1	-	-	-	-	-	-	1	No
Vicenza	-	-	1	-	1	2	-	-	-	-	-	-	4	Yes
Total	**7**	**12**	**13**	**16**	**19**	**37**	**22**	**13**	**15**	**2**	**0**	**0**	**156**	**20**

Lastly, the details of the bonds issued by regions are listed in Table APP.IV.3.

Table APP.IV.3 - Number of bonds in the sample per region and per year

Region	Year													Rating
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	
Abruzzo	-	1	1	-	1	-	1	-	-	-	-	-	4	Yes
Campania	-	-	-	-	-	-	1	-	-	-	-	-	1	Yes
Emilia Rom.	-	-	-	-	-	1	-	-	-	-	-	-	1	Yes
Friuli V. G.	-	1	-	1	1	1	1	1	-	-	-	-	6	Yes
Lazio	-	-	1	-	1	-	-	-	-	-	-	-	2	Yes
Liguria	-	-	-	-	3	-	-	-	-	-	-	-	3	Yes
Marche	-	-	-	1	-	-	-	-	-	-	-	-	1	Yes
Molise	-	-	-	1	-	1	-	-	-	-	-	-	2	Yes
Piemonte	-	-	-	-	-	-	2	-	-	-	-	-	2	Yes
Puglia	-	-	-	-	1	-	-	-	-	-	-	-	1	Yes
Sardegna	-	-	-	-	1	1	-	-	-	-	-	-	2	Yes
Sicilia	2	-	-	-	-	-	-	-	-	-	-	-	2	Yes
Toscana	-	1	6	-	-	-	2	-	-	-	-	-	9	Yes
Umbria	1	-	-	1	-	-	-	1	-	-	-	-	3	Yes
Val d'Aosta	-	-	1	-	-	-	1	-	-	-	-	-	2	Yes
Veneto	-	-	-	1	1	-	2	-	-	-	-	-	4	Yes
Total	**3**	**3**	**9**	**5**	**9**	**4**	**10**	**2**	**0**	**0**	**0**	**0**	**45**	**16**

APP.IV.2 Selection procedure for explanatory variables

Table APP.IV.4 reports the VIF indicator and the number of pair wise correlations (of both variables and regression coefficients) for those variables showing a VIF greater than 10 and a correlation above 50%.[44]

[44] According to Gunst and Mason (1980), multicollinearity is not a problem when the VIFs are below 10.

Table APP.V.4 - Multicollinearity test step 1

Variable	VIF	Number of correlated variables	Number of correlated coefficients
A_09_curr_rig	239.17	4	4
F_02_net_rev	119.90	1	4
A_08_pers_exp	72.38	4	4
F_01_pc_rev	29.66	1	2
A_04_pc_debt	26.92	2	2
A_03_debt_rev	10.93	1	5

Now, after having identified the variables with the highest VIF, in the following Table APP.IV.5 can be reported the pair wise cross-correlations of this variables with the other highly correlated variables, where coefficients' correlations are reported in parentheses.

Table APP.IV.5 - Correlation matrix step 1 (coefficients' correlations in parentheses)

Variable	A_01	A_03	A_04	A_05	A_08	A_09	F_01	F_02	E_02	I_03
A_01_curr_bal	1									
A_03_debt_rev	0.14 (0.36)	1								
A_04_pc_debt	-0.33 (-0.24)	0.25 (**-0.76**)	1							
A_05_debt_serv	-0.03 (**-0.68**)	0.35 (**-0.57**)	0.28 (0.14)	1						
A_08_pers_exp	-0.11 (**-0.63**)	**0.51** (**-0.55**)	0.31 (0.09)	0.39 (**0.96**)	1					
A_09_curr_rig	-0.18 (**0.69**)	0.41 (**0.57**)	0.37 (-0.15)	**0.88** (**-0.99**)	**0.76** (**-0.97**)	1				
F_01_pc_rev	-0.39 (0.36)	-0.33 (**0.74**)	**0.79** (**-0.93**)	0.02 (-0.18)	-0.13 (-0.11)	0.01 (0.20)	1			
F_02_net_rev	0.03 (**0.68**)	-0.35 (**0.57**)	-0.28 (-0.14)	**-1.00** (-)	-0.39 (**-0.96**)	**-0.88** (**0.99**)	-0.02 (0.18)	1		
E_02_pop	0.17 (0.11)	-0.23 (-0.15)	**-0.55** (0.21)	-0.30 (-0.11)	**-0.65** (-0.01)	**-0.56** (0.11)	-0.29 (-0.06)	0.30 (0.11)	1	
I_03_size	-0.03 (-0.16)	-0.25 (-0.02)	0.02 (-0.01)	-0.13 (0.04)	**-0.53** (0.07)	-0.35 (-0-05)	0.27 (-0.15)	0.13 (-0.04)	**0.53** (-0.34)	1

As shown in the table above, the three variables with the highest VIF (A_09, F_02 and A_08) have also the highest number of cross-correlations. Moreover, F_02 shows a perfect negative correlation with A_05 due to the fact that by construction these two variables are one the linear combination of the other.[45] Also, F_01 and A_04, besides being characterized by a high VIF, show a high correlation between themselves and with A_03. The latter A_03 is a very important indicator measuring the debt load of the issuer, its VIF is just slightly above the 10 threshold and its correlations are almost all due to the above cited variables. Furthermore, the four remaining variables in the table, which didn't show a high VIF are as well characterized by some high cross-correlations, particularly A_05 with both A_01 and A_03. Lastly, a separate analysis must be conducted for E_02 and I_03 (the population of the issuing government and the amount of the issue). These two variables, beyond being correlated with some

[45] Refer to the variables' description in Table IV.1.

other variables in the table, are also highly correlated with type of the issuer (region, city or province), with regions being characterized by the larger population figures and by the larger sizes of bond issues. Clearly, the inclusion of these variables could affect the estimation of the model. So, eight variables are to be dropped from the first version of the model (and only two variables listed in Table APP.V.5 are left, A_01 the current balance indicator and A_03 the debt revenue ratio. Then, the same procedure is applied to test the model without the dropped variables.

The second step of the model, without the eight dropped variables, shows an evident improvement in terms of multicollinearity, no variable has a VIF above 10 and the condition index has dramatically decreased from 140,337,717 for the first model to 162 for the second version of the model. But there is room for improvement since the condition index, although extremely improved, is still above the rule of thumb threshold of 30. So, as done before, cross-correlations (for both the variables and the coefficients) are checked.

Table APP.IV.6 - Correlation matrix step 2 (coefficients' correlations in parentheses)

Sym.	A_01	F_03	E_01	M_01	M_03	M_04	I_01
A_06	**0.53** (**-0.64**)						
F_03	0.03 (0.31)	1					
F_04	0.26 (-0.40)	**0.57** (**-0.64**)					
E_01	-0.15 (-0.07)	-0.42 (0.09)	1				
E_03	0.15 (-0.09)	0.40 (-0.14)	**-0.80** (0.40)				
M_01	-0.04 (-0.12)	0.01 (-0.13)	-0.12 (0.02)	1			
M_02	0.04 (-0.12)	-0.07 (-0.09)	0.13 (0.06)	**-0.66** (0.41)			
M_03	-0-03 (0.09)	-0.07 (0.21)	-0.14 (-0.09)	**0.56** (-0.31)	1		
M_04	0.02 (0.02)	0.03 (0.01)	0.19 (-0.11)	-0.41 (0.18)	**-0.68** (0.26)	1	
M_05	0.01 (0.03)	0.01 (0.04)	0.21 (-0.16)	-0.43 (-0.20)	**-0.66** (0.42)	**0.86** (**-0.69**)	
I_01	0.03 (-0.06)	-0.20 (0.20)	0.14 (0.05)	-0.11 (0.05)	-0.03 (-0.02)	0.04 (0.01)	1
I_02	0.02 (0.16)	-0.12 (-0.03)	0.16 (-0.06)	-0.12 (-0.03)	-0.06 (0.05)	0.08 (-0.03)	**0.87** (**-0.86**)

Table APP.IV.6 reports the correlation matrix of those variables with at least one cross-correlation above 50%. Two accounting indicators, A_01 (current balance) and A_06 (interest coverage ratio), have a similar construction hence

they are correlated. Similarly, two fiscal indicators, F_03 (financial autonomy) and F_04 (tax autonomy), are as well very similar and hence highly correlated. Moreover, the two socio-economic indicators in the table, E_01 (unemployment) and E_03 (per-capita income), show a very high negative correlation, because clearly an area characterized by high unemployment is also very likely to be characterized by low per-capita income. Furthermore, moving to the market indicators, it can be noticed that they are all cross-correlated. M_01 (BTP-BUND spread) is correlated with both M_02 (Italy's rating) and M_03 (international risk aversion), while M_03 is also correlated with M_04 (Italy's economic sentiment) and M_05 (Italy's GDP growth), and the two latter variables are highly correlated between themselves . Lastly, the two issue related indicators, I_01 (bond's maturity) and I_02 (bond's average life), are, by construction, extremely correlated. But given that the vast majority of the bonds in the sample are amortizing bonds which repay the principal by installments, the average life (I_02) is a better measure to take into account the effect of interest rates risk on bond yields. In addition, two dummy variables, D_03 (southern Italy) and D_04 (financial crisis), happen to be extremely correlated with economic indicators and with market indicators, therefore they cannot be included in the model.

So, given the above considerations, some of the mentioned variables are to be dropped as they are very likely to cause the multicollinearity detected by the high condition index in the previous version of the model. The chosen variables to be removed are A_06, F_04, E_01, M_02, M_03, M_04, I_02 and the two dummies D_03 and D_04.

At this stage, after the second step of the variable selection procedure, the following variables have left: A_01, A_02, A_03, F_03, E_03, M_01, M_05, I_02, D_01, D_02. This last version of the model show a condition index of 24, very low VIFs and no cross-correlation above 50%. The signals of multicollinearity have dramatically reduced, even if the condition index, although decreased is still in the "warning area". So, this last version of the model has been tested on the data. Three variables, A_02, F_03 and M_05, seem to cause some stability problems in other variables' coefficients. The following Table APP.V.7 show the coefficients obtained regressing each of these three variables against the remaining explanatory variables in the model. We can noticed that A_02 is extremely related to A_03 and significantly related to F_03 and M_01, that F_03 is extremely related to E_03 and D_02 and that M_05 show a very strong relationship with M_01 and a significant one with E_03.

Table APP.IV.7 - Cross-regression coefficients (t-stats in parentheses)

Explanatory Variables	A_02_tot_bal	F_03_fin_aut	M_05_gdp_cng
A_01_curr_bal	0.07 (0.82)	-0.09 (-0.96)	0.31 (0.30)
A_02_tot_bal	-	**0.15** **(2.84)**	-0.91 (-1.48)
A_03_debt_rev	**-0.09** **(-6.21)**	0.03 (1.84)	0.06 (0.33)
F_03_fin_aut	**0.13** **(2.84)**	-	0.88 (1.55)
E_03_pc_inc	0.05 (1.52)	**0.30** **(8.33)**	**-1.28** **(-2.91)**
M_01_btp_bund	**0.06** **(2.99)**	-0.03 (-1.19)	**-1.89** **(-7.94)**
M_05_gdp_cng	-0.01 (-1.48	0.01 (1.55)	-
I_02_avg_life	-0.01 (-1.33)	-0.01 (-1.21)	-0.01 (-0.55)
D_01_fixed	-0.00 (-0.02)	0.02 (1.58)	-0.12 (-0.77)
D_02_rated	-0.01 (-1.48)	**0.06** **(4.31)**	0.06 (0.39)

Therefore, these last three variables (A_02, F_03 and M_05) are to be excluded from the model to be estimated. Finally, the final version of the empirical model consists of seven variables (five explanatory variables and two dummy variables): A_01, A_03, E_03, M_01, I_02, D_01, D_02. This final version of the model is characterized by extremely low VIFs, no cross-correlated terms and a condition index of 21. Even if the concerns relating multicollinearity cannot be completely ruled out, the risk of computing affected estimates have been significantly reduced. The consistency, stability and significance of the parameters is analyzed in section IV.4.

APP.IV.3 Selection procedure for instrumental variables

The following procedure concerns the selection of the instrumental variables for the rating variable, the only possibly endogenous variable in the system. Market and issue-specific variables will not be instrumented given their clear exogenous nature. Two different lists of instrumental variables are identified, one for the Local Authorities sample and one for the Regions sample.

Table APP.IV.8 reports, for the Local Authorities sample, the VIF indicator and the number of pair-wise correlations (of both variables and regression coefficients) for those variables showing a VIF greater than 10 and a correlation above 50%.

Table APP.IV.8 - Multicollinearity test 1 - Local Authorities

Variable	VIF	Number of correlated variables	Number of correlated coefficients
A_04_pc_debt	16.61	4	2
F_01_pc_rev	12.51	3	1

Two variables, A_04 and F_01, are extremely correlated (93.39%), the former has been dropped given its higher VIF and the higher number of cross-correlations. Now, after having eliminated the variables most likely to affect estimates, in the following Table APP.IV.9 can be reported the pair wise cross-correlations of the remaining variables, where coefficients' correlations are reported in parentheses.

Table APP.IV.9 - Correlation matrix - Loc. Aut. (coefficients' correlations in parentheses)

Variable	A_02	A_06	A_07	F_01	F_02	F_03	F_04	E_01	E_02
A_02_tot_bal	1								
A_06_int_cov	0.01 (-0.21)	1							
A_07_curr_exp	0.43 (-0.44)	-0.24 (0.27)	1						
F_01_pc_rev	0.20 (-0.09)	-0.49 (0.40)	0.26 (0.01)	1					
F_02_net_rev	-0.07 (0.17)	0.26 (-0.19)	0.14 (-0.31)	-0.27 (-0.14)	1				
F_03_fin_aut	0.11 (-0.04)	-0.27 (0.08)	0.01 (0.01)	**0.53** (-0.33)	-0.48 (0.42)	1			
F_04_tax_aut	-0.25 (0.14)	0.18 (-0.04)	-0.30 (0.06)	-0.43 (0.29)	0.09 (-0.15)	0.08 **(-0.54)**	1		
E_01_unem	-0.15 (0.14)	-0.07 (0.11)	0.02 (-0.13)	-0.21 (-0.04)	-0.02 (0.32)	-0.45 (0.41)	-0.01 (-0.07)	1	
E_02_pop	-0.18 (-0.13)	0.23 (0.20)	-0.25 (0.18)	**-0.66** (0.29)	0.33 (-0.11)	**-0.56** (0.40)	0.48 (-0.46)	0.29 (-0.07)	1

As shown in the table above, four indicators show cross-correlations above 50%: F_01, F_03, F_04 and E_02. Of which the highest is between F_01 and E_02, negative at 66% level. The following Table APP.IV.10 reports the VIF indicator and the number of pair-wise correlations (of both variables and regression coefficients) for these four variables.[46]

Table APP.IV.10 - Multicollinearity test 2 - Local Authorities

Variable	VIF	Number of correlated variables	Number of correlated coefficients
F_03_fin_aut	3.21	2	1
E_02_pop	2.79	2	0
F_01_pc_rev	2.64	2	0
F_04_tax_aut	2.06	0	1

First, one of the two highly correlated variables, E_02 and F_01, must be dropped. The former, E_02, is chosen given its slightly higher variance inflation

[46] The VIF indicators for variable F_01 in tables APP.IV.9 and APP.IV.10 differ because the former include the variable A_04 in the regression while the latter doesn't.

factor. Moreover, the F_03 indicator (financial autonomy) is eliminated in favour of the similar F_04 indicator (tax autonomy) given the higher number of pair-wise correlations and the higher VIF. So, the final list of instrumental variables to be used for the Local Authorities sample is: A_02, A_06, A_07, F_01, F_02, F_04 and E_01.

Now, the same selection procedure is applied to the Regions sample. Table APP.IV.11 reports the VIF indicator and the number of pair-wise correlations (of both variables and regression coefficients) for those variables showing a VIF greater than 10 and a correlation above 50%.

Table APP.IV.11 - Multicollinearity test - Regions

Variable	VIF	Number of correlated variables	Number of correlated coefficients
F_04_tax_aut	32.23	1	3
F_03_fin_aut	28.51	1	3
A_07_curr_exp	20.47	4	3

Two fiscal variables F_03 and F_04 are extremely correlated (94.94%), the latter has been dropped given its higher VIF. Also A_07, the current expenditure indicator has been eliminated given its high VIF and the number of correlated variables. Now, after having eliminated the variables most likely to affect estimates, in the following Table APP.IV.12 can be reported the pair wise cross-correlations of the remaining variables, where coefficients' correlations are reported in parentheses.

Table APP.IV.12 - Correlation matrix - Regions (coefficients' correlations in parentheses)

Variable	A_02	A_04	A_06	F_01	F_02	F_03	E_01	E_02
A_02_tot_bal	1							
A_04_pc_debt	-0.43 (0.20)	1						
A_06_int_cov	0.02 (-0.11)	0.15 (0.37)	1					
F_01_pc_rev	-0.27 (-0.09)	**0.76 (-0.74)**	**0.52** (-0.42)	1				
F_02_net_rev	0.15 (-0.01)	-0.43 (**0.58)**	0.15 (0.11)	-0.06 (-0.35)	1			
F_03_fin_aut	0.18 (-0.08)	0.19 (0.26)	0.15 (0.10)	0.39 **(-0.60)**	-0.07 (0.15)	1		
E_01_unem	-0.27 (0.31)	0.09 (-0.09)	-0.19 (0.03)	-0.07 (-0.06)	-0.04 (-0.10)	-0.11 (0.12)	1	
E_02_pop	0.39 (0.16)	**-0.52** (-0.09)	-0.50 (0.15)	**-0.73 (0.55)**	-0.05 (0.05)	0.06 **(-0.51)**	0.16 (-0.29)	1

As shown in the table above, indicator F_01 (per-capita revenue) shows six cross correlations above 50% of which three above 70% and therefore has been dropped from the list of possible instrumental variables. Two more variables, A_04 and E_02, also show a couple of pair-wise correlations above 50%, nevertheless have been left given the limited number of cross-correlations

and the measures only slightly above 50%. The effect of these variables will be tested for over-identification in the GMM estimation. So, the final list of instrumental variables to be used for the regions sample is: A_02, A_04, A_06, F_02, F_03, E_01 and E_02.

Chapter V

Determinants of Local Governments' Ratings

This chapter empirically investigates the determinants of Italian sub-sovereign credit ratings. The analysis, in order to deal with the qualitative nature of ratings, adopts two different methodologies, a multinomial Ordered Probit model estimated through Maximum Likelihood Estimation and a non-linear numerical transformation of ratings allowing the use of standard Ordinary Least Squares regression. The analysis in this chapter is elaborated through four sections. Section V.1 focuses on the methodological issues. Section V.2 describes the dataset. Section V.3 illustrates the empirical specification. Section V.4 analyzes the results.

V.1 Methodology

In order to deal with the qualitative ordinal nature of ratings, this study approaches the investigation on the determinants of credit ratings under two different methods. First, as in Gaillard (2009), a multinomial ordered probit model is adopted. Then, a procedure to convert ratings judgements into numerical rating scores, which allows standard regression analysis, is implemented following Liu and Thakor (1984).

V.1.1 Ordered probit model

The multinomial ordered probit model is appropriate when dealing with a polytomous ordinal dependent variable such as the credit rating. The model defines the probability of the rating assessment attributed to a local government as a function of a set of explanatory variables. The model can be expressed as follows:

(V.1) $Y_{i,t} = \beta' X_{i,t} + \varepsilon_{i,t}$

Where $Y_{i,t}$ is the unobserved creditworthiness of the local government, β is a row vector of coefficients, $X_{i,t}$ is a column vector of explanatory variables and $\varepsilon_{i,t}$ is an *i.i.d.* disturbance term with $\varepsilon_{i,t} \sim N(0,1)$.[47]

[47] The model omits the intercept for identification purposes of the following log-likelihood optimization. Omitting the intercept is equivalent to setting the cut-off point $\mu_1 = 0$ as an identifying restriction. Moreover, the other necessary identification constraint is to set the variance parameter $\sigma^2 = 1$.

Since $Y_{i,t}$, the credit standing of a local government, is unobservable, it can be related to the observed ratings $y_{i,t}$ through a probability function. The rating judgments attributable to local governments need first to be ordered into ordinal values as displayed in the following Table V.1.

Table V.1 - Ordinal transformation of ratings

Rating category	Ordinal transformation	Rating category	Ordinal transformation
Aaa/AAA	17	Baa3/BBB-	8
Aa1/AA+	16	Ba1/BB+	7
Aa2/AA	15	Ba2/BB	6
Aa3/AA-	14	Ba3/BB-	5
A1/A+	13	B1/B+	4
A2/A	12	B2/B	3
A3/A-	11	B3/B-	2
Baa1/BBB+	10	Caa/CCC	1
Baa2/BBB	9	-	-

The observed rating $y_{i,t}$ takes the value $j = 1,2,\dots,17$ according to the relationship:

(V.2) $y_{i,t} = j \Leftrightarrow \mu_{j-1} < Y_{i,t} \leq \mu_j$;

where μ_j is the unknown cut-off point. This relationship can be exemplified as follows:

(V.3) $y_{i,t} = 1 \Leftrightarrow Y_{i,t} \leq \mu_1$;

$y_{i,t} = 2 \Leftrightarrow \mu_1 < Y_{i,t} \leq \mu_2$;

...

$y_{i,t} = 17 \Leftrightarrow \mu_{16} < Y_{i,t}$.

Then, indicating with Φ the cumulative function of the standard normal probability distribution, the implicit probabilities of the observed rating $y_{i,t}$ can be expressed as:

(V.4) $Prob(y_{i,t} = j) = \Phi(\mu_j - \beta' X_{i,t}) - \Phi(\mu_{j-1} - \beta' X_{i,t})$;

or, in terms of the actual ordinal outcomes:

(V.5) $Prob(y_{i,t} = 1) = \Phi(\mu_1 - \beta' X_{i,t})$;

$Prob(y_{i,t} = 2) = \Phi(\mu_2 - \beta' X_{i,t}) - \Phi(\mu_1 - \beta' X_{i,t})$;

...

$$Prob(y_{i,t} = 17) = 1 - \Phi(\mu_{16} - \beta' X_{i,t}) \, .$$

The model is estimated through *Maximum Likelihood Estimation* (MLE) where the log-likelihood function can be represented as:

(V.6) $\ln \mathcal{L} = \sum_{t=1}^{T} \sum_{i=1}^{N} \sum_{j=1}^{J} \ln \left(\Phi_{j,i,t} - \Phi_{j,i,t-1}\right)$;

where $\Phi_{j,i,t} = \Phi(\mu_j - \beta' X_{i,t})$ and $\Phi_{j,i,t-1} = \Phi(\mu_{j-1} - \beta' X_{i,t})$.

V.1.2 Rating score regression

The second estimation method consists in attributing a meaningful numerical value to each rating category, allowing the use of standard regression analysis. The problem in assigning arbitrary values to the qualitative rating categories is to find a numerical measure directly related to the latent variable determining the ratings, which is $Y_{i,t}$ the unobserved creditworthiness of the local government. To this end, being observable market prices of credit risk, the average bond yield differentials between rating classes have been chosen to compute a numerical rating score indicator.

The procedure, analogously to what has been done in section IV.3.1, consists in first calculating the yield differentials between rating categories, and then assigning a value proportional to the yield differentials to each rating category, where the highest score is assigned to the Aaa/AAA rating and a value equal to zero to the Caa/CCC category. The rating scores have been calculated as the absolute values of the average yield differentials between a given rating category and the lowest Caa/CCC category. The rating scores for each rating category are reported in Table V.2.[48]

Table V.2 - Numerical transformation of

Rating category	Rating score	Rating category	Rating score
Aaa/AAA	9.41	Baa3/BBB-	7.20
Aa1/AA+	9.28	Ba1/BB+	6.52
Aa2/AA	9.12	Ba2/BB	6.04
Aa3/AA-	8.93	Ba3/BB-	5.85
A1/A+	8.73	B1/B+	5.55
A2/A	8.56	B2/B	4.58
A3/A-	8.41	B3/B-	2.59
Baa1/BBB+	8.20	Caa/CCC	0.00
Baa2/BBB	7.82	-	-

The numerical score transformation allows the application of standard regression analysis model to the equation V.1 illustrated above, without the

[48] The yields' averages have been computed on daily data over the sample period 01/01/2005-31/12/2013, taken from the "BofA Merrill Lynch US Corporate Bond Effective Yield" indexes.

restrictions on intercept and errors' variance which was previously necessary for the ordered probit estimation.

V.2 Data

The data sample consists of the full set of the credit ratings assigned by the three major international rating agencies, Moody's Investors Service, Standard & Poor's Financial Services and Fitch Ratings, between 2005 and 2013 to the three tiers of Italian sub-sovereign governments (regions, provinces and cities).

V.2.1 Rating Distribution

The local governments sample includes 21 regions, 26 provinces and 38 cities, for a total number of 258 observations collected in three different cross-sectional periods: 2005 (96 observations), 2008 (107 observations) and 2013 (55 observations).[49] The following Table V.3 illustrates, in addition to the rating of the central government (the Republic of Italy), the rating distribution per year subdivided for rating category and government type.[50] Moreover, the table reports the rating changes between the years 2005-2008 and between 2008-2013, accounting for upgrades, downgrades, rating confirmations, new ratings and withdrawn ratings.

Table V.3 - Ratings' distribution for rating category, government type and rating changes

	2005	2008	2013	Pooled
Italy's rating	**Aa2/AA-/AA**	**Aa2/A+/AA-**	**Baa2/BBB/BBB+**	**-**
Rating Category				
Aaa/AAA	-	5	-	**5**
Aa1/AA+	7	2	-	**9**
Aa2/AA	12	8	-	**20**
Aa3/AA-	41	35	-	**76**
A1/A+	14	32	-	**46**
A2/A	15	17	4	**36**
A3/A-	4	4	3	**11**
Baa1/BBB+	2	3	15	**20**
Baa2/BBB	1	1	22	**24**
Baa3/BBB-	-	-	5	**5**
Ba1/BB+	-	-	3	**3**
Ba2/BB	-	-	1	**1**
Ba3/BB-	-	-	1	**1**
B1/B+	-	-	1	**1**
Total	**96**	**107**	**55**	**258**
Government Type				
Regions	35	37	35	**107**
Provinces	23	27	5	**55**
Cities	38	43	15	**96**
Total	**96**	**107**	**55**	**258**
Rating Changes				

[49] The credit rating for each local government is detected on the 31 December of each year.
[50] Italy's ratings reported on Table V.3 are Moody's, S&P and Fitch respectively.

	2005-2008	2008-2013
Upgrades	15	0
Downgrades	25	48
Unchanged	42	1
New ratings	25	6
Withdrawn	14	58

The representation in Table V.3 above show a dramatic change in the ratings' distribution for the year 2013. While years 2005 and 2008 are characterized by a similar composition, with all ratings above the Baa2/BBB category, the ratings attributed in 2013 suffered an overall downgrade following the heavy downgrade of the Republic of Italy. Moreover, the information on the rating changes in the table, between 2005-2008 and 2008-2013, helps understanding the different behaviour in 2013. While between 2005 and 2008 local governments experienced both upgrades and downgrades together with more new released ratings than withdrawn ratings, between 2008 and 2013 there were 48 downgrades and no upgrade, 58 withdrawn ratings and only 6 new ratings. Lastly, the distribution for government type in the table show how only the largest governments (regions) maintained a significant rating coverage over the sample period, with rated provinces and cities experiencing a dramatic drop in 2013 and, among these, with only the larger authorities keeping the rating assessment.[51]

V.2.2 Data Sources

The data on Moody's ratings have been collected from Moody's Investors Service official website. Data on S&P and Fitch ratings have been provided by the Italian branches of the two agencies for the purposes of this research.

The accounting data of each city and province in the sample have been collected from the *Finanza locale* database of the Italian Ministry of Interior. The accounting data of the regions have been collected from regional governments' websites or directly provided by regional offices.

The local socioeconomic data including income, population and unemployment have been obtained from the "Sitis" (*Sistema di Indicatori Territoriali*) data-warehouse of the Italian national institute for Statistics (Istat). The national economic data such as GDP and price indices have been collected from Istat.[52]

[51] The cities and provinces which maintained a rating coverage in 2013 are characterized by an average population of 1.103.193, compared to an average of 727.622 for rated cities and provinces in the 2005-2008 period.

[52] For further information about data sources see section IV.3.3. Each source website is reported in the References section.

V.3 Empirical Specification

As illustrated in section IV.4.1, a major issue concerning the definition of the empirical specification of the model to be estimated is multicollinearity, i.e. the cross-correlation (or linear dependence) among regressors. Given the ample availability of economic and accounting data for local governments, it is very likely that several observable variables may be driven by the same phenomenon such as, for example, the weak economic condition of an area leading to high unemployment and low per capita income or the high level of debt of a local authority leading to several poor financial ratios. The inclusion of redundant regressors can cause multicollinearity, affecting the estimation of regression's parameters and possibly leading to a wrong assessment of statistical significance. Therefore, a prerequisite for the empirical estimation is the careful selection of the most efficient variables to be included in the model, among the many economic, financial and fiscal indicators available.

V.3.1 Choice of variables

Following the variable selection procedure described in section IV.4.1 the variables expected to affect regression's estimates have been identified using standard multicollinearity diagnostics such as the variance inflation factor (VIF), the condition index and the pair wise cross-correlations of variables and coefficients. The details of the selection procedure for the elimination of the inefficient variables are given in Appendix V. The variable selection procedure has identified six variables, of which four explanatory variables and two dummy variables. Table V.4 below reports the description of the variables together with their formulas, measures and expected signs.[53]

Table V.4 - Description of the variables used in regression analysis

Variable	Symbol	Description	Formu	Measu	Exp.
Current Balance	A_01_curr_bal	Current revenues (CR) minus current expenditures (CE), over current revenues (CR).	(CR – CE) / CR	Ratio	+
Debt to Revenues	A_03_debt_rev	Total outstanding debt (D) over the sum of current revenues (CR) and capital revenues (CaR).	D / (CR + CaR)	Ratio	-
Financial Autonomy	F_03_fin_aut	Sum of tax revenues (TR) and other revenues (OR) over current revenues (CR).	(TR + OR) / CR	Ratio	+
Per capita Income	E_03_pc_inc	Local per capita added value (LAVpc) over national per capita added value (NAVpc)*.	LAVpc / NAVpc	Ratio	+
Year 2008 Dummy	D_05_2008	Takes value 1 if the rating assessment refers to year 2008, 0 otherwise.	-	1,0	?
Year 2013 Dummy	D_06_2013	Takes value 1 if the rating assessment refers to year 2013, 0 otherwise.	-	1,0	?

* For the cities in the sample, since data at city level are unavailable, these indicators refer to the figures of the corresponding provinces.

[53] It can be noted that three issuer-specific variables (A_01, A_03 and E_03) are the same as in the municipal bonds' analysis described in Table IV.5. This model specification, in addition, shows the financial autonomy indicator (F_03) and the two year dummies.

The final set of indicators, delivered by the variable selection procedure in Appendix V, comprises a wide set of regressors able to measure the main financial, fiscal and economic characteristics of a local government. The set of explanatory variables includes: a measure of the current deficit/surplus (Current Balance), a financial autonomy indicator (Financial Autonomy), a debt burden indicator (Debt to Revenues), a major economic condition indicator (Per capita Income) and two year dummies (Year 2008 and Year 2013). The two year dummy variables are meant to control for the general macroeconomic conditions, including the ratings assigned to the central government, characterizing the three different observation periods (base year 2005, 2008 and 2013).

The final version of the model proves to be free of any multicollinearity issues, showing a condition index of 16.89 with extremely low VIFs and cross-correlations. The correlation matrix is displayed in Table V.5 below.

Table V.5 - Correlation matrix (coefficients' correlations in parentheses)

Variable	A_01	A_03	F_03	E_03	D_05	D_06
A_01_curr_bal	1					
A_03_debt_rev	-0.01 (0.06)	1				
F_03_fin_aut	0.02 (0.06)	-0.23 (0.27)	1			
E_03_pc_inc	0.31 (-0.32)	0.14 (-0.19)	0.17 (-0.21)	1		
D_05_2008	-0.04 (0.04)	0.06 (-0.03)	-0.25 (0.08)	-0.02 (-0.01)	1	
D_06_2013	0.02 (-0.01)	-0.01 (-0.10)	0.40 (-0.34)	0.04 (0.05)	-0.44 (0.38)	1

V.3.2 Descriptive statistics

Table V.6 below reports the descriptive statistics of the dependent and independent variables adopted in the empirical analysis. For each variable in the sample the average is displayed together with the standard deviation in parentheses. Moreover, the data regarding the three sub-samples relating the years 2005, 2008 and 2013 are represented in the table.

Table V.6 - Variables averages per year (standard deviations in parentheses)

Variable	Pooled Sample	2005	2008	2013
Rating Ranking	12.54 (2.28)	13.55 (1.41)	13.36 (1.46)	9.18 (1.54)
Rating Score	8.60 (0.58)	8.84 (0.26)	8.81 (0.27)	7.77 (0.67)

Table V.6 - Variables averages per year (standard deviations in parentheses)

Variable	Pooled Sample	2005	2008	2013
Current Balance	0.08 (0.17)	0.08 (0.19)	0.07 (0.15)	0.08 (0.15)
Debt to Revenues	0.56 (0.46)	0.53 (0.41)	0.59 (0.45)	0.55 (0.56)
Financial Autonomy	0.77 (0.16)	0.75 (0.17)	0.72 (0.16)	0.89 (0.10)
Per capita Income	1.05 (0.27)	1.05 (0.26)	1.04 (0.24)	1.07 (0.33)
Observations	258	96	107	55

The data displayed in Table V.6 above show that, even if the rating indicators worsened in 2013, all economic and financial variables either remained stable or improved. This fact poses some insights for the following regression analysis, since the ratings have generally been downgraded probably following the macroeconomic context affecting the central government finances (and rating) rather than for specific local government factors.

V.4 Regression Results

This section presents the results of the two different models adopted in this chapter. First the outcome of the ordered probit model is illustrated, and then the findings of the standard regression analysis are discussed. While the ordered probit model is the natural choice when studying the behavior of an ordinal variable such as the credit rating, its properties are only valid asymptotically. Therefore, the strict assumptions on the errors' distribution together with the limited size of the sample require a further robustness test allowing heteroskedasticity and serial correlation in the errors. Hence, the standard regression on the numerical rating scores is estimated allowing standard regression's diagnostics and interpretation.

V.4.1 Poolability test

Before the estimation of the two models on the sample, it is necessary to test for the poolability of the data belonging to the three rating agencies. The following regressions test for structural differences in the intercept and slopes for the ratings released by S&P and Fitch, compared to the base group represented by Moody's ratings. The following Table V.7 reports the results of two regressions, a regressions analyzing the data of the three agencies altogether (Pooled), and a regression adopting a dummy variable taking the value 1 in case the ratings is, respectively, released by S&P or Fitch (and 0 if released by Moody's) and four interaction terms which have been tested both individually and jointly.

Table V.7 - Poolability test (t-stats in parentheses)

Explanatory Variables	Pooled	Poolability test
Current Balance	**0.40*** (2.78)**	**0.39* (1.74)**
Debt to Revenues	**-0.21*** (-3.51)**	**-0.50*** (-2.75)**
Financial Autonomy	-0.10 (-0.85)	**-0.56* (-1.81)**
Per capita Income	**0.58*** (6.19)**	**0.73*** (4.22)**
Year 2008 Dummy	-0.02 (-0.59)	**-0.06* (-1.84)**
Year 2013 Dummy	**-1.07*** (-11.59)**	**-1.13*** (-15.10)**
C	**8.39*** (75.83)**	**8.72*** (38.27)**
Observations	258	258
Adj. R2	66.18%	71.51%
F-test (prob.)	0.00%	0.00%
Condition index	16.89	46.49
White test (prob.)	0.00%	0.00%
Serial correlation LM test (prob.)	0.00%	6.53%
S.E. correction	Newey-West	White
Poolability diagnostics		
S&P Dummy	-	**-0.77** (-2.39)**
Current Balance x d_S&P	-	**-0.89** (-2.08)**
Debt to Revenues x d_S&P	-	0.31 (1.45)
Financial Autonomy x d_S&P	-	**0.88* (1.84)**
Per capita Income x d_S&P	-	-0.13 (-0.41)
Fitch Dummy	-	-0.30 (-1.10)
Current Balance x d_Fitch	-	-0.04 (-0.14)
Debt to Revenues x d_Fitch	-	**0.34* (1.75)**
Financial Autonomy x d_Fitch	-	**0.77** (2.09)**
Per capita Income x d_Fitch	-	-0.26 (-1.25)
Joint F-test S&P interactions (prob.)	-	0.00%
Joint F-test Fitch interactions (prob.)	-	2.42%

* Significant at 10% level.
** Significant at 5% level.
*** Significant at 1% level.

The poolability test, reported in Table V.7, detected a structural difference in the behaviour of the ratings released by the three different agencies. The differences are stronger for S&P ratings, with three significant variables and a joint F-test with a 0.00% probability, than for Fitch's which, however, has two significant variables and a 2.42% probability of rejecting the null in the joint F-

test. Therefore, in the following analysis the ratings of the three agencies will be studied separately.

V.4.2 Ordered probit model

The following Table V.8 reports the results of the ordered probit model, as illustrated in the previous sections, for the ratings assigned by the three agencies.

Table V.8 - Ordered probit models (z-stats in parentheses)

Explanatory	Moody's	S&P	Fitch
Current Balance	**2.04*** **	-0.25	**1.84*** **
	(3.02)	(-0.14)	**(2.88)**
Debt to Revenues	**-1.44*** **	**-0.91** **	**-1.08*** **
	(-3.86)	**(-2.55)**	**(-4.46)**
Financial Autonomy	0.70	1.58	**-1.28***
	(0.85)	(1.22)	**(-1.80)**
Per capita Income	**3.02*** **	**2.66*** **	**2.19*** **
	(5.89)	**(3.35)**	**(4.45)**
Year 2008 Dummy	0.10	**-0.72** **	-0.40
	(0.39)	**(-2.30)**	(-1.49)
Year 2013 Dummy	-10.22	-9.14	**-4.00*** **
	(-0.08)	(-0.03)	**(-8.18)**
Observations	95	64	99
Pseudo R2	41.14%	35.41%	33.79%
Chi2-LR (prob.)	0.00%	0.00%	0.00%
Condition index	16.54	22.50	17.84
Log likelihood	-118.67	-68.85	-127.82

* Significant at 10% level.
** Significant at 5% level.
*** Significant at 1% level.

The results of the ordered probit model, as anticipated by the poolability test in the previous section, show a different behaviour for the three rating agencies. Moody's results highlight the relevance of three out of the four explanatory variables adopted. Current Balance, Debt to Revenues and Per capita Income are all extremely significant and appear with the expected signs, while the Financial Autonomy indicator is non-significant. The results for S&P's ratings show two significant, and with the correct signs, variables (Debt to Revenues and Per capita Income) as in Moody's results (but with Debt to Revenues only significant at 5% level). However, the Current Balance, which was extremely significant in Moody's results, becomes non-relevant in S&P equation. Moreover, the Year 2008 Dummy is unexpectedly significant for S&P's, while the expected Year 2013 Dummy is not. Fitch's results are more similar to Moody's, with Current Balance, Debt to Revenues and Per capita Income extremely significant and with the expected signs. However, for Fitch's also the Financial Autonomy indicator is significant, even if with the wrong sign and only 10% significance level. In this last regression, moreover, the Year 2013 Dummy

appears very significant and with expected negative sign. Lastly, the models' goodness of fit indicator, the pseudo R-squared, is around 41% for Moody's and slightly lower for the two other rating agencies.[54] Needs to be considered, however, that, in addition to the mentioned caveats in using ordered probit on small sized samples, the S&P's sample (64 obs.) is significantly smaller than both Moody's and Fitch's (95 and 99 obs. respectively).

V.4.3 Standard regression analysis

The following Table V.9 reports the results of three regressions, one for each rating agency, adopting as dependent variable the rating scores' curve, based on bond yield differentials, illustrated in the previous sections. Moreover, the regressions' residual are tested for heteroschedasticity (White test) and serial correlation (LM test) and the t-stats are computed accordingly.

Table V.9 - Regression analysis (t-stats in parentheses)

Explanatory Variables	Moody's	S&P	Fitch
Current Balance	**0.43** **(2.19)**	-0.46 (-1.03)	**0.32** **(2.57)**
Debt to Revenues	**-0.46***** **(-2.93)**	**-0.19*** **(-1.80)**	**-0.18***** **(-4.20)**
Financial Autonomy	-0.16 (-0.67)	0.23 (0.82)	-0.20 (-1.49)
Per capita Income	**0.66***** **(4.30)**	**0.61**** **(2.31)**	**0.43***** **(4.80)**
Year 2008 Dummy	-0.01 (-0.01)	-0.09 (-1.33)	-0.07 (-1.37)
Year 2013 Dummy	**-1.50***** **(-11.48)**	**-1.09***** **(-6.81)**	**-0.77***** **(-11.99)**
C	**8.51***** **(46.71)**	**8.01***** **(30.94)**	**8.71***** **(60.14)**
Observations	95	64	99
Adj. R2	80.21%	64.84%	73.18%
F-test (prob.)	0.00%	0.00%	0.00%
Condition index	16.54	22.50	17.84
White test (prob.)	0.00%	1.43%	28.47%
Serial correlation LM test (prob.)	72.50%	50.03%	54.25%
S.E. correction	White	White	None
* Significant at 10% level.			
** Significant at 5% level.			
*** Significant at 1% level.			

The results of the standard regression analysis, reported in Table V.9 above, first of all, confirm the overall findings of the ordered probit model but appear clearer and more consistent. Here, Moody's and Fitch present identical results in terms of significance and signs, with minor difference in the magnitude of

[54] The analysis adopts McFadden's pseudo R-squared. This statistics is based on the ratio of the log-likelihood of the full model over the log-likelihood of an intercept-only model, therefore measuring the improvement of the model's effectiveness given by the inclusion of the explanatory variables.

coefficients. The three explanatory variables Current Balance, Debt to Revenues and Per capita Income, as in the ordered probit model, are extremely significant and with the expected signs, while the Financial Autonomy indicator is non-significant for both Moody's and Fitch. In S&P's results, as in the ordered probit model, the Current Balance in non-significant, while Debt to Revenues and Per capita Income are both significant but at lower probability levels compared to the other two rating agencies. Unlike ordered probit findings, here the role of the year dummies is unambiguous, with, as expected, the Year 2013 Dummy extremely significant and with the correct negative sign in all three regressions. This result point out to a possible structural break in 2013, due to the financial crisis, which will be tested in the next section. Lastly, it can be noted the overall high measure for the goodness of fit, with and adjusted R-Squared above 80% in Moody's regression and of 73% and 65% for Fitch and S&P respectively. As before, the smaller size of the S&P sample needs to be taken into account.

V.4.4 Financial crisis test

Since the descriptive statistics and the regressions' results highlighted a different behavior of the variables for the year 2013, an augmented specification allowing different slopes for the year 2013 is tested. This version of the model consists of the same variables in the standard model plus four interaction terms of the year 2013 dummy variable (taking the value 1 in case the data refer to the year 2013 and 0 otherwise) with the four explanatory variables (Current Balance, Debt to Revenues, Financial Autonomy and Per capita Income). Moreover, the four interaction terms have been tested both individually and jointly in order to assess for a structural break in the year 2013's estimation parameters. The results of the above cited analysis are reported in the following Table V.10.[55]

Table V.10 - Financial crisis structural test (t-stats in parentheses)

Explanatory	Moody's	S&P	Fitch
Current Balance	**0.23****	0.03	**0.24***
	(2.46)	(0.07)	**(1.76)**
Debt to Revenues	**-0.12****	-0.15	**0.21*****
	(-2.13)	(-1.44)	**(-4.81)**
Financial Autonomy	0.13	0.29	**-0.30****
	(0.96)	(0.80)	**(-2.39)**
Per capita Income	**0.49*****	**0.45****	**0.51*****
	(6.72)	**(2.19)**	**(4.88)**
Year 2008 Dummy	0.01	-0.08	-0.07
	(0.32)	(-1.02)	(-1.51)
Year 2013 Dummy	**-1.23****	-0.79	**-1.57****
	(-2.06)	(-0.71)	**(-2.08)**

[55] For completeness, the same structural break test have been run also for the year 2008. The test detected no structural difference for the year 2008.

Table V.10 - Financial crisis structural test (t-stats in parentheses)

Explanatory	Moody's	S&P	Fitch
Current Balance x d_2013	1.17 (1.62)	**-2.93**** **(-2.56)**	0.47 (1.39)
Debt to Revenues x d_2013	**-1.56***** **(-5.67)**	-0.07 (-0.38)	0.10 (1.14)
Financial Autonomy x d_2013	-0.50 (-0.79)	-1.12 (-0.89)	**1.01*** **(1.76)**
Per capita Income x d_2013	**0.68**** **(2.22)**	**0.79**** **(2.05)**	-0.19 (-0.60)
C	**8.32***** **(62.64)**	**8.07***** **(23.56)**	**8.71***** **(63.31)**
Observations	95	64	99
Adj. R2	90.87%	67.14%	74.03%
F-test (prob.)	0.00%	0.00%	0.00%
Joint F-test interactions	0.00%	0.00%	0.00%
Condition index	30.99	42.19	44.22
White test (prob.)	0.00%	25.82%	0.00%
Serial correlation LM test	61.59%	58.90%	83.47%
S.E. correction	White	None	White

* Significant at 10% level.
** Significant at 5% level.
*** Significant at 1% level.

The structural change test points out, as expected, the differences for the year 2013, in the coefficients and intercept of the explanatory variables. The joint F-test strongly rejects the null for all the three rating agencies. Needs to be specified, however, that the estimation of the four explanatory variables of the model (Current Balance, Debt to Revenues, Financial Autonomy and Per capita Income) is not reliable, since the inclusion of the interaction terms in the model has caused a rise in the condition index above the 30 threshold.

V.4.5 Summary of results

Summing up the results obtained in this section it can be noted, first of all, how both methodologies detected the same relevance for the explanatory variables in the model. For Moody's and Fitch three variables (Current Balance, Debt to Revenues and Per capita Income) are found to be extremely significant and with the expected signs, while for S&P the Current Balance appears as non-significant.[56] The positive sign of Current Balance and Per capita Income means the higher the indicator the better the rating, while the opposite goes for the negative sign of the Debt to Revenues variable. Moreover, the inclusion of the interaction terms to form the augmented model points out the different behavior of regressions' coefficients in the year 2013, which, in conjunction with the descriptive statistics illustrated above, can be attributed to the overall

[56] The ordered probit model applied to Fitch's ratings found a weakly significant, and with the wrong sign, Financial Autonomy variable. However, the relevance of this variable has been excluded by the results of standard regression analysis.

downgrade of the whole Italian public sector due to the recent sovereign financial crisis.

Furthermore, the comparison of the two methodologies adopted in the empirical analysis, ordered probit and standard regression, leans towards the latter. Standard regressions' estimation appear more consistent and, although the pseudo R-Squared of the ordered probit model cannot be directly compared to the standard regression's R-Squared, the ordinary least squares method seems to be better suitable for analyzing small sample cross-sections such as the data investigated in this study.

Appendix V

APP.V.1 Selection procedure for explanatory variables

The following Table APP.V.1 describes the complete list of variables included in this chapter with their formulas, measures and expected signs.[57]

Table APP.V.1 - Description of variables

Variable	Symbol	Description	Formula	Measure	Exp. sign
Accounting and financial variables					
Current Balance	A_01_curr_bal	Current revenues (CR) minus current expenditures (CE), over current revenues (CR).	(CR – CE) / CR	Ratio	+
Borrowing Need	A_02_ borr_need	Sum of current revenues (CR) and capital revenues (CaR) minus the sum of current expenditures (CE) and capital expenditures (CaE), over the sum of current revenues (CR) and capital revenues (CaR).	((CR + CaR) – (CE + CaE)) / (CR + CaR)	Ratio	+
Debt to Revenues	A_03_debt_rev	Total outstanding debt (D) over the sum of current revenues (CR) and capital revenues (CaR).	D / (CR + CaR)	Ratio	-
Per capita Debt	A_04_pc_debt	Total outstanding debt at constant prices* (Dcp) over population (P), log-transformed.	Ln(Dcp / P)	Ratio (log)	-
Debt Service	A_05_debt_serv	Sum of debt reimbursement (DR) and interest payments (I) over current revenues (CR).	(DR + I) / CR	Ratio	-
Interest Coverage	A_06_int_cov	Current revenues (CR) minus gross current expenditures (CE – I), over interest payments (I).	(CR – CE + I) / I	Ratio	+
Current Expenditures	A_07_curr_exp	Current expenditures (CE) over the sum of current expenditures (CE) and capital expenditures (CaE).	CE / (CE + CaE)	Ratio	-
Fiscal variables					
Per Capita Revenues	F_01_pc_rev	Sum of current revenues (CRcp) and capital revenues (CaRcp) at constant prices*, over population (P), log-transformed.	Ln((CRcp + CaRcp) / P)	Ratio (log)	+
Financial Autonomy	F_03_fin_aut	Sum of tax revenues (TR) and other revenues (OR) over current revenues (CR).	(TR + OR) / CR	Ratio	+
Tax Autonomy	F_04_tax_aut	Tax revenues (TR) over current revenues (CR).	TR / CR	Ratio	+
Socio-economic variables					
Unemployment	E_01_unem	Unemployment percent rate (U)**.	U	%	-
Population	E_02_pop	Number of residents (P), log-transformed.	Ln(P)	Log	?
Per capita Income	E_03_pc_inc	Local per capita added value (LAVpc) over national per capita added value (NAVpc)**.	LAVpc / NAVpc	Ratio	+
Dummy variables					

[57] In comparison to the variables used in chapter IV, here A_08, A_09, F_02, D_01, D_02 and D_04 are missing, plus every other variable identified by M and I. Moreover, this chapter specification has two new dummy variables (D_05 and D_06).

Table APP.V.1 - Description of variables

Variable	Symbol	Description	Formula	Measure	Exp. sign
Southern Italy	D_03_south	Takes value 1 if, according to the European Union NUTS classification (Nomenclature of Territorial Units for Statistics), the local government belongs to the ITF group (Abruzzo, Basilicata, Calabria, Campania, Molise, Puglia) or to the ITG group (Sardegna and Sicilia), 0 otherwise.	-	1,0	-
Year 2008	D_05_2008	Takes value 1 if the rating assessment refers to year 2008, 0 otherwise.	-	1,0	?
Year 2013	D_06_2013	Takes value 1 if the rating assessment refers to year 2013, 0 otherwise.	-	1,0	-

* Base year: 1999.
** For the cities in the sample, since data at city level are unavailable, these indicators refer to the figures of the corresponding provinces.

Table APP.V.2 reports, for the complete set of variables, the VIFs and the number of pair wise correlations exceeding the 50% threshold.

Table APP.V.2 - Multicollinearity test

Variable	VIF	Number of correlated variables	Number of correlated
A_01_curr_bal	3.13	1	1
A_02_ borr_need	2.98	1	2
A_03_debt_rev	2.36	1	0
A_04_pc_debt	2.54	1	1
A_05_debt_serv	1.63	1	0
A_06_int_cov	2.32	1	1
A_07_curr_exp	2.28	0	1
F_01_pc_rev	2.26	0	0
F_03_fin_aut	4.96	1	1
F_04_tax_aut	6.58	2	2
E_01_unem	7.54	2	1
E_02_pop	2.10	1	1
E_03_pc_inc	5.24	2	0
D_03_south	6.30	2	1
D_05_2008	1.69	0	0
D_06_2013	2.17	0	0

Table APP.V.2 shows no variable with a VIF above the 10 threshold. The condition index of the variance-covariance matrix of the variables in Table APP.V.2 is 63.61, well above the 30 threshold commonly considered in the literature. Therefore, a further analysis on the cross-correlations needs to be implemented in order to identify a more efficient version of the model. Variable F_01 and the two year dummies (D_05 and D_06) present no cross-correlations, so they will be kept in the model. Hence, the following correlation analysis will ignore the non-correlated variables D_05, D_06 and F_01.

Table APP.V.3 - Correlation matrix (coefficients' correlations in parentheses)

Variable	A_0	~~A_0~~	A_0	~~A_0~~	~~A_0~~	A_0	A_0	F_03	~~F_04~~	~~E_01~~	E_02	E_03	~~D_0~~
A_01_curr_bal	1												
~~A_02_ borr_need~~	**0.61 (-0.71)**	1											
A_03_debt_rev	-0.01 (-0.04)	0.11 (0.01)	1										
~~A_04_pc_debt~~	-0.41 (0.24)	-0.08 (-0.13)	0.30 (-0.33)	1									
~~A_05_debt_serv~~	-0.04 (-0.03)	-0.07 (0.09)	**0.56** (-0.41)	0.25 (-0.05)	1								
A_06_int_cov	0.45 (-0.13)	0.13 (-0.02)	-0.20 (-0.20)	**-0.59 (0.56)**	-0.14 (0.01)	1							
A_07_curr_exp	-0.29 (0.48)	0.23 **(-0.56)**	-0.07 (-0.02)	0.15 (0.08)	-0.17 (0.03)	-0.24 (0.16)	1						
F_03_fin_aut	0.02 (-0.05)	-0.01 (-0.03)	-0.23 (-0.09)	0.05 (-0.18)	-0.15 (-0.12)	0.15 (0.03)	0.22 (0.03)	1					
~~F_04_tax_aut~~	-0.09 (-0.05)	-0.16 (0.18)	-0.40 (0.11)	-0.12 (0.20)	-0.32 (0.13)	0.17 (-0.04)	0.33 (-0.19)	**0.79 (-0.79)**	1				
~~E_01_unem~~	-0.28 (0.10)	-0.21 (-0.10)	-0.03 (-0.18)	0.19 (0.01)	0.03 (0.01)	-0.11 (0.03)	0.18 (0.04)	0.03 (-0.12)	0.17 (0.17)	1			
E_02_pop	-0.19 (-0.01)	-0.16 (0.05)	-0.19 (0.06)	0.03 (-0.13)	-0.21 (0.04)	-0.09 (0.01)	0.26 (-0.09)	0.27 (0.33)	**0.52 (-0.54)**	0.28 (-0.31)	1		
E_03_pc_inc	0.31 (0.03)	0.30 (-0.11)	0.14 (-0.09)	-0.08 (0.11)	0.02 (0.05)	0.10 (0.10)	-0.16 (0.22)	0.17 (-0.35)	-0.11 (0.40)	**-0.73** (0.38)	-0.05 (-0.46)	1	
~~D_03_south~~	-0.28 (-0.06)	-0.30 (0.07)	-0.15 (0.14)	0.12 (0.01)	-0.02 (-0.01)	-0.10 (0.04)	0.06 (0.11)	-0.10 (-0.03)	0.09 (0.07)	**0.83 (-0.61)**	0.19 (-0.07)	**-0.82** (-0.31)	1

Table APP.V.3 above shows several cross-correlated terms among both variables and coefficients. Clearly, since many indicator have a similar construction or are meant to measure similar phenomena, this is reflected in the correlation statistics. Hence, correlated variables will be removed and the overall variance-covariance matrix will be tested. According to the information displayed in Table APP.V.3 the following variables have been eliminated: A_02, A_04, A_05, F_04, E_01 and D_03. Therefore, the list of variables left is: A_01 (Current Balance), A_03 (Debt to Revenues), A_06 (Interest Coverage), A_07 (Current Expenditures), F_01 (Per Capita Revenues), F_03 (Financial Autonomy), E_02 (Population), E_03 (Per capita Income), D_05 (Year 2008 Dummy) and D_06 (Year 2013 Dummy). The condition index for this version of the model is 47.01, well above the 30 threshold signalling multicollinearity. Moreover, four variables (A_06, A_07, F_01 and E_02) show correlation level below but very near the 50% threshold and seem to cause some stability problems in other variables' coefficients. This diagnosis points to the need of a further analysis on the last list of variables.

The following Table APP.V.4 show the coefficients obtained regressing each of the last four variables against the remaining explanatory variables in the model. It can be noticed that all the four variables are extremely related to remaining

variables in the model. Moreover, only dropping all this four variables allows to lower the condition index below the 30 threshold.

Table APP.V.4 - Cross-regression coefficients (t-stats in parentheses)

Explanatory Variables	A_06_int_cov	A_07_curr_exp	F_01_pc_rev	E_02_pop
A_01_curr_bal	**789.92** **(6.99)**	**-0.16** **(-2.44)**	**-0.68** **(-1.77)**	**-1.29** **(-2.13)**
A_03_debt_rev	-62.92 (-1.44)	-0.03 (-1.16)	**-0.89** **(-7.09)**	**-0.67** **(-3.15)**
A_06_int_cov	-	**-0.01** **(-2.70)**	**0.01** **(3.29)**	-0.01 (-0.36)
A_07_curr_exp	**-323.73** **(-2.70)**	-	-0.45 (-1.17)	**1.15** **(1.93)**
F_01_pc_rev	**65.05** **(3.29)**	-0.01 (-1.17)	-	**-0.23** **(-2.35)**
F_03_fin_aut	34.86 (0.26)	**0.16** **(2.28)**	**2.97** **(7.69)**	**2.30** **(3.51)**
E_02_pop	-4.63 (-0.36)	**0.01** **(1.93)**	**-0.09** **(-2.35)**	-
E_03_pc_inc	-66.18 (-0.96)	**-0.07** **(-1.91)**	-0.06 (-0.26)	-0.01 (-0.01)
D_05_2008	-33.18 (-0.84)	**0.07** **(3.29)**	0.13 (1.03)	-0.15 (-0.75)
D_06_2013	68.27 (1.30)	**0.15** **(5.92)**	0.02 (0.15)	0.12 (0.47)

Therefore, the variables A_06, A_07, F_01 and E_02 need to be excluded from the model. Finally, the final version of the empirical model consists of six variables (four explanatory variables and two dummy variables): A_01 (Current Balance), A_03 (Debt to Revenues), F_03 (Financial Autonomy), E_03 (Per capita Income), D_05 (Year 2008 Dummy) and D_06 (Year 2013 Dummy). This final version of the model is characterized by extremely low VIFs, no cross-correlated terms and a condition index of 16.89.

Conclusions

This PhD thesis empirically investigated the determinants of Italian municipal bond yields and credit ratings.

Firstly, chapter IV's results on municipal bond yields show that investors apply different pricing schemes to the different types of local governments. Specifically, bonds issued by regions are priced differently compared to those issued by local authorities (cities and provinces). The analysis on the latter category finds that the specific creditworthiness of a local authority is irrelevant in the pricing of a local authority's bond. This significant result might be explained by the strong reliance of local authorities' revenues on central government transfers and by the expectations of a bailout in the event of a city or province default. Hence, a local authority's default risk is closely linked to that of the Italian Government, leaving little or no role to the individual economic, financial and fiscal characteristics of the issuer. Conversely, this doesn't happen with yields paid by regions, as these are mainly driven by the economic strength of the issuer and are not affected by central government sovereign risk. The difference in regional bonds' pricing behavior can be attributed to their institutional nature. While cities and provinces possess a similar status and are subject to the same legislation, regions are characterized by a greater independence and by a significantly higher degree of financial autonomy.

Moreover, the divergences between regions and local authorities are confirmed also in the analysis of the role of credit ratings in affecting yields. The ratings assigned by international rating agencies to Italian local authorities are found to be relevant in the pricing process, with rated issuers paying, *ceteris paribus*, around ten basis points less than their unrated peers. However, the specific rating assessment assigned to an issuer (i.e. AA-, BBB+ etc.) does not affect yields. That is to say, for instance, that a BBB issuer does not face an interest rate penalty compared to a AA one, but both of them get a benefit from having a credit rating in comparison with an unrated issuer. Investors are not concerned with the credit quality information conveyed by ratings, but the presence of a credit rating increases the marketability of an issue in the secondary market, so the reason for this price discrimination can be attributed to liquidity risk, and not to default risk. On the other hand, whereas all issuer default-risk related variables, including rating, are irrelevant in the pricing of local authorities' issues, this is not true for the pricing of regional bonds. Again, it has been confirmed that the default risk of a region matters, either measured by economic indicators or by the credit rating. However, it has not be detected any additional

informational role for credit ratings beyond the information obtainable from publicly available financial and economic data.

Furthermore, chapter V's results help understanding the determinants of Italian local governments' credit ratings. First of all, the two different methods applied, ordered probit and standard regression analysis, even if from the methodological point of view the latter proved to be preferable to the former, both confirmed that few publicly observable indicators are able to explain up to 65-80% of the variance in ratings. Moreover, the ratings assigned by Moody's and Fitch resulted strongly driven by three explanatory variables such as current balance, debt to revenues ratio and per capita income, while for S&P only the two latter variables were relevant.

Also, the structural break test detected a significant change in ratings' behaviour during the recent euro-zone sovereign debt crisis. The analysis of descriptive statistics confirmed that, in this period, although all local governments' indicators remained stable, the Italian sub-sovereign ratings experienced a dramatic overall downgrade following the deterioration of the central government's rating. This means that, although rating agencies discriminated between rating categories according to the specific financial condition of local governments, the modal value of the sub-sovereign ratings' distribution was primarily affected by the central government's rating. Moreover, the series of central government's downgrades, characterizing the sovereign debt crisis, had a different impact on the three tiers of Italian sub-national governments. While the number of rated regions remained almost unchanged, the number of rated provinces and cities in the sample experienced, respectively, a 81% and 65% drop in 2013 compared to the pre-crisis period.

The findings in this thesis pose some policy considerations, both at the microeconomic and at the macroeconomic level. Under the former, local administrators should buy a credit rating since this significantly lowers interest expenditure, even if ratings appear to be largely driven by few simple publicly available indicators. From a systemic point of view, there is an issue concerning biased incentives, regarding the two lowest tiers of sub-sovereign governments, because highly-indebted local authorities are not penalized in terms of interest cost while the more creditworthy ones are constrained by sovereign risk. On the one hand, Italy being a risky issuer itself, sovereign risk affects those cities and provinces which are characterized by a very high credit standing, on the other hand bailout expectations advantage the less creditworthy local authorities which can borrow at the same interest rates of the high standing ones. Financial markets, in this context, are not able to impose debt discipline to local authorities, failing to penalize or reward borrowers according to the quality of

management. As pointed out by Bailey et al. (2009), “market discipline and control of borrowing is negated if national governments guarantee (whether explicitly or implicitly) the repayment of municipal debt”.

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