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Dottorando
GIOVANNI VITTORINO

Supervisore
PROF.SSA CLARA GRAZIANO

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PhD Student: Giovanni Vittorino

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Contents

CHAPTER 1

Introduction

1.1 Structure of the thesis

This thesis is divided in three papers on regional economics. The first paper is concerned with the short-run (risk-sharing) and long-run (redistributive) effects of inter-regional redistribution among Italian regions. The latter two papers are focused on obstacles to innovation in the Italian region Friuli Venezia Giulia, which is an important aspect to understand the capacity for economic recovery of a regional territory after the crises of 2007 and 2011. Financial and market obstacles to innovation and preference for internal funds have been found to be relevant in the region and, thus, financing innovation through public structures become more important to face long periods of economic crisis. Beside belonging to the same field of economics, the topics covered by these three papers are deeply interconnected as the redistribution of resources across regions could play an important role for allowing lagging regions to receive financial resources that could be targeted to the support of their own regional systems of innovation. In the future this latter point will deserve an in-depth study as it is widely accepted among scholars and policy makers that innovation is pivotal for the economic growth of territories and for their resilience especially when long-standing recessions hit the economy.

1.2 Overview of the papers

The first paper studies, for the period 1983-2015, the impact of the Central Government's fiscal policy on redistributive (long-run) and risk-sharing (short-run) effects of inter-regional redistribution among Italian regions. This assessment is relevant from a policy-making point of view as The MacDougall Report (1977) pointed out that the short-run objective of inter-regional redistribution is to allow the poorest areas to reach the consumption level of the richest areas, while in the long-run, it should aim at the convergence of regions in terms of economic growth. By following a narrative approach to isolate meaningful changes in fiscal policy paradigms, we focus on the spans 1983-1995,

1996-2007 and the period covering the unfolding of the economic and sovereign debts crises, 2008-2015. Our study presents several original contributions to the extant empirical literature on the redistributive (long-run) and the risk-sharing (short-run) features of inter-regional redistribution. First, we develop an empirical framework that allows us to disentangle the regional fiscal flow in its horizontal and vertical components[1] as well as to maintain the distinction between the redistributive (long-run) and the risk-sharing (short-run) features of redistribution. We focus on horizontal fiscal flows as we want to isolate the dimension of fiscal transfers among regions and to do so we have to control for the intertemporal dimension of inter-regional redistribution arising when at country-level we observe either a surplus or a deficit. In doing so we point out that the redistributive and risk-sharing effects of horizontal fiscal flows are tightly linked to the dimension of the primary balance for which the Italian Central Government is responsible. Second, we model the relevant equations in a way that allows us to avoid the over-fitting problems that affect previous studies on the topic. Third, we construct a database of regional fiscal variables covering over thirty years - obtained using homogenous data sources - that allows us to test whether the ability of horizontal fiscal flows to mitigate long-run differences and region-specific temporary shocks to economic activity changed over time. Finally, we estimate to what extent the expenditure and the revenue items of the horizontal fiscal flows among regions contribute to mitigate short- and long-term differences in Italian regions' per capita GDP. Regional fiscal variables are constructed following a top-down approach based on territorial statistical sources that are consistent with the benefit principle. Regarding the redistributive effects, we present evidence that the ability of horizontal fiscal flows to reduce long-run income disparities among Italian regions, albeit substantial, declined over time because of the increasing contributions of Italian regions to country-level fiscal adjustments that have been going on since the 1990s to control the huge public debt. We found evidence that the main drivers of the reduction in redistributive effects have been the expenditure for social protection and investment purposes that in relative terms penalized the Southern Italian regions. As far as risk-sharing is concerned, we found that the implicit insurance scheme among Italian regions, which had been in place until the mid-1990s, disappeared during the period 1996-2007. Finally, during the period 2008-2015, covering the years of economic and sovereign debts crises inter-regional redistribution amplified the effects of idiosyncratic shocks on region-level GDPs. This happened as local public finance behaved in a very pro-cyclical manner because of the decrease in transfers from the Central Government to local governments and the rise in taxes and duties levied by the sub-national tiers of Government after the 2011 sovereign debts' crisis. An important implication of this study is that an explicit insurance scheme against temporary shocks at regional level is advisable when it is not possible to rely on automatic stabilizers.

[1]We focus on the horizontal fiscal flow that is obtained by decomposing the regional fiscal flow (FF) as the sum of the vertical (VFF) and horizontal (HFF) fiscal flows, i.e. FF=HFF+VFF. In this framework, a surplus (deficit) at the country-level will be allocated at the regional level by reducing (increasing) the revenues (expenditures) of each region in proportion of the regions' share of revenues (expenditures). The VFF, that adds up to the country-level primary balance, captures either the financial flows from the Central Government to regions or the overall contributions of regions to the country-level surplus. Thus, the VFF is informative about the role of each region with respect to a country's primary balance position. The negative values of VFF provide a measure of the contribution of each region to the country-level primary surplus or, for positive values, how much each region receives out of the national primary deficit. In Section 2.3 we provide a simple numerical example on how to implement the methodology.

The second paper[2] focuses on financial constraints to innovation in Friuli Venezia Giulia during the span 2005 to 2015. We assess if financial constraints to innovative firms are more severe than for non-innovative ones, as hypothesized by the theoretical literature on innovation financing. We rely on two data sources: the wave 2008-2010 of the Community Innovation Survey (CIS) and the Italian Company Account Database (CAD). We use two indicators of financial constraints: the sensitivity of physical investment to cash flow estimated through the micro-econometric model first developed by Fazzari et al. (1988) (indirect indicator) and the perception of financial obstacles declared by firms in the CIS 2008-2010 (direct indicator). We define broad innovators as those firms that declare to be engaged in any innovation-related activity listed by the CIS and we further investigate on the combined effect of innovation attitude and size as small firms are hypothesized to be more affected by financial constraints. Results for the microeconometric analysis point out a significant sensitivity of physical investment to cash flow both for broad innovators and non-innovators with not significant differences between the two groups. Among broad innovators, larger firms show a significantly higher sensitivity than smaller firms which is at odds with the theoretical literature that hypothesizes small firms to be more likely to suffer financial constraints. Looking at the responses of broad-innovators to the CIS we find evidence of a significantly higher percentage of small firms that declared financial obstacles to be of medium high importance. We explain the highest sensitivity of larger innovators with their higher involvement in Research and Development (R&D) projects which is the most demanding form of innovation activity which also implies higher reliance on internal funds due to the reticence to disclose relevant information on their projects to external financiers to get funds. Our explanation is validated by the fact that testing the sensitivity of investment to output for R&D performers and for non-R&D performers, the indicator is significantly higher for the first group. Moreover, among the group of R&D performers, there is not significant difference between small and large firms.

In the third paper[3] we assess the perception of of CIS listed obstacles to innovation by potential innovators in Friuli Venezia Giulia for the period 2006 to 2015 exploiting the CIS 2008-2010 and CIS 2010-2012 data as well as the Italian Company Account database (CAD). We divide potential innovators in two groups: innovation-active firms, i.e. firms that are engaged into innovation projects and deterred firms, i.e. firms that are interested in innovation but have been deterred by some obstacles. We want to find a relationship between the perception of obstacles to innovation and the degree of engagement into innovative activities. Following the literature, we hypothesize that the higher the involvement into innovation, the lower the perception of obstacles to innovation. We divide obstacles in three macro classes: financial, human resources and market related. We introduce a new qualitative measure of innovation intensity where the lowest ranked activity in innovation is the external acquisition of technology and the highest ranked activity is R&D which entails not only financial efforts, but also relational, human and knowledge capital. The quantitative analysis is divided into two parts. First, we run a cross-section analysis based on the CIS wave 2008-2010 employing a multivariate probit to assess the relationship between the probability of perceiving as important the three groups of obstacles and the intensity of engagement into innovation. We control for firms' specific characteristics such as size, sector and also for financial and profitability indicators as

[2]Other co-authors: Maria Claudia Schneider (University of Udine).

[3]Other co-authors: Simona Iammarino (London School of Economics and Political Science) and Tiziana Sodano (Bank of Italy).

they have been found to be related with the probability to suffer financial obstacles by the empirical literature. Second, we run a panel analysis matching the firms surveyed in both CIS waves 2008-2010 and 2010-2012 through a random effect probit model. The results for the cross-section analysis show that financial, and market obstacles are felt as less important by innovation-active firms with respect to deterred ones. As expected, the perceived importance decreases with the involvement into innovation. No differences have been found for human resources related obstacles. The panel analysis shows us that financial obstacles are perceived as more important both by deterred firms and by R&D firms, while results are the same as the cross-sectional analysis for market and human resources related obstacles. Furthermore, we use our CIS-CAD 317 firms' panel dataset to grasp additional insights on how the relationship between the probability of perceiving barriers to innovation as important is affected by the deteriorating macroeconomic conditions following the sovereign debt crisis. Results show that the probabilities that all firms perceive financial and human resources obstacles as important are considerably reduced for the years 2010-2012 indicating that in the second stage of the crisis such barriers become more pervasive, affecting innovators and non-innovators alike. On the contrary, the perception of market-related obstacles rose substantially in 2010-2012, particularly for non-innovators, suggesting that the worsening of the internal and external macroeconomic environment further discourage from innovate, undermining the overall capacity of the system to react to the crisis.

CHAPTER 2

Inter-regional redistribution and fiscal policy in Italy

Inter-regional redistribution and fiscal policy in Italy[1]

Giovanni Vittorino[2]

January, 2019

[1]The views expressed in this paper are those of the author and do not necessarily reflect the views of the Bank of Italy or of the Eurosystem. I am grateful to Stefano Comino, Clara Graziano, Maria Laura Parisi, Laura Rondi, Paolo Sestito and to two anonymous referees for their insightful comments and suggestions. All remaining errors are my own.

[2]Bank of Italy and University of Udine, Italy.

Abstract

This paper studies, for the period 1983-2015, the impact of the Central Government's fiscal policy on the redistributive (long-run) and risk-sharing effects (short-run) of horizontal fiscal flows among Italian regions. The main novelty of this study is an empirical framework that allows us to disentangle the horizontal and vertical components of regional fiscal flows and to test whether the redistributive and risk-sharing effects of horizontal fiscal flows changed over time. Our estimates suggest that although the redistributive effects of horizontal fiscal flows are substantial, their magnitude declined after the 1990s as a consequence of the fiscal adjustments undertaken by the Italian Government, to which regions are the ultimate contributors. We also point out that after the unfolding of the recent economic and sovereign debts crises, the horizontal fiscal flows started to act as a risk-enhancing device with respect to short-term shocks to Italian regions' economic activity.

JEL Classification Numbers: D82; D92; G32; O31; O32.

Keywords: Public Finance, Regional Fiscal Flows, Inter-regional Redistribution, Risk-Sharing, Regional Economics.

2.1 Introduction

The redistribution of resources among territories is at the core of the debate on fiscal federalism[1] in Italy, and it is a relevant topic with respect to a reshaping of the European Monetary Union (EMU) governance[2] that would allow for the countries of the euro area to share a sizable supranational budget. Moreover, inter-regional redistribution is currently on top of the political agenda in Italy[3] as after the 2008 economic crisis a further divergence occurred between Center-Northern and Southern regions in the capability to generate tax revenues, which tend to be proportional to the gross domestic product (GDP), and thus to finance of public spending.

It is possible to measure the size of the implicit inter-regional redistributive activity among Italian regions by computing the regional fiscal flow, i.e. the difference between the public spending referred to a territory and the public revenues collected from the same; residents in regions with a positive fiscal flow are, on average, net beneficiaries of the inter-regional redistribution carried out by the public sector, while those with a negative flow are net contributors. It follows that a centralized system of taxes and transfers, such as the Italian one, is capable of mitigating the long-run disparities in terms of GDP by ensuring an almost uniform provision of public goods and services to all citizens across territories, despite of the marked dualism in terms of economic prosperity (and fiscal capacity) between the Northern and Southern regions. Conversely, in the short-run, redistribution should act as a risk-sharing device that entitles a region to receive financial transfers to offset a tax revenue loss in the event of a short-run negative shock to a region's economic activity, and in circumstances related to low labor force mobility and the stickiness of the implicit exchange rate between territories[4] (Blanchard et al., 1992; Obstfeld and Peri, 1998).

According to the extant empirical literature[5] and to our estimates, the long-lasting socioeconomic dualism between Center-North and South (Figures 2.2(a) and (b)) is re-

[1] In 2001, the Constitutional Law No. 3 introduced fiscal federalism with the Reform of the Title V of the Italian Constitution. In Articles 117 and 119, the Reform establishes the autonomy of sub-national tiers of government in making decisions about taxes and expenditures within the guidelines and boundaries defined by the laws of the Italian State. Within this framework, the Central Government has the responsibility to coordinate the whole system of taxes and transfers to guarantee equalizing transfers to sub-national tiers of the Government that are unable to provide with their own resources those public services that meet a set of homogenous minimum quality and quantity standards.

[2] The MacDougall Report (1977) pointed out that the short-run objective of inter-regional redistribution is to allow the poorest areas to reach the consumption level of the richest areas, while in the long-run, it should aim at the convergence of regions in terms of economic growth.

[3] This is not surprising as the Articles 32, 34, 38, and 53 of the Italian Constitution prescribe that public intervention must aim at reducing the long- and short-run socio-economic gaps among territories.

[4] For instance, regional GDP deflators could be used as a proxy for region-specific price levels.

[5] See Maggi and Piperno (1992), Agostinelli et al. (1996), Magnani (1997), Decressin (2002), Staderini and Vadalá (2009), Cannari and Chiri (2006), Ambrosanio et al. (2010), Arachi et al. (2010), Cerea (2013), Giannola et al. (2016) and Petraglia et al. (2017).

flected in the implicit financial flows among Italian regions, which during the period 1983-2015 represented 4.3% of the Italian GDP on an annual basis (Figure 2.3(b)). Moreover, implicit fiscal flows among Italian regions and country-level fiscal policy are deeply interconnected for two reasons. First, the Italian system of taxes and transfers to subnational entities (Regions, Provinces and Municipalities) is highly centralized and the Central Government is directly responsible for roughly 80% of overall taxes and 70% of public spending. Second, the Italian Central Government is directly responsible for the country-level primary balance of which residents of Italian regions are the ultimate beneficiaries, when there is a deficit, or to which they are the ultimate contributors in the case of a surplus.

In this study, we focus on the horizontal fiscal flow that is obtained by decomposing the regional fiscal flow (FF) as the sum of the vertical (VFF) and horizontal (HFF) fiscal flows, i.e. $FF = HFF + VFF$.[6] Our choice is consistent with the extant literature according to which inter-regional redistribution should be treated as a pure transfer of resources among regions by neutralizing any national-level deficit/surplus (see Arachi et al., 2010; IMF, 2011; Ruggeri, 2009). In this framework, a surplus (deficit) at the country-level will be allocated at the regional level by reducing (increasing) the revenues (expenditures) of each region in proportion of the regions' share of revenues (expenditures). The VFF, that adds up to the country-level primary balance, captures either the financial flows from the Central Government to regions or the overall contributions of regions to the country-level surplus/deficit. Thus, the VFF is informative about the role of each region with respect to a country's primary balance position. The negative values of VFF provide a measure of the contribution of each region to the country-level primary surplus or, for positive values, how much each region receives out of the national primary deficit.

The objective of this study is to assess the impact of the Central Government's fiscal policy on the redistributive and risk-sharing effects of horizontal fiscal flows (HFFs) among Italian regions during the spans $1983-1995$, $1996-2007$ and the period $2008-2015$. The choice of the relevant time spans followed a narrative approach and it is an attempt to isolate meaningful changes in the paradigm of fiscal policy. The chosen periods cover the most relevant fiscal policy breaks while preserving enough data observations for running econometric estimates.

The first sub-period falls in the pre-EMU era and it is mostly characterized by the lack of fiscal discipline with the Central Government running primary deficits. The period $1996-2007$ covers the fiscal discipline imposed through the rules of the Stability and Growth Pact introduced in 1997.[7] This period also encompasses the Italian pension

[6]See the Appendix and Section 2.3 for more details on how regional fiscal flows have been computed.
[7]Italy adopted the Stability and Growth Pact with Law No. 448 in 1998.

system reform, that represented a major shift from a retributive to a contributive pension system[8], and the fiscal decentralization introduced in 1997.[9] Finally, the last period 2008-2015 is characterized by the unfolding of the economic and sovereign debts crises.

Our study presents a number of original contributions to the extant empirical literature on the features of inter-regional redistribution pioneered by Von Hagen (1992), Bayoumi and Masson (1995) and Mélitz and Zumer (2002). First, we develop an empirical framework that allows us to disentangle the regional fiscal flow (FF) in its horizontal (HFF) and vertical (VFF) components as well as to maintain the distinction between the redistributive (long-run) and the risk-sharing (short-run) features of redistribution. Second, we model the relevant equations in a way that allows us to avoid the over-fitting problems that in some circumstances could deliver spurious estimates. Third, the availability of a database covering over thirty years - obtained using homogenous data sources[10] - allows us to test whether the ability of HFFs to mitigate long-run differences and region-specific short-run shocks to economic activity changed over time. Finally, we estimate to what extent the expenditure and the revenue items of the HFFs among regions contribute to mitigate short- and long-term differences in Italian regions' per capita GDP.

This paper contributes to the extant literature by showing that the redistributive and risk-sharing effects of HFFs are tightly linked to the dimension of the primary balance for which the Italian Central Government is responsible. Our estimates suggest that although the redistributive effects of HFFs on the economic activity of Italian regions are substantial, their magnitude declined after the 1990s driven by VFFs, i.e., the fiscal adjustments decided by the Central Government to which Italian regions are the ultimate contributors. We point out that the fall of the expenditures both in capital account and social protection, that in relative terms penalized Southern Italian regions, were the main drivers of the reduction of the redistributive effect. We show that, after the 1990s, HFFs did not exhibit any risk-sharing effect with respect to short-run region-specific shocks. Moreover, after the unfolding of the recent economic and sovereign debts crises, the HFFs started to act as a risk-enhancing device due to the sharp rise in taxes and duties levied by the sub-national tiers of Government. Moreover, descriptive statistics support that our findings are likely to be driven by the fiscal adjustments undertaken by the Italian Government after the 2011 sovereign debts' crisis.

This paper continues as follows. In Section 2.2, we review the most relevant literature on the effects of inter-regional redistribution and some studies related to Italian regions.

[8]The so-called "Riforma Dini" was introduced by the Law No. 335 in 1995.

[9]The so-called "Riforma Bassanini" was introduced by the Laws No. 59 and 127 in 1997. The reform went through subsequent modifications over time.

[10]Relying on heterogenous data sources Giannola et al. (2016) provided a reconstruction of fiscal data at regional level for Italy for the period 1951-2010.

In Section 2.3 we describe how to compute the HFFs and the VFFs. In Section 2.4, we explain the model specification and the estimation methodology underlying our analysis. In Section 2.5, we present some descriptive statistics and the results of our analysis. The last Section concludes.

2.2 Literature Review

In this study, we focus on the redistributive (long-run) and risk-sharing (short-run) effects of HFFs over the last thirty years in Italy. For this purpose, we provide a summary of two main literature's strands to give an account of the most important methodological and empirical contributions in general and for the Italian case.

Since the seminal contribution of Musgrave (1961) on fiscal federalism unveiled the trade- off between efficiency and equality arising when fiscal transfers take place across heterogeneous territories within a federation, researchers and policy makers have devoted much effort in the attempt to identify the optimal level of fiscal transfers with respect to the social welfare function of a federation. In a nutshell, most of the empirical studies implicitly assume that the social welfare function of a society can be proxied by an ideal distribution of income (Cowell, 2011) that the Central Government can target through a system of taxes and transfers. According to Buchanan (1950), the first researcher that introduced the concept of fiscal transfer (fiscal residuum), an equitable system of taxes and transfers should ensure that the same fiscal residual applies to taxpayers with the same level of income (see Staderini and Vadalá, 2009, p. 1, note 1). Conversely, from a positive point of view, there is an extensive amount of empirical literature that has developed a methodological framework to analyze the redistributive and risk-sharing effects of inter-regional fiscal transfers across territories. Most of these studies investigate how much income and consumption smoothing across regions within a state, or across states within a federal entity, is determined both in the short- and in the long-run by inter-regional fiscal transfers rather than by market forces.

Von Hagen (1992) and Bayoumi and Masson (1995) were among the first researchers to empirically apply the distinction between the long-run and the short-run features of inter-regional redistribution highlighted by The MacDougall Report (1977) for EMU countries. However, the conclusions reached by earlier empirical literature are often contradictory. Some studies on the US and Canada found a low or no role for inter-regional redistribution and stressed the role of market forces (Von Hagen, 1992; Asdrubali et al., 1996). Other empirical contributions emphasized the need for federal taxes and transfers as a major mechanism of income and consumption smoothing within monetary unions (Sachs and Sala-i Martin, 1992; Eichengreen, 1993 and Fatás et al., 1998). More recently, Poghosyan et al. (2016), using a single equation pooled mean group estimator,

found that the ability of regional fiscal transfers to provide risk-sharing and redistribution mostly depends on central budget automatic stabilizers that are transmitted to regions through federal taxes and transfers to individuals. Their estimates suggest that fiscal transfers have a risk-sharing effect in a 4-11% range while their redistributive effect is between 13 and 24% of a 1% shock to per capita GDP. Poghosyan et al. (2016) suggest either to centralize pro-cyclical spending and revenue functions or to establish a "rainy-day" fund in those federations in which automatic stabilizers do not work properly, for instance, at the European level.

According to Mélitz and Zumer (2002), the earlier studies lack consistency, as they often compare narrow (broad) measures of transfers, such as direct taxes and money transfers alone, with broad (narrow) measures of the economic activity, such as GDP (disposable income), thus underestimating (overestimating) the effects of inter-regional fiscal transfers on consumption smoothing. Mélitz and Zumer (2002), using a common accounting and econometric methodology to evaluate to what extent region-specific GDP shocks are absorbed via inter-regional transfers, provide updated estimates of five studies on inter-regional redistribution and output/personal income stabilization. They point out that previous studies would not have differed greatly in their estimates of the stabilization effects of inter-regional transfers if they had adopted a consistent accounting choice for fiscal variables and economic activity. Mélitz and Zumer (2002) estimated that the stabilization of shocks to personal disposable income oscillate in a range between 12% and 20% of a 1% shock to per capita GDP for the United Kingdom, Canada and the United States. The use of the GDP (instead of personal income) and a broader definition of transfers (the net fiscal transfer) delivers different coefficients for both redistribution and risk-sharing, as the broader measure of net transfers includes fundamental in-kind public services, such as health and education, that are financed by net transfers to lower tiers of Governments, subsidies and other transfers to firms.

Our study improves the estimation framework proposed by Mélitz and Zumer (2002) along two directions. First, our estimation framework allows us to disentangle the regional fiscal flow (FF) in its horizontal (HFF) and vertical (VFF) components as well as to maintain the distinction between the redistributive (long-run) and the risk-sharing (short-run) features of redistribution. Second, we model the relevant equations in a way that allows to avoid the over-fitting problems that affect previous studies on the topic.

For the Italian case, Decressin (2002) provides an interesting study on inter-regional redistribution, for the span $1983 - 1992$, using the estimation techniques proposed by Bayoumi and Masson (1995), Obstfeld and Peri (1998) and Mélitz and Zumer (2002). Decressin (2002) estimates that an Italian region with a per capita GDP 1% below the Italian average ends up with a per capita GDP that is 0.65%-0.75% below the average, i.e. a redistributive effect in a 25%-35% range. In addition, in the event of a 1% short-run

shock to the per capita GDP of a region, the risk-sharing estimates range from an impact of 10% to 15%. Decressin (2002) also estimates the impulse response functions of the fiscal flow components (consumer spending, welfare spending, total expenditure and revenue) to a shock to economic activity, by running the bivariate VAR originally proposed by Obstfeld and Peri (1998), substantially confirming their findings. The main conclusion of this study is that the greatest part of the redistribution and risk-sharing among Italian regions is due to public expenditures, as the peculiar institutional framework in Italy guarantees everyone a high and uniform access to health care and education, despite the low level of expenditure in social protection policies. Decressin (2002) is at odds with our study and other scholarly studies that pointed out the leading role of current tax revenues as the main drivers of redistributive and risk-sharing effects (Sachs and Sala-i Martin, 1992; Von Hagen, 1992).

Arachi et al. (2010) study the effects of the inter-regional redistribution among Italian regions during the period $1996 - 2002$, pointing out the importance of controlling for the presence of regional trends and the role of different tiers of government. In their methodological framework, conceptually close to the present study, fiscal flows are defined for specific levels of Government as the difference between total expenditure (net of interest payments and transfer to other levels of government) and total revenue (net of transfers from other levels). To grasp the effect of a specific institutional profile, fiscal flows are decomposed in vertical and horizontal flows by sterilizing the country-level primary balance. Arachi et al. (2010) show that approximately 75% of total redistribution is due to horizontal flows among entities of the same tier of government, while only 25% is linked to vertical flows among different levels of government. The main finding is that regional fiscal flows significantly smooth long-run regional differences in per capita GDP and that 90% of total redistribution is linked to horizontal flows, while the remaining 10% is connected to vertical flows.

Giannola et al. (2016), using heterogeneous data sources, estimated a redistributive effect of HFFs on Italian regions per capita GDP of 43.4% for the period 1985-2010 (34.4 for the period 1951-2010). They also find that being a Special Statute Region implies a higher redistributive effect of 1%-2%. Finally, Petraglia et al. (2017) concluded that during the period 1983-1992, with respect to their effect as a percentage of the GDP, HFFs had a redistributive effect in a range of 19.3%-30.5% of GDP (10.3%-18.3% during the period 1951-1965) and a risk-sharing effect of 8.9%-15.3% (4.0%-9.2% for the period 1951-1965) of a 1% shock to per capita GDP.

We contribute to the extant literature on Italy as our dataset, covering over thirty years and obtained using homogenous data sources, allows us to test whether the ability of HFFs to mitigate long-run differences and region-specific short-run shocks to economic activity changed over time.

In this study we estimate the regional fiscal flows for Italy using the methodology proposed by Staderini and Vadalá (2009) that allows for an allocation on a regional basis of the expenditure and revenue items of the country-level Public Administrations' consolidated economic account released by Istat, encompassing all tiers of government. Under the hypothesis that each region behaves as a single economy (Mundell, 1963), fiscal variables at the regional level are constructed following a top-down approach based on territorial statistical sources that are consistent with the benefit principle.

2.3 How to Measure Inter-Regional Redistribution: Horizontal and Vertical Fiscal Flows

Italian regions (21 entities that include 3 Special Statute Regions and the Autonomous Provinces of Trento and Bolzano) differ substantially from one another in many respects, such as the geographic features (e.g., different cost structures for public services), the demographic structure (e.g., welfare spending), the stock of human capital (e.g., general education attainments), the propensity of firms to innovate, the indicators of crime and the levels of economic activity (Table 1). In this respect, the regions of the Center-North of Italy and the Southern ones represent two distinct clusters also in terms of fiscal capacity (proxied by GDP). Further peculiarities emerge by looking at their institutional setup as Special statute Regions/Provinces are characterized by a higher degree of legislative and fiscal autonomy than Ordinary Statute Regions[11], that allows Special statute entities to withhold most of the Central Government's tax revenues levied within their territories (see Panicara et al., 2012).

Due to the lack of official data on fiscal variables at the regional level, we resorted to the methodology proposed by Staderini and Vadalá (2009).[12] We compute for the span 1983-2015 the regional fiscal flow (FF_{it}) by allocating on a regional basis the expenditures (G_t) and revenues (T_t) items of the Italian Public Administrations' consolidated economic account (Istat).[13], i.e. to estimate the Italian primary balance at the regional level.[14]

This accounting choice is consistent with our aim to assess the smoothing properties of inter-regional redistribution with respect to long-run and short-run shocks to a region's per capita GDP. In fact, the accounting of regional fiscal flows must be consistent with the relevant output measure (personal income vs. GDP).[15]

[11] See the Italian Constitution, Article 116.

[12] For other methodological approaches to the Italian case, see also Magnani (1997), Cannari and Chiri (2006), Maggi and Piperno (1992) and Ambrosanio et al. (2010).

[13] The estimation of the regional fiscal flows for Italy is not straightforward because of the scarcity of official territorial data. In the Appendix, we illustrate the details of the methodology proposed by Staderini and Vadalá (2009).

[14] In the Appendix are provided more details on how regional fiscal flows have been computed.

[15] Mélitz and Zumer (2002) and Decressin (2002) pointed out that the way one measures economic activity

Table 1

Italian regions' socioeconomic statistics and indicators for the year 2015 (1)

(real euros and percentage values)

REGION AND AREA	Surface *(Sq. km)*	Population *(millions)*	Demographic structure by age class *(0-14)*	*(65yr)*	Per capita GDP *(euros)*	Innovative firms (2) *(percentage values)*	Unemployment rate *(percentage values)*	Net internal migration rate *(percentage values)*	Households in relative poverty *(percentage values)*	Crime rate (3) *(percentage values)*
Piemonte	25,387	4.4	12.9	24.5	28,923	34.7	10.2	0.6	6.6	6.4
Valle d'Aosta - Vallée d'Aoste	3,261	0.1	13.9	22.5	34,360	25.7	8.9	−0.8	7.2	11.7
Lombardia	23,864	10.0	14.2	21.6	35,950	35.4	7.9	1.1	4.6	23.0
Bolzano-Bozen	7,398	0.5	16.1	19.0	41,215	30.7	3.8	2.1	(∗)	15.3
Trento	6,207	0.5	15.0	20.7	34,659	35.0	6.8	2.2	(∗)	26.6
Veneto	18,407	4.9	14.0	21.7	30,899	40.1	7.1	0.3	4.9	16.5
Friuli Venezia Giulia	7,862	1.2	12.6	25.1	29,201	38.4	8.0	0.8	8.7	29.7
Liguria	5,416	1.6	11.5	28.0	30,495	30.4	9.2	0.7	8.5	23.2
Emilia Romagna	22,453	4.4	13.5	23.5	33,620	33.1	7.7	1.9	4.8	24.0
Toscana	22,987	3.7	12.8	24.8	29,500	33.2	9.2	1.1	5.0	23.4
Umbria	8,464	0.9	13.0	24.6	23,779	29.4	10.4	0.1	(∗)	32.4
Marche	9,401	1.5	13.2	23.7	26,019	28.4	9.9	−0.3	7.6	29.8
Lazio	17,232	5.9	13.8	20.7	31,023	27.2	11.8	0.7	6.9	29.1
Abruzzo	10,832	1.3	12.8	22.6	24,203	22.5	12.6	−0.8	11.2	33.5
Molise	4,461	0.3	11.9	23.4	18,926	17.4	14.3	−2.5	21.5	30.3
Campania	13,671	5.9	15.5	17.6	17,219	17.5	19.8	−3.2	17.6	28.8
Puglia	19,541	4.1	14.0	20.5	17,197	25.3	19.7	−1.9	18.7	19.9
Basilicata	10,073	0.6	12.7	21.6	19,510	26.8	13.7	−3.3	25.0	31.2
Calabria	15,222	2.0	13.8	20.2	16,499	25.5	22.9	−3.5	28.2	29.5
Sicilia	25,832	5.1	14.5	19.9	17,099	21.2	21.4	−2.5	25.3	20.6
Sardegna	24,100	1.7	11.9	21.6	19,341	24.4	17.4	−0.9	14.9	19.7
Italy	302,073	60.7	13.8	21.7	27,094	31.9	11.9	−0.2	10.4	23.0
Center-Northern regions	178,341	39.9	13.6	22.7	31,918	33.8	9.4	0.9	6.0	22.0
Southern regions	123,732	20.9	14.2	19.8	17,820	21.9	19.4	−2.4	20.4	24.8
Ordinary Stature regions	227,412	51.6	13.3	22.6	28,014	30.2	11.0	−0.6	12.2	23.2
Special Statute regions	74,661	9.2	14.0	21.5	21,766	29.2	12.4	0.2	14.0	21.6
Coefficient of variation (%)	2.5	4.1	8.3	10.8	26.6	19.3	43.8	–	75.4	30.8
Maximum value	25.832	10.0	16.1	28.0	28.0	41.215	40.1	2.2	28.2	33.5
Minimum value	3.261	0.1	11.5	17.6	17.6	16.499	17.4	−3.5	4.6	6.4

Source: Istat. (1) Base year 2010. (2) Share of firms that are attempting to introduce product or process innovation. (3) Reported crimes, per 100,000 of the population, for which the Judicial authorities have started criminal proceedings and persons involved.

Thus, in our study, the relevant regional fiscal flows are those that include all the categories of public expenditures and revenues, i.e., public consumption and investments, social protection in the form of money transfers and in-kind welfare, transfers that affect local production and grants minus social security contributions, and direct and indirect taxes. In this way, we are also able to isolate the spending and revenue items that are responsible for the inter-regional redistributive activity.

Given G_{it} and T_{it}, the region's i total expenditures and total revenues at time t, the regional fiscal flow is given by:

$$FF_{it} = G_{it} - T_{it} \quad \forall i, t$$

By construction budget items at the regional level sum up to the corresponding national level variables, i.e. $G_t = \sum_{i=1}^{21} G_{it}$ and $T_t = \sum_{i=1}^{21} T_{it}$. Thus the country-level primary balance (FF_t) is the sum of regional fiscal flows:

$$FF_t = \sum_{i=1}^{21} G_{it} - \sum_{i=1}^{21} T_{it} = \sum_{i=1}^{21} FF_{it} \quad \forall i, t$$

As already noted, regional fiscal flows among Italian regions and country-level fiscal policy are deeply interconnected for two reasons. First, the Italian Central Government is directly responsible for the country-level primary balance. Second, there is a high degree of centralization of the Italian system of taxes and transfers to sub-national entities (Regions, Provinces and Municipalities). Earlier studies (Arachi et al., 2010; IMF, 2011; Ruggeri, 2009) pointed out that if inter-regional redistribution is a pure transfer of resources among regions, one should neutralize any national level deficit/surplus. This choice is motivated by the circumstance that "*interregional redistribution measures the fiscal resources transferred among regions through federal intermediation. For a consistent measure of interregional redistribution, the allocated federal revenues must equal the allocated expenditures*" (Ruggeri, 2009, p. 16).

Given that we treat each region as a separate economy, we must consider the HFFs among regions as the regional fiscal flow net of its vertical component, i.e. the share of the Central Government budget for which each region is "accountable". From an economic point of view, a meaningful representation of the interpersonal redistribution requires the decomposition of the regional fiscal flow with respect to its vertical and horizontal components in order to keep into account the inter-temporal nature of the inter-regional redistribution:

$$FF_{it} = HFF_{it} + VFF_{it}$$

(GDP vs. personal income) and net transfers (broad vs. narrow measures) affect the results when we aim to assess the implications of inter-regional redistribution.

The vertical component (VFF_{it}) that adds up to the country-level primary balance captures either the financial flows from the Central Government to regions or the overall contributions of regions to the country-level surplus/deficit. Our approach is different from the one adopted by Arachi et al. (2010), as we focus on pure inter-regional redistribution only (HFF) and we treat the VFFs as the result of country-level fiscal policy that can only moderate or amplify the effects of the FF on economic activity ($HFF_{it} = FF_{it} - VFF_{it}$). To the best of our knowledge, it is the first time that this approach has been proposed.

The HFFs, representing the economic flows occurring among regions, are obtained by computing the expenditures and revenues at the regional level under the constraint that the budget at the national level is balanced all the time. Thus, if we observe a surplus (deficit) at the country-level, it will be allocated at the regional level by reducing (increasing) the revenues (expenditures) of each region in proportion of the regions' share of revenues (expenditures). By construction, at country-level, it must hold that:

$$FF_t = \sum_{i=1}^{21} HFF_{it} + \sum_{i=1}^{21} VFF_{it} = VFF_t \quad \forall t$$

The horizontal fiscal flow HFF_{it}, under the constraint that the government budget at national level is balanced, must satisfy the following condition:

$$\sum_{i=1}^{21} HFF_{it} = \sum_{i=1}^{21} G^h_{it} - \sum_{i=1}^{21} T^h_{it} = 0 \; \forall t$$

where G^h_{it} and T^h_{it} are the *i-th* region's budget items under the constraint that the country-level budget is balanced at time t. It follows that:

1. If one observes a budget surplus ($G_t < T_t$), then the horizontal fiscal flow HFF_{it} for region i at time t reads:

$$\begin{aligned} HFF_{it} &= G_{it} - G_t \left(\frac{T_{it}}{T_t} \right) \\ &= G^h_{it} - T^h_{it} \end{aligned}$$

2. If one observes a budget deficit ($G_t > T_t$), then the horizontal fiscal flow HFF_{it} for region i at time t reads:[16]

$$\begin{aligned} HFF_{it} &= T_t \left(\frac{G_{it}}{G_t} \right) - T_{it} \\ &= G^h_{it} - T^h_{it} \end{aligned}$$

[16]There is a third scenario in which the Central Government runs a balanced budget, but it is not interesting.

Finally, the vertical fiscal flow of region i at time t is computed as:

$$VFF_{it} = FF_{it} - HFF_{it}$$

To clarify the methodology presented in this Section, we provide the following example for a country with two regions (1 and 2). Let's assume $G_1 = 30$, $G_2 = 70$, $T_1 = 10$, $T_2 = 190$. Thus, we can compute the fiscal flows for the two regions, i.e. $FF_1 = G_1 - T_1 = 20$ and $FF_2 = G_2 - T_2 = -120$. It follows that at national level we observe a primary surplus, i.e. $(G_1 + G_2) - (T_1 + T_2) = G - T = 100 - 200 = -100$. By following the procedure described above we obtain the following HFFs and VFFs for the two regions: $HFF_1 = 25$, $VFF_1 = -5$, $HFF_2 = -25$ and $VFF_2 = -95$. It is straightforward to verify that HFFs have been computed under the constraint that the budget at the national level is balanced, i.e. $HFF_1 + HFF_2 = 0$. Moreover, VFFs sum up to the national-level budget surplus as $VFF_1 + VFF_2 = -100$.

2.4 The econometric framework

In this Section, we propose a framework to estimate the redistributive and risk-sharing effects of HFFs, based on the degree of the persistence of region-specific shocks.[17] As in Bayoumi and Masson (1995), we distinguish between the redistributive (long-run) and risk-sharing (short-run) features of inter-regional redistribution, as HFFs can reduce long-term economic differentials and act as an insurance scheme among the territories by smoothing out the impacts of short-run region-specific shocks to per capita GDP. We also take into account the important implication of disentangling the HFF and VFF components of regional fiscal flows by nesting HFF and VFF into the single equation framework proposed by Mélitz and Zumer (2002), encompassing both short- and long-run features of inter-regional redistribution. In the next Section we present the estimates for the whole sample 1983-2015 and the sub-periods 1983-1995, 1996-2007 and 2008-2015.

Our starting point is the following equation proposed by Mélitz and Zumer (2002):[18]

$$ff_{it} = \mu + \gamma \overline{x}_{i.} + \varphi \left(x_{it} - \overline{x}_{i.} \right) + \epsilon_{it} \tag{2.1}$$

where ff_{it} represents the fiscal flow of region i at time t, $\overline{x}_{i.}$ is the long-run average of the per capita GDP over T periods, $(x_{it} - \overline{x}_{i.})$ captures per capita GDP deviations

[17] A third case is represented by the stabilization that takes place in presence of a common shock. This case is not relevant when talking about inter-regional redistribution, as a common shock is just a country-level shock.

[18] The original equation proposed by Mélitz and Zumer (2002) is $y_{it} = \alpha_d + \beta_d \overline{x}_{i.} + \beta_s \left(x_{it} - \overline{x}_{i.} \right) + \epsilon_{it}$. This formulation is equivalent to equation 2.1, given that $y_{it} = x_{it} + hff_{it}$, $\beta_d = \gamma - 1$ and $\beta_s = \varphi - 1$. As shown in this Section, this formulation is likely to induce an over-fitting problem.

from its long-run level and ϵ_{it} is the error term. The redistributive effect is given by $-\gamma$, implying that each region i with a long-run per capita GDP one euro below (over) the Italian average will receive (devolve) $-\gamma$ cents from (to) other regions. The coefficient $-\varphi$ captures the size of risk-sharing, e.g., each region i will receive $-\varphi$ euro cents as a compensation for a one euro negative shock to its per capita GDP. All variables are standardized with respect to the Italian per capita GDP in order to control for common macroeconomic shocks.[19]

Our methodology is also robust to the over-fitting problem arising with the estimation approach used so far in other studies. In fact, using $y_{it} = x_{it} + hff_{it}$ (see Mélitz and Zumer, 2002), as dependent variable, determines and over-estimation of the regression statistics such as R^2 and the t-statistics, that may affect the significance of regression estimates. The over-fitting problem arises as y_{it} is a composite variables that includes the dependent variable x_{it} itself. In Table 2 we report the estimates for the risk-sharing effects, using both our framework and the formulation used so far in the extant literature. Estimates are obtained using a Pooled OLS and are numerically identical. Estimates obtained using the traditional approach exhibit an over-fitting problem as it delivers very high R^2, high t-stats and consequently lower p-values. This could be a serious problem when a coefficient estimate is close to be rejected as we could end up with spurious estimated coefficient.

In the same fashion of equation 2.1 it is possible to estimate the redistributive and risk-sharing effects of VFFs:

$$vff_{it} = \mu^v + \gamma_v \overline{x}_{i.} + \varphi_v \left(x_{it} - \overline{x}_{i.}\right) + \epsilon^v_{it} \tag{2.2}$$

Given that HFFs are equal to $hff_{it} = ff_{it} - vff_{it}$ we can subtract the right- and left-hand side of equation 2.2 from equation 2.1 and we obtain:

$$hff_{it} = \mu^h + \gamma_h \overline{x}_{i.} + \varphi_h \left(x_{it} - \overline{x}_{i.}\right) + \epsilon^h_{it} \tag{2.3}$$

where $\gamma_h = (\gamma - \gamma_v)$ and $\varphi_h = (\varphi - \varphi_v)$, $\epsilon^h_{it} = (\epsilon_{it} - \epsilon^v_{it})$ and $\mu^h = (\mu - \mu^v)$; in the absence of country-level fiscal adjustments or deficits (i.e., $vff_{it} = 0$ for all i, t that imply $\gamma_v = 0$ and $\varphi_v = 0$) we would observe $\gamma_h = \gamma$ and $\varphi_h = \varphi$ that can be estimated using equation 2.1. Equation 2.3 disentangles the HFF and VFF components of regional fiscal flows, capturing the country-level fiscal adjustments that may moderate or amplify the redistributive and risk-sharing features of inter-regional redistribution.

The redistributive and risk-sharing effects captured by equation 2.3 can also be estimated separately in order to have more flexibility in the choice of the most suitable

[19] For a given region i at time t and a generic variable Z_{it} in per capita terms, we standardize Z_{it} as $z_{it} = \frac{Z_{it}}{X_t}$, where X_t is the country level per capita GDP.

estimator. To estimate the redistributive effects of HFF, we exploit the cross-sectional dimension of our dataset:

$$\overline{hff}_{i.} = \mu^h + \gamma_h \overline{x}_{i.} + \kappa_i^h \tag{2.4}$$

while the risk-sharing equation is estimated exploiting also the time dimension of our panel:

$$hff_{it} = \alpha_i^h + \varphi_h x_{it} + u_{it}^h \tag{2.5}$$

where $\alpha_i^h = \overline{hff}_{i.} - \varphi_h \overline{x}_{i.}$ is the region-specific fixed effect. Finally, the error terms of equations 2.4 and 2.5 are such that $\epsilon_{it} = \kappa_i^h + \mu_{it}^h$.

To allow for the testing of the redistributive effects over sub-periods we decided to use an approximation of equation 2.4:

$$hff_{it} = \mu^h + \gamma_h \cdot x_{it} + \lambda_t + \upsilon_{it}^h \tag{2.6}$$

To choose the most appropriated estimation methodology for equations 2.5 and 2.6, we preliminarily investigated the behavior of our data. Equation 2.6 can be estimated by using a simple OLS with robust standard errors. To keep into account the presence of outliers, we run equation 2.6 using the whole set of regions and iteratively excluding one region at time. We determined that Valle d'Aosta heavily affects the magnitude of estimates, and we decided to eliminate this small influential region (see Figure 2.1 that reports the regression lines excluding only three regions to highlight the outlier problem).[20]

To estimate equation 2.5, we decided to exclude capital account's items from the fiscal variables, as they are extremely volatile. To use variables in level, we resorted to the estimation technique used by Canova and Ravn (1996) and Arachi et al. (2010) that allows us to run a simple OLS, using as variables the cycle components of Hodrick-Prescott (HP) filtered variables with a penalty parameter equal to 7. Thus, equation 2.5 becomes:

$$\left(hff_{it} - \tilde{hff}_{it}\right) = \varphi_h \cdot (x_{it} - \tilde{x}_{it}) + \lambda_t + u_{it}^h \tag{2.7}$$

where $(x_{it} - \tilde{x}_{it})$ denotes the cycle component of the HP-filtered x_{it} and $\tilde{x}_{it}$ is its trend component. Results obtained comparing our estimates for Equation 2.7 with other estimation strategies for risk-sharing are described in Subsection 2.5.3 and reported in Table 7.

[20] The other regression lines, obtained excluding iteratively the other Italian regions are available upon request.

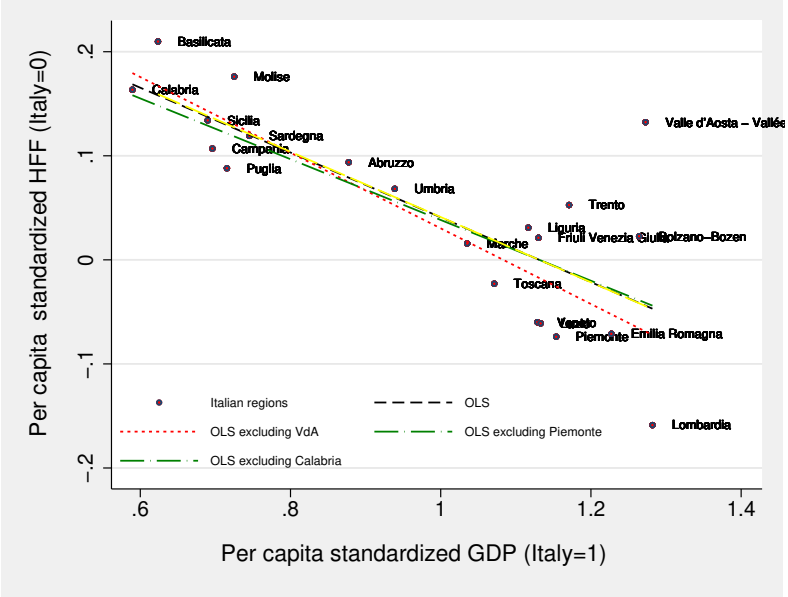


Figure 2.1: Redistributive effects under different samples - Period 1983-1995

From a policy-making point of view, it seems desirable to test how redistributive and risk-sharing effects of HFFs changed over time. To do so, we considered the following modified version of equations 2.6 and 2.7:

$$hff_{it} = \mu^h + \sum_{j=1}^{3} \gamma_h^j \cdot g^j \cdot x_{it} + \lambda_t + \kappa_i^h \tag{2.8}$$

and

$$\left(hff_{it} - h\tilde{f}f_{it}\right) = \sum_{j=1}^{3} \varphi_h^j \cdot g^j \cdot (x_{it} - \tilde{x}_{it}) + \lambda_t + u_{it}^h \tag{2.9}$$

where g^j is a time dummy taking a value of 1 over the sub-periods 1983-1995, 1996-2007 and over the 2008-2015 span, 0 otherwise. We can also decompose the HFF redistributive and risk-sharing effects modeled in equations 2.6 and 2.7 to isolate the moderating/magnifying effect of the VFF both for redistributive and risk-sharing effects, by running a simple OLS on equations 2.8 and 2.9.

2.4.1 Assessing the role of regional fiscal flow items with respect to the overall redistributive and risk-sharing effect

In order to measure the individual impact of various expenditure and revenue items of the HFF, we also run a series of partial regressions by exploiting the fact that hff_{it} is

Table 2

Estimation of risk-sharing effects and over-fitting problems - Period: 2008-2015				
Explanatory variables	**Dependent variable** $\left(hff_{it} - h\tilde{f}f_{it}\right)$		$(y_{it} - \tilde{y}_{it})$	
	Coefficient	t-.stat	Coefficient	t-stat
φ_h	0.269^{**} (0.12)	2.17	0.269^{***} (0.12)	10.22
R^2	0.16		0.53	
Number of observations	160		160	
Number of regions	20		20	
Per region observations	8		8	

Our Equation 2.7: $\left(hff_{it} - h\tilde{f}f_{it}\right) = \varphi_h \cdot (x_{it} - \tilde{x}_{it}) + \lambda_t + u^h_{it}$.
Extant literature approach: $(y_{it} - \tilde{y}_{it}) = (1 - \varphi_h) \cdot (x_{it} - \tilde{x}_{it}) + \lambda_t + u^h_{it}$ where $y_{it} = x_{it} + hff_{it}$.
Estimates have been obtained running a pooled OLS with robust standard errors. Yearly dummies (λ_t) have been included. The sample does not include Valle d'Aosta and all variables are in per capita terms and standardized with respect to the Italian per capita GDP. Coefficients' significance level: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

a composite variable given by the algebraic sum of the HFF items. To do so, we use the following decomposition of the HFF for the i-th region at time t:

$$\begin{aligned} hff_{it} &= g^h_{it} - t^h_{it} \\ &= \sum_{e=1}^{3} g^h_{iet} - \sum_{r=1}^{2} t^h_{irt} \end{aligned} \tag{2.10}$$

In this way, it is possible to isolate the contributions of each expenditure (social protection expenditures, other current expenditures and investments) and revenue (social contributions, other current revenues and capital account revenues) items of HFF for equations 2.6 and 2.7.

2.5 Results

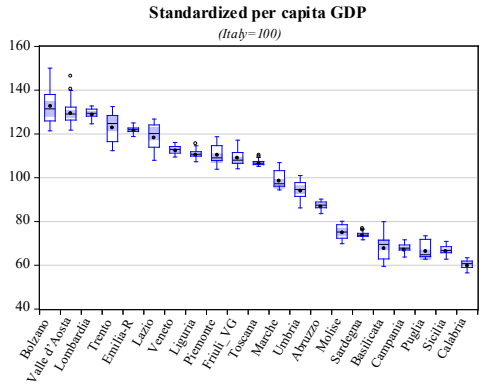
In this Section we present the dataset's variables and the estimation results concerning the decomposition of the HFF and VFF redistributive and risk-sharing effects for the whole sample and the three sub-periods 1983-1995, 1996-2007 and 2008-2015. The relevant periods have been chosen on a narrative basis, i.e. according to the main breaks in the paradigm of the Italian fiscal policy that affected the system of taxes and transfers, and allow to have enough data observations for running econometric estimates (see Introduction).

We also provide an assessment of the contributions of the various items of HFFs to the the overall redistributive and risk-sharing effect. We report the estimates for the whole period 1983-2015; we decided not to present the results on the whole period as they

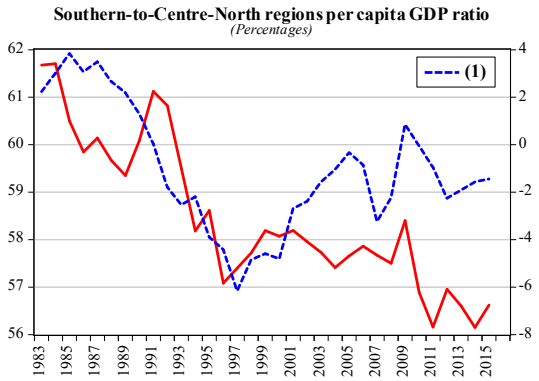
are not very informative, being nothing more than averages of the coefficients estimated across the sub-periods.

2.5.1 The North-South economic dualism and the horizontal flows among regions

Inter-regional redistribution in Italy is a relevant policy-making issue, as regional differences, especially in the levels of economic activity, are striking and long-lasting. For the period 1983-2015, Figure 2.2(a) reports the ranking of Italian regions in terms of standardized per capita GDPs; the richest region was the Autonomous Province of Bolzano, with a value of 133.0, while the poorest region was Calabria, with a value of 60.5. During the same period, the average per capita GDP of the Southern regions and the Center-Northern regions was equal to 68.6 and 117.3, respectively. Tables A.3-A.5 show that the dispersion of Italian regions' standardized per capita GDPs, as measured by the coefficient of variation, is ample and increasing over time.



(a) Italian regions per capita GDP - Period 1983-2015. Source: Own elaborations on Istat data and various data sources (see the Appendix and Section 2.3). Base year 2010.



(b) Southern regions per capita GDP as a share of that of the Center-Northern region. (1) Italy's primary balance-to-GDP ratio: $(G_t - T_t)/GDP_t$. Source: Own elaborations on Istat data. Base year 2010.

Figure 2.2

During the 1980s, the well-known dualism between Southern and Center-Northern Italian regions in the levels of economic activity widened. After a period of relative stability that followed the takeover in 1999 of monetary policy decisions by the Governing Council of the European Central Bank (ECB), the GDP gap became even more ample with the unfolding of the sovereign debts crisis in 2011 when the Italian Central Government was forced to undertake fierce fiscal consolidation measures[21] to re-establish the

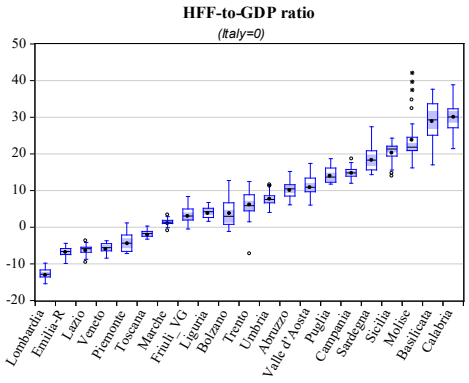
[21] Three fiscal packages were introduced between July and December 2011 to ensure the long-run sustainability of the Italian public debt (roughly 130% of Italian GDP). One of these packages was aimed at ensuring the pension system sustainability by tying work-life duration to life expectancy and weakening employment and insurance schemes. For an extensive analysis of the macroeconomic and fiscal policy developments in Italy during the 2000s, see Bassanetti et al. (2013).

confidence of the financial markets in the sustainability of the public debt. Figure 2.2(b) reports both the Central Government's primary balance and a proxy for the economic development gap computed as the ratio between the Southern and the Center-Northern regions' per capita GDPs. After 2011, Italy went through a severe fiscal adjustment, despite the worsening of the gap between the Center-North and South of Italy in terms of relative per capita GDPs.

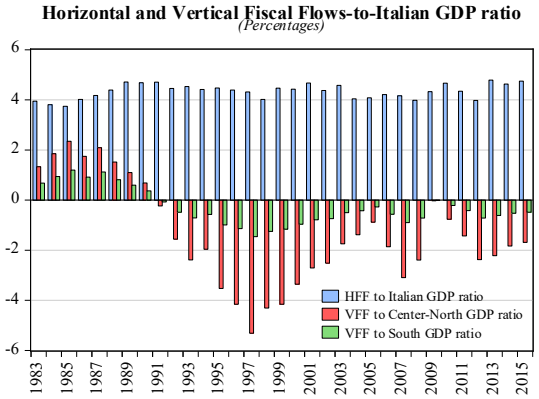
Our data evidence that HFFs routed from Center-Northern Italian regions to Southern ones are substantial and seem closely linked to the persistent economic dualism between Center-Northern and Southern regions (Tables A.3-A.5). These implicit financial transfers, carried out by the Italian system of taxes and transfers, resulted in an "interpersonal" redistribution with equalization purposes and contributed to financial cohesion policies aimed at re-balancing the socio-economic differences between territories. During the period 1983-2015, HFFs roughly equal to 4.3% of the Italian GDP per year (Figure 2.3(b)), allowed for the Southern regions' citizens to enjoy levels of per capita public spending that exceeded tax revenues that were collected in their territories (fiscal capability). Looking at Figure 2.3(a) that reports a box-plot of HFFs for each Italian region over the period 1983-2015. It emerges that Southern regions have constantly been the major beneficiaries of inter-regional redistribution (together with the special statute regions and the smallest regions), while all the Center-Northern ordinary statute regions have been the main contributors. As reported in Tables A.3-A.5 and Figure 2.3(a), during the period 1983-1995 (1996-2007), HFFs represented the 17.4% (18.0%) share of the per capita GDP of Southern regions' area. During the period 2008-2015, this value has risen to 19.2% of the area GDP, reflecting the large downfall in the levels of economic activity during the crisis. For Center-Northern regions, HFFs have been negative and roughly steady over the three periods, ranging from -5.7 to -5.9% of the area's GDP.

Looking at the single items of inter-regional redistribution, we observed that differences in public expenditures have been less striking than those observed for tax revenues (Tables A.3-A.5), even if over the 1983-2015 period, the per capita public expenditure of the Center-Northern regions has been on average 10 percentage points above that of the Southern regions (Figure 2.4(a)). During the same time span, the tax revenues of the Center-Northern regions have been 35 percentage points above the Southern regions' levels (Figure 2.4(c)). Moreover, throughout the whole period, the standardized per capita primary public expenditures were less dispersed (18.4% in the period 1983-1995, 22.4% during the period 1996-2007 and 19.0% during the period 2008-2015) than tax revenues were (27.5% for the span 1983-1995, 28.0% for the span 1996-2007 and 25.8% during the period 2008-2015).

HFFs must also be confronted with the VFFs, i.e., the repartition on a regional basis of the primary balance for which the Central Government is ultimately responsible. Figure



(a) Horizontal fiscal flows over regional GDPs - Period 1983-2015. Source: Own elaborations on Istat data and Regional Public Accounts data (see the Appendix and Section 2.3). Base year 2010.



(b) All variables are percentages of the Italian GDP; The Italian primary balance (net of interest payments and international flows) as a ratio of GDP is given by $VFF_t^{CN} + VFF_t^S$. Negative values of VFF_t^{CN} and VFF_t^S measure the area's contribution to country-level fiscal adjustments, while positive amounts represent the part of the country-level deficit that is routed to each area. Source: Own elaborations on Istat data and Regional Public Accounts data (see the Appendix and Section 2.3). Base year 2010.

Figure 2.3

2.3(b) reports the decomposition of regional fiscal flows in their horizontal and vertical components as a percentage of Italian GDP for the span 1983-2015. During the 1980s, Italy ran primary deficits that were implicitly routed to inter-regional redistribution in the form of VFFs. Conversely, since the 1990s, the Italian Central Government has started to run primary surpluses to control its huge public debt, and both Center-Northern and Southern regions have contributed to such fiscal adjustments. Across the time span 1983-1990, the Government has provided the Center-Northern and Southern regions VFF resources representing 1.6% and 0.8%, respectively, of the Italian GDP. Conversely, the period 1992-2008 was characterized by substantial primary surpluses, and the yearly contribution of the Southern region and the Center-Northern region to the country-level primary surplus has been, respectively, 0.8% and 2.6% of the Italian GDP. With the onset of the economic crisis, during the span 2009-2011 the magnitude of the Southern regions' contribution to the country-level surplus decreased to 0.2% of the Italian GDP, while the Center-Northern regions' contribution has been equal to 0.7%. As already highlighted, the subsequent sovereign debt crisis in 2011 forced the Italian Government to undertake fierce fiscal consolidation measures. In this context, during the span 2012-2015, the contribution in terms of VFFs of the Center-Northern and Southern regions to the national primary surplus rose again to 2.0% and 0.6%, respectively, of the Italian GDP.

Figure 2.2(b) suggests the possible existence of two channels that may magnify the way through which inter-regional fiscal flows affect the Southern regions' economic activity. The first channel is represented by the economic activity's degree of dependence

on public spending that is proxied by the index proposed by Geri and Volpe (1993)[22] reported in Figure 2.4(b), which measures the regional public spending-to-GDP ratio. Data tell us that the index remained roughly stable for Center-Northern regions, while it went slightly up for Southern regions, as per capita public spending in the Southern regions exhibited a slightly upward trend during the last 15 years (Figure 2.4(a)), while during the same period, per capita GDP went down at a faster rate. The second channel is the tax effort[23] that measures the regional tax-to-GDP ratio with respect to the country-level average. Data show that the tax burden gap between the Center-North and the Southern regions declined from 11.3 in the span 1983-1995 to 8.6 percentage points during the period 1996-2007. In 2008-2015 the gap was 3.8 percentage points, and in 2012, the South experienced for the first time a tax burden 0.3 percentage points above that of the Center-North (Tables A.3-A.5 and Figure 2.4(d)).

Throughout the span 1983-2015, in fact, the Southern regions' per capita GDP gap and the country-level primary balance exhibited a correlation coefficient of 0.60, suggesting that the path followed by the Southern regions' per capita GDP gap and the country-level primary deficits ($G_t - T_t$) can be explained in relative terms with respect to the Center-Northern regions by both the higher degree of dependence of the Southern regions' economic activity on public spending and by the lower tax effort of the Southern regions. However, the correlation coefficient between the Southern regions' per capita GDP gap and the country-level primary balances decreased from 0.79 over the period 1983-2001 to 0.15 during the 2002-2015 span, suggesting that since the 2000s, the higher degree of relative dependence of the Southern regions' economic activity on public spending (Figure 2.4(b)) has been counterbalanced by a sharp increase in the Southern regions' tax effort (Figure 2.4(d)).

Figures 2.4(c) and (d) shows that the Center-Northern regions pay on average more taxes than the Southern regions both in per capita terms and with respect to the size of their GDPs (Tables A.3-A.5). This evidence is consistent with a progressive fiscal system, such as the Italian one, in which the tax effort of richer regions is usually higher than the one of poorer regions. Note that since the mid-1990s the tax efforts of the two areas has progressively converged, as the Southern regions' tax revenues grew faster than that of the Center-Northern regions (Figure 2.4(d)). A possible explanation is that after the 2000s, local taxation has risen, forcing the Southern regions' sub-national tiers of Government (Regions and Municipalities) to levy taxes at the local level (Figures 2.5(c) and (d)) to finance an increasing share of public spending not covered anymore by Central Government transfers (Figures 2.5(a) and (b)). This should not sound surprising as finan-

[22] The indicator of region i's economic activity dependency on public spending is equal to its per capita public expenditure divided by the Italian average, i.e., $(G_{it}/Pop_{it})/(G_t/Pop_t)$.

[23] The region i tax effort is equal to its per capita tax revenue divided by the Italian average, i.e., $(T_{it}/Pop_{it})/(T_t/Pop_t)$.

cially distressed regional health systems (Aimone Gigio et al., 2018) and Municipalities are over-represented in the Southern regions (Degni et al., 2017).

2.5.2 Redistributive Effects

Tables 3 and 4 report the redistributive effects of the HFF on the GDP, obtained from estimating equations 2.6 and 2.8 using a pooled OLS with yearly dummies over the three sub periods j where $j = 1$ for 1983-1995, $j = 2$ for 1996-2007 and $j = 3$ for 2008-2015.

In Table 3, we report the estimates obtained for equation 2.8 and present a decomposition of HFF redistributive effects that allows us to disentangle the overall redistributive activity (FF) among Italian regions from the VFF component that captures the amplifier/moderator role played by the country-level primary balance on the HFF redistributive effects. We estimated the decomposition of HFF redistributive effects ($-\gamma_h^j = -(\gamma^j - \gamma_v^j)$) by estimating equation 2.8 for HFF, FF and VFF given that HFF=FF-VFF. We also conducted a series of Wald tests on the estimated coefficients to assess if their values are statistically different from one period to another.

Looking at the time profile of the estimated redistributive effects of HFFs ($-\gamma_h^j$) reported in the second column of Table 3, we notice that the ability of HFFs to smooth long-run differentials in the regions' levels of economic activity decreased over time from 35.8% in the period 1983-1995 to 28.9% during the span 1996-2007. Finally, during the period 2007-2015, which covers also the economic and sovereign debts crises, we found a redistributive effect of HFF of 29.9% of the standardized per capita GDP. The Wald tests suggest that the changes in the redistributive effects over time are statistically different only when we compare the first span 1983-1995 with the second and the third sub-period.

Considering that HFFs are obtained as the difference among overall inter-regional flows (FF) and VFFs (see Section 2.3), a further investigation of our estimates ($-\gamma_h^j$) suggests that after the mid-1990s the HFFs' redistributive effects went down due to the VFF component that captures the contribution that Italian regions were implicitly required to give to the country-level primary surpluses run by the Central Government. In the Italian case, VFFs contributed to moderate the redistributive effects that would have been reached in a country-level balanced budget situation. As reported in column 4 of Table 3, VFFs had a slight moderating role ($-\gamma_v^j$) on the HFFs redistributive effects during the span 1983-1995, i.e. VFFs contributed to a 1% amplification of an existing 1% long-run differential in regional GDP levels. During the two subsequent sub-periods, VFFs exhibited a moderating effect of 4.3% during the period 1996-2007 and 2.0% for the 2008-2015 crisis period. Wald tests suggest that the estimates of γ_v^j are statistically dif-

ferent across the sub-periods of our analysis. Our estimates highlight that inter-regional redistribution is closely tied to nation-wide fiscal policy, especially when a country is forced to run primary surpluses year after year as a consequence of its huge public debt. During bad times, this implies that a country has limited room to let automatic stabilizers work; thus, all territories are called to contribute to primary surpluses. A possible explanation is that redistributive effects after the mid-1990s have been pushed down by a tighter country-level fiscal discipline that indirectly contributed to amplify the long-lasting economic dualism between Center-Northern and Southern Italian regions (Figure 2.2(a)) whose GDP is highly dependent on public spending (Figure 2.4(a)).

Table 3

Testing redistributive effects over time (Equation 2.8)						
Explanatory variables	**Dependent variable**					
	HFF: ff_{it}^{h}		FF: ff_{it}		VFF: ff_{it}^{v}	
	Coefficient	s.e.	Coefficient	s.e.	Coefficient	s.e.
γ	-0.315***	0.01	-0.340***	0.01	0.025***	0.00
γ^1	-0.358***	0.05	-0.368***	0.05	0.010***	0.00
γ^2	-0.289***	0.08	-0.332***	0.08	0.043***	0.00
γ^3	-0.295***	0.08	-0.315***	0.08	0.020***	0.00
μ	0.389***	0.05	0.421***	0.05	-0.032***	0.00
	Wald tests across sub-periods (p-value)					
$\gamma^1 = \gamma^2$	0.02		0.21		0.00	
$\gamma^1 = \gamma^3$	0.05		0.11		0.00	
$\gamma^2 = \gamma^3$	0.87		0.66		0.00	
R^2	0.65		0.64		0.97	
Number of observations	660		660		660	
Number of regions	20		20		20	
Per region observations	33		33		33	

We estimate the following versions of Equation 2.8: $z_{it} = \mu + \sum_{j=1}^{3} \gamma^j \cdot g^j \cdot x_{it} + \lambda_t + \kappa_{it}$ where $z_{it} = \{ff_{it}^{h}, ff_{it}, ff_{it}^{v}\}$; $\gamma^j \cdot g^j = \gamma^1$ if t=1983-1995; γ^2 if t=1996-2007; γ^3 if t=2008-2015; γ if t=1983-2015. Estimates have been obtained running a pooled OLS with robust standard errors. Yearly dummies (λ_t) have been included. The sample does not include Valle d'Aosta and all variables are in per capita terms and standardized with respect to the Italian per capita GDP. Coefficients' significance level: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

It is also important to assess which are the fiscal items that have been responsible for the reduction in the redistributive effects after the mid-1990s, as the results of the assessment has important policy implications. In Table 4, we present the results obtained by running a several partial regressions for equation 2.6, using the spending and revenue items of HFFs to isolate the contributions each item to the overall redistributive effect that we have already presented. Our estimates suggest that redistributive effects for Italian regional economies are reached through the tax system while expenditure items tend to amplify long-run differentials in regional GDPs. We found that tax revenues are the only drivers of inter-regional redistribution across the sub periods under scrutiny

Table 4

Decomposition of HFF hff_{it} redistributive effects' components (Equation 2.6)						
Dependent variables	**Period**					
	1983-1995		1996-2007		2008-2015	
	Coefficient	s.e.	Coefficient	s.e.	Coefficient	s.e.
Social expenditures	0.072***	0.00	0.082***	0.01	0.065***	0.01
Other current expenditures	0.031***	0.02	0.035***	0.01	0.036**	0.02
Capital expenditures	-0.010	0.01	0.036***	0.01	0.047***	0.01
Primary expenditures (g_{it})	0.093***	0.02	0.153***	0.02	0.148***	0.02
Contributive revenues	-0.146***	0.00	-0.124***	0.00	-0.141***	0.01
Other current revenues	-0.305***	0.01	-0.315***	0.01	-0.300***	0.01
Total revenues ($-t_{it}$)	-0.451***	0.01	-0.441***	0.01	-0.443***	0.01
Horizontal fiscal flow ($g_{it} - t_{it}$)	-0.358***	0.02	-0.289***	0.02	-0.295***	0.03
Number of observations	260		240		160	
Number of regions	20		20		20	
Per region observations	13		12		8	

Equation 2.6 has been estimated recursively using the decomposition shown in Equation 2.10. Note: Estimates have been obtained by using pooled OLS with robust standard errors. Yearly dummies have been included. All variables are in per capita terms and standardized with respect to the Italian per capita GDP. Coefficients' significance level: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

(45.1%, 44.1% and 44.3% of per capita GDP), while expenditures tend to restrain redistributive effects (−9.3%, −15.3% and −14.8% of per capita GDP). This result is at odds with the findings of Decressin (2002) and Arachi et al. (2010) for Italy and is due to a different decomposition approach we decided to employ to disentangle the contributions of expenditures and revenues to the overall estimate.[24] This interpretation is consistent with our descriptive statistics that highlighted that Southern regions levels of spending are constantly below the ones of Center-Northern regions, although public spending in Italian regions is less dispersed than taxes.

During the span 1983-1995, the redistributive effect has been positively affected by social contributions (14.6%) and other current revenues (30.5%) that include direct and indirect revenues, while the role of revenues in capital account was negligible. Social protection and other current expenditures negatively affected redistribution (−7.2% and −3.1%, respectively), while the contribution of capital account expenditures was not significant. For the period 1996-2007, we found that the positive effect of revenues on redistribution is more or less stable, while public expenditures accounted for the fall of redistribution with respect to the 1983-1995 span. Again, the redistributive effects were driven by social contributions (12.4%) and other current revenues that include direct, and indirect revenues (31.5%), while the contribution of revenues in capital account is negligible. Social protection, other current expenditures and capital account expenditure negatively affected redistribution (−8.2%, −3.5% and −3.6%, respectively). Finally, for the period 2008-2015, we observed a further reduction in the HFF's redistributive effect that was driven by capital account spending.

A plausible explanation of our results is that that the ability of the Italian system of taxation and transfers to reduce per capita GDP disparities among Italian regions declined over time because of the increased divergence of Italian regions in terms of expenditures for social protection and in capital account (see Tables 4 and A.3-A.5). Our findings are consistent with the descriptive statistics in which we highlighted how the tax burden of Southern regions increased over time in connection with the increase in the share of locally financed public spending as a consequence of a substantial reduction in the transfers from the Central Government to sub-national tiers of Government (Figures 2.5 (a) and (b)). It seems plausible that the sub-national tiers of government, especially the Municipalities, started to decrease non-current expenditures that are notoriously more difficult to cut and started to raise local taxation (Figure 2.5 (c) and (d)) to fit the Internal Stability Pact rules that are a direct consequence of the budgetary target followed by the Italian Government to comply with the Stability and Growth Pact introduced

[24] In running partial regressions, we decided to re-scale variables with respect to the Italian per capita GDP, while in Decressin (2002) and Arachi et al. (2010), each variable is scaled by the corresponding country-level per capita value.

with the Maastricht Treaty (Balassone and Franco, 2003). From a policy-making point of view, this evidence raises a crucial policy issue regarding the need for the Italian Central Government to setup a mechanism to foster public investment spending that is pivotal for growth. Looking at the data, we see that the capital spending of Southern regions is well below that of the Center-Northern ones and went down at a higher pace, especially during the 2008-2015 period with the exception of 2015, when the sharp rise in the Southern regions' capital spending was driven by the need to spend the greatest part of the European funds (ERDF/ESF Funds) associated with cohesion policies for the programming period 2007-2013 (Banca d'Italia, 2016).

2.5.3 Risk-Sharing effects

To assess risk-sharing effects of HFFs, i.e. the ability of HFFs to smooth short-run region-specific shocks hitting the Italian regions' GDP, we estimated equations 2.7 and 2.9 using a pooled OLS on variables taken as the cycle components of the corresponding variables that we have used to evaluate redistributive effects. As in Canova and Ravn (1996) and Arachi et al. (2010), we used a HP-filter with a penalty parameter equal to 7. As already mentioned in Section 2.4, in estimating risk-sharing effects we decided to exclude from the analysis the region Valle d'Aosta and capital account items, as they are extremely volatile. The results are reported Tables 5 and 6.

Looking at the risk-sharing effects of HFFs ($-\varphi_h^j = -(\varphi^j - \varphi_v^j)$) obtained by estimating equation 2.9 for each component of the coefficient (i.e. HFF, FF and VFF), reported in Table 5, we found that an insurance scheme for stabilizing short-run economic to a region's GDP was implicitly in place until mid-1990s (13.1%), confirming the findings of Decressin (2002), while we did not find any risk-sharing effect for the period 1996-2007. Finally, during the period 2008-2015, our results suggest that HFFs acted as a risk-enhancing device, i.e. they amplified short-run shocks to regional GDPs (-26.7%). We find evidence that while during the period 1996-2007, VFFs acted as a risk-enhancing device and thus as an amplifier of the risk-enhancing effect among Italian regions observed for fiscal flows (FF) to amplify risk-sharing; during the 2008-2015 period we found that the risk-sharing effect of VFFs is not statistically significant.

Looking at the decomposition of the risk-sharing effect of HFFs (Table 6) obtained by estimating equation 2.7, we observe that during the span 1983-1995, social expenditures contributed to smooth short-run shocks to regional GDPs (2.1%), while this function disappeared during the subsequent time spans. Once again, the drivers of stabilization effects are the taxation items. During the period 1983-1995, all revenue items contributed to smooth regional shocks, while for period 1996-2007, we observe that only contributive revenues acted as a risk-sharing mechanism. Finally, for the span 2008-2015, we found

Table 5

Testing risk-sharing effects over time (Equation 2.9)						
Explanatory variables	**Dependent variable**					
	HFF: $\left(hff_{it} - h\tilde{f}f_{it}\right)$		FF: $\left(ff_{it} - \tilde{f}f_{it}\right)$		VFF: $\left(hff^{v}_{it} - h\tilde{f}f^{v}_{it}\right)$	
	Coefficient	s.e.	Coefficient	s.e.	Coefficient	s.e.
φ	0.008	0.05	0.011	0.05	-0.003	0.01
φ^1	-0.131***	0.02	-0.125***	0.03	-0.006	0.01
φ^2	0.002	0.13	0.041	0.14	-0.040**	0.02
φ^3	0.267**	0.12	0.232*	0.12	0.034	0.02
	Wald tests across sub-periods (p-value)					
$\varphi^1 = \varphi^2$	–		–		–	
$\varphi^1 = \varphi^3$	0.00		0.00		–	
$\varphi^2 = \varphi^3$	–		–		–	
R^2	0.15		0.24		0.90	
Number of observations	660		660		660	
Number of regions	20		20		20	
Per region observations	33		33		33	

We estimate the following versions of Equation 2.9: $(z_{it} - \tilde{z}_{it}) = \sum_{j=1}^{3} \varphi^j \cdot g^j \cdot (x_{it} - \tilde{x}_{it}) + \lambda_t + u_{it}$ where $z_{it} = \{ff^h_{it}, ff_{it}, ff^v_{it}\}$; $\varphi^j \cdot g^j$=φ^1 if t=1983-1995; φ^2 if t=1996-2007; φ^3 if t=2008-2015; φ if t=1983-2015.
Estimates have been obtained running a pooled OLS with robust standard errors. Yearly dummies (λ_t) have been included. The sample does not include Valle d'Aosta and all variables are in per capita terms and standardized with respect to the Italian per capita GDP. Coefficients' significance level: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

that other current revenues acted as a risk-enhancing device (24.1%). Looking more in detail to this taxation item, we see that it encompasses direct and indirect taxation, including consumption and property taxes that are partially levied by sub-national tiers of Government. A possible explanation for these results is that during the last 10 years the Italian Central Government did not set up any insurance scheme to cope with difficult economic cycles, leaving sub-national entities to deal with the negative effects of local economy downturns. In Italy this situation has been exacerbated by the impossibility of permitting automatic stabilizers work, due to the fiscal consolidation measures that have been introduced to control the path of the Italian public debt.

2.5.4 Robustness checks

To verify that our estimates differ from other studies only because of the fact that we excluded outliers from the analysis and as a consequence of our methodological choices in computing the regional fiscal flows, we decided to compare them with those obtained with the econometric approaches proposed by other studies. To make the comparison as simple as possible, we decided to estimate redistributive and risk-sharing effects for Italy during the period 1983-1992 as in Decressin (2002). Providing more detail, Arachi et al. (2010) applied an HP filter to fiscal and economic activity variables and employed the same techniques used by Mélitz and Zumer (2002). Conversely, Poghosyan et al.

Table 6

Decomposition of hff_{it} risk-sharing effects' components (Equation 2.7)						
Dependent variables	**Period**					
	1983-1995		1996-2007		2008-2015	
	Coefficient	s.e.	Coefficient	s.e.	Coefficient	s.e.
Social expenditures	-0.021***	0.01	-0.007	0.02	-0.006	0.02
Other current expenditures	0.001	0.02	0.002	0.03	0.021	0.03
Primary expenditures (g_{it})	-0.002	0.02	-0.005	0.03	0.015	0.05
Contributive revenues	-0.048***	0.01	-0.051**	0.02	0.013	0.04
Other current revenues	-0.063***	0.02	-0.058	0.12	0.241**	0.11
Total revenues ($-t_{it}$)	-0.111***	0.02	0.006	0.12	0.254**	0.12
Horizontal fiscal flow ($g_{it} - t_{it}$)	-0.131***	0.02	0.002	0.13	0.269**	0.12
Number of observations	260		240		160	
Number of regions	20		20		20	
Per region observations	13		12		8	

Equation 2.7 has been estimated recursively using the decomposition shown in Equation 2.10. Note: Estimates have been obtained by using feasible generalized least squares (FGLS) with fixed effects, allowing for an $AR(1)$ heteroskedastic cross-correlated error term. Yearly dummies have been included. All variables are in per capita terms and standardized with respect to the Italian per capita GDP. Coefficients' significance level: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. R^2 and constants have not been reported but are available upon request.

(2016) relied on a pooled mean group estimator[25] developed by Pesaran et al. (1999) that is based on an error correction mechanism equation. We also decided to take the first-differences of our variables, as GDP is highly persistent due to the presence of auto-correlation, while our fiscal variables suffer non-stationarity, as suggested by unit-root diagnostic tests. To control for the non-stationarity of our variables, equation 2.5 can be restated using first-differenced variables:

$$\Delta hff_{it} = \theta_i^h + \varphi_h \Delta x_{it} + \upsilon_{it}^h \tag{2.11}$$

where θ_i^h captures region-specific fixed effects and controls for the presence of a drift in the error term (see Mélitz and Zumer (2002) for more details). Estimates for equation 2.11 (see Table 7 and Table 8) are obtained using a feasible GLS (FGLS), allowing for an $AR(1)$ heteroskedastic cross-correlated error term and for region-specific fixed effects, as well as by using a system GMM developed by Blundell and Bond (1998). Finally, we estimate risk-sharing effects, relying on a system GMM estimator developed by Blundell and Bond (1998)[26] that allows us to control for the potential endogeneity of GDP with respect to fiscal variables and to remove fixed effects. In Table 8, we report the estimates obtained with our estimation methodology as well as those obtained with the estimation methodologies used by Decressin (2002), Arachi et al. (2010) and Poghosyan et al. (2016). We conclude that our estimation strategy is quite robust, as we did not observe any improvement in the quality of estimates by using alternative methodologies. Note that our estimate of inter-regional redistribution for the period $1983-1995$ is much higher than the 27.5% originally found by Decressin (2002) for the span 1983-1992. The difference is due to our choice of eliminating a small influential region from the analysis (Valle d'Aosta); otherwise, we would have obtained similar results. In Section 2.2 are presented the original results obtained in the existing literature.

2.6 Conclusions

Our estimates indicate that the redistributive power of horizontal fiscal flows among Italian regions is substantial, and we present evidence that its magnitude declined over

[25] We estimated the following equation:

$$\Delta hff_{it} = \phi_i^h \left[hff_{it-1} - \theta_h - \gamma_h x_{it-1} + \psi_h \cdot time \right] + \varphi_h \Delta x_{it} + \eta_{it}^h$$

This equation encompasses the redistributive features of inter-regional redistribution ($-\gamma_h$) as well as the risk-sharing effect ($-\varphi_h$) following a short-run deviations of GDP from its long-run value. This framework allows for the assessment of both redistributive and risk-sharing effects, relying on a single-step estimation procedure.

[26] The Blundell and Bond (1998) estimator is a refinement of the original GMM methodology pioneered by Holtz-Eakin et al. (1988) and Arellano and Bond (1991).

Table 7

Different estimators to assess risk-sharing effects

Explanatory variables	**Dependent variable**					
	(a) FGLS: Δhff_{it}		(b) System GMM: Δhff_{it}		(c) OLS: $\left(hff_{it} - h\tilde{f}f_{it}\right)$	
	Coefficient	s.e.	Coefficient	s.e.	Coefficient	s.e.
φ_h	-0.046***	0.01	0.020	0.05	-0.008	0.05
φ_h^1	-0.079***	0.02	-0.082*	0.04	-0.131***	0.02
φ_h^2	0.023	0.03	0.051	0.07	0.002	0.13
φ_h^3	0.050*	0.03	0.019	0.10	0.269**	0.12
Hansen test *(p-value)*			1.00			
Test AR(1) first diff.*(p-value)*			0.01			
Test AR(2) first diff.*(p-value)*			0.63			
Number of observations	640		640		660	
Number of regions	20		20		20	
Per region observations	32		32		33	

Equation 2.11: $\Delta hff_{it} = \theta_i^h + \sum_{j=1}^{3} \varphi_h^j \cdot g^j \cdot \Delta x_{it} + \lambda_t + v_{it}^h$ where $\varphi_h^j \cdot g^j = \varphi_h^1$ if t=1983-1995; φ_h^2 if t=1996-2007; φ_h^3 if t=2008-2015. φ_h if t=1983-2015.
(a) Estimates for Equation 2.11 have been obtained by using feasible generalized least squares (FGLS), allowing for an AR(1) heteroskedastic cross-correlated error term. Yearly dummies (λ_t) have been included.
(b) Equation 2.11. Note: Instruments for the Blundell and Bond (1998) system GMM estimator are given by lags 1-2 of the explanatory variable levels and first differences. Yearly dummies (λ_t) have been included.
(c) Equation 2.7: $\left(hff_{it} - h\tilde{f}f_{it}\right) = \gamma_h \left(x_{it} - \tilde{x}_{it}\right) + \lambda_t + u_{it}^h$, using the cycle components of the corresponding HP filtered variables (penalty parameter equal to 7) obtained by subtracting from each variable its trend component (i.e., $h\tilde{f}f_{it}$ and $\tilde{x}_{it}$). Yearly dummies (λ_t) have been included.
The sample does not include Valle d'Aosta and all variables are in per capita terms and standardized with respect to the Italian per capita GDP. Coefficients' significance level: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 8

Redistributive and risk-sharing effects - Period: 1983-1992

	Dependent variables: HFF							
Estimation methodology	Our estimates		Decressin (2002)		Arachi et al. (2010)		Poghosyan et al. (2016)	
	$-\gamma_h$	$-\varphi_h$	$-\gamma_h$	$-\varphi_h$	$-\gamma_h$	$-\varphi_h$	$-\varphi_h$	$-\varphi_h$
Equation 2.6: Pooled OLS	-0.350***				-0.350***			
Equation 2.5: FGLS with Fixed Effects and $AR(1)$ error		-0.276***						
Equation 2.5: System GMM		-0.086***						
Equation 2.5: Fixed Effects				-0.219***				
Equation 2.4: OLS			-0.350***					
Equation 2.11: FGLS with Fixed Effects and $AR(1)$ error		-0.088***						
Equation 2.11: Fixed Effects				-0.093**				
Equation 2.7: OLS						-0.089**		
ECM Equation: PMG							-0.315***	-0.080***

The sample does not include Valle d'Aosta and all variables are in per capita terms and standardized with respect to the Italian per capita GDP. Yearly dummies have been included.
Coefficients' significance level: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.
Equation 2.6: $hff_{it} = \mu^h + \gamma_h x_{it} + \lambda_t + v_{it}^h$. For Arachi et al. (2010), we estimated an equation with the trend component of HP filtered variables with a penalty parameter equal to 7: $h\tilde{f}f_{it} = \mu^h + \gamma_h \tilde{x}_{it} + \epsilon_{it}^h$.
Equation 2.5: $hff_{it} = \alpha_i^h + \varphi_h x_{it} + u_{it}^h$.
Equation 2.4: $\overline{hff}_{i.} = \mu^h + \gamma_h \overline{x}_{i.} + \kappa_i^h$.
Equation 2.11: $\Delta hff_{it} = \theta_i^h + \varphi_h \Delta x_{it} + v_{it}^h$.
Equation 2.7: $\left(hff_{it} - h\tilde{f}f_{it}\right) = \varphi_h \left(x_{it} - \tilde{x}_{it}\right) + \lambda_t + u_{it}^h$ where we $\left(hff_{it} - h\tilde{f}f_{it}\right)$ and $\left(x_{it} - \tilde{x}_{it}\right)$ are the cyclical components of HP filtered variables (with penalty parameter equal to 7) as in Arachi et al. (2010).
ECM equation: $\Delta hff_{it} = \phi_i^h \left[hff_{it-1} - \theta_h - \gamma_h x_{it-1} + \psi_h \cdot time\right] + \varphi_h \Delta x_{it} + \eta_{it}^h$.
Note: Instruments for Equation 2 are given by lags 1-2 of the explanatory variable levels and first differences. Arellano-Bond test for $AR(2)$ in first differences: $H0$ accepted with a p-value of 0.79.

time because of the contributions of Italian regions to country-level fiscal adjustments that have been going on since the 1990s. We also show that after the 2011 sovereign debts' crisis, fiscal flows acted as a risk-enhancing device with respect to short-run region-specific shocks to economic activity.

In a nutshell, the emerging picture is that the ability of HFFs to reduce long-run income disparities among Italian regions declined over time for several reasons. First, since the 1990s, the Italian Central Government's need to run primary surpluses to control the huge public debt has been moderated by the redistributive effects of HFFs. Looking at the channels that determined the restraining of redistributive effects, we found evidence that the main drivers have been the expenditure for social protection and investment purposes that in relative terms penalized the Southern Italian regions.

As far as risk-sharing is concerned, we found that the implicit insurance scheme among Italian regions, which had been in place until the mid-1990s, disappeared during the period 1996-2007 and turned into a risk-enhancing mechanism during the period 2008-2015, covering the years of economic and sovereign debts crises. During the crisis, HFFs amplified the effects of short-run shocks on a region's per capita GDPs. We present evidence that this happened through the channel of direct and indirect taxation, that includes revenues levied directly by sub-national levels of government such as Regions and Municipalities, implying that local public finance behaved in a very pro-cyclical manner due also to the decrease of transfers from the Central Government to sub-national tiers of government.

An important policy implication of this study is that an explicit insurance scheme to smooth region-specific shocks is advisable in those countries or federations in which it is not possible to let automatic stabilizers work. This is likely to happen in those situations characterized by a huge public debt, as in Italy, or because of an incomplete governance framework due, for instance, to the fragmentation of national fiscal policies in a situation in which there is a single monetary authority, as is the case in Eurozone countries within the European Union. Defining an optimal insurance scheme, either public or market-based, is one of the main challenges for national governments and for a federation of states, such as the European Union, in order to accelerate the integration process of the national economies' budgetary governance.

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Appendix: Regionalization of the Public Administrations' consolidated account and other data sources

In this Section we provide a detailed explanation of the methodology, proposed by Staderini and Vadalá (2009), that we follow to estimate fiscal variables for the Italian regions. The starting point is a reclassification scheme of the Public Administrations' consolidated economic account[27] (see Table A.2) that takes into account the primary balance ($FF_t = G_t - T_t$) net of international financial flows (EU_t). The regionalization of the country-level fiscal variables requires an estimation of the relevant "regionalization coefficients" based on territorial statistical sources that are consistent with the benefit principle.

Following this methodology we excluded two items when generating regional fiscal variables. First, international financial inflows and outflows, such as transfers from/to EU and international aids, have been ruled out as they can be considered pure financial transfers without a direct impact on Italian residents. Second, we excluded interest payments (I_t), as a territorial statistical source allowing for the regionalization of this item consistently with the benefit principle is not available (Decressin, 2002) and Staderini and Vadalá (2009).

The allocation of revenue (T_t) items at regional level reflects, consistent with the benefit principle, the geographical location of the taxpayer (Table A.1). Thus, social contributions paid by workers and the main direct taxes such as personal (Irpef) and corporate (Ires) income taxes are allocated according to the localization of income declarations. Two adjustments are needed. First, the regional breakdown of corporate taxes paid by multiregional firms is made according to the regional distribution of firms' personnel expenditure. Second, social contributions paid directly by the firm on behalf of workers are allocated according to the regional distribution of firms' personnel costs. Indirect taxes, such as the tax on productive activities (IRAP), value added tax (IVA), excises on energy products and property taxes, are regionalized on the basis of the localization of where consumption and/or production take place.

Consistent with the benefit principle, the regionalization of primary current expenditure (G_t) items takes into account the economic nature of each item (Table A.1). Pure public goods (General public services, Defense, Public Order and Security, and Recreational activities) are allocated on a per capita basis on the ground that all residents are benefited in the same way. Finally, health and education expenditures are allocated by consolidating at the regional level the balance sheets of sub-regional entities; health

[27] The *Conto economico consolidato delle Amministrazioni Pubbliche* is released by the Italian National Institute of Statistics (Istat), and it is compliant with the rules of European System of National and Regional Accounts (ESA 2010) defined by EU Regulation 549/2013.

expenditures are adjusted to take into account inter-regional health mobility, while education expenditure takes into account the regional distribution of school personnel. Capital expenditure is allocated at the regional level according to the location of the public works and of the beneficiaries of investment grants.

The repartition criteria to regionalize expenditures and revenues for the two spans $1983-1992$ and $1996-2015$ follow the benefit principle and are consistent with one another, even if the regionalization coefficients are obtained from different data sources. Due to the lack of territorial statistical sources, the repartition coefficients for the years $1993-1995$ are obtained by linearly interpolating data from the other two spans.

For the period $1983-1992$, the Public Administrations' consolidated economic account is disaggregated on a regional basis by using as regionalization coefficients the corresponding items from the regional economic accounts (data are on accrual basis) available from Istat (Agostinelli et al., 1996). For the span $1996-2015$, the regionalization coefficients for the expenditure and revenue items are computed using Istat's regional level data[28] (on accrual basis) as well as the Regional Public Accounts (on cash basis) released by the Agency for Territorial Cohesion.[29]

Other regional-level variables - namely, GDP, GDP deflators and population levels - are released and updated annually by Istat. Tables A.2-A.5 report the descriptive statistics of all variables that are used in this study for the sub-periods 1983-1995, 1996-2007 and 2008-2015.

[28] The final consumption expenditure of the Public Administrations and the subsidies to production come from the ISTAT's *Territorial Accounts* (2017). Social security benefits are taken from ISTAT's *Regional Household disposable income* for the period $1996-98$ and various issues of ISTAT's *Italian statistical yearbook* (Chapter 4) for the period $1999-2015$. Social contributions were taken from the (Regional Public Accounts) released by the Agency for Territorial Cohesion for the period $1996-2001$ and the *Italian statistical yearbook* (Chapter 4) for the period $2002-2015$. All other expenditure and revenue items are taken from Regional Public Accounts. The final consumption expenditures of the Public Administrations follows the COFOG classification, and are adjusted with respect to the geographic dislocation of school personnel.

[29] See Staderini and Vadalá (2009) for a more detailed description of the methodology.

Table A.1

Regionalization of the Istat Public Administrations' consolidated account

Expenditure and Revenue items	Regionalization criteria (Statistical Source)
1. Final consumptions by expenditure area:	
• General public services, Defense, Public order and Safety, Recreation, Culture and Religion	• Regional population (Istat)
• Economic affairs, Housing and Community amenities	• Regional Value added by economic sector for market firms at regional-level (Istat)[a]
• Environmental protection	• Region-level environmental expenditure (CPT)
• Health	• Expenditures of regional health systems net of inter-regional mobility of patients (Istat)
• Education	• Regional distribution of public schools staff (Ministry of Education, Universities and Research)
• Social protection (current only)	• Regional-level general Government expenditures related to this function (Istat)
2. Production subsidies and other current transfers to enterprises	Regional distribution of employees of enterprises benefiting subsidies (Istat)
3. Social security benefits in cash and other current transfers to households and social private institutions	Regional distribution of payments (Istat)
4. Gross fixed capital investments, inventory changes net acquisitions of valuables and of non-produced financial assets.	Location of public works (CPT)
5. Investment grants to households and other capital transfers to households	Regional destination of payments (CPT)
6. Investment grants to enterprises and other capital transfers to enterprises	Regional destination of payments (CPT)
7. Direct taxes and capital taxes	Residence of taxpayers (CPT)
8. Indirect taxes	Residence of taxpayers (CPT)
9. Social contributions (effective and imputed)	Residence of taxpayers (Istat)
10. Interest income and other forms of income and rents	Residence of taxpayers (CPT)
11. Current transfers from households and enterprises	Residence of taxpayers (CPT)
12. Production of goods and services for sale and for own use and residual sales	Residence of taxpayers (CPT)
13. Insurance indemnities and transfers from households and public entities	Residence of taxpayers (CPT)
14. Other capital transfers from households and enterprises	Residence of taxpayers (CPT)

[a] For the construction sector non-market public investments have also been included.

Table A.2

Reclassified Public Administrations' consolidated account

(year 2015; current billion of euros and percentage values)

	Amount	As a share of corresponding total	As a share of GDP
EXPENDITURE			
Final consumption of Public Administrations (1)	305.5	41.5	18.6
Production subsidies and other current transfers to enterprises	29.8	4.3	1.8
Social security benefits in cash and other current transfers to households and social private institutions	341.1	46.3	20.7
Direct taxes, land rents and insurance premiums	2.4	0.3	0.1
TOTAL CURRENT EXPENDITURE	**678.8**	**92.4**	**41.3**
Gross fixed capital investments (2)	37.4	4.8	2.3
Investment grants to households and other capital transfers to households	3.8	0.3	0.2
Investment grants to enterprises and other capital transfers to enterprises	26.3	2.5	1.6
TOTAL CAPITAL EXPENDITURE	**67.5**	**7.6**	**4.1**
TOTAL EXPENDITURE (G_t)	**746.3**	**100.0**	**45.4**
REVENUE			
Direct taxes and capital taxes (3)	**244.2**	**32.2**	**14.8**
Indirect taxes (4)	249.9	30.8	15.2
Social contributions (effective and imputed)	219.1	28.1	13.3
Interest income and other forms of income and rents (5)	11.1	1.5	0.7
Current transfers from households	10.8	1.4	0.7
Current transfers from enterprises	7.4	1.0	0.5
Production of goods and services for sale and for own use	24.4	3.1	1.5
Residual sales (−)	14.0	1.8	0.9
Insurance indemnities and transfers from households and public entities	0.1	0.0	0.0
TOTAL CURRENT REVENUE	**780.8**	**99.9**	**47.5**
Other capital transfers from households	0.3	0.0	0.0
Other capital transfers from enterprises	0.9	0.1	0.1
TOTAL CAPITAL REVENUE	**1.2**	**0.1**	**0.1**
TOTAL REVENUE (T_t)	**782.0**	**100.0**	**47.5**
PRIMARY BALANCE ($FF_t = G_t - T_t$)	**-35.7**		**-3.2**
NET FINANCIAL TRANSFERS TO INTERNATIONAL ENTITIES (EU_t)	15.8		0.6
INTEREST PAYMENTS (I_t)	68.1		4.1
NET BORROWING ($NB_t = FR_t + I_t + EU_t$)	**44.2**		**2.7**

Source: Own elaborations on Istat data. (1) It includes compensations of public employees, purchases of goods and services by market producers, intermediate consumption and indirect taxes. (2) It includes the following residual items: inventory changes, net acquisitions of valuables and non-produced financial assets. (3) 90% of them come from personal income taxes (Irpef), corporate income taxes (Ires), taxes on automobile possession, savings and capital gains. (4) Almost 90% of them come from value added taxes (IVA), taxes on productive activities (Irap), municipal property tax (Imu), waste tax (Tasi), excise duties on energy products and legal monopolies. (5) It includes also dividends, withdrawals income of quasi-corporations, reinvested earnings on direct foreign investment, land rents and exploitation rights on raw materials sources.

Table A.3

Italian regions' revenues, primary expenditures and fiscal balances (1)

(averages over the period 1983-1995; standardized real euros per capita - Italy=100)

	Primary expenditures		Tax Revenues		Fiscal Flows-to-GDP[3]		HFF-to-GDP[3]	GDP	Tax Burden[4]
	Total	Of which: *Social security*[2]	**Total**	Of which: *Social contributions*	**Total**	Of which: *Social security balance*			
Piemonte	100.6	114.9	119.7	123.1	-6.9	0.6	-6.5	115.3	103.8
Valle d'Aosta - Vallée d'Aoste	168.3	129.8	134.4	116.0	10.6	3.1	10.6	127.5	105.3
Lombardia	95.0	106.2	135.9	134.4	-13.1	-1.6	-12.5	128.0	106.1
Bolzano-Bozen	139.8	105.5	134.7	115.4	1.7	0.3	2.0	126.5	106.3
Trento	130.2	103.0	117.4	117.7	4.4	-0.2	4.6	117.2	100.0
Veneto	93.3	92.7	108.9	111.6	-5.9	-0.9	-5.5	113.0	96.2
Friuli Venezia Giulia	120.4	122.2	115.1	120.3	1.6	2.1	1.8	113.1	101.8
Liguria	122.2	134.0	114.1	111.0	2.8	4.9	2.9	112.0	101.9
Emilia Romagna	106.6	116.6	125.1	120.7	-6.4	1.2	-6.0	122.6	101.7
Toscana	104.5	113.9	110.3	110.0	-2.3	2.4	-2.0	107.1	103.0
Umbria	112.5	113.4	94.8	98.6	7.7	4.3	7.7	94.1	100.8
Marche	102.5	102.4	98.4	101.8	1.4	1.8	1.5	103.3	95.1
Lazio	103.1	101.7	118.9	119.7	-5.9	-0.7	-5.5	113.4	105.1
Abruzzo	103.1	95.4	79.1	76.8	10.8	4.7	10.7	87.9	90.0
Molise	112.8	89.5	67.3	69.0	25.4	5.9	25.0	72.9	92.3
Campania	91.1	78.4	63.4	64.6	15.8	4.6	15.4	69.7	91.2
Puglia	85.1	83.1	62.4	64.5	12.6	5.6	12.3	71.5	87.3
Basilicata	113.1	83.7	59.3	62.1	34.4	6.9	33.5	62.3	95.7
Calabria	97.1	82.9	54.7	54.2	29.3	9.1	28.6	59.0	93.0
Sicilia	99.1	89.9	64.3	61.6	20.6	7.8	20.2	69.1	93.2
Sardegna	102.6	87.2	71.9	72.3	16.4	4.6	16.2	74.7	96.1
Italy (2)	**100.0**	**100.0**	**100.0**	**100.0**	**-0.2**	**1.7**	**0**	**100.0**	**100.0**
Center-Northern regions	102.8	108.7	120.3	120.2	-6.3	0.2	-5.9	116.9	102.9
Southern regions	95.1	84.6	64.1	64.1	17.8	6.0	17.4	70.2	91.5
Ordinary Statute Regions (OSRs)	**98.7**	**100.8**	**103.7**	**104.1**	**-2.2**	**1.2**	-2.0	**103.3**	**100.4**
Northern OSRs	99.6	109.1	124.3	124.0	-8.5	-0.1	-8.1	120.7	102.9
Central OSRs	104.1	106.6	111.6	112.6	-3.0	0.9	-2.7	108.6	102.9
Southern OSRs	92.8	82.5	63.1	64.1	16.9	5.6	16.6	70.0	90.3
Special Statute Regions (SSRs)	**107.2**	**95.7**	**79.8**	**77.9**	**13.5**	**4.9**	13.3	**82.2**	**97.0**
Northern SSRs	128.8	115.4	120.5	118.6	2.7	1.3	2.9	117.4	102.5
Southern SSRs	100.0	89.2	66.2	64.3	19.5	7.0	19.1	70.5	94.0
Coefficient of variation (%)	18.4	15.7	27.5	25.5	–	–	–	23.2	5.7
Maximum value	168.3	134.0	135.9	134.4	34.4	9.1	33.5	128.0	106.3
Minimum value	85.1	78.4	54.7	54.2	-13.1	-1.6	-12.5	59.0	87.3

Source: Own elaborations on Regional Public Accounts data released by the Ministry of Economic Development. (1) Base year 2010. (2) It includes other current transfers to families and social private institutions. (3) Taken as percentages with respect to the corresponding are GDP. (4) It is the ratio of revenues (social contributions, direct and indirect taxes) to GDP standardized for the corresponding Italian value.

Table A.4

Italian regions' revenues, primary expenditures and fiscal balances (1)

(averages over the period 1996-2007; standardized real euros per capita - Italy=100)

	Primary expenditures		Tax Revenues		Fiscal Flows-to-GDP[3]		HFF-to-GDP[3]	GDP	Tax Burden[4]
	Total	Of which: *Social security*[2]	**Total**	Of which: *Social contributions*	**Total**	Of which: *Social security balance*			
Piemonte	104.7	119.0	115.1	119.6	-7.6	4.4	-3.7	108.7	105.9
Valle d'Aosta - Vallée d'Aoste	180.7	113.2	146.7	118.6	6.2	2.9	10.0	134.0	109.6
Lombardia	96.4	110.3	135.1	139.7	-15.9	0.6	-12.1	129.8	104.0
Bolzano-Bozen	151.7	97.1	125.2	117.1	4.6	1.1	8.0	133.6	93.7
Trento	144.3	96.1	127.9	120.8	1.6	0.6	5.1	127.9	100.0
Veneto	92.1	95.1	110.5	115.7	-10.0	1.2	-6.4	113.8	97.1
Friuli Venezia Giulia	121.9	123.0	113.0	116.0	-0.4	5.5	3.4	107.2	105.5
Liguria	124.8	137.2	110.4	98.8	1.6	9.4	5.3	110.4	100.1
Emilia Romagna	106.1	119.7	127.1	125.4	-10.7	3.5	-6.9	121.6	104.5
Toscana	104.1	114.4	109.9	104.7	-5.9	5.5	-2.2	106.5	103.3
Umbria	116.8	116.1	95.7	92.1	5.0	7.9	8.6	98.3	97.3
Marche	100.0	102.6	98.0	97.1	-2.8	5.1	0.9	96.9	101.3
Lazio	103.3	105.9	122.2	126.2	-9.8	1.4	-6.2	123.5	99.0
Abruzzo	102.1	93.9	81.2	81.0	6.1	6.2	9.4	87.1	93.2
Molise	118.7	86.8	70.1	71.4	21.2	6.9	24.5	78.8	88.9
Campania	86.8	73.2	61.6	59.5	11.9	7.0	15.1	67.6	91.2
Puglia	84.7	82.4	61.2	59.4	11.4	9.7	14.8	64.6	94.6
Basilicata	111.9	81.8	60.6	66.2	25.8	7.4	28.9	71.3	84.9
Calabria	100.4	83.1	55.5	55.0	26.2	11.2	29.4	61.5	90.3
Sicilia	95.9	79.0	62.3	56.8	17.1	9.0	20.5	66.3	93.9
Sardegna	109.9	88.3	77.3	72.6	14.2	7.6	18.0	73.2	105.6
Italy (2)	**100.0**	**100.0**	**100.0**	**100.0**	**-3.6**	**4.1**	**0**	**100.0**	**100.0**
Center-Northern regions	103.7	111.2	120.3	121.7	-9.4	2.7	-5.7	117.8	102.1
Southern regions	93.9	80.3	63.7	61.1	14.6	8.3	18.0	68.0	93.5
Ordinary Statute Regions (OSRs)	**98.5**	**102.1**	**103.7**	**104.5**	**-5.7**	**3.7**	-2.0	**103.4**	**100.3**
Northern OSRs	100.5	112.2	123.7	126.2	-11.5	2.4	-7.8	120.2	102.9
Central OSRs	104.0	108.9	113.0	112.8	-6.9	3.5	-3.2	112.6	100.4
Southern OSRs	91.3	79.9	62.6	61.4	13.8	8.2	17.1	68.0	91.9
Special Statute Regions (SSRs)	**108.5**	**88.8**	**79.8**	**75.1**	**10.8**	**6.6**	14.3	**80.8**	**98.8**
Northern SSRs	136.0	111.3	120.5	117.3	1.6	3.2	5.3	118.5	101.7
Southern SSRs	99.4	81.3	66.0	60.7	16.3	8.6	19.8	68.0	97.0
Coefficient of variation (%)	22.4	16.8	28.0	26.6	–	–	–	24.4	6.4
Maximum value	180.7	137.2	146.7	139.7	26.2	11.2	29.4	134.0	109.6
Minimum value	84.7	73.2	55.5	55.0	-15.9	0.6	-12.1	61.5	84.9

Source: Own elaborations on Regional Public Accounts data released by the Ministry of Economic Development. (1) Base year 2010. (2) It includes other current transfers to families and social private institutions. (3) Taken as percentages with respect to the corresponding are GDP. (4) It is the ratio of revenues (social contributions, direct and indirect taxes) to GDP standardized for the corresponding Italian value.

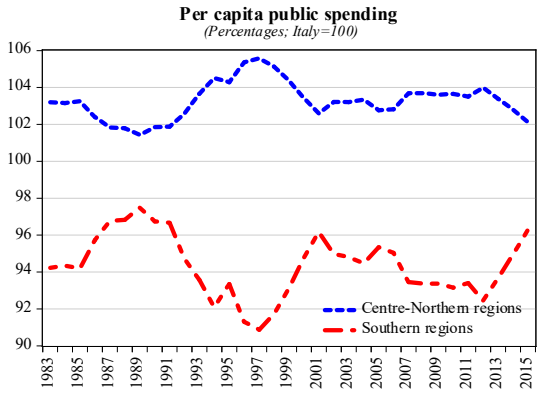
Table A.5

Italian regions' revenues, primary expenditures and fiscal balances (1)

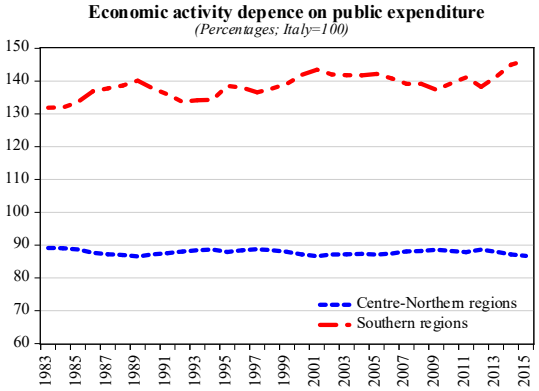
(averages over the period 2008-2015; standardized real euros per capita - Italy=100)

	Primary expenditures		Tax Revenues		Fiscal Flows-to-GDP[3]		HFF-to-GDP[3]	GDP	Tax Burden[4]
	Total	Of which: *Social security*[2]	**Total**	Of which: *Social contributions*	**Total**	Of which: *Social security balance*			
Piemonte	104.1	116.2	107.8	106.9	-3.6	8.0	-1.6	106.1	101.6
Valle d'Aosta - Vallée d'Aoste	165.2	107.4	133.0	110.3	8.9	4.9	11.0	128.9	103.3
Lombardia	97.7	108.6	137.1	146.3	-15.4	1.3	-13.3	131.6	104.2
Bolzano-Bozen	138.3	88.9	131.6	131.6	0.2	-0.1	2.1	142.6	92.3
Trento	146.4	97.3	120.2	122.3	7.3	2.2	9.2	125.9	95.5
Veneto	94.1	96.0	106.8	111.3	-7.0	3.5	-5.1	111.7	95.6
Friuli Venezia Giulia	119.8	118.4	107.3	111.4	3.1	7.8	5.2	106.3	100.9
Liguria	117.2	128.9	107.9	94.3	1.7	11.4	3.7	110.5	97.7
Emilia Romagna	101.7	114.3	122.8	121.9	-9.9	5.0	-7.8	121.0	101.5
Toscana	102.4	110.9	104.5	100.4	-2.9	7.7	-0.9	107.3	97.5
Umbria	106.2	112.6	92.3	86.9	4.8	11.6	6.9	90.0	102.8
Marche	96.3	103.7	92.5	92.1	-0.2	8.4	1.8	95.7	96.7
Lazio	107.9	108.1	126.0	131.5	-8.8	3.0	-6.7	122.0	103.5
Abruzzo	102.3	95.2	82.2	79.2	8.3	9.2	10.2	87.5	93.9
Molise	109.0	91.8	71.7	64.6	20.3	12.5	22.3	74.6	96.2
Campania	84.8	74.8	63.1	58.9	12.8	10.4	14.8	65.0	97.2
Puglia	87.6	86.9	64.9	59.6	13.8	14.2	15.9	63.6	102.0
Basilicata	105.9	88.9	66.9	65.2	22.2	12.0	24.1	72.0	92.9
Calabria	107.3	86.1	58.0	52.7	33.7	16.0	35.7	61.5	94.3
Sicilia	94.2	78.4	62.3	56.3	19.9	12.1	21.9	64.7	96.4
Sardegna	109.5	94.1	72.1	70.5	20.5	12.1	22.4	74.3	96.9
Italy (2)	**100.0**	**100.0**	**100.0**	**100.0**	**-2.1**	**6.2**	**0**	**100.0**	**100.0**
Center-Northern regions	103.3	109.3	118.6	121.0	-7.8	4.5	-5.8	117.4	101.0
Southern regions	93.8	82.6	65.0	60.3	17.2	12.1	19.2	66.8	97.2
Ordinary Statute Regions (OSRs)	**98.8**	**102.0**	**103.8**	**104.4**	**-4.3**	**5.8**	-2.2	**103.3**	**100.5**
Northern OSRs	100.1	109.8	121.7	125.0	-10.1	4.0	-8.0	120.1	101.4
Central OSRs	104.5	108.8	112.3	113.1	-5.2	5.6	-3.1	111.5	100.8
Southern OSRs	91.8	82.7	65.1	60.5	15.8	12.2	17.9	66.7	97.5
Special Statute Regions (SSRs)	**106.9**	**88.7**	**78.4**	**75.2**	**13.7**	**9.1**	15.6	**80.9**	**96.9**
Northern SSRs	132.0	106.8	116.7	118.1	3.7	4.3	5.7	119.5	97.6
Southern SSRs	98.0	82.3	64.8	59.8	20.1	12.1	22.1	67.1	96.5
Coefficient of variation (%)	19.0	13.8	25.8	27.8	–	–	–	25.1	3.6
Maximum value	165.2	128.9	137.1	146.3	33.7	16.0	35.7	142.6	104.2
Minimum value	84.8	74.8	58.0	52.7	-15.4	-0.1	-13.3	61.5	92.3

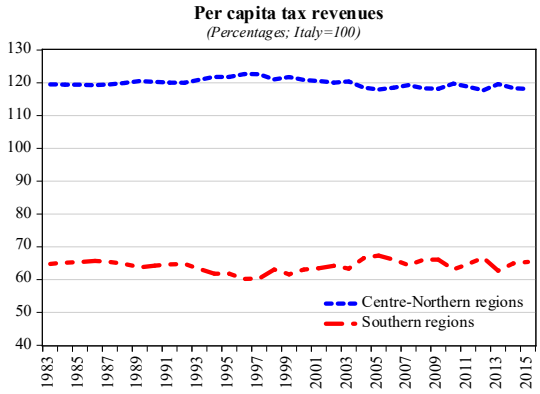
Source: Own elaborations on Regional Public Accounts data released by the Ministry of Economic Development. (1) Base year 2010. (2) It includes other current transfers to families and social private institutions. (3) Taken as percentages with respect to the corresponding are GDP. (4) It is the ratio of revenues (social contributions, direct and indirect taxes) to GDP standardized for the corresponding Italian value.



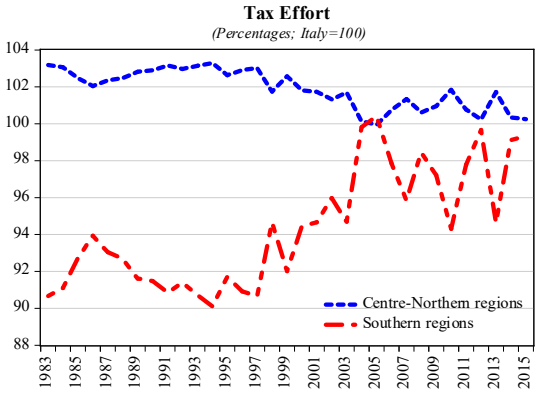
(a) The per capita public expenditure of the Southern regions as a share of that of the Center-Northern regions.
Source: Own elaborations on Istat data and Regional Public Accounts data (see the Appendix and Section 2.3). Base year 2010.



(b) The dependence ratio is equal to the expenditure-to-GDP ratio of the i-th area divided by the Italian Expenditure-to-GDP ratio $(G_{it}/GDP_{it})/(G_t/GDP_t)$.
Source: Own elaborations on Istat data and Regional Public Accounts data (see the Appendix and Section 2.3). Base year 2010.

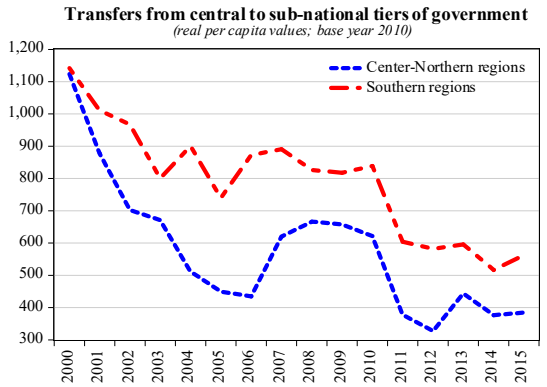


(c) The per capita tax revenues of the Southern regions as a share of that of the Center-Northern regions one. Source: Own elaborations on Istat data and Regional Public Accounts data (see the Appendix and Section 2.3). Base year 2010.

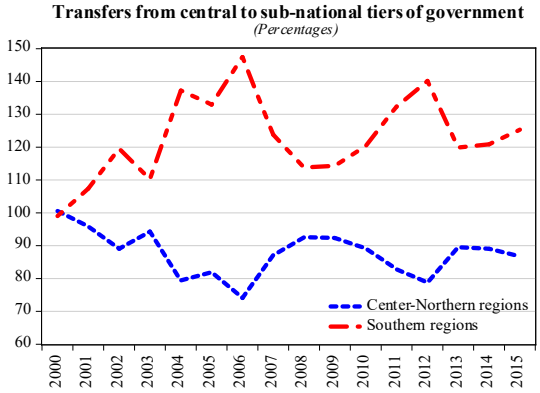


(d) The tax effort is equal to the tax-to-GDP ratio of the i-th area divided by the Italian tax-to-GDP ratio $(T_{it}/GDP_{it})/(T_t/GDP_t)$.
Source: Own elaborations on Istat data and Regional Public Accounts data (see the Appendix and Section 2.3). Base year 2010.

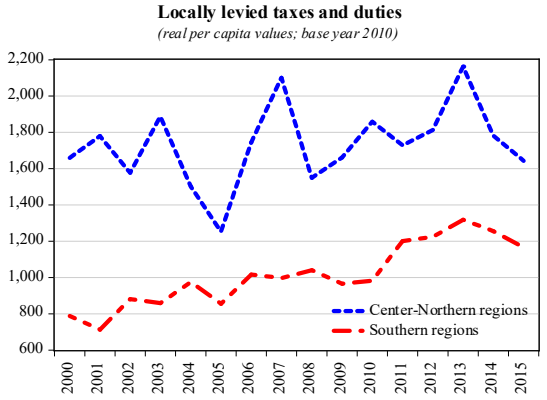
Figure 2.4



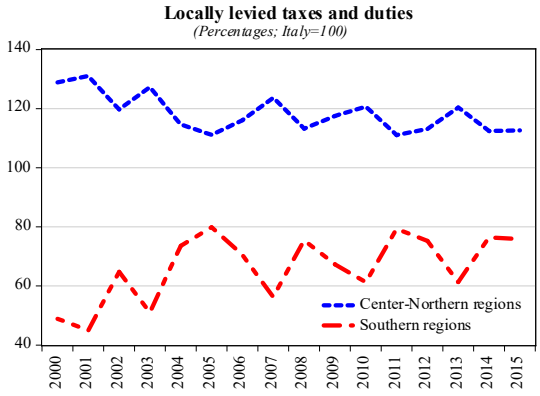
(a) Source: Own elaborations on Regional Public Accounts data released by the Agency for Territorial Cohesion.



(b) Source: Own elaborations on Regional Public Accounts data released by the Agency for Territorial Cohesion.



(c) Source: Own elaborations on Regional Public Accounts data released by the Agency for Territorial Cohesion.



(d) Source: Own elaborations on Regional Public Accounts data released by the Agency for Territorial Cohesion.

Figure 2.5

CHAPTER 3

Innovative firms and financial constraints: The case of the Italian region Friuli Venezia Giulia

Innovative firms and financial constraints: The case of the Italian region Friuli Venezia Giulia[1]

Giovanni Vittorino[2] Maria Claudia Schneider[3]

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[2]Bank of Italy and University of Udine, Italy.

[3]University of Udine, Italy.

Abstract

This paper investigates the existence of financial constraints and the preference for internal funding for innovative and non-innovative firms of different sizes located in the Italian region Friuli Venezia Giulia during 2005-2015. Our analysis is based on a unique dataset matching firm-level accounting data with information on firms' innovation propensities from the 2008-2010 wave of the Community Innovation Survey (CIS). We rely both on the sensitivity of physical investment to cash flow, an indirect measure of financial constraints, and on a CIS-based direct measure of financial constraints. The sensitivity of investment to cash flow is higher among large firms engaged in innovation-related activities, although this result is at odds with firms' perceptions of financial constraints reported in the CIS survey. A higher sensitivity is associated with involvement in R&D projects, which determines a strict preference for internal funds due to the reticence to disclose relevant information to external financiers.

JEL Classification Numbers: D82; D92; G32; O31; O32.

Keywords: Investments, Innovation, Finance, Financial Constraints, Small Firms, Community, Innovation Survey.

3.1 Introduction

In the last decade, policy-makers have been attempting to remove factors that may hamper innovation for two reasons. First, there is a consensus that innovation is pivotal to promoting economic growth through a boost in productivity which has been decreasing in Italy since the middle 1990s. Second, firms' recovery in the aftermath of the latest economic and financial crisis seems closely linked to their competitiveness in delivering products and services that can be sold at international marketplaces. In this study, we focus on the financial constraints faced by firms established in the Italian region Friuli Venezia Giulia (FVG) during 2005-2015. We assess the existence and severity of financial constraints both for innovative and non-innovative firms of different sizes, relying on data from the 2008-2010 wave of the Community Innovation Survey (CIS) matched with accounting data for 2005-2015 from the Italian Company Accounts Database (CAD, Centrale dei Bilanci). Departing from the theoretical literature we expect that small innovative firms are more likely to suffer financial constraints constraints because of their opacity and the nature of their activity which leads to high information asymmetries in the capital markets.

We consider two different approaches in investigating financial constraints. First, based on the methodology in the seminal study by Fazzari et al. (1988), we test for the sensitivity of physical investments to internal funds (cash flow) as a measure for the financial constraint level. Other papers have used this methodology to study the effects of financial constraints on innovation activity (Himmelberg and Petersen, 1994; Bond et al. (2005); Ughetto, 2008; Magri, 2009; Brown et al., 2009). Following this strand of empirical literature, we investigate on differences on physical investment sensitivity to cash flow between innovative and non-innovative firms of different sizes by using two definitions of innovators. Following Bond et al. (2005) and Magri (2009), we test the sensitivity of investment to cash flow using an error correction model (ECM) for investment demand with a system general method of moments (GMM) estimator.

Second, we use a direct indicator of financial constraints based on data from the CIS 2008-2010 wave. We use CIS descriptive statistics to assess to what extent innovative firms perceive the lack of internal and external funds as hampering factors by following the approach of innovation studies that have criticized the econometric tests based on the sensitivity of physical investment to cash flow because this indicator is an indirect measure of financial constraints that can be subject to interpretation problems (Canepa and Stoneman, 2008; Savignac, 2008).

Since the 1960s, FVG, a small and highly industrialized region in the north-east of Italy, has been characterized by high gross domestic product (GDP) growth rates, but the macro-economic indicators of the region have shown several weaknesses during and after

the recent economic and financial crisis. The region has a high incidence of innovative firms, with a relevant presence of small and medium size enterprises (SMEs), supported by a financial system characterized by the presence of local banks. According to the Italian National Institute for Statistics (Istat), FVG is a leading innovation-oriented region in Italy. In 2010, FVG was the Italian region with the highest percentage of innovators and among the top three Italian regions in the rate of patents per million inhabitants at the European Patent Office and R&D expenses (from public and private sectors) as a ratio of regional GDP (Istat-Cnel, 2013; Istat, 2015, Istat, 2016 and Istat, 2017).

From the macro-economic context, the credit crunch induced by the economic and financial crisis hit the regional economy severely and, subsequently, credit demand decreased, driven by a fall in investment (Banca d'Italia, 2018). In FVG, investments decreased more severely than in the rest of Italy between 2012 and 2014. Moreover, despite the exports of the region being above the national average prior to the crisis, it suffered a sharper drop than the rest of Italy between 2007 and 2013, recovering only between 2014 and 2016 FGB (2014, 2017). The economic crisis also had a severe effect on the percentage of firms that introduced product or process innovation, which decreased from the 58.8% in CIS wave 2010 to 42.2% in CIS wave 2014 while regarding the level of public and private sectors' R&D expenses as a ratio of the regional GDP, FVG remained above the Italian regional average since the onset of the crisis as this indicator increased from 1.4 in CIS 2010 to 1.6 in CIS 2014 (Istat-Cnel, 2013; Istat, 2015, Istat, 2016 and Istat, 2017) due to a sharp drop in regional GDP.

The contributions of our study are as follows. First, we focus on a regional context that provides an ideal setting to study the importance of financial constraints for innovation during crises as, among European countries, Italy has been one of the most severely hit by the recent economic downturn and financial crisis. Focusing on a specific region allows us to overcome the problems of country-level analyses, since financial constraints and innovation propensity are affected by region-specific factors. For instance, Guiso (1998) and Bartoloni (2013) determine that firms located in southern Italian regions, characterized by lower levels of per capita GDP relative to the north-central regions, have more difficult access to external finance than firms with similar characteristics in northern regions.

Second, we match the CIS data with accounting data in the CAD, which allows us to use two different approaches to analyze the relevance of financial constraints to innovation activities: one is based on micro-econometric models and the other on survey responses on the hampering factors to innovation. Our study is the first one, to the best of our knowledge, that matches an indirect measure of financial constraints based on the micro-econometric approach developed by Fazzari et al. (1988) with a direct indicator that can be inferred by responses to the CIS survey. This approach allows us to control

for potential weaknesses in the micro-econometric model.

Finally, our dataset allows us to rely on a broad, input-based definition of innovative firms, investigating on the existence of financial constraints for several forms of innovation. Indeed, although R&D expenditure and intangible assets are the main determinants of innovation, innovative projects require several types of other investments. The CIS questionnaire, besides in-house R&D, also provides information on other forms of investment related to innovation, such as external R&D; acquisition of machinery, equipment, and software; acquisition of external knowledge; expenditure training for innovative activities; market research; and cost advertising. We compare two definitions of innovators: we call *broad innovators* all firms that declare to be engaged in innovative project listed by the CIS and *R&D performers* those firms engaged exclusively in in-house and external R&D activities (strictly technical innovators).

Our results show that the measure of investment to cash flow sensitivity is relevant but not statistically different between broad innovators and non-innovators. Among broad innovators, larger firms show a higher sensitivity than small ones, which is not in line with the responses to the CIS wave 2010. In the light of descriptive statistics and of the responses to the CIS, we interpret the higher sensitivity of physical investment to cash flow for larger broad innovators as the result of the higher incidence of firms engaged in R&D projects in this group. Being engaged in R&D, large firms are reticent to disclose relevant information on their projects to external financiers and prefer to use internal funds.

The remainder of this paper is organized as follows. In the Section 3.2, we review the recent literature on the existence of financing constraints and preference for internal funding among innovative firms. In the Section 3.3, we present the dataset and descriptive statistics. In the Section 3.4, we explain the model and estimation methodology. In the Section 3.5, we discuss the results and the last Section concludes the paper.

3.2 Literature Review

3.2.1 Innovation financing, information asymmetries, and financial constraints

Since the end of the 1980s, a relevant literature strand considered firms that are subjected to asymmetric information on the capital markets as more affected by financial constraints (Fazzari et al., 1988; Hubbard, 1998). In particular, the literature on financing constraints considers innovative firms and as most affected than other groups by asymmetric information related problems in the capital market.

Since Arrow (1962) unveiled the characteristics of non-rivalry, non-excludability, and uncertainty of the invention process, a large and increasing body of theoretical and empirical literature studied innovation financing and the intrinsic characteristics of innovative projects that exacerbate information frictions. Several authors point out that R&D investments and high-tech related investments are particularly subjected to information asymmetries on capital markets as follows (Hall, 1992; Hall and Lerner, 2010; Guiso, 1998; Bhattacharya and Ritter, 1983; Carpenter and Petersen, 2002).[1] First, managers are reticent to disclosing valuable technological information outside the firm for fund raising, as information produced within R&D projects is highly non-rival and non-excludable and is subject to a value loss for the firm if disclosed to competitors (Bhattacharya and Ritter, 1983). Second, innovation-related projects require advanced technological knowledge to be evaluated and external financiers often do no possess the adequate skill for in-depth assessment. Third, the highly uncertain payoff of innovation projects makes it difficult for external financiers to rely on classic risk-return valuation measures based on mean variance models. Finally, R&D investments are skilled-labor intensive, consisting mainly of salary payments and highly specific physical assets, a characteristic that may lead to low levels of collaterals, which enhances bankruptcy costs. All these features determine a firm's marked preference for internal funds in pursuing innovative projects and enhance asymmetric information problems on capital markets, leading to higher costs and\or a lack of fund availability. Therefore, R&D performer firms are hypothesized as more likely to rely on internal funds and to face financial constraints.

We aim to assess whether financial constraints and the preference for internal funds are higher for firms that are engaged in innovative projects in the broad sense (any innovation listed under CIS) and for firms only engaged in R&D. We also consider the combined effects of innovative attitude and size: an analysis of financial constraints cannot disregard the firm' size as small firms are hypothesized to be more subjected to asymmetric information in the capital market and to be more likely to incur in information asymmetries in the capital market due to their opacity (Berger and Udell, 1995). To assess the existence of financial constraints, we rely on an indirect indicator and on a direct indicator. The first is based on a micro-econometric model of investment demand and the second is based on survey data, where firms are explicitly asked about their perception of financial obstacles for innovative projects.

The strand of empirical studies on innovation financing based on the micro-econometric approach by Fazzari et al. (1988) assess whether financial constraints are significant for innovation-related investments andor if financial constraints are higher for

[1]Other scholars, such as Parisi and Sembenelli (2003), pointed out to that the level of R&D spending is negatively affected by the user cost of capital. Moreover, the user cost of capital tends to be higher during recession times.

innovative firms than non-innovative ones. This approach tests the existence of financial constraints considering the sensitivity of investment to cash flow as a measure of financial constraints (Fazzari et al., 1988).

This strand of empirical works considers several definitions of innovative firms. Commonly, following the theoretical literature, innovative firms are considered those performing R&D andor those involved high tech sector. Recently the European cohesion policy recognized the importance of innovation inputs other than R&D as major recipient of funding (Diukanova and Lopez-Rodriguez, 2014) and researchers in innovation related topics started to use survey-based definition of innovators grounded on involvement in non R&D inputs (see Mairesse and Mohnen, 2010 for an overview). Among studies on financial constraints to innovative firms, Magri (2009) follows this approach by using a survey-based definition of innovative firms as per those firms that gained revenues from successfully introduced any product and or process innovation. We follow this approach and we ground our definition of innovators on the survey-based literature on obstacles to innovation. We adopt a broad input based definition of innovation as in D'Este et al. (2012) where innovative firms are those that declare to be engaged in at least one of the innovation activities listed in the CIS.

Regarding the choice of the dependent variable in the model of investment demand, studies on innovation may rely on the sensitivity of physical investment to cash flow and/or on the sensitivity of R&D expenses to cash flow. The approach undertaken by the studies on innovation financing is mixed. Several authors (Himmelberg and Petersen, 1994; Ughetto, 2008) consider that, beside R&D expenses an analysis of physical investments' sensitivity to cash flow is important to assess the existence of financial constraints for innovative firms as the knowledge produced within R&D projects ends up being embodied in plant and equipment. Some studies test two separate models using physical investment and R&D expenses as dependent variables (Himmelberg and Petersen, 1994; Bond et al., 2005), other only test the sensitivity of R&D expenses to cash flow and other financing forms such as external equity for innovative firms (Brown et al., 2009; Brown et al., 2012). Panel studies on the sensitivity of investment to cash flow for innovative firms based in Italy (Ughetto, 2008; Magri, 2009) are subjected to a limitation since R&D expenses data are not computable from the financial statements, thus for Italian innovative firms only the sensitivity of physical investment to cash flow can be tested. In our study we follow Magri (2009) and Ughetto (2008) by investigating on the sensitivity of physical investment to cash flow. This is consistent with data availability but also with the theoretical approach that considers that the output of R&D projects determines physical investments.

The definition of innovators differs. The major part of these studies define innovators on the basis of engagement in R&D activities or on the basis of the engagement in high

tech sectors, being strictly based on technical innovation. Magri (2009) uses a survey based definition that implies that the firm is engaged into a broader set of innovation activities such as product and process innovation.

The main micro econometric studies on financial constraints to innovation on which our work is based are reviewed in Table 1.

By relying on a model of physical investment demand and on the estimators employed by Magri (2009) and Bond et al. (2005), our micro-econometric analysis presents a number of contributions to the literature. First, we focus on firms operating in a homogeneous macro-economic setting based on a regional context. Second, we rely on a broad input-based definition of innovators grounded on CIS responses. Third, we analyze a longer time span, encompassing the economic crisis.

Finally, we also rely on a direct, survey based indicator of financial constraints as an alternative to the use of the sensitivity of investment to cash flow, as an indicator of financial constraints, has been widely criticized by Kaplan and Zingales (1997, 2000). One of the critiques is that the nature of the sensitivity of investment to cash flow can be related to precautionary savings motives or irrational behaviors of managers who choose internal funds over low-cost external ones. This critique is relevant for the financing R&D and high-tech related investments, as managers may choose not to ask for external financing because they do not want to reveal the details of innovative projects outside the firm: in this case, the heavy reliance on internal funds can be unrelated to credit rationing. Critiques to this approach have been also moved by the survey based literature on innovation financing (Canepa and Stoneman, 2008; Savignac, 2008): the CIS responses on lack of funds are more precise at pointing out the existence of external financial constraints while a high sensitivity of investment to cash flow may reflect just a strict preference for internal funds that could originate from reasons other than credit rationing or high cost of external funds. We rely on the 2008-2010 CIS survey and we look at the descriptive statistics on the perception of financial factors that hamper innovation to offer support to the micro-econometric analysis. We use the survey responses to determine the importance of the lack of internal and external sources of financing as hampering factors for innovative firms of different sizes.

The main limit when comparing the CIS responses on financial constraints with the sensitivity of investment pending to cash flow is that firms' responses are valid only for the three years covered by the survey, while the indirect indicator is calculated on a micro econometric model based on data covering a longer time span. Nonetheless, we choose a longer time-span for the econometric analysis in order to find robust estimates and we rely on an important CIS wave that covers the years following the crisis and the credit crunch.

Table 1 - Main scholarly contributions

Authors	Country	Data Source	Selection of firms and definition of innovators	Methodology	Sample selection and split	Results
Magri (2009)	Italy	Survey of Manufacturing Firms (Mediocredito Centrale), wave 1998-2000 + CAD for accounting data 1993-2000	Sample: all respondents to the Survey of Manufacturing firms that also display accounting data in the CAD. Innovators: those firms that gained revenues from successfully introduced innovation (output-based definition).	Test for differences in physical investment sensitivity to cash flow based on a dynamic error correction model of investment demand. Estimation method: system GMM estimation (Arellano and Bover 1995).	Sample encompasses both innovative and non-innovative firms. Sample is split by innovation attitude and size (small innovators, large innovators, small non-innovators, and large non-innovators). Size: small firms with 20 or less employees, large firms with more than 20 employees.	Small innovators show lower sensitivity of physical investment to cash flow than the other groups. Small innovators are considered deep-pocket firms with abundant internal funds, higher than the demand for investment spending.
Ughetto (2008)	Italy	Survey of Manufacturing Firms, waves 1998-200 and 2001-2003 + AIDA database from Bureau van Dijk, 1998-2003.	Sample: all respondents to both waves of the Survey of Manufacturing that also display accounting data in the AIDA database. Two definitions of innovators are used and confronted in two separate models: **1.** Innovators: R&D performers. Non-innovators: non-R&D performers **2.** Innovators: high-tech sector. Non-innovators: non-high-tech sectors.	Test for differences in physical investment sensitivity to cash flow based on a sales accelerator model of investment demand. Estimation method: within-firm and first difference GMM (Arellano and Bond 1991).	Sample comprises both innovative and non-innovative firms. The sample is split by size following the European Union classification. The two groups of small and large firms are further split in innovative and non-innovative firms.	Among small firms, high-tech and R&D performers show a higher sensitivity of investment to cash flow than non-high-tech and non-R&D. Among large firms, innovators (R&D, high-tech) show a lower sensitivity than non-innovators (non-R&D, non-high-tech).
Brown, Fazzari, and Petersen (2009)	US	Compustat database 1990-2004	Publicly traded firms in high-tech sectors.	Test of R&D expenses sensitivity to cash flow and external equity financing (i.e., funds raised with new stock issues) using an investment model based on the dynamic optimization of Euler condition for non-perfectly competitive firms with a quadratic adjustment costs of assets accumulation. Primary estimation method: first difference GMM (Arellano and Bond 1991).	The sample is composed by only high-tech sector firms in the Compustat and is split into young and mature firms.	Younger firms show a significant statistical relation between R&D investment and both internal cash flow and external equity, while mature firms do not show a significant relationship.

Table 1 (continued) - Main scholarly contributions

Authors	Country	Data Source	Selection of firms and definition of innovators	Methodology	Sample selection and split	Results
Brown, Martinsson, and Petersen (2012)	16 European countries: Focus on the UK, Sweden, Germany and France	Compustat Global Database 1995-2007	Firms that perform R&D.	Test of R&D expenses sensitivity to cash flow and external equity financing (i.e., funds raised with new stock issues) with a Euler equation also controlling for changes in cash holdings. Estimator: system GMM	The sample encompasses only firms that perform R&D. The tests are carried out for the subgroups of young and mature, of small and large, and of high dividend and low dividend payout.	Firms in market-based financial systems (UK and Sweden) show higher sensitivity of R&D to the selected financial variables, especially for younger and smaller firms. In Germany, the sensitivity of R&D to the financial variables is significant for all firms while, in France, it is not significant.
Bond, Harhoff, and Reenen (2005)	UK and Germany	Data stream online for UK and Bundesanzeiger for Germany. Period: 1985-1994	Firms that perform R&D and firms that operate in high-tech sectors.	Test of R&D and fixed investment sensitivity to cash flow through an error correction model. Estimator: system GMM estimator (Arellano Bover 1995).	**Analysis 1**: R&D performers in the UK and R&D performers in Germany. **Analysis 2**: High-tech sector firms in the UK and high-tech sector firms in Germany. Both groups are further divided into R&D and non-R&D performers.	For R&D performers: fixed investments are significantly correlated to cash flow only for UK firms. R&D expenses are not significantly correlated to cash flow for either of the two countries. R&D performers, among high-tech firms, shows fixed investment significantly related to cash flow only for UK.
Himmelberg and Petersen (1994)	US	Compustat Period: 1983-1987	Small high-tech firms.	Test for sensitivity of R&D spending and physical investments to cash flow through an accelerator and Tobin Q model of investment demand.	No split of the sample.	Significant sensitivity of R&D and physical investment to cash flow.

3.3 Data, variables, and descriptive statistics

3.3.1 Data sources and sample definition

Our analysis is based on a dataset obtained by merging firm-level data from two different sources. First, we use the CIS wave 2008-2010, provided by the FVG's Regional Statistical Department for a representative sample of respondent firms of FVG[2] both by industry and size (number of employees).[3] As per Magri (2009), small firms are those with no more than 20 employees. Second, we rely on the Italian CAD (Centrale dei Bilanci) to construct indicators of financial structure from 2005 to 2015 (see Appendix Table A.1).

We adopt an input-based definition of innovative firm that considers the actual engagement in product and process innovation. Following D'Este et al. (2012), we define as innovative those firms that declare to be engaged in any innovative projects listed in CIS wave 2010. We call these firms broad innovators to distinguish them from firms that are only engaged in R&D projects (Table A.2 in the Appendix). Under the assumption that an innovative status is persistent, our sample consists of all firms included in the CIS survey for wave 2008-2010 and display accounting information from CAD for 2005-2015 for at least five consecutive years. On average, during 2005-2015, CAD firm-level accounting data match around 70.6% of the firms included in the CIS dataset, for a sample of 800 firms of which 310 are broad innovators (Table 2). We further divide the sample by innovation attitude and size (Table 3).

Following Magri (2009), the cash flow is computed as net profit plus depreciation and amortization (non-monetary costs) and represents a broad measure of the self-financing ability of the firm. Physical investment is taken directly from the flow of funds into the CAD and is only referred to by tangible fixed assets. Both investment and cash flow are scaled by the previous year capital stock, determined at the replacement value starting from 2004 using the *perpetual inventory method*. The value of capital stock of tangible fixed assets for firm i at time t is computed as:

$$K_{it} = K_{it-1}(1 - \delta) + I_{it}$$

where the investment flow at time t has been deflated in 2010 prices using the Gross Fixed Capital Formation deflator by The United Nations Economic Commission for Europe and a depreciation rate (δ) fixed at 0.05. Finally, firm i's initial value of

[2]NUTS2, according to the Eurostat classification.

[3]CIS data provide qualitative and quantitative information on firms' characteristics, such as undertaken innovative activities, and factors that either hamper the innovation process or prevent firms from engaging into innovative activities at all. The dataset includes all firms with 250 employees or more and a random sample of those with at least 10 employees.

capital stock has been obtained by multiplying the book value of capital at time 0 by the estimated value of the average firm's capital life:

$$K_{i0} = K_{i0}^{book-value} * \left[(sec - age \times (\delta_{i0}^{book-value}) \times 0.5\right]$$

where *sec-age* represents the sector useful life of capital, and $\delta_{i0}^{book-value}$ the share of capital already depreciated at time 0. Finally, the parameter 0.5 allows us to consider "that depreciation for tax purposes is faster than economic depreciation" (Magri, 2009, p. 204).

We further investigate the financial constraints to innovation through a direct indicator using the CIS responses on the perception of hampering factors to innovation. We concentrate on the group of broad innovators and look at the differences between large and small firms. The sample encompasses all firms engaged in at least one innovative activity listed by the CIS and that display full accounting data in the CAD for 2010. The analysis of the CIS responses is based on a sample composed of 346 innovative firms[4] (firms that were declared to be engaged in an innovation project), which comprises 202 small and 142 large firms.

In the CIS wave 2008-2010, the firms were asked to rank the importance of several factors in preventing or hampering innovation activities. Among the hampering factors, firms were asked to express how important *Lack of funds within your enterprises or group* (internal financial constraints) and *Lack of finance from sources outside your enterprise* (external financial constraints) have been. Table A.2 in the Appendix reports all hampering factors considered by CIS 2008-2010.

Following Canepa and Stoneman (2008) and D'Este et al. (2012), we consider hampered a firm engaged in innovative activities if it perceives a certain obstacle of medium or high importance. We construct the frequency rankings of each hampering factor for the two groups of small and large broad innovators and grade their importance. Subsequently, we concentrate on financial constraints and assess the differences in the percentage of small and large broad innovators that declared that internal and external financial constraints as hampering factors of medium or high importance.

A description of the variables drawn from the CIS and the definitions of other variables drawn from our CIS-CAD dataset are reported in Tables A.1 and A.2 in the Appendix.

[4]The sample is larger than the CIS-CAD one because we are considering the year 2010 only.

3.3.2 Descriptive statistics

Following Magri (2009), we analyze the differences in general characteristics, financial structure, and investment attitude, dividing the sample according to the innovation attitude (broad innovators and non-innovators). We also look at the combined effects of innovation attitude and size (firms with 20 employees or less are considered small and firms with more than 20 employees are considered large) by dividing the sample into four sub samples: small broad innovators, large broad innovators, small non-innovators, and large non-innovator firms.

We consider the general characteristic that may impact financial constraints and investment spending. Age is considered relevant by the empirical and theoretical literature, as often mature firms with a recorded history and cumulated internal funds are subject to lower information asymmetries on the capital market and may find less difficulties in accessing external funds. Involvement in R&D projects is linked to higher uncertainty and reluctance from managers to disclose information, leading to a strong preference for internal funds and higher information asymmetries. Being export oriented is considered by the literature a signal of high productivity and diversification benefits, which may lower information asymmetries on the capital markets (Campa and Shaver, 2002), although during the crisis, export in the region has been severely affected (see Banca d'Italia, 2018). Partnership into groups may also lower financial constraints by promoting the internal pooling of resources.

Table 2 compares broad innovators and non-innovators with respect to their general characteristics, financial structure, and investment attitude for 2005-2015. Innovative firms are, on average, more export oriented, more likely to be part of a group, show a lower sales growth rate, and have a higher share of graduate-level education employees. Regarding fixed assets composition, innovative firms show a higher proportion of intangible to fixed assets,[5] which is in line with the fact that innovation needs resources linked to knowledge and intangibles. Regarding debt composition for 2005-2015, innovative firms relied more on financial debt[6] than non-innovative firms on average, signaling that financial debt has been important during the analyzed period to pursue innovation in the region.

Table 3 compares small and large firms among broad innovators and non-innovators. Among broad innovators, large firms are older, more export oriented, display a higher share of firms that employ at least one graduate employee, and are more involved into R&D projects. Larger firms are also more likely to be part of a group, be involved in cooperation agreements, and they have easier access to public grants. Regarding prof-

[5]Fixed assets are expressed as the sum of tangible and intangible assets.
[6]Financial debts are considered as a share of total liabilities.

Table 2 - Information on the CIS-CAD sample for FVG

Data descriptive statistics

(Means; Percentages)

	Full sample	Broad innovators	Non-innovators	p-value
General characteristics				
Size (# employees)	67 (18)	123 (26)	34 (16)	0.001
Age (# years)	22 (21)	23 (20)	22 (22)	0.165
R&D projects	22.8	60.7	–	–
Exporter	39.6	56.4	29.4	0.000
Part of a group	18.3	29.5	11.5	0.000
Cooperation agreements	9.3	24.9	–	–
Graduate workers	55.9	73.7	45.1	0.000
Public grants	16.5	43.9	–	–
Innovative product new to the market	17.7	47.1	–	–
Profits (ROA)	3.8 (0.9)	1.7 (0.9)	4.9 (0.8)	0.366
Sales (euros) growth rate	1.4 (1.4)	0.5 (0.1)	5.0 (5.1)	0.000
Tangible assets/Total assets	22.5 (18.0)	23.0 (19.0)	22.6 (17.8)	0.793
Intangible assets/Fixed assets	12.1 (4.7)	14.3 (4.8)	10.3 (3.4)	0.001
Financial structure				
Equity/Total liabilities	34.0 (34.4)	33.3 (33.6)	34.1 (34.0)	0.614
Financial debts/Total liabilities	31.6 (32.0)	34.3 (35.1)	30.5 (29.5)	0.001
Leverage	54.5 (49.2)	55.4 (52.4)	55.5 (47.9)	0.979
Short term debts/Total financial debts	65.4 (66.2)	66.3 (69.1)	64.6 (64.6)	0.321
Investment attitude				
Cash flow/Capital$(t-1)$	33.1 (12.1)	40.5 (13.9)	30.6 (11.6)	0.188
Physical investments/Capital$(t-1)$	16.1 (6.4)	15.7 (7.0)	17.0 (6.3)	0.723
(Cash flow−Physical investments)/Capital$(t-1)$	17.8 (4.6)	24.7 (6.0)	13.7 (4.1)	0.096
Number of firms	800	310	490	

Note: Median values are reported between parentheses, The sample comprises firms surveyed by the 2008-2010 wave of the CIS, for which corresponding accounting data were available in the CAD over the period 2005-2015 for at least five consecutive years. The last column reports the p-values of the t-test for equal means (unequal variances) among subgroups.

itability, small broad innovators are, on average, more profitable in terms of return on assets (ROA) and display higher sales growth rates. The lower sales growth of innovators relative to non-innovators in Table 2 is thus driven by larger firms, which display a negative sales growth rate during the analyzed period (−0.03). For asset composition, larger innovators show a higher proportion of tangible assets in total assets as a sign of lower bankruptcy costs, which may facilitate the access to external debt. Regarding liability, our descriptive statistics are at odds with Magri (2009) as, in our sample, small innovators are more leveraged than large innovators. However, the difference in the ratio of financial debt to total liabilities is not significantly different. Nonetheless, small innovators display a lower equity to total liabilities (28.9$versus$36.3). Small innovators also adopt a more aggressive investment policy than large ones as per the physical investment rate (19.1$versus$13.2), which is in line with Magri (2009).

Among non-innovators, large firms are older, more export oriented, more likely to be part of a group, and display higher sales growth rates. Regarding the composition of fixed assets in terms of intangibles, no differences have been identified. Small firms are more leveraged than larger firms, while regarding the investment attitude among non-innovators, no significant differences have been found. Overall, size matters more for the asset and financial structure of innovators than for non-innovators.

Table 3 - Information on the CIS-CAD sample for FVG

Data descriptive statistics

(Means; Percentages)

	Broad innovators			Non-innovators		
	Small	Large	p-value	Small	Large	p-value
General characteristics						
Size (# employees)	14 (14)	204 (64)	0.001	13 (13)	65 (35)	0.000
Age (# years)	19 (17)	27 (22)	0.000	21 (21)	24 (22)	0.005
R&D projects	44.6	72.7	0.000			
Exporter	37.8	70.2	0.000	25.6	35.2	0.016
Part of a group	10.8	43.4	0.000	5.5	20.7	0.000
Cooperation agreements	14.2	32.8	0.000			
Graduate workers	54.7	87.9	0.000	32.6	64.3	0.000
Public grants	34.5	51.0	0.002			
Innovative product new to the market	46.6	47.5	0.000			
Profits (ROA)	2.4 (1.1)	1.1 (0.7)	0.036	2.1 (1.2)	9.2 (0.4)	0.428
Sales (euros) growth rate	11.8 (12.4)	- 0.3 (−0.3)	0.001	5.9 (5.8)	4.9 (4.9)	0.000
Tangible assets/Total assets	20.8 (15.5)	24.6 (22.9)	0.050	22.5 (16.9)	22.9 (18.5)	0.771
Intangible assets/Fixed assets	16.2 (6.0)	12.9 (4.7)	0.122	10.1 (3.1)	10.7 (4.3)	0.657
Financial structure						
Equity/Total liabilities	28.9 (29.2)	36.3 (34.1)	0.009	34.4 (38.5)	33.6 (29.9)	0.706
Financial debts/Total liabilities	30.3 (28.9)	37.3 (38.0)	0.001	30.4 (28.4)	30.6 (31.0)	0.922
Leverage	63.2 (53.6)	49.6 (52.4)	0.099	60.9 (48.1)	47.2 (47.2)	0.012
Short term debts/Total financial debts	66.0 (70.8)	66.6 (68.6)	0.828	64.6 (65.4)	64.6 (63.8)	0.994
Investment attitude						
Cash flow/Capital$(t-1)$	43.9 (16.2)	37.9 (12.6)	0.548	29.7 (12.6)	32.1 (9.5)	0.856
Physical investments/Capital$(t-1)$	19.1 (7.1)	13.2 (7.0)	0.007	18.1 (6.3)	15.2 (6.1)	0.587
(Cash flow−Physical investments)/Capital$(t-1)$	24.8 (6.5)	24.7 (4.1)	0.989	11.5 (4.7)	17.0 (3.1)	0.643
Number of firms	129	181		289	202	

Note: Median values are reported between parentheses, The sample comprises firms surveyed by the 2008-2010 wave of the CIS, for which corresponding accounting data were available in the CAD over the period 2005-2015 for at least five consecutive years. The last column reports the p-values of the t-test for equal means (unequal variances) among subgroups.

Table 4 presents the survey responses analysis and shows the frequency rankings associated with each hampering factor for the groups of small and large broad innovators. The results show that the most important hampering factor is the high cost of innovation for both large and small innovative firms. The lack of internal funds is ranked second by small firms and third by large firms, while the lack of external finance is ranked second by large firms and third by small firms. Therefore, the lack of internal and of external funds are among the most important hampering factors for all innovators regardless of their size.

Table 4 - Ranking of factors hampering broad innovators, 2010

Factors hampering innovation	**Small**	**Large**
Lack of funds within your enterprise or group	2	3
Lack of financing from sources outside your enterprise	3	2
Innovation costs too high	1	1
Lack of qualified personnel	7	6
Lack of information on technology	9	8
Lack of information on markets	8	9
Difficulty in finding cooperation partners for innovation	5	7
Market dominated by established enterprises	6	5
Uncertain demand for innovative goods or services	4	4
Number of firms	204	142

Note: Own elaborations using CIS data. Small firms are those with up to 20 employees.

Tables 5 and 6 respectively report the impact of the lack of external and internal financing for innovators by firm size. The percentage of small firms that declared of medium or high importance the hampering effect of the lack of external or internal funds is significantly higher, suggesting that small broad innovators were affected more by financial constraints during the onset of the crisis.

3.4 Micro-econometric methodology

We assess the importance of financial constraints for FVG's innovative firms by testing for differences in the sensitivity of fixed physical investment to cash flow by innovation status and size. We then concentrate on innovative firms and assess the differences in the perception of financial obstacles between small and large firms.

Usually, financial variables display a high degree of persistence. To control for this feature and the dynamic nature of the relationship linking firm investment attitude and financial variables such as the incidence of cash flow over capital stock, we need an

Table 5 - Impact of the lack of external financing by firm's size, 2010. Percentage of the sample of broad innovators

Degree of perception of the obstacle	Firm's size		
	Small	Large	Chi-square (χ^2)
No or low effect	39.7	43.7	
Medium or high effect	60.3	56.3	0.54*
Number of firms	204	142	

Note: Own elaborations using CIS data. Small firms are those with up to 20 employees. H0: row and columns variables are independent. *statistically significant at 10%.

Table 6 - Impact of the lack of internal funds by firm's size, 2010. Percentage of the sample of broad innovators

Degree of perception of the obstacle	Firm's size		
	Small	Large	Chi-square (χ^2)
No or low effect	34.8	43.7	
Medium or high effect	65.2	56.3	2.77*
Number of firms	204	142	

Note: Own elaborations using CIS data. Small firms are those with up to 20 employees. H0: row and columns variables are independent. *statistically significant at 10%.

econometric strategy that allows us to cope with endogenous error terms. Following Bond et al. (2005), we employ an Error Correction Model (ECM) estimated through a system GMM (Arellano and Bond, 1991; Arellano and Bover, 1995; Blundell and Bond, 1998), which allows us to work with a panel dataset featuring many firms over a short period of time.

The ECM departs from a specification of the long-term capital level based on a CES production function of a profit maximizing firm and allows for a flexible dynamic adjustment model for capital stock. Without adjustment costs, the long-run capital stock (k_{it}) of firm i at time t is specified as a log linear function of the output (y_{it}) and the user cost of capital (j_{it}):

$$k_{it} = \alpha + y_{it} - \sigma j_{it} \tag{3.1}$$

To control for adjustment costs without resorting to a fully micro-founded model, we follow Bond et al. (2005), using a flexible specification nesting the long-run capital stock level into Equation 3.1 into a general autoregressive-distributed lag (ADL) dynamic regression model. The $(2, 2)$ ADL is specified as:

$$k_{it} = \alpha_0 + \alpha_1 k_{it-1} + \alpha_2 k_{it-2} + \beta_0 y_{it} + \beta_1 y_{it-1} + + \beta_2 y_{it-2} + \gamma_0 j_{it} + \gamma_1 j_{it-1} + \gamma_2 j_{it-2} + \epsilon_{it} \tag{3.2}$$

The model is reparametrized in error correction form, separating the short from long-term effects:

$$\begin{aligned} \Delta k_{it} = {} & \alpha_0 + (\alpha_1 - 1)\,\Delta k_{it-1} + \beta_0 \Delta y_{it} + (\beta_0 + \beta_1)\,\Delta y_{it-1} \\ & + \gamma_0 \Delta j_{it} + (\gamma_0 + \gamma_1)\,\Delta j_{it-1} - (1 - \alpha_1 - \alpha_2)\,(k_{it-2} - y_{it-2}) \\ & + [\beta_0 + \beta_1 + \beta_2 - (1 - \alpha_1 - \alpha_2)]\,y_{it-2} + (\gamma_0 + \gamma_1 + \gamma_2)\,j_{it-2} + \epsilon_{it} \end{aligned} \tag{3.3}$$

The coefficient $[\beta_0 + \beta_1 + \beta_2 - (1 - \alpha_1 - \alpha_2)]$ allows us to test the long-run proportionality restriction $(\beta_0 + \beta_1 + \beta 2)\,/(1 - \alpha_1 - \alpha_2) = 1$ (Bond et al. (2005)). The variation of output is proxied by the sales growth rate, the variation of the users' cost of capital is controlled by adding to the model firm- and year-specific effects, and the variation of capital stock is approximated by the investment rate as:

$$\Delta k_{it} = \frac{I_{it}}{K_{it-1}} - \delta_{it}$$

where the depreciation rate, δ_{it}, also captures firm-specific effects. To investigate the explanatory power of financial variables Bond et al. (2005) we include both current

and lagged terms in the ratio of cash flow to the beginning-of-period capital stock. The model we estimate takes the following form:

$$\left(\frac{I_{it}}{K_{it-1}}\right) = \mu_t + \rho\left(\frac{I_{it-1}}{K_{it-2}}\right) + \zeta_0\Delta y_{it} + \zeta_1\Delta y_{it-1} + \xi\left(k_{it-2} - y_{it-2}\right) + \phi y_{it-2} + \lambda_0\left(\frac{CF_{it}}{K_{it-1}}\right) + \lambda_1\left(\frac{CF_{it-1}}{K_{it-2}}\right) + \eta_i + \epsilon_{it} \tag{3.4}$$

In our specification, I are the investments in tangible fixed assets, K is the stock of capital determined through the perpetual inventory method, Δy is the sales growth rate, and CF is the cash flow (net profits plus amortization and depreciation). Time-fixed effects (μ_t) and firm-specific effects (η_i) are included to control for the variation of the user cost of capital.

Equation 3.4 controls for future profits expectations by including the sales growth rate and presents advantages from using the market value of installed capital (see Ughetto, 2008), that is, the Tobin's marginal Q (see Tobin, 1969). First, it allows us to include in the analysis firms that are not publicly-traded. Second, it allows us to overcome the critiques that empirical studies replace, by making strong assumptions, the marginal Q with the average Q, that is, the value of a unit of capital derived from the firm's value on the stock market (see Schiantarelli, 1996).

Following Arellano and Bover (1995) and Blundell and Bond (1998), we use a system GMM estimator, which controls for firm-specific effects by transforming equations in first differences by using endogenous variables lagged over two or more periods as valid instruments under the constraint that no serial correlation occurs in the time-varying component of the error term. The original equations with variables in level are added under the assumption that instruments are orthogonal to the firm-specific effects.

Given that equation we estimate is derived from a micro-founded economic model, we do not need to carry out any specification tests (such as AIC or BIC criteria) to select the optimal number of lags.

We estimate Equation 3.4 to test for the sensitivity of physical capital to the cash flow interacted with two dummies for the groups of innovative and non-innovative firms. We also run the model interacting the coefficient with four dummies that capture both size and innovation attitude for small innovative, large innovative, small non-innovative, and large non-innovative firms.

As in Magri (2009), to control for the presence of outliers, we estimate Equation 3.4 after dropping the observations belonging to the 1st and 99th percentiles for all the variables. We also control for sector-specific factors using a dummy indicating if the firm

belongs to the manufacturing, services, or construction sectors. We do not include the first lag of the cash flow variable, as the coefficient estimates are never significant.

3.5 Results

We first estimate Equation 3.4 using the broad definition of innovators. The results, reported in Table 7, show the model is correctly specified for all sub-samples and the error correction terms are correctly signed.

Table 7 - Error correction model, system GMM, dependent variable: $\frac{I_{it}}{K_{it-1}}$, 2005-2015

By firms' size and engagement status				
Dependent variable: I_{it}/K_{it-1}	**By Firms' Size and Engagement Status**			
Explanatory variables	By innovation status		By innovation status and size	
	Coefficient	s.e.	Coefficient	s.e.
CF_{it}/K_{it-1}· broad innovators	0.074^{***}	0.02		
CF_{it}/K_{it-1}· non-innovators	0.076^{***}	0.02		
$CF_{it}/K_{it-1} \cdot d1$			0.050^{***}	0.01
$CF_{it}/K_{it-1} \cdot d2$			0.100^{***}	0.02
$CF_{it}/K_{it-1} \cdot d3$			0.063^{***}	0.02
$CF_{it}/K_{it-1} \cdot d4$			0.004	0.02
I_{it-1}/K_{it-2}	0.030	0.03	0.031^{*}	0.03
Δy_{it}	-0.003	0.02	-0.008	0.01
Δy_{it-1}	0.037^{***}	0.01	0.031^{***}	0.01
y_{it-2}	-0.006	0.01	0.007	0.01
ecm_{it}	-0.022^{**}	0.01	-0.013	0.01
Hansen test *(p-value)*	0.20		0.20	
Test AR(1) first diff.*(p-value)*	0.00		0.00	
Test AR(2) first diff.*(p-value)*	0.46		0.35	
Wald Tests *(p-value)*				
CF_{it}/K_{it-1}· broad innovators= CF_{it}/K_{it-1}· broad innovators	0.92			
$CF_{it}/K_{it-1} \cdot d1 = CF_{it}/K_{it-1} \cdot d2$			0.05	
$CF_{it}/K_{it-1} \cdot d1 = CF_{it}/K_{it-1} \cdot d3$			0.54	
$CF_{it}/K_{it-1} \cdot d1 = CF_{it}/K_{it-1} \cdot d4$			–	
$CF_{it}/K_{it-1} \cdot d2 = CF_{it}/K_{it-1} \cdot d3$			0.15	
$CF_{it}/K_{it-1} \cdot d2 = CF_{it}/K_{it-1} \cdot d4$			–	
$CF_{it}/K_{it-1} \cdot d3 = CF_{it}/K_{it-1} \cdot d4$			–	
Number of observations	3,290			
Number of firms	738			
Per firm observations	9		9	

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Note: $d1 = 1$ for small broad innovators; $d2 = 1$ for large broad innovators; $d3 = 1$ for small non-innovators; $d4 = 1$ for large non-innovators. For level equations, instruments are given by lags 2 and 3 of the model's variables. The instruments are obtained by taking lags 1-3 of the variables' first differences. Year dummies have been included. Estimates have been obtained by using the xtabond2 program written by Roodman (2009). Small firms are those up to 20 employees. First and 99th percentile observations have been dropped.

The sensitivity of physical investment to cash flow is given by coefficient λ_0. In the left column in Table 7 we consider a dummy for broad innovators and non innovators and in the right column we consider four dummies that capture the effects of cash flow on

physical investment for the four sub-groups of firms divided by innovation attitude and size: small broad innovators ($d1$), large broad innovators ($d2$), small non-innovators ($d3$), and large non-innovators ($d4$). Both coefficients for broad innovators (0.074) and non innovators (0.076) are statistically different from zero, indicating a significant sensitivity of investment to cash flow, but no differences have been found between the two group. When looking at the four dummies that capture innovation attitude and size (right column), a higher sensitivity of investment to cash flow is found for large broad innovators $d2$ (0.100), followed by the group of small non-innovators $d3$ (0.063), small broad innovators $d1$ (0.050), and large non-innovators, which show a coefficient not significantly different from zero.

The results point out that innovative attitude enhances the investment to cash flow sensitivity only for large firms. Small firms show a significant investment to cash flow sensitivity regardless of their engagement in innovation, as the coefficient for small non-innovators is not statistically different from that of small innovators. Nonetheless, among broad innovators, small firms show a lower sensitivity than large ones.

The literature on financial constraints hypothesizes that small firms are subjected more to financial constraints than large firms, thus the hypothesis drawn from the theoretical literature is that small innovators should be more likely to suffer financial constraints, hence this should be the group with the highest investment to cash flow sensitivity. Therefore, if we consider the investment to cash flow sensitivity as an indicator of financial constraints, we would expect a lower coefficients for larger firms. In this respect, our results for the group of broad innovators are at odds with the literature, but also with our descriptive statistics. Indeed, regarding the financial structure, small innovators show several characteristics that may negatively impact bank financing decisions, such as a higher leverage and lower share of tangible assets to total assets, which determine a lower level of collaterals.

Moreover, we compare the sensitivity of investment to cash flow with the direct indicator of financial constraints based on CIS responses in Tables 5 and 6. The CIS based indicator shows that a significantly larger percentage of small firms declared to have suffered financial constraints of both external and internal nature during the crisis. The CIS data analysis evidences that small firms, which show a lower sensitivity of investment to cash flow declare to be more financially constrained. We thus want to understand if the higher sensitivity of investment to the cash flow of larger broad innovators is linked to financial constraints or if it is the result of a preference for internal funds due to the type of innovation investment pursued by firms. We look at the percentage of firms that introduced R&D projects among broad innovators, finding that the percentage of large firms engaged in R&D is significantly higher than that of small firms (seeTable 3). We re-estimate the model described above by defining as innovators only the R&D performer

firms.

The results, shown in Table 8, point to a significantly higher sensitivity of investment to cash flow for R&D performers than non-R&D performers (0.095 versus 0.052). For the difference in R&D involvement and size, no statistically significant difference in the level of the coefficient between larger and smaller R&D performers was identified, which proves that the difference in the coefficients between small and large broad innovators is driven by larger firms' higher R&D involvement.

Table 8 - Error correction model, system GMM, dependent variable: $\frac{I_{it}}{K_{it-1}}$, 2005-2015

By Firms' Size and R&D Status				
Dependent variable: I_{it}/K_{it-1}	**By Firms' Size and Engagement Status**			
Explanatory variables	By R&D status		By R&D status and size	
	Coefficient	s.e.	Coefficient	s.e.
CF_{it}/K_{it-1}· R&D performers	0.095***	0.02		
CF_{it}/K_{it-1}· non-R&D performers	0.052***	0.02		
$CF_{it}/K_{it-1} \cdot d1$			0.067***	0.03
$CF_{it}/K_{it-1} \cdot d2$			0.093***	0.02
$CF_{it}/K_{it-1} \cdot d3$			0.042**	0.02
$CF_{it}/K_{it-1} \cdot d4$			0.029	0.03
I_{it-1}/K_{it-2}	0.018	0.03	0.027	0.02
Δy_{it}	-0.007	0.03	0.024	0.02
Δy_{it-1}	0.035***	0.01	0.034***	0.01
y_{it-2}	0.001	0.01	0.001	0.01
$ecm = k_{it-2} - y_{it-2}$	-0.023***	0.01	-0.017**	0.01
Hansen test *(p-value)*	0.21		0.19	
Test AR(1) first diff.*(p-value)*	0.00		0.00	
Test AR(2) first diff.*(p-value)*	0.36		0.46	
Wald Tests *(p-value)*				
CF_{it}/K_{it-1}· R&D performers= CF_{it}/K_{it-1}· non-R&D performers	0.07			
$CF_{it}/K_{it-1} \cdot d1 = CF_{it}/K_{it-1} \cdot d2$			0.42	
$CF_{it}/K_{it-1} \cdot d1 = CF_{it}/K_{it-1} \cdot d3$			0.42	
$CF_{it}/K_{it-1} \cdot d1 = CF_{it}/K_{it-1} \cdot d4$			–	
$CF_{it}/K_{it-1} \cdot d2 = CF_{it}/K_{it-1} \cdot d3$			0.03	
$CF_{it}/K_{it-1} \cdot d2 = CF_{it}/K_{it-1} \cdot d4$			–	
$CF_{it}/K_{it-1} \cdot d3 = CF_{it}/K_{it-1} \cdot d4$			–	
Number of observations	3,290			
Number of firms	739			
Per firm observations	9		9	

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

Note: $d1 = 1$ for small R&D performers; $d2 = 1$ for large R&D performers; $d3 = 1$ for small non-R&D performers; $d4 = 1$ for large non-R&D performers. For the level equations instruments are given by lags 2 and 3 of the model's variables. The instruments are obtained by taking lags 1-3 of the variables' first differences. Year dummies have been included. Estimates have been obtained by using the xtabond2 program written by Roodman (2009). Small firms are those up to 20 employees. First and 99th percentile observations have been dropped.

3.6 Conclusions

We test for differences in the existence of financial constraints for innovative and non-innovative firms in FVG (firms that declared to be engaged in at least one of the CIS listed innovation activities) by considering the size class for 2005-2015. The analysis is carried out using a micro-econometric approach to test the sensitivity of investment to cash flow and is further developed by analyzing the CIS responses that shed light on the determinants of investment level for the groups of innovative firms. Our estimates show that, during the analyzed period, the sensitivity of physical investment to cash flow was relevant for all firms but higher for innovative ones, although not statistically different. We also divided the sample according to innovation attitude and size. Large broad innovators show the highest sensitivity of investment to cash flow, followed by small non-innovative firm and then by small broad innovators. Large non-innovative firms have a non-significant coefficient.

We further carry out a descriptive analysis to better understand and interpret the meaning of the sensitivity of investment to cash flow for broad innovators. We analyze the CIS 2008-2010 responses on the hampering factors to innovation investment, concentrating on the importance of the lack of internal and external funds. Financial obstacles are among the top three hampering factors for both small and large broad innovators, but the percentage of small firms that declare that the lack of internal and external funds are important hampering factors (high or medium importance) is significantly higher than the percentage of larger firms.

A possible explanation for the higher sensitivity of investment to cash flow of large innovators relative to small broad innovators is the higher share of large firms engaged in R&D projects. The non-rivalry and non-excludability of R&D inputs and outputs can be a deterrent for managers to disclose details related to these projects to external financiers. Indeed, there is the risk that competitors may appropriate technological information produced by the firm, so that their projects lose value. In this case, the sensitivity of investment to cash flow signals a strict preference for internal funds for large innovators and financial constraints for small innovators. Our interpretation is supported by the fact that, when we run the model by considering the differences between R&D performers and non-R&D performers, the group of R&D performers shows no significant difference in the sensitivity of investment to cash flow between small and large firms.

The main policy implications are related to the severe financial constraints faced by all small firms and, in particular, by small broad innovators in the analyzed period. Policy makers should stand ready to provide measures to facilitate access to finance for this group of firms encouraging innovative behavior during economic downturns. Regarding the R&D performers, we explained the higher sensitivity of investment to cash flow as

strict preference for internal funds on the basis of responses for the years 2008 to 2010. We do not know if in the subsequent years with the ongoing of the crisis, once exhausted these funds, this preference turned to actual financial constraints or, in the worst cases, to underinvestment. Anyway, regarding this strict preference for internal funds, an important implication for policymaker is to encourage partnership between public entities such as regional research centers and universities with those firms that pursue R&D in order to jointly pursue these types of projects to avoid potential counter-cyclicality of innovation. This is especially important after having observed long periods characterized by several waves of recession such as the one that hit Italy between 2008 and 2014.

The main limits of our study are the following. First the measure of financial constraints from the econometric model is calculated on a 10 year time-span to obtain robust results, while the CIS based measure encompasses only 3 years, although relevant to the assessment of financial constraints, being the years following the economic crisis $(2008 - 2011)$. Second, we made the very restrictive hypothesis of persistent innovation status: a firm that declared to be engaged in innovative projects in CIS wave 2010 is considered an innovator for the whole span 2005-2015.

Further research should consider including more than one CIS wave to check for robustness when comparing direct and indirect indicators. A further nation based study should consider a cross regional analysis.

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Appendix

Table A.1

CIS 2008-2010 **and** 2010-12 **questionnaire: innovative activities**			
Classes	Items	Not engaged	engaged
Technology acquisitions	Acquisition of extramural R&D	☐	☐
	Acquisition of machinery	☐	☐
	Acquisition of other technologies	☐	☐
Training & Marketing	Training for innovative activities	☐	☐
	Marketing for new productprocesses	☐	☐
Internal R&D	In-house R&D	☐	☐
	Design	☐	☐
	Other activities supporting innovation	☐	☐

Table A.2 - List of variables

Variables	Source	Type	Definitions
Age	CAD	Integer number	Difference between the current year and the date of firm i's establishment
Size	CAD	0/1	1 if firm i has up to 20 employees at the end of 2010, 0 otherwise
R&D projects	CIS	0/1	1 if firm i is engaged in R&D projects, 0 otherwise
Exporter	CIS	0/1	1 if firm i sells its products and services also on the international marketplaces, 0 otherwise
Part of a group	CIS	0/1	1 if firm i belongs to a group, 0 otherwise
Cooperation agreements	CIS	0/1	1 if firm i innovation-related partnerships with other firms, 0 otherwise
Graduate workers	CIS	0/1	At least one employee has a university degree in firm i
Public grants	CIS	0/1	1 if firm i has received public funded grants for innovation-related investments, 0 otherwise
Sector Dummies	CIS	0/1	Sector dummies capturing the macro sector to which firm i belongs to
Cash flow	CAD	Euros	Net profits plus depreciation allowances
Capital stock	CAD	Euros	The economic value of the net capital stock (property, plant, and equipment) is measured at replacement value by using the perpetual inventory method
Return on assets (ROA)	CAD	Percentages	Earnings before interest and taxes / Total assets
Sales (euros) growth rate	CAD	Percentages	Total revenues growth rate
Tangible assets/Total assets	CAD	Percentages	Net equipment and gross plants/Total assets
Intangible assets/Total assets	CAD	Percentages	Immaterial assets/Total assets
Equity/Total liabilities	CAD	Percentages	Capital and reserves/Total liabilities
Financial debts/Total liabilities	CAD	Percentages	Total bank and other financial debts /Equity plus financial debts
Leverage	CAD	Percentages	Financial debts / Equity plus financial debts
Short term debts/Total financial debt	CAD	Percentages	Financial debts expiring in less than one year/Total bank and other financial debts

CHAPTER 4

Firms' perceptions of barriers to innovation and resilience: the Italian region Friuli Venezia Giulia during the crisis

Firms' perceptions of barriers to innovation and resilience: the Italian region Friuli Venezia Giulia during the crisis[1]

Simona Iammarino[2] Tiziana Sodano[3] Giovanni Vittorino[4]

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[2]London School of Economics and Political Science, and Science and Technology Policy Research (SPRU), University of Sussex, UK.

[3]Bank of Italy.

[4]Bank of Italy and University of Udine, Italy.

Abstract

The purpose of this paper is to connect the literature on firm obstacles to innovation to the concept of regional economic resilience by empirically assessing the relationship between the intensity of firms' engagement in innovative activities and self-reported obstacles to innovation during the unfolding of the latest economic and financial downturn. The analysis is grounded on a unique dataset on firm-level accounting data (CAD) as well as information drawn from two waves (2008-10 and 2010-12) of the Community Innovation Survey (CIS) for a representative sample of firms in the Italian region of Friuli Venezia Giulia. Our data point out that the economic system of the region has been vulnerable to the recent economic and financial crisis. Moreover, our main results support the existence of severe deterring barriers in the region and that during the recent economic crisis firms' uncertainty about the evolution of market conditions dominated any pre-existent relationship between non market-related hampering factors and the intensity of innovative activities. Furthermore, in correspondence with the sovereign debt crisis firms' perception of market-related obstacles rose dramatically while that of financial and human resources-related obstacles decreased, suggesting that the firms of the region have not been resilient with respect to sizeable exogenous shocks that severely hit the economy.

JEL Classification Numbers: O31, O32, O33.

Keywords: Obstacles to innovation, Engagement in innovation activities, Regional resilience, Economic and financial crisis.

4.1 Introduction

The role of innovation in fostering economic growth has been at the core of the policy debate particularly in the most recent years, as policy makers have been trying to remove obstacles to innovative investments and introduce incentives to facilitate the engagement with new ideas of firms willing to recover from the aftermath of the economic and financial crisis started in 2008. Firm innovation capabilities have been recognized as one of the main determinants of regional resilience, or "the capacity of a regional or local economy to withstand or recover from market, competitive and environmental shocks to its developmental growth path [...]" (Martin and Sunley, 2015, p. 13). Given that investing in innovation does not automatically imply that firms will come up with new products, processes or organizational structures, managers and policy makers have actively sought to identify and remove those factors that may hamper the innovation process. In the extant literature, most of the contributions have focussed either on the driving forces behind firm innovation or on the determinants of regional resilience, with little overlap between the two research lines. This paper investigates the relationship between the intensity of firms' engagement in innovation activity and their perception of such obstacles in the Italian region of Friuli Venezia Giulia (FVG), and considers how such a relationship was affected by the financial and sovereign debt crisis that hit most European countries between 2008 and 2012.

Since the 1960s the region of FVG, a small and heavily industrialized region located in the North-East of Italy, has been characterized by high GDP growth rates. Unfortunately, the credit crunch that followed the 2011 economic and financial crisis severely hit the region's economy and the reduction in firms' investments was sharper than in the rest of Italy between 2012 and 2014 Banca d'Italia (2018).

The study presents a number of original contributions to the still sparse literature on the regional dimension of obstacles to innovation and firms' behaviour in the aftermath of economic and financial shocks. First, the focus is on firms located in FVG, a region characterized by industrial clusters of SMEs operating mostly in traditional sectors. Focussing on within-region firms' innovative behaviour provides interesting insights on the environmental components of firms' risk perceptions and their potential contribution to the resilience of the local system as a whole. The case of FVG is especially interesting for a reflection on the many medium-income regions in Europe still competitive and wealthy relative to the mean of their country, which however were severely hit by the crisis that added up to an enduring decline in the most recent decades brought about by technological change and globalization pressures (Iammarino et al., 2018). Second, we introduce a new qualitative measure of innovation intensity that represents a proxy of the efforts with which firms carry out innovative activities: more complex operations need a wider range

of investment channels, thus a deeper intensity. The lowest ranking in innovation activity is the external acquisition of technology that mainly requires economic resources; the highest ranked activity is R&D that entails not only financial efforts, but also relational, human and knowledge capital.

Third, the study is based on a unique dataset that comes from matching two different sources: the Community Innovation Survey (CIS), providing detailed information on firms' innovation activity, and the Company Accounts Database (CAD), containing accounting information in order to widen the range of firms' characteristics and have a better coverage of financial features. The combination of these data sources, and the timing of the panel structure (matching a subset of 317 potential innovators present in two CIS waves, 2008-2010 and in 2010-2012), allow us to grasp some effect of the consecutive waves of the economic and sovereign debt crisis.

Fourth, regarding the empirical strategy, the major concern is to control for the selection bias issue arising when firms display heterogeneity in their propensity to innovate. We therefore operate a careful choice of the relevant sample to analyse by focusing only on the firms that showed a real interest in innovation, that we define potential innovators (D'Este et al., 2012). Next, we address endogeneity issues by working along two directions: enriching our model by exploiting firm-level accounting information and relying on the most robust estimation techniques.

Our results grasp several aspects of the relationship between the intensity of engagement in innovative activities and reported obstacles of firms in the FVG region. Overall, the emerging picture points to the existence of strong deterrent barriers (i.e. those literally preventing firms from innovating), in particular related to financial and market factors while obstacles related to human resources are instead pervasive, affecting innovation-active and deterred firms alike. In the second stage of the crisis (2010-12) firms' perception of the relevance of financial barriers is the highest at the extreme of the distribution, i.e. for non-innovators and for firms more intensely engaged in innovative investments, while that of market-related obstacles remains distinctively high for deterred firms. After the crisis hit, the relevance of demand risk and uncertain competition market is perceived even more acutely by all local firms, and particularly by the non-innovators, further curtailing investment in innovation in the region and countercyclical strategies to cope with the crisis effects.

Based on a descriptive analysis of the evolution of Friuli Venezia Giulia's economic system in terms of innovation capabilities and employment levels before and after the sovereign debt crisis we point out that the regional economic system has been vulnerable the recent economic downturn. This evidence seems connected to the lack of resilience of FVG's non-innovative small and medium enterprises, i.e. those firms that are less

export oriented. Thus we conclude that firms' perception of market-related obstacles rose dramatically during the recent sovering debt crisis reflecting the general vulnerability of the regional economic systems to exogenours sizeable shocks.

The paper is organized as follows: Section 4.2 discusses the literature background; Section 4.3 describes the data, presents descriptive statistics of the variables used in the analysis and a descriptive analysis to assess the resilience of the regional economic system; Section 4.4 explains the econometric approach and discusses the estimation results; Section 4.5 concludes and presents policy-making implications.

4.2 Literature background

4.2.1 Firms, innovation obstacles and engagement

A large body of scholarly literature has addressed the relationship between firms' engagement in innovative activities and factors that may hamper firms' aspiration to innovate (see, for a review, D'Este et al., 2012). This eminently empirical literature, mainly based on data from innovation surveys such as the European Community Innovation Survey (CIS), has largely focused either on the factors that affect the firm's perception of the importance of obstacles to innovation (e.g. Mohnen and Rosa, 2001; Baldwin and Lin, 2002; Baldwin and Hanel, 2003; Galia and Legros, 2004; Iammarino et al., 2009), or on the impact of such obstacles on the propensity to innovate (e.g. Arundel, 1997; Tourigny and Le, 2004; Mohnen and Roller, 2005; Savignac, 2006 and 2008; Mohnen et al., 2007; Mancusi and Vezzulli, 2010).

The first approach - which is closer to our empirical analysis here - focuses mainly on why firms perceive differently the obstacles to innovation and the extent to which individual obstacles are complementary. Common results are that the greater the firm's engagement in innovation activities, the higher the importance attached to obstacles to innovation; and that the latter are perceived differently depending on firms' characteristics (e.g. size, sector). One explanation for the positive association between engagement in innovation and perception of barriers is that innovative firms are more likely to encounter obstacles (selection bias) and that the decision to innovate is influenced by some latent variable that is also correlated with obstacles. Baldwin and Lin (2002), for example, using a representative sample of Canadian firms, point out that the perception of obstacles to innovation is higher for innovators than for non-innovators: in their view, innovators' awareness of obstacles is a signal of their ability to solve problems relating to the innovation process. Galia and Legros (2004), relying on a sample of innovation-active French firms, reach similar conclusions and provide an important contribution by identifying as complementary those obstacles that are positively correlated and that can be

grouped in homogenous sets. In the same vein, D'Este et al. (2012) distinguish between two kinds of barriers to innovation: the first corresponds to revealed barriers and reflects the steepness of the innovation process and the firm's learning experience in investing in innovation; the second type, deterring barriers, encompasses the obstacles that prevent firms from committing to innovation investment tout court. To apply such a distinction, D'Este et al. (2012) identify potential innovators according to their aspiration to innovate, regardless of whether they were engaged or not in innovative activities: non-innovators, who self-report having faced barriers, fall in the group of potential innovators. This allows mitigating the selection bias problem by ruling out from the analysis firms that are not interested in investing in innovation at the observed point in time, either because they had done it previously or because it is not justified on the basis of market and competitive conditions.

One of the main merits of the second approach, which focusses on the opposite causal relationship - i.e. the role of obstacles perceptions in affecting the probability to engage in innovation -, is the emphasis put on the possible endogeneity of the regressors (e.g. Mohnen and Roller, 2005; Savignac, 2006; Mohnen et al., 2007). More recent studies, particularly concerned with financial barriers, point out that the positive relationship between firm's perception of obstacles and engagement in innovation can be attributed to a combination of several sources of bias (e.g. Canepa and Stoneman, 2008; Savignac, 2008; Mancusi and Vezzulli, 2010; Silva and Carreira, 2012), such as the presence of heterogeneous unobserved firm-specific factors (such as entrepreneurial behaviour, risk propensity or market opportunities) that may impact on both aspects of the relationship, or the simultaneous determination of the obstacle perception and the decision to innovate.

The perception of obstacles to innovation is an inherently firm-specific dimension (Sitkin and Pablo, 1992; Ferriani et al., 2008). On the other hand, as the conceptualization of risk perception in the geography literature (e.g. Cutter et al., 2000) as pointed out, the extent to which a population (in this case, of firms) perceive external risks depends on both subjective evaluations, which are specific to the actors, and objective environmental conditions, which apply to the probability of occurrence of a certain shock under specific temporal and spatial contexts. In recent studies following the Schumpeterian tradition, innovation strategies have been considered as cyclical, inasmuch as firms (in specific industries and regions) tend to reduce their innovative efforts in presence of uncertain and risky market conditions (e.g. Francois and Lloyd-Ellis, 2009); however, it has also been suggested that periods of economic instability or crisis generate a fertile environment for firms (in specific industries and places) to adopt counter-cyclical strategies and innovate (e.g. Aghion and Saint-Paul, 1998; Archibugi and Filippetti, 2011).

4.2.2 Firms' perceptions and regional resilience

The relationship between innovative behaviour and perception of barriers cannot thus be properly understood without considering the set of opportunities and constraints firms face as a result of their external - industrial, technological and institutional - environment and its evolution (e.g. Nelson and Winter, 1982; Shane, 2001). The 2008 economic and financial crisis across Europe and the rest of the world uncovered a highly uneven geographical distribution of environmental factors, thereby drawing attention to differences between regions in their vulnerability to economic shocks and their ability to adapt to serious disruptions in the economic environment (e.g. Davies, 2011; Martin, 2011, 2012; Fingleton et al., 2012; Cellini and Torrisi, 2014; Sensier et al., 2016).

Despite the overriding attention paid to regional economic resilience in the last decade, the conceptual framing of the notion remains the subject of considerable academic debate (e.g. Bristow and Healy, 2014; Martin and Sunley, 2015; Boschma, 2015). Evolutionary theorists have emphasised the importance of selection environments, firm fitness, sectoral variety, innovation capacity and institutional arrangements, and asserted the need to grasp the "capacities to withstand or resist the shock in the first place, the robustness of its firms and institutions in responding to it, and the extent and nature of the regional economy's recovery from it" (Sensier et al., 2016, p. 131; Martin, 2012; Martin and Sunley, 2015). Little effort has been devoted so far in considering the relevance of firms' innovation perceptions and strategies in determining regional vulnerability and resilience to shocks.

Long-standing research on innovation and regional development has emphasised that in dynamic regional innovation systems, often characterised by large urban agglomerations, firms tend to perceive barriers - of the revealed type - as a result of the steep learning curve behind their innovative efforts (e.g. Iammarino et al., 2009): agglomeration externalities andor diversification of the local knowledge base support firms' exploration of emerging opportunities and new markets (e.g. Rodriguez-Pose, 1999; Gordon and McCann, 2005; Todtling and Trippl, 2005; Escribano et al., 2009), contributing to the resilience of the system as a whole to future shocks. Conversely, in technologically stable or inert regional systems, relatively more specialised, oriented toward exploitation, refinement and efficiency improvements, firms experience more deterrent barriers and are discouraged from innovative ventures (e.g. Gagliardi and Iammarino, 2018).

Distinct geographical patterns in the perception of the obstacles to innovation characterise in particular single domestic firms and SMEs: the perception of barriers, in other words, does not significantly differ across regions if firms are multinationals or multiplants (see Iammarino et al., 2009 for Italy; and Gagliardi and Iammarino, 2018 for the UK). In addition, in the Italian case, domestic firms located in the macro-regions of Northern and

Central Italy tend to perceive obstacles to innovation as relevant significantly less than their counterpart located in the South Iammarino et al. (2009). While these studies have considered cross-regional differences within one national innovation system, the present work offers an additional perspective on firms' innovation investments and perception of obstacles, and their reactions during a global economic shock, within the context of a specific regional innovation system, FVG. Looking specifically to the resilience of the innovative activities to exogenous environmental variables, Cruz-Castro et al. (2017) study the effect of firm-specific factors on the probability to continue in-house R&D activity during and after the crisis in Spain. Cruz-Castro et al. (2017) find out that larger firm size, export-orientation, high productivity, access to public grants, the share of R&D employees and engagement in cooperation agreements lowered the probability to quit innovative projects during the 2008-2012. Beside firm-specific characteristics, Cruz-Castro et al. (2017) find out that the probability of continuing in house R&D also depend on the economic size of the specific regions and on the regional innovation system.

North-Eastern Italy - the macro-region of FVG - is a striking example of the Italian economic miracle of the 1960s that turned a land of poverty and migration into a highly industrialized and wealthy region. The industrial development has mainly been driven by industrial clusters of SMEs operating in traditional industries. In particular, FVG's leading specializations include furniture and electric appliances and heavy industry, such as machinery, metals and steel production (FVG, 2015). Even if FVG presents a percentage of workers with higher education in sciences and technologies and a percentage of workers employed in high technology sectors below the Italian average, the region has a high incidence of innovative firms with a relevant presence of small and medium size enterprises (SMEs). According to the Italian National Institute for Statistics (Istat), during the 2010s FVG has been a leading innovation-oriented region in Italy in terms of percentage of innovators, rate of patents per million of inhabitants and expenses in Research and Development (R&D) activities as a ratio to regional GDP (see Istat-Cnel, 2013; Istat, 2015, Istat, 2016 and Istat, 2017).

Many enterprises, especially the suppliers with low export capacity, have suffered increasingly from globalization processes; more in detail, despite in the years preceding the crisis the export of the region raised more than the national average it suffered a sharper reduction than in the rest of Italy between 2007 and 2013, recovering only between 2014 and 2016 FGB (2014, 2017). The economic crisis severely hit the propensity of FVG's firms to innovate as, on the basis of the CIS surveys for the waves 2010-12 and 2012-14, the percentage of firms that innovated went down from 58.8% in 2012 from to 42.2% in 2014.

FVG is also very weakly internationally integrated, with a share of only 1.6% of all foreign-owned enterprises located in Italy at the end of 2015 - the lowest of the North

of the country - and very limited active internationalization of local firms abroad (ITA, 2018). Moreover, after the economic crisis export drop more severely compared to the rest of the Italy and the ability to attract foreign direct investment is low. Recently, the financial and economic crisis has severely affected the regional economic performance: the GDP growth was negative in 2008 (-2.0%) and 2009 (-6.7%), and after a weak recovery in the following two years, it turned negative again in 2012 (-2.1%), following the national trend Faggian et al. (2018). Despite being above the national average in terms of level of economic wealth measured by GDP per capita, indicators point out that during the economic and financial downturns the difficulties of the regional productive sectors were deeper and longer than the country average.

4.3 Data, Variables and Descriptive Evidence

4.3.1 Data sources and sample definition

Our analysis is grounded on an original dataset that was built by matching micro-data from two different sources. The first is the Community Innovation Survey (CIS), provided by the Regional Statistical Department for a representative sample of firms of the FVG region.[1] CIS data, collected according to EUROSTAT harmonized rules (see, for all, Mairesse and Mohnen, 2010), represents an extremely rich source of qualitative and quantitative information on firms' characteristics and innovative behaviours, including their perception of the obstacles obstructing the innovation process. The survey, that covers all firms with 250 employees or more and a random sample of those with at least 10 employees, is representative of the regional productive sector by both industry and firm size (i.e. number of employees).

The 2008-2010 CIS wave collected answers from $1,134$ respondent firms in the region, while the 2010-2012 wave consisted of $1,139$ units. Starting from the 2008-10 wave, 835 potential innovators, i.e. those firms that were truly interested in innovation in the period observed, were selected.[2] As some of the respondents were surveyed in both waves, a panel of 317 potential innovators (634 observations) was extracted across 2008-10 and 2010-12.

The second source is represented by the Italian Company Accounts Database (CAD, Centrale dei Bilanci). This dataset, which is maintained by a consortium of banks, contains firms' accounting information especially related to the enterprise's financial structure. One minor drawback of this source is that CAD data are available only for firms borrowing from banks belonging to the consortium. A further limitation is that account-

[1] NUTS2 according to Eurostat classification.

[2] Potential innovators were selected from the CIS as the subsample of firms that either engaged in innovation activities or reported to have been hampered by at least one obstacle.

ing data, reflecting Italian accounting rules, are more detailed for larger firms than for smaller ones. We extracted firm-level financial data for the years 2006 to 2014 that match about 80 percent of the firms included in the 2008-10 CIS wave: the resulting CIS-CAD sample consists of 925 firms, of which 691 potential innovators including the 317 firms of our panel. Our empirical analysis in Section 4.4 uses first the CIS-CAD cross-section sample to run a multivariate probit model to grasp insights on the relationship between the perception of obstacles and firms' innovation behaviour, and then performs a random-effect panel probit on the 317 firms' subsample to study how firms' attitudes toward innovation obstacles were affected by the unfolding of the sovereign debt crisis.

4.3.2 Variables and main indicators

Defining barriers to innovation

The survey allows to identify a direct measure of obstacle perception through each firm's own assessment. The CIS questionnaire has a dedicated Section reporting various categories of obstacles: all respondent firms (both engaged and not engaged in innovation activities) reported the importance of each obstacle type according to a Likert scale ranging from 0 to 3 (not at all, low, medium or high importance). We collapsed answers into binary indicators taking value 1 if the firm perceived the importance of an obstacle as high, and 0 in all other cases.

After checking for cross-correlations between individual obstacles in each survey wave, we harmonised the 2008-10 and 2010-12 CIS questionnaires and we grouped them in three categories: financial, human resources and market obstacles (Table A.1 in the Appendix).[3] The classification is coherent with that used by Galia and Legros (2004) and D'Este et al. (2012), and reflects the structure of the CIS questionnaire administered to firms. Financial barriers refer to difficulties in financing innovation investments deriving from lack of appropriate funding; human resources obstacles are related to the scarcity of qualified personnel; market barriers reflect the presence of incumbent firms with high market power, and/or the uncertainty of demand for innovative products or services.

Measuring engagement in innovation

We model innovation intensity by sorting firms' involvement with respect to the specific forms of investment required to implement the project (Koschatzky, 1999). The wider is the range of channels necessary to undertake a particular innovation project, the more complex and risky is to implement it, and therefore the higher the intensity of the firm's engagementeffort.

[3]To ensure coherence between the slightly different questionnaires adopted in the two CIS waves in relation to the obstacles to innovation, the analysis here is based on the shorter obstacles list reported in the 2010-12 wave, thus on the cross-wave harmonised information included in our dataset.

The simplest way to innovate is through the external acquisition of technology, since it mostly requires financial resources. Innovation intensity deepens when new available knowledge, whatever the source, has to be disseminated inside or outside the firm involving relational and communication investments (e.g. Rogers, 2004): for instance, in the case of process innovations the new technologies become truly effective when employees feel confident in using them as a result of training programs; while in the case of new products or services, marketing schemes are crucial to promote goods' quality to potential customers. Internal R&D is generally considered the most demanding form of firm's engagement in innovation, in that it requires significant amounts of financial, relational and technological resources that only a relatively small number of firms can deploy.

Both 2008-10 and 2010-12 CIS questionnaires asked firms to report whether they engaged in any of eight listed innovative activities. We grouped them into three indicators that grasp different qualitative aspects of innovation investments according to the above considerations. They were defined as dummy variables taking value 1 if the firm has engaged in that particular innovation effort in the reference period (Table A.2 in the Appendix): such dummies are mutually exclusive since for each firm only the dummy representing its highest degree of innovation effort takes value 1. Starting from the highest, the ranking is: Internal R&D, Training & marketing, Technology acquisition. Whereas previous literature has mainly relied on quantitative measures (e.g. the number of undertaken innovative activities or the amount of expenses), our measure of innovation intensity, that ranks the intensity of the firm's innovative engagement on the basis of the qualitative variety of investments, offers a deeper understanding of the relation under study.

Potential innovators

The existing literature has showed that the correlation between innovative activities and obstacles is severely affected by selection bias issues if the estimation is performed on the full available sample. As mentioned in Section 4.2.1 above, in order to tackle this problem we need to identify firms that did not innovate because they were overcome by deterrent barriers, from those that were simply not interested in carrying out innovation projects in the reference period. This latter category of firms represents an important source of upward selection bias and it should be left out from the analysis (Hajivassiliou and Savignac, 2008).

As in Savignac (2008), Hajivassiliou and Savignac (2008), Mancusi and Vezzulli (2010) and D'Este et al. (2012), we focussed our analysis on firms that showed an aspiration to innovate, i.e. the potential innovators. Our selection rule was the following: either the firm engaged in some form of innovation investment as described above (innovation-active), or it did not and was deterred by at least one obstacle (deterred). This criterion

restricted our selected sample to 835 firms from the 1,134 respondents of the 2008-10 CIS wave: the remaining firms were excluded from the analysis, as considered 'not in the innovation contest' D'Este et al. (2012) since, albeit not constrained by any barrier, they declared not to have engaged in innovative activities either because of the lack of demand for innovation from the relevant market's competitive conditions, or because still relying on previously (to the surveyed period) introduced innovations.

4.3.3 Descriptive analysis

Tables 1 and 2 report the main characteristics of firms in the FVG region included in the CIS 2008-2010. Table 1 shows that, restricting our analysis to potential innovators only, the sample reduces from 1,134 to 835 units; among them 47.7 percent reported financial barriers as important obstacles to innovation, while human resources and market obstacles were each reported by 11 and 35.7 percent of the sample. Thus, potential innovators perceive as the most pervasive obstacles those related to the lack of financing opportunities (both internal and external) and market factors such as the demand uncertainty and the presence of incumbent firms.

Table 1 - Information on the CIS Wave 2008-2010 sample of Friuli Venezia Giulia

Data descriptive statistics *(percentage of firms)*					
	Full sample		Potential innovators		p-value
	Mean	Std. Dev.	Mean	Std. Dev.	
*Types of obstacles**					
Financial obstacles	35.1	47.7	35.1	47.7	0.000
Human resources obstacles	8.1	27.3	11.0	31.3	0.032
Market obstacles	26.3	26.3	35.7	47.9	0.000
*Firms' characteristics***					
Technology acquisitions	31.9	46.7	43.4	49.6	0.000
Training & Marketing	18.3	38.7	24.9	43.3	0.000
R&D	21.1	40.8	28.6	45.2	0.000
Organizational innovation	34.9	47.7	40.8	49.2	0.008
Marketing innovation	26.5	44.2	31.0	46.3	0.031
Exporter	36.4	48.1	39.3	48.9	0.196
Public grants	15.0	35.7	20.4	40.3	0.002
Part of a group	17.2	37.8	18.9	39.2	0.327
Cooperation agreements	8.6	28.0	11.6	32.1	0.027
Graduate workers	52.6	50.0	55.4	49.7	0.217
Abandoned innovation projects	3.6	18.7	4.9	21.6	0.165
Ongoing innovation activities	18.7	39.0	25.4	43.5	0.000
More than 20 employees	41.7	49.3	41.4	49.3	0.903
Revenues above 50 million euros	5.6	23.1	6.5	24.6	0.452
Number of observations	1,134		835		

*Percentage of firms assessing items as highly important.
**Percentage of firms presenting a specific characteristic.

Table 2 focuses on potential innovators to show the main differences between the firms engaged in innovation activities and those that were deterred by the obstacles.

As expected, innovation-active firms show on average a lower incidence of obstacles' perception, while they display much higher firm size (in terms of both workforce and revenues), incidence of graduated employees, participation in corporate groups, export capacity; the introduction of organizational and marketing innovations is about three times higher as that of deterred firms.

Table 2 - Potential innovators of the CIS Wave 2008-2010 sample of Friuli Venezia Giulia

Innovation active and hampered firms *(percentage of firms)*					
	Engaged in innovative activities? No (Deterred)		Yes (Innovation-active)		p-value
	Mean	Std. Dev.	Mean	Std. Dev.	
*Types of obstacles**					
Financial obstacles	58.2	49.4	36.3	48.2	0.000
Human resources obstacles	12.9	33.6	9.0	28.6	0.065
Market obstacles	46.9	50.0	23.6	42.5	0.000
*Firms' characteristics***					
Technology acquisitions	-	-	90.0	30.0	-
Training& Marketing	-	-	51.7	50.0	-
R&D	-	-	59.5	49.2	-
Organizational innovation	18.5	38.9	64.9	47.8	0.000
Marketing innovation	14.3	35.1	49.0	50.1	0.000
Exporter	27.3	44.6	52.2	50.0	0.000
Public grants	-	-	42.3	49.5	-
Part of a group	10.4	30.6	28.1	45.0	0.000
Cooperation agreements	-	-	24.1	42.8	-
Graduate workers	41.6	49.3	70.4	45.7	0.000
Abandoned innovation projects	-	-	10.2	30.3	-
Ongoing innovation activities	-	-	52.7	50.0	-
More than 20 employees	30.0	45.9	53.7	49.9	0.000
Revenues above 50 million euros	1.6	12.6	11.7	32.2	0.000
Number of observations	433		402		

*Percentage of firms assessing items as highly important.
**Percentage of firms presenting a specific characteristic.

Descriptive statistics also provide a first insight about the relationship under study. Table 3 shows the incidence of firms perceiving each obstacle as highly important according to the intensity of their engagement in innovation: null (innovation deterred), or investing in innovation through different, increasingly demanding, channels - i.e. external acquisition of technology, marketing and training activities, and R&D projects. The first observation is that obstacles to innovation are very relevant for deterred firms, supporting the existence of deterrent barriers of financial, market and, to a lesser extent, personnel-related nature preventing firms' innovation efforts. We also find evidence of a statistically significant non-linear relation between innovation intensity and obstacles related to financial and market factors: as firm innovation engagement becomes positive, at first the perception of obstacles decreases (deterrent barriers on simpler forms of innovative investment are no longer effective), then it rises again possibly reflecting the relevance of revealed barriers when investing in more involving and risky innovation

projects.

Table 3 - Firm innovation intensity and perception of obstacles

Innovation active and hampered firms : CIS Wave 2008-2010 *(Percentage of potential innovators assessing the obstacle as highly important by innovation intensity)*					
	Degree of engagement in innovation				
	Deterred firms	**Innovation-active firms**			
Type of obstacles		External acquisitions	Training & Marketing	R&D	Chi-square (χ^2)
Financial	58.2	31.0	38.1	38.1	41.52***
Human resources	12.9	10.0	6.4	9.2	3.93
Market	46.9	18.0	25.4	25.5	50.94***

***statistically significant at 1%.
**statistically significant at 5%.

Table 4 shows the same relationship but referring to the subset of 317 firms that represents the panel component. Interestingly, during the second CIS wave 2010-12 a lower percentage of potential innovators appear to be deterred by financial and human skill barriers with respect to the previous wave, while the perception of market obstacles sharply rises for any level of innovation intensity. Innovation active firms, as expected, becoming more aware of the credit crunch and of the unfolding of the sovereign debts crisis, perceive a higher relevance of financial constraints, but the main concern for most firms' in the region remain the uncertainty coming from market and demand conditions.

Table 4 - Firm innovation intensity and perception of obstacles in CIS panel subsample 2008-2012

Innovation active and hampered firms: CIS panel subsample *(Percentage of potential innovators assessing the obstacle as highly important by innovation intensity in each CIS wave)*					
	Degree of engagement in innovation				
	Deterred firms	**Innovation-active firms**			
Types of obstacle		External acquisitions	Training & Marketing	R&D	Chi-square (χ^2)
		2008-2010 Wave			
Financial	50.0	16.7	32.0	31.5	18.21***
Human	13.5	5.6	8.0	8.3	3.09
Market	47.3	16.7	16.0	19.4	30.64***
		2010-2012 Wave			
Financial	28.5	35.0	28.6	35.0	0.85
Human resources	2.1	0.0	3.6	1.3	0.98
Market	60.6	50.0	32.1	56.6	8.44**

***statistically significant at 1%.
**statistically significant at 5%.
H0: row and column variables are independent.

The innovation capabilities and vulnerability of Friuli Venezia Giulia economic system during the crisis

In this Section we assess the performance of Friuli Venezia Giulia region's innovation capabilities during the crisis and its aftermath and we explore the role of different firms

and sectors with respect to the vulnerability of the regional economic system to 2011 sovereign debt crisiss following the procedure proposed by Bristow and Healy (2018). First, we use macro level data on employment to detect turning points in the regional economy business cycle. Second, we move to a micro level analysis to grasp some indication on which kind of firms played a major role in the vulnerability of the economic system. Finally, we connect descriptive results to the previous Section evidence of the sharp rise in market obstacles perception.

According to the Regional Innovation Scoreboard (European Commission, 2017), the Italian region Friuli Venezia Giulia is a "moderate+ Innovator"[4] and, since 2011, its innovation performance has been increasing over time. More in detali, data reported in the Regional Innovation Scoreboard (European Commission, 2017) highlight that Friuli Venezia Giulia is a strong innovator in the Italian context while it is only a moderate innovator compared to the EU average (see Table 5). The labor market of the region shows a higher incidence of people working both in the manufacturing and public administrations sectors with respect to the Italian and the EU averages and also per capita GDP is slightly above the Italian and EU averages.

Table 5 - Composition of the Regional Innovation Scoreboard 2017

		Score (normalized for outliers)	Standardized score (as a % of the benchmark area)	
		FVG	Italy	European Union
Enablers of innovation	Percentage of population (age 25-64) with a university degree	0.348	109	63
	Public R&D expenditures (% of GDP)	0.554	111	101
	Employment in knowledge-intensive services and medium-high/high-tech manufacturing (% of total workforce)	0.545	98	102
Innovation activity	Business R&D expenditures (% of GDP)	0.367	109	81
	Public-private co-publications	0.316	129	106
	EPO patent applications per billion GDP (in PPP)	0.492	162	126
Innovation capacity	Regional Innovation Index 2017	0.399	119.2	87.8
	Regional Innovation Index 2011	0.383	114.9	86.6

Source: (European Commission, 2017). See Bristow and Healy (2018) for more details.

According to the Regional Innovation Scoreboard (European Commission, 2016), the innovation capability of the region increased also during the recent sovereign debt crisis hitting its peak in 2014 and then it went down during the period 2015-16 (Figure 4.1).

To assess the resilience capability of the Italian region Friuli Venezia Giulia and to grasp its interplay with the performance of the innovative and non-innovative firms of the region we decided to follow a two-step analysis. First of all, we assess the resilience of the region according to the procedure suggested by Bristow and Healy (2018), i.e.,

[4] "Moderate Innovators are all regions with a relative performance between 50% and 90% of the EU average in 2017. The RIS 2017 introduces three subgroups within each performance group to allow for more diversity at the regional level: the top one-third regions (+), the middle onethird regions, and the bottom one-third regions (-), creating the following 12 performance groups: Innovation Leaders +, Innovation Leaders, Innovation Leaders -, Strong + Innovators, Strong Innovators, Strong - Innovators, Moderate + Innovators, Moderate Innovators, Moderate - Innovators, Modest + Innovators, Modest Innovators, and Modest - Innovators." (see European Commission, 2017, Methodology Report, p. 31.)

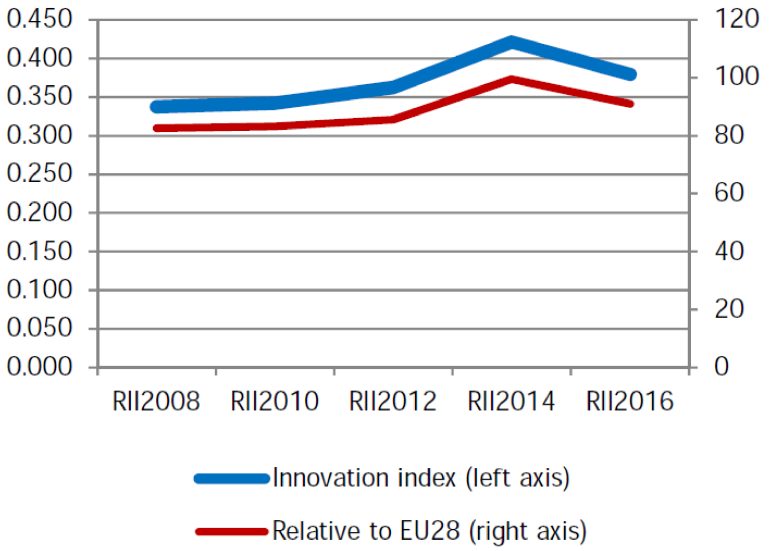

Figure 4.1: Source: European Commission (2016)

we evaluate the output and the employment loss of the region during the sovereign debt crisis. Second, we observe *ex-post* if there has been a recovery.

As in Martin (2012), resilience is measured in absolute terms and not in a comparative way with respect to other territories. Thus, we adopt the following rule to decide if FVG looks like a resistant region, a recovered region, a still recovering region or a still downturn economy: "Resilient regions then are those that either did not experience a downturn in employment following the global economic shock (Resistant) or those that experienced a downturn in employment but recovered to pre-shock peak levels by 2011 (Recovered). Regions that were not resilient to the crisis are those that have not recovered to pre-shock peak levels by 2011, and this category is subdivided into two further categories: those that have registered an upturn in employment but had not recovered to their pre-shock peak by 2011 (Not Recovered: Upturn) and those that were still to record an upturn in employment by 2011 (Not Recovered: Downturn)." (see Bristow and Healy, 2018, p. 273).

Looking the dynamics of the employment of FVG (using Istat data) we conclude that it took 6 years to Friuli Venezia Giulia to come back to its 2011 level and it is still far away from the 2007-08 peak. We also observed that the region's economic system has been vulnerable to the severe 2011 economic shock more than other North Eastern regions and the Italian average (see Figure 4.2).

A micro level analysis of employment dynamics helps us to understand which firms (innovative vs. non-innovative) are "more responsible" of the region economic system lack of resilience. Our data do not match 1-to-1 Istat macro data but being CIS data

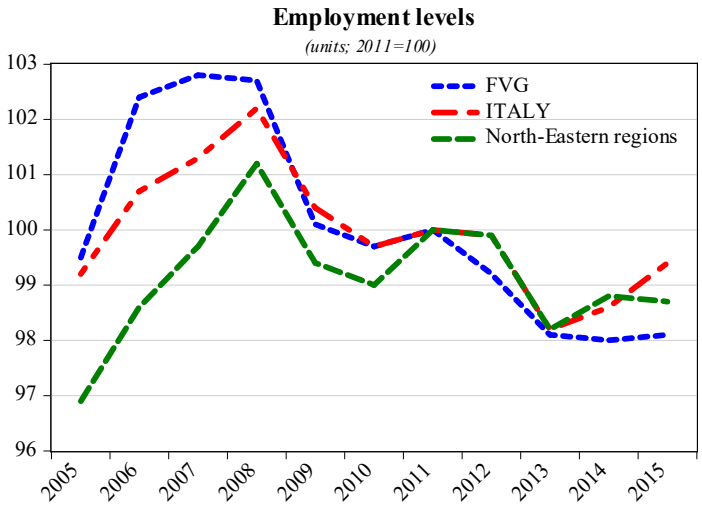

Figure 4.2

representative of the regional economic system, we believe that they are a good proxy of macro level dynamics:

Table 6 - Employment dynamics in Friuli Venezia Giulia

Average number of employees	2008	2010	2012
Total	71.8	71.5	71.1
Innovation-active	132.2	132.8	137.3
Innovation-inactive	38.6	37.9	33.1

Source: Authors' elaborations on CIS waves 2008-2010 and 2010-12

Table 6 shows that, on average, innovative firms beside having a larger number of employees were also able to increase their labor force even after the 2011 economic shock while for non-innovative firms we observe a reduction in the number of employees. This is not a conclusive evidence, but it suggests that non-innovative firms, i.e. SMEs firms, were not able to respond to the downturn following the sovereign debt crisis.

4.4 Empirical analysis

4.4.1 Dealing with endogeneity

We are interested in estimating the relationship between the probability that an obstacle is perceived as important and the intensity of innovation engagement. After

selecting the sample of potential innovators, we tackled the endogeneity of innovation intensity regressors.

The first source of endogeneity is associated to the existence of unknown heterogeneous factors that are correlated with both the probability to perceive obstacles as important and the decision to innovate. We deal with the potential bias deriving from relevant variables left out from the regression by widening the set of our controls relying on the additional information provided by the CAD dataset. In particular, we add two important exogenous variables from the accounting data: 1. the return on assets (ROA) i.e. the ratio of earnings before interest and taxes on total assets, calculated as a 4-year average; 2. the ratio of financial debts to the sum of firm's own resources and financial debts (leverage). The first index is an indicator of the ability to generate returns, and is therefore correlated with productivity. The second, computed as the share of external debt on total resources (external and internal) captures the general stability of the firm financial structure, its sustainability over time and its resilience to external shocks. Firms able to generate positive and sustainable returns are better equipped to cope with the risks entailed by innovation investments and therefore they should perceive obstacles as less threatening.

The second endogeneity source derives from the fact that the choice to innovate and the assessment of obstacles could be simultaneously determined at firm level. In fact, firms are likely to examine the opportunity to innovate by considering both potential benefits and costs as early as in the planning stage of their innovation strategies. Such preliminary assessment also includes estimates of risks and obstacles, even though further barriers might come into consideration during the project implementation phases. Moreover, the problem of simultaneity in obstacle assessment and innovation decision is enhanced by the particular nature of the dataset: CIS data comes from survey waves each covering a three-year period considering it as a single time span. The fact that answers, potentially referring to different moments of the innovation process, are collapsed to the same time dimension would imply by itself a structure of simultaneity even for decisions that are temporally consecutive. Therefore, we consider the assessment of obstacles and the decision about the intensity of innovation investment as simultaneously determined.[5] We start our analysis by first focusing on the cross-sectional data CIS-CAD 2008-10: as reported in Section 4.3.1, the resulting sample CIS-CAD is made of 691 potential innovators innovators covering the years from 2006 to 2014.[6] A multivariate

[5]For instance, D'Este et al. (2012) employed a multivariate probit model to study the effects of several classes of endogenous constraints on firms' innovation propensity relying on survey data.

[6]Merging the data implies losing some observations and selection bias may affect the distribution firms' propensity to innovate. As a robustness check, we therefore estimated our equations relying on the full set of CIS potential innovators. Under this setup the signs of the estimates obtained using CIS data match those we got using CIS-CAD data although they exhibit a smaller magnitude.

probit model (MVP) takes into account the fact that the obstacles are simultaneously determined. We then try to overcome the limits imposed by cross-sectional methods and control for firm-specific unobservables by estimating a random-effect probit model relying on the CIS-CAD panel subset of 317 potential innovators that were surveyed in both CIS waves.

4.4.2 Cross-sectional analysis: the multivariate probit model

On the cross-section 2008-10 CIS-CAD we run a multivariate probit (MVP)[7] model that represents the multiple-equation extension of the univariate probit model.[8] It allows the joint estimation of two or more probit equations through the interaction of their errors terms. The disturbances are jointly distributed as a standardized multivariate normal, with zero mean, unit variance and free cross-correlations. When the correlation coefficient between two equations' disturbances is significantly different from zero, this specification accounts for the existence of omitted or unobservable factors that affect both dependent variables simultaneously; whereas, when the correlation is not different from zero, the two equations can be estimated separately as univariate probit models. Relying on the estimation procedure developed by Cappellari and Jenkins (2003), we estimate a system of three equations, one for each obstacle group (financial, human resources, and market). For each firm $i = 1, \ldots, N$ and each set of obstacles y_{ij}:

$$Prob\left(y_{ij} = 1\right) = \alpha_j + \beta_j^{'} x_{ik} + \gamma_j^{'} z_{ir} + \epsilon_{ij} \tag{4.1}$$

with j indicating the class of obstacle: y_{ij}={Financial, Human resources, Market}; k indicating the intensity level of innovation activity: x_{ik}={technology acquisition, training & marketing, internal R&D}; and z_{ir} is the set of control variables.

We tested several specifications of our model including the relevant CIS indicators and extending and refining the set of regressors with accounting variables drawn from CAD. Our final specification includes a set of control variables capturing firm-specific characteristics such as macro-sector of activity, size, human capital endowment, and several dummies capturing whether the firm belongs to a group, and measures of innovativeness and failures. Size is expected to be negatively related with high perception of financial obstacles (Savignac, 2008), being an indicator of lower financial constraints. From the CAD data we included two variables that have been found to affect the probability to suffer financial constraints, following Savignac (2008), who finds that measures

[7]The starting point would be the univariate probit model with three equations, one for each obstacle group considered. However, such model imposes two restrictions on the data: that the assessment of each obstacle is not correlated with that of the others, and that innovation intensity variables are exogenous. Both restrictions conflict with the hypothesis of simultaneous determination of obstacles and innovation investment, therefore we opted for a more flexible model.

[8]In the case of the linear regression model the analogous extension is the seemingly unrelated regression.

of profitability and own funds impact on the probability to suffer financial constraints. The first measure we consider is ROA which accounts for the productivity and it is hypothesized to be negatively related with the perception of financial obstacles. The other measure is the share of financial debt on total asset (leverage) which accounts for the financial structure of the firms and it is hypothesized to be positively related with the perception of financial obstacles as it signals the difficulty of getting credit for highly indebted firms. All variables are ratios so to exclude any scale effect, that is already captured by the size dummy. The complete list of variables is reported in Table A.3 in the Appendix.

Table 7 shows several aspects of the relationship between innovation activity and reported obstacles. Overall the emerging picture points to the existence of high and significant deterrent barriers in relation to financial and market factors. When obstacles are not binding so severely to prevent innovation tout court, firms can and do engage in innovation activity: external acquisition of technology, in-house training, and marketing and R&D activities significantly reduce firms' perception of financial and market obstacles. On the other hand, firms' perceptions of human resources-related obstacles do not show any strongly significant relation with our innovation intensity variables. This means that these obstacles have been relevant for both innovation- active and deterred firms alike.

The strong correlation between innovation intensity and lower relevance of financial and market constraints reflects the peculiar time span of our data: the years between 2008 and 2010 were deeply marked by the inversion of the economic cycle started in September 2008 with the collapse of Lehman Brothers, the leading American investment bank. The financial crisis spread from the United States' larger banks to all over the world, and from the financial sector to the real sector through a severe credit crunch. Banks heavily reduced their lending activity, and interest rates on outstanding debts increased significantly. Therefore, firms' perception of financial and market obstacles is likely to markedly differ between those firms already 'on the innovation ladder' and those non-innovators that did not innovate because of discouraged by such barriers.

Regarding the effect of other controls, as expected, financial constraints are felt significantly less by the largest firms in terms of both number of employees and revenue (more than 50 million euros highly significant). Firms worries related to demand and market entry barriers are associated with the regional sectoral structure, being less relevant for firms operating in non-manufacturing sectors.[9] Lack of human resources and demand uncertainty are neither exacerbated nor mitigated by CAD-based financial in-

[9]Looking at the FVG economy value added, firms operating in the sector of services account for roughly 70% of the total while manufacturing and construction firms represent respectively the 23 and 4% of the total (Banca d'Italia, 2018).

Table 7 - Cross-section regression CIS-CAD 2008-10

Results of multivariate probit - CIS-CAD: 2008-2010						
	Dependent variables[a]					
Explanatory variables	**Financial Obstacles**		**Human Resources Obstacles**		**Market Obstacles**	
	Coefficient	s.e.	Coefficient	s.e.	Coefficient	s.e.
Technological acquisition	-0.762***	0.174	-0.247	0.221	-0.905***	0.179
Training&Marketing	-0.573***	0.213	-0.593*	0.303	-0.596***	0.211
R&D	-0.460***	0.165	-0.427*	0.229	-0.864***	0.170
Part of a group	-0.098	0.157	0.157	0.201	0.061	0.159
Less than 10 years in business	0.150	0.127	0.026	0.165	0.077	0.129
More than 20 employees	-0.227*	0.122	0.086	0.158	-0.050	0.123
Revenues between 10 and 50 million of euros	-0.130	0.171	-0.028	0.228	0.013	0.173
Revenues above 50 million of euros	-0.741***	0.294	0.014	0.333	-0.130	0.265
Graduate workers	-0.157	0.116	-0.250			
textsuperscript*	0.152	0.066	0.117			
Construction sector	0.137	0.138	-0.100	0.173	-0.253*	0.139
Service sector	0.069	0.129	-0.248	0.167	-0.241*	0.130
Return on Assets (RoA)[b]	-0.016*	0.008	0.013	0.009	0.006	0.008
Leverage[b]	0.008***	0.002	0.000	0.000	-0.001	0.002
Abandoned innovation projects	0.202	0.254	0.329	0.306	0.403*	0.251
Ongoing innovation activities	0.285*	0.154	0.234	0.210	0.048	0.158
Constant	-0.153	0.166	-0.979***	0.171	0.208	0.166
Number of observationsfirms	691					

[a] Whether the firm assesses at least 1 barrier-item as highly important, for each set of barriers.

[b] Averages over the periods 2006-2014.

* p < 0.10 ** p < 0.05 *** p < 0.01

dicators. Considering financial obstacles instead, the behaviour of firm-level financial indicators is coherent with the expectations on firms' management theory on the one hand and with the financial conditions prevailing in the reference period on the other hand. The measure of profitability, ROA, shows a significant negative correlation with financial barriers: higher returns on assets mean more internal resources that the firm can manage freely, therefore lowering perception of financial constraints. In times when the functioning of ordinary credit flows was severely impaired, cash availability was likely to be essential in order to pursue the firm's strategic purposes, including risky investments in innovation. The index of firm financial structure (leverage) shows a small, albeit highly significant, impact. As expected, being part of a group is negatively correlated to the probability of perceiving financial obstacles to innovation. On the other side, we found that the perception of human and market-related obstacles is enhanced for firms that belong to a group perhaps because these firms are more aware of these types of obstacles than independent firms that are usually smaller, less oriented to international markets and less engaged in R&D activities.

4.4.3 Robustness analysis

We conducted a robustness analysis of the results obtained for Equation 4.2 over two dimensions. First, we collapsed the three obstacles in one single obstacle and we find that as expected our estimates are sharper than the estimates obtained considering the three obstacles separately. However, this new obstacle measure is not very informative as it implies that almost every potential innovator in our dataset is constrained. Thus, we conclude that our approach allows us to shed some light on the role of each of the obstacles.

Second, we aggregated consider simple innovators thus in our innovation intensity measure we collapse low, medium and high levels of importance. We estimate again Equation 4.2 and we did not notice any qualitative difference in the results except that the variable that identifies the innovation status gives sharper a coefficient especially for market obstacles.

4.4.4 The random-effect panel probit model

We exploit both CIS survey waves in order to control for firm specific heterogeneous unobserved factors. By matching firms' records we obtain a balanced panel of 317 potential innovators surveyed in both waves.[10] For the j-th obstacle y_{ijt} and the k-th measure of innovation intensity x_{ikt}, we estimate the following univariate equation:

$$Prob\left(y_{it}=1\right)=\alpha_j+\theta_i+\beta_j^{'}x_{ikt}+\gamma_j^{'}z_{irt}+\epsilon_{ijt} \tag{4.2}$$

where each wave is denoted by t with $t=\{1,2\}$, x_{ikt} is the vector of variables measuring innovation intensity, and z_{irt} contains the set of control variables as for Equation 4.2. As in Greene (2012), to control for the incidental parameter problem and the presence of firm-specific unobserved factors θ_i, we run a random-effect probit model relying on the estimation procedure suggested by Mundlak (1978) and Chamberlain (1980).

Results reported in Table 7 show, first of all, that innovation-deterred firms continue to perceive financial obstacles rather more acutely than firms active in the simplest form of innovative investment: in other words, financial obstacles preoccupations are equally relevant at the extreme of the distribution (either non-innovators or highly innovators) also during the unfolding of the crisis. This is consistent with all the controls for financial obstacles: firm size in terms of revenues negatively affect financial barriers' perception; the latter are heavily associated to the financial indicators. The ROA index negatively

[10] As mentioned above, as the CIS questionnaire for the 2010-2012 wave differs slightly from that for 2008-2010, we use the three barriers indicators (financial, human resources, and market) that are homogeneous throughout the whole 2008-2012 span.

affects the probability that financial barriers are perceived as important, while leverage has a significant, positive effect. Thus, an imbalanced financial structure, such as an excessive weight of external debt, signals the firm's weakness: it exposes the firm to the risk of a higher burden should interest rates raise and, therefore, it increases the likelihood of insolvency.

Table 7 - Panel regression CIS-CAD 2008-10

Multivariate probit results - Wave: 2008-2010 *(subsample panel for the CIS-CAD Waves 2008-2010 and 2010-2012)*						
	Dependent variables[a]					
Explanatory variables	**Financial Obstacles**		**Human Resources Obstacles**		**Market Obstacles**	
	Coefficient	s.e.	Coefficient	s.e.	Coefficient	s.e.
Technological acquisition	-0.542**	0.252	-0.194	0.379	-0.799***	0.224
Training&Marketing	-0.148	0.241	-0.109	0.361	-0.854***	0.236
R&D	-0.230	0.201	0.127	0.282	-0.626***	0.184
Part of a group	-0.236	0.158	-0.131	0.244	0.282***	0.184
Less than 10 years in business	0.051	0.161	0.051	0.237	-0.112	0.149
More than 20 employees	-0.115	0.149	0.062	0.222	-0.129	0.138
Revenues between 10 and 50 million of euros	-0.416**	0.223	-0.075	0.345	0.144	0.197
Revenues above 50 million of euros	-0.706***	0.285	0.252	0.389	0.122	0.236
Graduate workers	-0.117	0.143	-0.428***	0.220	-0.150	0.132
Construction sector	0.074	0.191	-0.075	0.266	0.423**	0.176
Service sector	-0.137	0.180	0.266	0.184	0.448**	0.179
Return on Assets (RoA)[b]	-2.941***	1.027	0.397	1.479	-3.026***	0.993
Leverage[b]	1.182***	0.227	-0.112	0.308	-0.213	0.199
Abandoned innovation projects	0.480	0.305	0.599	0.418	0.609**	0.283
Ongoing innovation activities	0.309*	0.191	-0.399	0.298	-0.207	0.172
Constant	-0.662***	0.226	-1.250***	0.343	0.096	0.204
Number of observations	631					
Number of firms	317					

[a] Whether the firm assesses at least 1 barrier-item as highly important, for each set of barriers.
[b] Averages over the periods 2006-2010 for the first wave and 2010-2014 for the second wave.
* p < 0.10 ** p < 0.05 *** p < 0.01

The lack of adequate human resources again is not linked to the intensity of the engagement in innovative activities, suggesting that the lack of qualified personnel has a similar impact on both innovative firms and non-innovators. However, the engagement in any of the three levels of innovation intensity, still significantly reduces the perception of market barriers as important: innovativeness is intrinsically linked to control of market conditions. The second phase of the crisis sees an increase in the dominance of market and competitiveness risks for firms, particularly SMEs with no previous innovation investment. Consistently, a high and sustainable ability to generate income, measured by the ROA, becomes strongly significant in reducing perceptions of market and demand constraints; whilst the presence of recently abandoned innovation projects and operating in the construction sector substantially increase the likelihood that firms regard market obstacles as important.

Furthermore, we use our CIS-CAD 317 firms' panel dataset to grasp additional

insights on how the relationship between the probability of perceiving barriers to innovation as important is affected by the deteriorating macroeconomic conditions following the sovereign debt crisis. Results are presented in Table 8 showing that for the second CIS wave 2010-2012 the probabilities that all firms perceive financial and human resources obstacles as important are considerably reduced - both coefficients of the dummy 2010-12 are negative and significant at the 1% level: this might indicate that in the second stage of the crisis such barriers become more pervasive, affecting innovators and non-innovators alike. The perception of market-related obstacles instead rises substantially, and particularly for non-innovators, suggesting that the worsening of the internal and external macroeconomic environment further discourage them from innovative (and counter-cyclical) strategies, undermining the overall capacity of the system to react to the crisis. Consistently with the findings of Gagliardi and Iammarino (2018), this outcome is likely to be triggered by the high incidence of SMEs in the FVG productive structure, as well as its relative specialization in traditional sectors that were already facing tougher competition from emerging economies in the years before the crisis.

Table 8 - Panel regression CIS-CAD 2008-10

Results of multivariate probit - CIS-CAD: 2008-2010

(subsample panel for the CIS-CAD Waves 2008-2010 and 2010-2012)

Explanatory variables	Dependent variables[a]					
	Financial Obstacles		Human Resources Obstacles		Market Obstacles	
	Coefficient	s.e.	Coefficient	s.e.	Coefficient	s.e.
Dummy 2010-12	-0.494***	0.132	-1.304***	0.399	0.640***	0.123
Technological acquisition	-0.637**	0.263	-0.470	0.514	-0.737***	0.241
Training&Marketing	-0.137	0.252	0.193	0.486	-0.914***	0.251
R&D	-0.307	0.212	0.024	0.378	-0.575***	0.196
Part of a group	-0.061	0.172	0.311	0.349	0.049***	0.157
Less than 10 years in business	0.069	0.170	0.077	0.330	-0.130	0.161
More than 20 employees	-0.144	0.158	0.022	0.309	-0.116	0.149
Revenues between 10 and 50 million of euros	-0.464**	0.236	-0.259	0.483	0.218	0.214
Revenues above 50 million of euros	-0.811***	0.303	0.105	0.530	0.242	0.258
Graduate workers	-0.138	0.150	-0.500*	0.391	-0.141	0.142
Construction sector	0.071	0.202	-0.101	0.371	0.466***	0.191
Service sector	-0.153	0.191	-0.410	0.375	0.042	0.174
Return on Assets (RoA)[b]	-3.822***	1.121	-1.063	2.171	-2.514**	1.046
Leverage[b]	1.236***	0.242	-0.187	0.438	-0.184	0.215
Abandoned innovation projects	0.444	0.322	0.772	0.599	0.702**	0.304
Ongoing innovation activities	0.286	0.198	-0.752	0.476	0.238	0.185
Constant	-0.426*	0.245	-1.067**	0.491	-0.265	0.230
Number of observations	634					
Number of firms	317					

[a] Whether the firm assesses at least 1 barrier-item as highly important, for each set of barriers.

[b] Averages over the periods 2006-2010 for the first wave and 2010-2014 for the second wave.

* p < 0.10 ** p < 0.05 *** p < 0.01

4.5 Conclusions

In this study we investigated the relationship between the intensity of firms' engagement in innovative activities and self-reported obstacles to innovation for a representative sample of firms in the Italian region of Friuli Venezia Giulia in the years of the big recession ($2008 - 2010$) and the sovereign debt crisis ($2010 - 2012$). Results support the existence of severe financial and market obstacles hampering mostly non-innovator firms in the region while barriers related to human resources are more pervasive, affecting both innovation-active and deterred firms alike.

Relying on a subset of firms that were surveyed both in 2008-2010 and 2010-2012 we provide evidence that innovativeness is intrinsically linked to a stronger control of the market and demand conditions. The CAD-based indicators of firms' financial health increase their overall influence on the perception of obstacles for our panel, and their sign is in line with expectations: profitability (ROA index) mitigated financial and market obstacles; leverage points to much higher perception of financial barriers for firms with an imbalanced financial structure. In correspondence with the sovereign debt crisis, the perception of market-related obstacles rose dramatically for all firms, while the perception of financial and human resources-related obstacles decreased.

Estimation results and our analysis on the FVG's economic system vulnerability point out that the sharp rise in firms' perception of market obstacles to innovation, and the associated uncertainty, reflect the high level of vulnerability of FVG's firms to sizeable exogenous shocks to the economic activity. This interpretation is coherent with the dynamics observed, especially in the labour market, in the regional economic environment as the rise in market-related obstacles is closely linked to the sharp reduction in the propensity to invest and to innovate of FVG's firms. Moreover, during the credit crunch the downfall in the investments and exports of FVG's firms, two main characteristics of innovative firms, was sharper than in the rest of Italy.

Clearly it is very difficult for local policy makers to address the need of tools that can help firms to mitigate the consequences of a rise in market-related obstacles. In line with the findings of the existing scholarly contributions on the link between regional economic resilience and innovation, we identify few directions in which the problem could be tackled in a traditional but still lively economic system such as FVG. First, innovation-related activities should be supported through a system of financial incentives to stimulate the propensity to innovate of firms.

Second, it is important to provide counselling services to help firms, especially the SMEs, that want to look for new markets and be informed on the new directions of the market demand. This implies the set-up of regional policy tools to help firms, especially

SMEs, to move from the traditional sectors to high-tech ones.

Third, it is important to empower the regional system of innovation by promoting the clustering of innovative firms and the sharing of knowledge.

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Appendix

Table A.1

CIS questionnaire (2008-10 **and** 2010-2012 **harmonised): obstacles to innovation**					
Classes	Items	Degree of importance			
		Not experienced	Low	Medium	High
Financial obstacles	Lack of adequate finance	☐	☐	☐	☐
Human resources obstacles	Lack of qualified personnel	☐	☐	☐	☐
Market obstacles	Lack of demand	☐	☐	☐	☐
	Dominant market share held by competitors	☐	☐	☐	☐

Table A.2

CIS 2008-2010 **and** 2010-12 **questionnaire: innovative activities**			
Classes	Items	Not engaged	engaged (highest engagement only)
Technology acquisitions	Acquisition of extramural R&D	☐	☐
	Acquisition of machinery	☐	☐
	Acquisition of other technologies	☐	☐
Training & Marketing	Training for innovative activities	☐	☐
	Marketing for new productprocesses	☐	☐
Internal R&D	In-house R&D	☐	☐
	Design	☐	☐
	Other activities supporting innovation	☐	☐

Table A.3 - List of variables

Variables	Source	Type	Definitions
Any innovation output introduced	CIS	0/1	1 if firm i introduces a process or a product innovation into the market in years 2008-10 or 2010-12, 0 otherwise. A process innovation is the implementation of a new or significantly improved production process, distribution method, or support activity for goods or services, such as maintenance systems or operations for purchasing, accounting, or computing (exclude purely organizational innovation). A product innovation is the market introduction of a new or significantly improved good or service with respect to its capabilities, user friendliness, components or sub-systems. Process or product innovations (new or improved) must be new to the enterprise, but not to the market.
Organization inn.	CIS	0/1	1 if firm i introduces an organizational innovation in year t, 0 otherwise. An organizational innovation is a new organizational method in the enterprise's business practices (including knowledge management), workplace organization and decision making, or external relations that has not been previously used by the enterprise. It must be the result of strategic decisions taken by management. It exclude mergers or acquisitions, even if for the first time.
Marketing inn.	CIS	0/1	1 if firm i introduces a marketing innovation in year t, 0 otherwise. A marketing innovation is the implementation of a new marketing concept or strategy that differs significantly from the enterprises existing marketing methods and which has not been used before. It requires significant changes in product design or packaging, product placement, product promotion or pricing. It exclude seasonal, regular and other routine changes in marketing methods.
Innovation intensity	CIS	0/1	As explained in the paper, used to build firms' engagement in innovation, see Table A.3 above.
Part of a group	CIS	0/1	1 if firm i belongs to a group, 0 otherwise
Less than 10 years	CAD	0/1	1 if firm i is less than 10 years old, 0 otherwise
More than 20 employees	CAD	0/1	1 if firm i has more than 20 employees at the end of 2010 or 2012, 0 otherwise
Revenue 10-50 mil. euros	CAD	0/1	1 if firm i has an average revenue between 10 and 50 millions of euros per year, 0 otherwise
Revenue greater 50 mil. euros	CAD	0/1	1 if firm i has an average revenue above 50 millions of euros per year, 0 otherwise
Graduate workers	CIS	0/1	At least 1 employee has a university degree in firm i
Abandoned inn. projects	CIS	0/1	1 if firm i abandoned innovation activities in the years 2008-10 or 2010-12, 0 otherwise.
Ongoing inn. projects	CIS	0/1	1 if firm i had innovation activities still ongoing at the end of 2010 or 2012, 0 otherwise.
Sector Dummies	CIS	0/1	Sector-specific component captured by sector dummies
Time Dummy		0/1	Time-specific component captured by time dummy
Return on assets (ROA)	CAD	Percentages	Earnings before interest and taxes / Total assets
Leverage	CAD	Percentages	Financial debts / Equity plus financial debts

CHAPTER 5

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