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Tesi di Dottorato

LENDING RELATIONSHIPS, BANK EFFICIENCY AND LOCAL INSTITUTIONS. EVIDENCE BASED ON SMALL FIRMS AND LOCAL BANKS.

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TITOLO TESI

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Introduction and summary

This thesis offers a collection of three papers, which can be read independently of each other. The opening work: "Institutional Quality and Multiple Banking Relationships: An Empirical Analysis Based On The Italian Manufacturing Sector", empirically investigates whether local institutional quality affects multiple banking relationships using a sample of small and medium-sized Italian manufacturing firms observed from 2003 to 2006 and the Institutional Quality Index (IQI) proposed by Nifo and Vecchione (2014).

The empirical literature on financial intermediation has intensively investigated the determinants of multiple banking relationships, recognizing the interplay of firm characteristics, bank-firm relationship features, banking and judicial system characteristics. Besides, managers' decisions and firms' characteristics may be influenced by several external factors defined at the local level. In particular, besides enforcement systems, excessive bureaucratisation, inefficient organisation of public services, corruption, shadow economy, insufficient infrastructures, unsatisfactory social and cultural environment may affect firms and banks' propensity to establish close banking relationships. A better quality of institutions could mitigate asymmetric information problems between banks and firms facilitating interactions, increasing trust, reducing transaction costs, thus helping them to reap the benefits connected to close banking relationships. However, much of the existing research on multiple banking relationships (Ongena and Smith, 2000; Detragiache et al., 2000; Hernández-Cánovas and Koëter-Kant, 2010; Masciarelli, 2011) does not consider the possible overall impact that institutional contexts may have on a firm's choice of being multiple banked.

Differently from the scholars mentioned above, the first chapter focuses on the effects of institutions on multiple banking offering a wider vision of the phenomenon, evaluating the impact of institutional quality as a whole and the impact of single components of a synthetic index. My

main testing hypothesis is that variation in local institutional quality may play a role in shaping bank-firm relationships.

Adopting several estimators to address concerns of unobserved heterogeneity and potential endogeneity of some covariates, the econometric analysis is carried out controlling for a set of determinants suggested by the variegate literature on banking relationships. According to my main finding, institutional quality tends to be a relevant determinant of multiple banking: a better quality of institutions is often associated with a smaller number of bank relationships for a firm. Thus, efficient institutions seem to foster environments where banks and firms favourably interact to exchange information and promote close banking relationships.[1] The results suggest that the typical close banking relationships problems, such as the *hold-up*, the s*oft budget constraint* and the *liquidity* problem may be mitigated in environments characterized by high institutional quality. In particular, institutional quality might represent an indirect form of control to avoid opportunistic and anti-social behaviour, and lead firms to establish a smaller number of bank relationships.

The second piece of work offers new empirical evidence on the impact of local institutional quality on bank cost efficiency, focusing on Italian mutual cooperative banks.[2]

A growing literature recognizes the importance of institutions in affecting the efficient operations of banks. Demirgüç-Kunt et al. (2004), Lensink et al., (2008), Hasan et al. (2009), and Lensink and Meesters (2014) show that better institutional quality induce banks to be more efficient. However, there is no evidence on the potential influence of local institutional quality on bank efficiency of

[1] The term *relationship banking* defines a provision of financial services by a bank that invests to obtain private information on the financed firm and through repeated interaction over time, evaluates the profitability of these investments (Boot, 2000).

[2] Mutual cooperative banks are an important part of the Italian banking system: in 2016, 4382 BCCs operate in 2676 municipalities, within 101 Italian provinces (Federcasse, 2016). Through their territorial specialization, mutualistic nature, and governance structure BCCs have promoted the economic and social development of local markets (Finocchiaro, 2002).

local banks such as cooperative banks (henceforth, BCCs). Due to their strong connection with the territory that they serve, economic, regulatory and institutional differences at local level may play a crucial role in fostering BCCs efficiency, and explain the heterogeneity in efficiency among BCCs in different local areas.

Using a unique dataset of 371 Italian BCCs observed from 2007 to 2012 and the Institutional Quality Index (IQI) proposed by Nifo and Vecchione (2014), this is the first study that examines the impact of local institutional quality on BCC efficiency across Italian provinces, while controlling for bank specific factors and provincial macroeconomic and financial sector conditions. This analysis allows testing two contrasting views: the *public interest view* and the *political economic view*. According to the first, weak institutions negatively affect bank efficiency by impeding banks to attract funds in the cheapest way or allocate them in an optimal way. The second view argues that weak institutions improve bank efficiency, thanks to a regulatory capture effect (Barth et al., 2006; Lensink and Meesters, 2014; ElKelish and Tucker,2015).

Adopting both parametric (Stochastic Frontier Analysis - SFA) and non-parametric (Data Envelopment Analysis - DEA) techniques to retrieve measures of cost efficiencies and accounting for bank specific factors and cross-provinces differences in macroeconomic and financial sector conditions, the main results show that better local institutions substantially influence the efficient cost operations of BCCs, giving support to the public view of the banking sector.

The third essay contributes to the literature on lending relationships by investigating the impact of long lasting lending relationships on small and medium sized firms (henceforth, SMEs) technical efficiency.

An increasing number of studies show that lending relationships may have various effects on the financing and performance of firms, both positive and negative. On one hand, a *close lending relationship* may: entail flexible and long-term contracts (Stiglitz and Weiss, 1981; Boot 2000;

Elyasiani and Goldberg 2004; Udell 2008), overcome information asymmetries and agency issues that create liquidity constraints reducing credit to firms (Diamond, 1984; Bhattacharya and Chiesa, 1995), discourage firm's strategic default (Bannier, 2007), increase the amount of credit (e.g.: Petersen and Rajan, 1994,1995; Berger and Udell, 1995; Cole, 1998; Harhoff and Korting, 1998; Hernandez-Canovas and Martinez-Solano, 2010), provide funding for firms' long term projects probably not profitable in the short term (Boot, 2000) and require lower collateral (e.g.: Berger and Udell, 1995; Harhoff and Korting, 1998; Voordeckers and Steijvers, 2006; Chakraborty and Hu, 2006; Jimenez et al., 2006; Brick and Palia, 2007; Steijvers et al., 2010; Bharath et al., 2011; Agostino and Trivieri, 2017). On the other hand, strong bank-firm ties may have some "dark sides", such as *hold-up*, *liquidity*, and *soft-budget constraint* problems (Boot, 2000; Elyasiani and Goldberg, 2004; Udell, 2008).

According to Montoriol Garriga (2006) lasting banking relationships generate value and increase economic efficiency. However, little is known on the effect of enduring banking relationships on firms' technical efficiency, namely the ability of firms to maximize their output given their technology and productive resources (or vice versa, the ability to minimize the amount of inputs required to produce a given output level), to the best of my knowledge the only paper dealing with this topic being Yildirim (2017).

In the third chapter, linking the literature on costs and benefits of banking relationships (Boot, 2000; Elyasiani and Goldberg, 2004; Udell, 2008) with the literature on agency costs and managers' incentive (e.g.: Jensen and Meckling, 1976; Jensen, 1986; Nickell et al., 1997; Schmidt, 1997; Nickell and Nicolitsas, 1999), the research hypothesis is that the equilibrium between advantages and disadvantages of enduring banking relationships might be different depending on the level of firms' indebtedness. The empirical investigation is conducted on a sample of European manufacturing SMEs, observed over the period 2001-2008. Measures of firms' efficiency are retrieved by adopting both parametric and non-parametric techniques.

Findings indicate that as firm's indebtedness increases, the overall positive effect of long term lending relationships tends to decline, signaling that the interaction of moral hazard problems may jeopardize firms' technical efficiency.

In summary, in the light of the empirical evidence so far described, well-developed local institutions, made of both informal and formal rules and their enforcement, could be fundamental to shape bank-firm relationships. More in details, the problems associated with close banking relationships, such as the *hold-up*, the *soft budget constraint* and the *liquidity* problem may be mitigated in environments characterized by high institutional quality. Moreover, a better institutional quality may also induce more efficient cost management of BCCs, which is crucial to guarantee the continuity of services offered to their customers. Besides, according to the results, the balance between benefits and costs of longer banking relationships depends on firm's indebtedness. In particular, for low firm's indebtedness, the benefits of longer lending relationships tend to prevail on their costs, thus increasing manager's incentive to achieve efficient technical practices. However, this effect tends to decline as indebtedness increases, presumably due to moral hazard problems related to higher debt, that eventually, reduce managers' incentives to pursue higher production efficiency.

In terms of policy implications, the results of this thesis indicate that better local institutions may foster closer banking relationships and lead to greater banking efficiency. Policymakers should design good local institutions, promoting environments where banks and firms favourably interact to exchange information and promote well-functioning banking relationships, strengthening the role of BCCs as "territorial banks", who offer banking services to local communities, support the individual business ideas and contribute to the economic development of the Italian local areas. Besides, since lending relationships are crucial for Italian SMEs, which tend to establish ties with local banks, banks should reduce the tendency to continuously move bank officers from one bank's decision-making center to another reducing the possibility to gather soft information. Finally,

restructuring processes (i.e. mergers and acquisitions) could weaken these relationships, thus affecting firm's technical efficiency. This could prove to be very important especially in bank based financial systems, where SMEs typically depend on bank loans, and the local supply of credit is crucial to respond to their financial needs.

Introduzione

Questa tesi consta di tre articoli, che possono essere letti indipendentemente l'uno dall'altro. Il primo lavoro: "*Institutional Quality and Multiple Banking Relationships: An Empirical Analysis Based On The Italian Manufacturing Sector*", analizza empiricamente se la qualità istituzionale locale influisce sul multi-affidamento bancario utilizzando un campione di piccole e medie imprese (PMI) manifatturiere italiane osservate dal 2003 al 2006 e l'indice di qualità istituzionale (IQI) proposto da Nifo e Vecchione (2014).

La letteratura sul rapporto banca impresa ha indagato le determinanti del multi-affidamento bancario identificando tra queste le caratteristiche dell'impresa, del rapporto banca-impresa, del sistema bancario e giudiziario. Tuttavia, le decisioni dei manager potrebbero essere influenzate anche da diversi fattori esterni definiti a livello locale. In particolare, l'eccessiva burocratizzazione, l'organizzazione inefficiente dei servizi pubblici, la corruzione, l'economia sommersa, le infrastrutture insufficienti, i contesti sociali e culturali potrebbero influenzare la propensione delle imprese e delle banche di stabilire strette relazioni bancarie. Una migliore qualità istituzionale potrebbe mitigare i problemi di informazione asimmetrica tra banche e imprese facilitando le interazioni, aumentando la fiducia, riducendo i costi di transazione, permettendo così a banche e imprese di cogliere i benefici connessi alle strette relazioni bancarie. Tuttavia, gran parte della letteratura empirica sul multi-affidamento (Ongena e Smith, 2000, Detragiache et al., 2000; Hernández-Cánovas e Koëter-Kant, 2010; Masciarelli, 2011) indaga le determinanti del multi-affidamento considerando l’effetto di alcune dimensioni della qualità istituzionale.

A differenza degli studi sopra citati, il primo capitolo si concentra sugli effetti della qualità istituzionale locale sul multi-affidamento bancario, offrendo una visione più ampia del fenomeno, poiché mira a valutare l'impatto delle istituzioni nel loro insieme e l'impatto delle singole

componenti di un indice sintetico. In questo capitolo si vuole testare se le variazioni della qualità istituzionale locale giocano un ruolo determinante nel definire le relazioni banca-impresa.

Adottando diversi stimatori per affrontare i problemi di eterogeneità non osservata e potenziali problemi di endogeneità della variabile d'interesse e di alcuni regressori, l'analisi econometrica viene condotta controllando per un insieme di determinanti suggerite dalla letteratura sul rapporto banca-impresa.[3] Secondo i risultati, la qualità istituzionale tende a essere un fattore determinante del multi-affidamento bancario: una migliore qualità istituzionale è spesso associata a un minor numero di rapporti bancari per un'impresa. Pertanto, istituzioni efficienti sembrano promuovere ambienti in cui banche e imprese interagiscono favorevolmente per scambiarsi informazioni e promuovere strette relazioni bancarie. I risultati suggeriscono che i tipici problemi legati alle *close banking relationships*, quali l'*hold-up*, il s*oft budget constraint* e il *liquidity problem* potrebbero essere mitigati in ambienti caratterizzati da un'elevata qualità istituzionale. In particolare, la qualità istituzionale locale potrebbe rappresentare una forma indiretta di controllo per evitare comportamenti opportunistici e antisociali e indurre le imprese a stabilire un minor numero di relazioni bancarie.

Il secondo articolo indaga l'impatto della qualità istituzionale locale sull'efficienza di costo delle banche di credito cooperativo (BCC) italiane.

Un crescente letteratura riconosce l'importanza delle istituzioni nell'influenzare l'efficienza delle banche. Demirgüç-Kunt et al. (2004), Lensink et al. (2008), Hasan et al. (2009) e Lensink e Meesters (2014) mostrano che una migliore qualità istituzionale induce le banche a essere più efficienti. Tuttavia, non ci sono studi che indagano la potenziale influenza della qualità istituzionale locale sulle banche locali, come ad esempio le banche di credito cooperativo. A causa della loro

[3] Le stime sono state condotte con l'impiego di differenti metodi di stima: Probit, Poisson, Arellano e Bover (1995), Blundell e Bond (1998) *System Generalised Method of Moments* e il metodo delle variabili strumentali.

forte connessione con il territorio, le differenze economiche, normative e istituzionali a livello locale potrebbero essere significative nel determinare l'efficienza delle BCC e spiegare l'eterogeneità nell'efficienza tra le BCC operanti in diverse aree locali.

Utilizzando un campione di 371 BCC italiane osservate dal 2007 al 2012 e *l'Institutional Quality Index* (IQI) proposto da Nifo e Vecchione (2014), questo è il primo studio che esamina l'impatto della qualità istituzionale locale sull'efficienza delle BCC, controllando al contempo per fattori specifici delle banche e per le condizioni macroeconomiche e finanziarie provinciali. L'analisi consente di testare due ipotesi contrastanti: la *public interest view* e la *political economic view*. Secondo la prima, le istituzioni deboli incidono negativamente sull'efficienza delle banche ostacolando la loro capacità di attrarre fondi in modo economico e/o di allocarli in modo ottimale. La seconda, sostiene che le istituzioni deboli migliorano l'efficienza delle banche, grazie ai *regulatory capture effects* (Barth et al., 2006; Lensink e Meesters, 2014; ElKelish e Tucker, 2015).

Adottando sia tecniche parametriche (Stochastic Frontier Analysis - SFA) che non parametriche (Data Envelopment Analysis - DEA) per ottenere misure di efficienza di costo delle banche controllando per le differenze nelle condizioni macroeconomiche e finanziarie a livello provinciale, i risultati mostrano che una migliore qualità istituzionale locale influenza in modo sostanziale l'efficienza di costo delle BCC, avvalorando la *public interest view*.[4]

Il terzo saggio studia l'impatto delle relazioni di credito di lunga durata sull'efficienza tecnica delle piccole e medie imprese.

[4] La principale analisi econometrica è condotta stimando congiuntamente una funzione di costo e una funzione di efficienza, seguendo la specificazione di frontiera stocastica proposta da Battese e Coelli (1995) e di Greene (2005), mentre per le prove di robustezza, si adotta la procedura Data Envelopment Analysis (DEA) *bootstrap* a due stadi proposta da Simar e Wilson (2007). Inoltre, per tener conto dell'endogeneità della variabile d'interesse si adotta un test recentemente proposto da Karakaplan e Kuntlu (2013) nel contesto delle frontiere stocastiche ed un *Instrumental Variable Method* nella procedura DEA a due stadi.

Una crescente letteratura mostra che le relazioni di credito possono avere vari effetti, sia positivi che negativi sul finanziamento e sulle performance delle imprese. Da una parte, una *close lending relationship* potrebbe: permettere contratti più flessibili e a lungo termine (Stiglitz e Weiss, 1981, Boot 2000, Elyasiani e Goldberg 2004, Udell 2008), superare le asimmetrie informative e i problemi di agenzia che creano vincoli di liquidità riducendo il credito alle imprese (Diamond, 1984; Bhattacharya and Chiesa, 1995), scoraggiare i default strategici delle imprese (Bannier, 2007), aumentare la disponibilità di credito (Petersen e Rajan, 1994,1995; Berger e Udell, 1995; Cole, 1998; Harhoff e Korting, 1998; Hernandez-Canovas e Martinez-Solano, 2010), fornire finanziamenti per progetti a lungo termine, probabilmente non redditizi a breve termine (Boot, 2000) e richiedere minori garanzie (Berger e Udell, 1995; Harhoff e Korting , 1998; Voordeckers e Steijvers, 2006; Chakraborty e Hu, 2006; Jimenez et al., 2006; Brick and Palia, 2007; Steijvers et al., 2010; Bharath et al., 2011; Agostino e Trivieri, 2017). D'altra parte, una *close lending relationship* può comportare alcuni costi scaturenti dall'*hold-up*, *soft-budget constraint* e dal *liquidity problems*, (per una rassegna: Boot, 2000, Elyasiani e Goldberg, 2004; Udell, 2008).

Secondo lo studio di Montoriol Garriga (2006), le relazioni bancarie durature generano valore e aumentano l'efficienza economica delle imprese. Tuttavia, quasi del tutto sconosciuto è l'effetto delle relazioni di credito di lunga durata sull'efficienza tecnica delle imprese, intesa come la capacità dell'impresa di massimizzare l'output data la tecnologia e le risorse produttive (o viceversa, la capacità di minimizzare la quantità di input necessari per produrre un dato livello di output).[5]

Nel terzo capitolo, dove si collegano le predizioni teoriche della letteratura sui costi e i benefici dei rapporti bancari (per una rassegna: Boot, 2000; Elyasiani e Goldberg, 2004; Udell, 2008) con quelle sui costi di agenzia e incentivi dei manager (per una rassegna: Jensen e Meckling, 1976;

[5] L'unico studio che tratta di questo argomento è Yildirim (2017).

Jensen, 1986; Nickell et al., 1997; Schmidt, 1997; Nickell e Nicolitsas, 1999), si vuole verificare se l'equilibrio tra vantaggi e svantaggi dei rapporti bancari duraturi ha effetti eterogenei sugli incentivi dei manager e, conseguentemente sull'efficienza tecnica dell'impresa a seconda del livello d'indebitamento della stessa. L'indagine empirica è condotta su un campione di PMI manifatturiere europee, osservate nel periodo 2001-2008. Le misure di efficienza delle imprese sono stimate adottando tecniche parametriche e non parametriche.[6]

I risultati indicano che all'aumentare dell'indebitamento dell'impresa, l'effetto positivo delle relazioni di credito a lungo termine tende a diminuire, suggerendo che i problemi di moral hazard legati al debito potrebbero indebolire l'efficienza tecnica delle imprese.

In sintesi, alla luce dell'evidenza empirica prodotta nei lavori fin qui descritti, una migliore qualità istituzionale a livello locale, costituita sia da regole formali e informali che dalla loro applicazione, potrebbe essere determinante per costituire rapporti banca-impresa ben funzionanti. I problemi associati alle *close banking relationships*, quali l'*hold-up*, il *soft budget constraint* e il *liquidity problems* potrebbero essere mitigati in contesti caratterizzati da migliori istituzioni locali. Inoltre, una migliore qualità istituzionale potrebbe anche indurre una migliore efficienza delle banche locali, fondamentale per garantire la continuità dei servizi offerti ai propri clienti. Infine, l'equilibrio tra benefici e costi delle *close banking relationships* sembra avere un effetto eterogeneo sugli incentivi dei manager, e conseguentemente sull'efficienza tecnica dell'impresa a seconda del livello dell'indebitamento della stessa. Infatti, l'impatto delle *close lending relationships*

[6] Per misurare l'efficienza e modellare la relazione tra l'efficienza e le sue determinanti, si adottano metodi non parametrici e parametrici. Per le stime principali, si adotta la procedura DEA *bootstrap* a due stadi proposta da Simar e Wilson (2007), mentre per le prove di robustezza si adotta la specificazione (*one-step*) di frontiera stocastica proposta da Battese e Coelli (1995). Per affrontare potenziali problemi di endogeneità, si adotta un test recentemente proposto da Karakaplan e Kuntlu (2013) nel contesto delle frontiere stocastiche.

sull'efficienza delle imprese è positivo per i bassi livelli di debito, e diminuisce al crescere dell'indebitamento dell'impresa.

In termini di *policy implications*, l'evidenza empirica presentata in questa tesi suggerisce ai *policymakers* l'adozione di politiche rivolte a migliorare le istituzioni locali. Questo consentirebbe di creare contesti in cui banche e imprese interagiscono favorevolmente per scambiarsi informazioni e stabilire relazioni bancarie ben funzionanti. Allo stesso tempo, politiche rivolte al miglioramento della qualità istituzionale potrebbero favorire una maggiore efficienza delle BCC, consentendole di svolgere la loro funzione sociale e il loro ruolo di "banche del territorio" che offrono servizi bancari alle comunità locali, supportano idee imprenditoriali e contribuiscono allo sviluppo economico delle aree locali italiane. Inoltre, poiché le relazioni di credito sono cruciali per le PMI, che tendono a stabilire legami con le banche locali, le banche dovrebbero ridurre la tendenza a spostare continuamente gli agenti bancari da un centro decisionale ad un altro riducendo la possibilità di raccogliere *soft information*. Muovendo dalla stessa considerazione, i processi di ristrutturazione (ad esempio, fusioni e acquisizioni) potrebbero indebolire le relazioni di credito, influenzando in tal modo l'efficienza tecnica delle imprese. Ciò potrebbe rivelarsi molto importante, specialmente nei sistemi finanziari basati sulle banche, dove le PMI dipendono dai prestiti bancari e l'offerta di credito locale è fondamentale per rispondere alle loro esigenze finanziarie.

FIRST CHAPTER

INSTITUTIONAL QUALITY AND MULTIPLE BANKING RELATIONSHIPS: AN EMPIRICAL ANALYSIS BASED ON THE ITALIAN MANUFACTURING SECTOR.

ABSTRACT

Using a unique sample of small and medium-sized Italian manufacturing firms observed from 2003 to 2006 and the Institutional Quality Index (IQI) proposed by Nifo and Vecchione (2014), this study investigates the relationship between institutional quality and multiple banking relationships. Besides, exploiting the multidimensional nature of the IQI, the effect of institutional quality on multiple banking is evaluated as a whole and for the different sub-indexes composing it. The econometric analysis is carried out controlling for a set of determinants suggested by the variegate literature on banking relationships and adopting several estimators to address concerns of unobserved heterogeneity and potential endogeneity of some covariates. According to my results, it seems that institutional quality negatively influences both the number of banking relationships and the propensity of firms to be multiple banked. Hence, a better quality of institution may be relevant in mitigating asymmetric information problems in the borrower-lender relationship. More specifically, the results obtained show that the propensity of firms to be multiple banked is lower as the efficiency of the legal system and the administrative capacity of local governments increase. All in all, institutional differences seem to play a role in shaping multiple banking relationships in Italy.

1. INTRODUCTION

Multiple banking relationships – which occur when firms maintain relationships with different banks - are widespread in Italy and many studies have empirically investigated the determinants of this phenomenon with regard to small and medium firms (henceforth, SMEs), since they represent the bulk of the Italian productive structure.[7] The determinants suggested by the variegate literature on multiple banking relationships concern firm characteristics, bank-firm characteristics, judicial and banking system characteristics (Detragiache et al.,2000; Cosci and Meliciani, 2005, Vulpes, 2005; Pelliccioni and Torluccio, 2007; Tirri,2007). However, much of the existing research on multiple banking relationships looks at these determinants without considering the possible effect that institutional contexts may have on a firm's choice of being multiple banked. To fill this lacuna, my study investigates whether the quality of institutions at local level contributes to explain the number of bank relationships, taking advantage of a unique panel of Italian manufacturing SMEs observed from 2003 to 2006 and of the Institutional Quality Index (IQI) recently built by Nifo and Vecchione (2014).

During the last decade, the topic of the role of institutional quality in the economic development of a country has come to prominence. Many studies emphasize that institutional quality promotes economic development of a country focusing on the impact of institutional quality on macroeconomic factors (Guiso et al 2004; La Porta et al. 1997, 1998; Beck and Levine, 2004). However, very few studies try to assess the impact of institutional quality at the microeconomic level. In particular, within a country there could exist local institutional differences that may play a crucial role in explaining the number of bank relationships for a firm. A better quality of institutions could mitigate asymmetric information problems between borrowers and lenders. Indeed, institutional

[7] In Italy the vast majority of firms (more than 95%) are SMEs.

quality may facilitate the interaction among economic agents, increasing trust between parts, reducing transaction costs, thus helping to reap the benefits connected to close relationships. [8]

To my knowledge, comprehensive studies analysing the overall impact of institutional quality on multiple banking are not available yet. The empirical contributions in the literature on multiple banking are aimed at evaluating the effect of one single aspect of institutional quality on the firm's number of bank relationships in Italy and in other countries. Among these, focusing on the efficiency of judicial and financial system, Ongena and Smith (2000) find that differences in legal and financial environments across European countries explain the heterogeneity in the number of bank relationships established by large firms. Likewise, Detragiache et al. (2000), analyzing a sample of Italian manufacturing SMEs, find that Italy's judicial and banking system matter in explaining the firms' number of bank relationships. Similarly, Hernández-Cánovas and Koëter-Kant (2010), investigating a sample of SMEs from nineteen European countries, indicate that legal origins and judicial efficiency of a country explain the likelihood of multiple banking. In the same vein, but focusing on social capital, Masciarelli (2011), considering a sample of Italian manufacturing firms, finds a significant effect of social capital on both the firms' probability to establish a relationship with a limited number of banks and the maturity of the loan.

Differently from the scholars mentioned above, this study focuses on the effects of institutions on multiple banking offering a wider vision of the phenomenon, since it evaluates the impact of institutions as a whole and the impact of single components of a synthetic index. My main testing hypothesis is that variation in local institutional quality contexts may play a role in shaping bank-firm relationships.

[8] Close banking relationships are built by repeated interactions that facilitate banks to closely monitor firms having access to private information (Boot,2000). Private information is accumulated over time making easier flexible and long term contracts.

Italy represents an interesting laboratory for testing the effect of institutional quality on the firm's number of bank relationships since a) multiple banking is diffuse among Italian SMEs (Detragiache et al., 2000), b) the institutional endowment differs at the local level (Bianco et al., 2005; Nifo and Vecchione, 2014).

From a methodological standpoint, I adopt several different estimators (Probit, Poisson and *System GMM*), to address concerns of unobserved heterogeneity and potential endogeneity. According to my main finding, institutional quality tends to be a relevant determinant of multiple banking: a better quality of institutions is often associated with a smaller number of bank relationships for a firm. Thus, efficient institutions seem to foster environments where banks and firms favourably interact to exchange information and promote close banking relationships. The results suggest that the typical close banking relationships problems, such as the *hold-up*, the s*oft budget constraint* and the *liquidity* problem may be mitigated in environments characterized by high institutional quality. In particular, institutional quality might represent an indirect form of control to avoid opportunistic and anti-social behaviour, and lead firms to establish a smaller number of bank relationships.

The remainder of this chapter is organized as follows. Next section provides a review of the relevant literature. Section 3 illustrates the empirical question, the methodology employed and the data used. Section 4 comments on the results obtained, while section 5 concludes.

2. LITERATURE REVIEW

2.1. The determinants of multiple banking relationships.

In this section, I review benefits and costs of multiple banking, which are expected to drive the propensity of firms to be multiple banked. Among benefits, firms may avoid several issues deriving from close lending relationships, such as the *hold up*, the *soft budget constraint* and the *liquidity* problem (Boot, 2000). In close banking relationships the main bank might take advantage from its

bargaining power by applying rates on loans that do not reflect the real credit worthiness of firms, causing the *hold-up* problem (Sharpe 1990, Rajan,1992). Moreover, according to Von Thadden (1995), firms might borrow from several banks instigating competition among them trying to reduce the so-called main bank's "monopoly rent". What is more, multiple banking relationships might prevent the main bank's practise of keeping financing unproductive projects of client firms, avoiding the *soft budget constraint* problem (Carletti et al. 2004).[9] Besides, in a close lending relationship, the main bank might go bankrupt or might have temporary liquidity problems (Detragiache et al.,2000) generating *liquidity risks* that firms could mitigate by practicing multiple banking (Elsas et al., 2004).[10]

On the other hand, multiple banking hinders the benefits associated with close lending relationships. In fact, in the course of a lending relationship, information asymmetries and agency problems could be mitigated by a main bank that may be able to acquire *soft information* from its financed firms, leading, at the same time, to more valuable monitoring and screening processes (Bhattacharya and Chiesa, 1995; Diamond, 1984). What is more, in a close lending relationship characterized by mutual trust among parties, a main bank may be disposed to renegotiate the credit line or the interest rate of its clients in financial distress. In addition, it may be inclined to provide funding for firm's long term projects probably not profitable in the short term (Boot, 2000). Moreover, in a close lending relationship, a firm may get higher amount of credit by outside lenders using its reputational gain obtained by new credit offered by its main bank (Fama, 1985; James,

[9] The goal of this practice is to avoid firms' default and resume all their financing.

[10] Firms in some context may desire to establish multiple banking to obtain benefits from the free riding activity practiced by multiple creditors or might want to benefit from multiple services and transaction centers (Ongena and Smith,2000).

1985). [11]

Finally, multiple banking relationships rather than a firm's choice, may be a consequence of banks' opportunistic behaviour. First of all, given the constraints that banks have to meet, such as the regulatory and managerial requirements, they may prefer to minimize and share of the counterpart risk by diversifying their exposures to a higher number of firms (Carletti et al. 2004). Also, banks may tend to act as *free riders*: considering information as a public good and believing that other banks will bear the cost of monitoring the firm, no one has incentive to do costly monitoring activities (Foglia et al.1998).

2.2. Empirical contributions on the determinants of multiple banking relationships in Italy

Several studies have investigated the determinants of multiple banking in Italy, suggesting the interplay of firm characteristics, bank-firm relationship features, banking and judicial system characteristics.[12] Moreover, the empirical contributions on multiple banking may be categorized in two strands: the first one investigates the determinants of the phenomenon and the second one the effects.[13]

In the first strand, using a cross-section of 1849 SMEs Italian manufacturing firms for the year 1994, Detragiache et al. (2001) investigate how firms' characteristics, banks' characteristics and the

[11] Generally, information asymmetries between parts induce the best performing firms to prefer fewer banking relationships to show their soundness (Bris and Welch, 2005). Besides, firms changing lending institutions may face higher interest rates applied by less informed new banks (so-called *switching costs*) (Sharpe, 1990).

[12] A review of the literature about the determinants of multiple banking in other countries is in appendix 1.

[13] Although these studies address new important determinants of the phenomenon of interest, their main weakness is that they do not contemplate the endogeneity problem of several determinants. Indeed, some important determinants are likely to be defined simultaneously with the number of banking relationships for a firm, hence they need to be treated as endogenous. To give an example, the concentration and the number of lending relationships are likely intertwined: closer ties with a main bank may influence the propensity to establish further banking relationships. On the other hand, the latter are bound to reverberate on the share of credit granted by the main bank.

efficiency of the judicial system of Italy may influence the number of bank relationships for firms.[14] The authors find a positive correlation between the country's judicial system inefficiency in loan recovery mechanism and multiple banking relationships, evidencing that, as predicted by their theory, the firm's choice to be multiple banked also depends on the efficiency of the enforcement system where the firm operates in.[15] Moreover, the probability of a firm to be multiple banked positively depends on its size, its debt, its propensity to innovate and on banks' features. Detragiache et al. (2001) results support the theory according to which multiple banking leads to a stable supply of credit reducing the risk of early liquidation of the investment project caused by internal problems of the main bank.

Tirri (2007) investigates the effect of Italy's banking system characteristics on multiple banking. Using a dataset of 9500 Italian firms observed from 1997 to 2004 and applying a probit and a GLS estimator, she finds that less transparent firms and those characterized by high risk, high level of debts and lower profits have multiple relationships. Besides, as predicted by the theoretical literature, she shows that firms operating in credit markets more concentrated tend to induce competition among banks increasing their number of bank relationships. This latter result is robust also taking into account the dynamic of the dependent variable, i.e. the presence of "state dependence" in the firm's choice of the number of bank relationships.[16]

Considering SMEs based on three different European regions, including Italy, and controlling for

[14] They focus on Italian manufacturing SMEs for different reasons, among these, the high variation of the number of banking relationships and the heterogeneous efficiency of the legal system in the Italian regions.

[15] They apply a Heckman selection model. In particular, they estimate the probability of multiple banking by using a probit model and the number of banking relationships by applying an OLS estimator including the Mill's ratio to correct for selection bias.

[16] In particular, in the GLS(re) estimation, the effects of the past number of bank relationships is positive and statistically significant indicating that the number of bank relationships that a firm has at time t-1 is positively related with the number of bank relationships at time t.

firms' characteristics, Mercieca et al. (2009) focus on whether banking market consolidation and competition may influence the number of bank relationships. [17] Using a Tobit model, the authors confirm the robustness of some firms' specific determinants (such as firms' size and age) and show that the greater is the competition between banks the higher is the probability for firms to be involved in multiple banking relationships, exploiting the possibility to choose the best relation inducing competition among banks. These results give support to the hypothesis that SMEs employ multiple banking relationships to avoid the *hold-up* problem and to get benefits from banking market competition.

According to Cosci and Meliciani (2002, 2005) the phenomenon appears conditioned not only by some characteristics of firms, but also by the behaviour of banks.[18] They find that the probability of multiple banking is positively influenced by firms' leverage, size, age and the riskiness of the industry to which they belong and negatively affected by being a co-operative. In particular, they report that firms belonging to a Hi-Tech sector, thus more opaque, have a higher probability to establish more banking relationships. In addition, they find evidence that multiple banking is a consequence of the opportunistic behaviour of banks rather than an optimal firm's choice.

Another study tending to confirm the hypothesis of the opportunistic behavior of banks is Vulpes (2005).[19] Using an ordered logit model, he finds that multiple banking is an increasing function of a firm's size, age, debt and rating. This last result may be caused by banks' risk aversion that leads them to prefer firms whose creditworthiness is easier to evaluate due to their structural governance and their information transparency.

[17] They use a dataset of 522 SMEs for the year 2001. The regions considered are: Emilia-Romagna in Italy, Bavaria in Southern Germany and the South-East of England.

[18] They perform a cross-section analysis on 393 firms customers of an Italian bank, while, for the study of 2005, they use Unicredit-Capitalia data on 2612 Italian manufacturing firms for the period from 1998 to 2000.

[19] Vulpes (2005) uses a dataset about 20.000 Italian firms for the year 2003.

A last study, that focuses on an Italian sample and that considers the majority of the determinants met in the studies examined so far, is Pelliccioni and Torluccio (2007).[20] They find that multiple banking is positively related to firms' size and debt. By contrast, a higher opaqueness seems to determinate a reduction of the aforementioned number. The duration of the relationship with the main bank, instead, seems not statistically significant. Finally, they highlight a significant effect of the concentration of the local banking market on the number of bank relationships.

Summarizing, despite the difference in the econometric methodology applied and the samples examined, some variables appear to be robust in explaining multiple banking: firm's size, age, leverage, opaqueness and the concentration of the banking market.

Apart from Tirri (2007), the literature so far reviewed does not take into account the dynamics underlying the choice of banking relationships. Indeed, the past number of relationships may be another important determinant of multiple banking. Therefore, an open question is whether there is an inertia in the firm's choice of being multiple banked. In particular, is the choice of the number bank relationships for a firm influenced by its past choices? As discussed above, there are some costs associated with close banking relationships that may induce firms to establish multiple relationships. When firms experience the *hold up* or the *liquidity* problem may be persuaded to switch to another bank.[21] By contrast, firms that benefit from close lending relationships are expected to maintain the relationship with their main bank, generating a "true state dependence"

[20] Pelliccioni and Torluccio (2007) use the eighth survey of Capitalia, including about 4452 manufacturing firms for the period from 1998 to 2000.

[21] Indeed, banks may initially apply a low interest rate and then increase it slowly inducing the borrower to switch bank and looking for more favorable conditions elsewhere (Ioannidou and Ongena,2010). The "captured" firm has all incentives to switch bank and get a lower interest rate. Although firms must pay a switching cost, they would be willing to pay that costs when switching cost are smaller than the interest rate that firms have to bear.

(Heckman, 1981). All in all, the firms' choice may be influenced by their experience, as well as by their unobserved characteristics that might cause an inertia in the number of banks chosen.[22]

2.3. Institutional Quality and multiple banking relationships

The idea that cultural, social and historical factors, institutions and the political and administrative context may play an important role in promoting development at macro and micro economic level has been studied by the economic literature.

As concerns the economic growth of countries, a strand of literature provides support to the role of institutional quality as a factor that decisively affects productivity and the development of economic and financial systems (La Porta et al. 1997 and 1998; Levine 1998; Hall and Jones, 1999; Acemoglu et al., 2001, 2002; Easterly and Levine, 2003).

Besides, a strand of literature has considered the link between institutional endowment and firms' financial behaviour (Claessens and Leaven, 2003; La Rocca et al., 2010). As a matter of fact, managers' decisions and firms' characteristics are influenced by several external factors outside firms' control, such as the excessive bureaucratisation, enforcement systems, inefficient organisation of public services, corruption, shadow economy, insufficient infrastructures, unsatisfactory social and

[22] Some papers study why firms switch to new banks and the effects of switching. Ioannidou and Ongena (2010) and Barone et al. (2010) analyze the role of switching costs in the corporate loan market, in particular in Bolivia and Italy. They find that new banks tend to initially apply low interest rates to attract switcher firms, and they may increase them during the relationship even if the financial condition of the borrower remains unchanged. These results support the existence of the *hold up* problem in close lending relationships, highlighting that multiple banking may mitigate it. Moreover, Barone et al. (2010) provide evidence of inertia in the firm's choice of its main banking partner caused by the existence of switching costs. According to Cole (1998), Farinha and Santos (2002) and Gopalan et al., (2011), the likelihood to switch and to get credit from a potential lender depends on the bank-firm characteristics and on firms' characteristics. However, Cole (1998) shows that potential lenders of a firm having multiple relationships, bear private information that is less valuable, hence influencing negatively their decision to extend credit to them. Moreover, Gopalan et al. (2011) find that the existence of a relationship with a large bank has a negative effect on the probability to switch to a new bank, while it has no influence on the firm's propensity to establish multiple banking relationships.

cultural environment. This link becomes significant when firms' financial choices are particularly connected to different geographical locations. In this case, the above-mentioned factors at the local level may be significant to clarify the heterogeneity in the firms' number of bank relationships.

Economic, social and institutional contexts may also influence firms and banks' propensity to establish close banking relationships. A better quality of institutions could mitigate the asymmetric information in the borrower-lender relationship.[23] Indeed, institutional quality may facilitate the interaction among economic agents, fostering close banking relationships and increasing trust between parts willing to gain all benefits connected to it.

To my knowledge, the extant literature investigates only the effect of single aspects of institutional quality on multiple banking in Italy and in other countries. Among the existing contributions, focusing on the efficiency of judicial and financial system, Ongena and Smith (2000) apply a Tobit model and show that strong judicial systems and strong creditors' protections seem decreasing the number of banks for firms, in a sample of European countries. By contrast, firms tend to maintain multiple banking relationships in countries where the banking system is relatively stable and not concentrated. Similarly, Detragiache et al. (2000), analyzing a sample of Italian manufacturing SMEs, find that Italy's judicial and banking system characteristics matter in explaining the firms' number of bank relationships. Moreover, Hernández-Cánovas and Koëter-Kant (2010), making inference on a sample of SMEs from nineteen European countries, show that the legal origins and the judicial efficiency of a country explain the likelihood of multiple banking. In the same vein, but focusing on social capital, Masciarelli (2011) investigates the effects of geographically bound social capital at the provincial level on firm-bank relationships, considering a

[23] Firms characterized by small dimension and high opacity may have difficulties in obtaining credit by local banks reluctant to offer credit in worse institutional settings (Haselmann and Wachtel, 2010). SMEs cannot catch the benefits of moving to the international capital and institutional markets since they are not easily accessible to them.

sample of Italian manufacturing firms. She finds a significant effect of social capital on firms' probability to establish a relationship with a limited number of banks and on the maturity of the loan.

2.3.1. What are the dimensions of institutional quality? A review of the literature.

Defining institutions is hard since there is not a common definition provided by the literature. North (1990) defines institutions as "*the rules of the game in a society; (and) more formally, (as) the humanly devised constraints that shape human interaction*" (p. 477). However, as Amin (1999) highlights, the economy is dominated by external forces including "*formal institutions such as rules, laws, and organization, as well as informal or tacit institutions such as individual habits, group routines and social norms and values*." (p. 367). [24] Thus, informal institutions such as norms, social convections, informal networks and interpersonal relationships are components of the dominant view of institutions.[25]

2.3.2. Government effectiveness and *Regulatory quality*

One of the key purposes of government's activity is to promote social and economic development. The efficiency of governments in managing the provision of public goods and the formulation of public policies is a significant determinant of countries' growth (Knack and Keefer, 1995). Indeed, formal institutions offer a variety of functions such as provision of social protection, investment in profitable assets (physical infrastructure, R&D facilities) and macroeconomic stability (Chang, 2003). Likewise, among firms, institutions create place-specific forms of interactions where

[24] A definition of informal institutions, definition frequently interchangeable with that of social capital, is offered by Helmke and Levitsky (2004): "*We define informal institutions as socially shared rules, usually unwritten, that are created, communicated and enforced outside of officially sanctioned channels*", (p. 727)

[25] Informal institutions arise from interpersonal and repeated interactions among agents (Rodrígues-Pose and Storper,2006; Fukuyama,2000).

sharing common territories' characteristics, enjoying trust and values reducing transaction costs (Fukuyama, 2000; North, 2005).

According to Putnam (2000), good formal institutions allow innovation, mutual learning and productivity growth and open the doors to new ideas and implementation of proficient projects and new strategies for firms in any given territory.[26] Through activities of business regulation- such as, simplified rules, promotion of entrepreneurial learning and innovation- governments may implement business environment conditions that make firm's business more successful. Moreover, more stable economic environments and regulatory conditions may allow SMEs to receive business friendly loans from banks. Indeed in many countries, SMEs are part of a large number of initiatives to foster their financing, including public guarantee funds and government subsidized lines of credit. In particular, credit guarantee scheme by reducing the asymmetric information between bank and firm might lead to both lower interest rates (D'Ignazio and Menon, 2013) and lower credit concentration (Mistrulli et al,2010). On the other hand, during a relationship based on credit guarantee scheme, a bank may discover that firms involved in the program are not as risky and unprofitable as initially supposed, becoming prone to provide funds outside the program in the future (Meyer and Nagarajan, 1996). Therefore, bank credit could depend on government programs supporting SMEs (De la Torre et al. 2010) and these programs, acting as a facilitator in the bank-firm ties (Zacchini and Ventura, 2009), may influence banking relationships. In other words, the ability of local government to manage and implement policy and programs may affect the firm's number of banking relationships and its propensity to be multiple banked. [27]

[26] These particular dynamics could be captured by two dimensions of the IQI here used: *Government effectiveness* and *Regulatory quality*.

[27] On the other hand, firms' activity and survival may be adversely affected by local inefficient regulatory systems (Falck,2007).

2.3.3. Rule of Law

Banks represent the SMEs' key source of financing and the dominant suppliers of credit in most economies and, in particular, in bank-based financial system, such as the Italian one. La Porta et al. (1997, 1998) and Levine (1998) state the existence of a strong tie between a country's financial system and its institutional environment.[28] In particular, firms resorting to external funds to realize new investments are influenced by the role of the enforcement system. However, the efficiency of the judicial system may mitigate asymmetric information and reduce problems of opportunism, with significant effects on the costs and benefits associated to bank-firm relationship. In contexts characterized by low quality of institutions and inefficient legal enforcement, banks have to deal with additional risks deriving from outside environments (Levine,1998) making them reluctant to invest for the presence of high agency costs (Papaioannou, 2009). [29] More in detail, legal enforcement influences the propensity of banks to provide finance as the difficulty to get back the liquidation value of collateral and the firm's bankruptcy risk increase. In civil law countries, such as Italy, where it is harder to enforce long-term contracts, banks exert their bargaining power in order to mitigate

[28] La Porta et al. (1997,1998) state a link between institutional and legal variables and economic/financial outcomes. They show that cross-country differences in creditor protection could be explained by differences in legal origin. In particular, analyzing different countries, they find that those with England common law origins seem to have better institutions, less corrupt governments and they provide a stronger legal protection to creditors and shareholders. By contrast, countries with French common law origins offer a weaker legal protection to them, bad quality of institutions and more legal formalism. England common law origins seem leading to better outcomes for the financial system.

[29] Qian and Strahan (2007), analyzing a sample of large firms located in forty-three different countries, study how laws and institutions influence large firms' financial contracts. Consistently with Ongena and Smith (2000), they find that in countries with better protection of credit rights the number of banks for a firm is lower. In this environment, firms can catch all benefits deriving from credit expansion at long term and at lower interest rate. By contrast, they show that weak legal protection leads to shorter maturities and multiple lenders. Beck et al.(2004) show that institutional development matters in explaining firm's financing obstacles: firms report lowers financing obstacles if located in countries with higher level of institutional development.

borrowers' opportunistic behaviour (Ergungor, 2004). [30] Indeed, in such environments, at the rising of a conflict between borrower and lender, a bank tends to act without judicial assistance and extract rents by putting into effect its power. In doing so, a bank prefers to involve other lenders diversifying its exposures to a higher number of firms (Ergungor, 2004; Carletti et al. 2004) reducing, at the same time, the *soft budget constraint* problem.[31] By contrast, in efficient legal enforcement banks can less effortlessly monitor the firm's credit risk, reducing the expected loss in case of default offering better loan contracts (Levine,1998).[32] Moreover, the efficiency of judicial enforcement influences firms' financial decisions (Cheng and Shiu, 2007): the choice of an optimal combination between debt and equity for SMEs not only depends on firm-specific characteristics but also on the institutional context in which firms operate. Indeed, the local institutional environment is crucial for SMEs, being for them harder to overcome local institutional inefficiency (La Rocca et al., 2010). They may need efficient institutions at the local level characterized by high magistrate productivity, low trial times and rigorous enforcement of the law to reduce the cost of contracting between bank and firm making easier the access to external funds.

To summarize, on a theoretical ground, following the traditional view, close lending relationships should dominate in an environment where the legal system strongly protects the interest of creditors and banks could easily control the debtor's level of default risk. By contrast, multiple banking may

[30] According to Ergungor (2004) a lower effectiveness to resolve conflicts between parts is recorded in civil-law courts than in common-law one. Civil-law courts have less flexibility in formulating new laws and construing laws.

[31] However, this banks' practice implies costs: banks' bargaining power may reduce borrowers' incentive to find credit for valuable investment projects that would be lost (Rajan, 1992) reducing the allocative efficiency of credit and deploying resources not based on risk-return criteria.

[32] Haselmann and Wachtel (2010) discover a significant causal relationship between the propensity of bankers to accept collateral and the quality of the legal system. In particular, their results show that a bank is inclined to lend to less transparent firms and to agree to several types of assets as collateral, in better legal system. By contrast, in worse legal environments, banks prefer to lend to firms and costumers able to offer valuable information on their projects and better guarantees.

dominate in weak institutional environment where creditors resort to shorter-term loans and more diffuse ownership, being relative easier in this case, to enforce contracts (Diamond, 2004).[33] On the other hand, a higher quality of the local enforcement system may allow SMEs to obtain credit more easily, and hence foster multiple banking relationships, as intermediaries may increase the number of clients being less afraid of borrowers exhibiting opportunistic behaviour (Agostino et al. 2002).

2.3.4. Voice & Accountability

Di Liberto and Sideri (2015) investigate the simultaneous impact of formal and informal institutions on economic performance, finding that institutions and their quality matter for the economic development of Italian regions.[34] In particular, they observe heterogeneity in the functioning of the same formal institutions in different environments, evidencing that informal factors could explain these differences across provinces. Indeed, in many contexts, although formal institutions are significant in shaping economic frameworks, informal institutions produce important incentives and constraints that drive social behaviours (Helmke and Levitsky,2004).[35]

From the literature on multiple banking emerges a study of Masciarelli (2011) that investigates the impact of social capital on both the firm's decision to be single banked and the maturity of the loan, using a sample of Italian manufacturing firms observed from 2001 to 2006 and applying a Logit

[33] Multiple banking helps the strategic behaviour of banks to grant small amounts of funding in order to share risk and minimize monitoring and screening costs (Diamond, 1984). Moreover, multiple banking decreases borrowers' incentive to practice strategic default since the ex-post cost of debt restructuring increases (Bolton and Scharfstein, 1996).

[34] They measure the economic performance of Italian regions by the total value added per capita at province (NUTS3) level .

[35] In high-trust societies, written contracts are less likely to be needed, and individuals do not have to specify every possible contingency (Knack and Keefer, 1997).

and an OLS estimator.[36] Considering the literature on asymmetric information (Sharpe,1990; Diamond, 1991; Rajan,1992; Boot, 2000), she recognises that trust, social interactions and information disclosure matter in the development of an efficient system of banking relationships.[37] In particular, she argues that high social capital environment might facilitate interactions between banks and firms as long as social capital mitigates asymmetric information drawbacks. In high social capital contexts, banks' monitoring activity may be heightened by the presence of networks where individuals are connected by weak or strong ties mitigating the information asymmetries and agency problems that may cause typical close lending relationships issues.[38] A high level of social interactions and trust, determined by a high level of social capital, may make easier the exchangeability of information between bank and firm: a firm may trust a bank prone to not divulge confidential information, on the contrary, a bank might trust a firm disposed to exchange private and true information.[39] Finally, Masciarelli (2011) finds that social capital promotes close lending relationships and that the debt maturity increases in high social capital contexts. [40]

[36] She uses a dataset that is the result of a combination of several datasets: Unicredit surveys for firm specific data and data collected by Italian Institute of Statistics for measures of social capital at the provincial level. For the Logit model she uses as dependent variable a dummy variable taking value 1 if a firm has up to two banking relationship and 0 otherwise. For the OLS model, the dependent variable is the debt maturity of a loan.

[37] According to Uzzi (1999), social embeddedness influences the access and cost of financial capital for firms.

[38] The flow of information about firms is more accessible as long as networks allow the diffusion of private information. Individuals and firms in the same network might benefit by social interactions, facilitating the acquisition of sufficient knowledge to recognize trustworthy and untrustworthy contexts.

[39] Moreover, Masciarelli (2011) recognizes the existence of three possible channels through which social capital may affect the number of bank relationships: the *connectivity*, the *quality* and the *punishment effect*. The first one promotes the exchangeability of information among agents; the second one sponsors the exchange of soft and private information; the third one ensures the existence of punishment mechanisms against opportunistic and antisocial behaviours.

[40] Among her results, Mascarelli (2011) confirms the determinants of single banking relationships.

Relying on the literature, the existence of informal institutions may be one of the key conditions shaping banking relationships.[41] Favourable socio-economic contexts, strong territorial rootedness, private information disclosure, trust, social interactions may lead banks and firms to establish close lending relationships being easier for banks to gain firm's qualitative information and easier to write contacts. [42] Yet, where trust improves access to credit (Knack and Keefer, 1997), multiple relationships might materialize.

2.3.5. Corruption

A high level of corruption in the government activities creates an unfavourable environment exerting a significant influence on firms' incentives and chances to perform good economic activities, influencing their economic and financial decisions. Firms located in provinces characterized by widespread corruption where politicians and supervisors do not maximize social welfare but maximize their own private welfare, are subjected to an allocation of credit not based on risk return criteria forcing them to give up on profitable investment strategies (Beck et al., 2006).[43] In provinces where corruption is widespread, a firm reluctant to engage in corruption behavior may lose its competitive position respect to its corrupted competitors. Therefore, it may decide in

[41] As mentioned in the literature review on multiple banking, banks' informational advantages stimulate them to behave as monopolists to extract rents, taking possession of financed firms and practicing high interest rates on loans that do not reflect the real credit worthiness of firms (Sharpe 1990, Rajan 1992). Consequently, firms may prefer to establish multiple banking relationships to avoid an informational capture and to instigate competition among banks. It is likely that in presence of asymmetric information multiple banking arises: monitoring costs are relatively high and banks may prefer to share risk with other banks by practicing the free riding strategy. On the other hand, firms may be inclined to establish multiple relations with banks to hide their effective financial situation avoiding a careful monitoring by banks (Foglia et al.1998).

[42] The sub index of IQI *Voice and Accountability* is built considering election participation, books published, the spread of collaborative and associative practices. Such proxies are interpretable also as expressions of civic sense, thus social capital.

[43] Corruption in financial intermediaries impedes firms to find external finance (Beck et al.,2006).

engaging in bribery to preserve its position on the market. SMEs may deal with corruption when they practice with public sector, private sector and network of people strongly related to the local territorial context. Xiaolan Zheng et al. (2013) argue that the institutional environment influences the choice to engage in corrupted behavior, and the likelihood of being wedged and punished, and thus contributes to variation in lending corruption. Indeed, corruption and political ties shaping the allocation of credit, may increase transaction costs, asymmetric information and agency costs hindering well-functioning banking relationships.

Existing literature on banking relationships do not directly investigate the potential effect of corruption and political connection on multiple banking. However, most empirical studies have analyzed the effect of the latter on access to finance (La Porta et al.,1997; Rodriguez et al., 2005; Nguyen and VanDijk, 2012).[44] Relying on the literature, the effect of corruption on multiple banking relationships may be ambiguous. In bank-firm relationships, high levels of informational asymmetry make the credit market a fertile ground for corruption. On the one hand, according to the law and finance theory, corruption having a negative effect on protecting banks and enforcing contracts, discourages banks from giving credit (La Porta et al.,1997). Corruption could act as obstacle to obtain lending, given that it may represent a tax that increases the cost of the loan for the borrower (Fungacova et al.,2015) and, contemporaneously, a cost for banks allocating resources in a suboptimal way. So, highly corrupted contexts encouraging opportunistic behaviors and increasing the degree of contractual riskiness may discourage bank-firm ties. On the other hand, the complexity and the disproportionate bureaucratic of the lending process selection and decision

[44] Several contributions in the literature state the existence of the impact of corruption- meant as political influences- on the lending process, finding that politically connected firms get preferential access to finance (Khwaja and Mian, 2005) and lower interest rate (Sapienza, 2004; Claessens et al., 2008; Cingano and Pinotti, 2013) especially in development countries. Moreover, this impact is particularly relevant even at the local level and where corruption is relatively more widespread (Infante and Piazza, 2014).

phases create incentives for engaging in corruption in order to facilitate, allow and speed up the process (Xiaolan Zheng et al., 2013). This may be particularly true for SMEs more financially constraint than large firms. Moreover, corruption can favour bank debt if borrower decide to propose a bribe to corruptible bankers to get a loan (Weill, 2011; Beck at al., 2006) or resort to political connection to obtain preferential access to finance (Khwaja and Mian, 2005) and lower interest rate (Sapienza, 2004; Claessens et al., 2008; Cingano and Pinotti, 2013). Indeed, firms' political connections are considered important resource for them in context where the enforcement of the legal system is weak (Fisman, 2001). So, corruption may "oil the wheels" of the bureaucratic procedures required to obtain credit (Weill, 2011; Fisman, 2001; Xiaolan Zheng et al., 2013), making easier to establish multiple banking relationships.

3. EMPIRICAL ANALYSIS

3.1. Testing hypotheses, empirical question and econometric models

My main testing hypothesis is that variation in local institutional quality contexts may play a role in shaping bank-firm relationships. The impact of institutional quality on multiple banking may be ambiguous depending on the impact of each sub-component. In other words, the impact of each sub-component on multiple banking is an "open empirical question". In particular, in contexts characterized by more efficient judicial systems being easier to write and enforce contracts single banking could dominate, as main banks may be more inclined to concentrate their credit exposure where the enforcement system enables a more effective credit protection (Ongena and Smith,2000; Detragiache et al.2000; Hernández-C. and Koëter-K.,2010). On the other hand, a higher quality of local enforcement system may allow SMEs to obtain credit more easily, and hence foster multiple banking relationships, as intermediaries may increase the number of clients being less afraid of borrowers exhibiting opportunistic behaviour (Agostino et al. 2002). Moreover, the ability of local

government to manage and implement policy and programs may affect the firm's number of banking relationships and its propensity to be multiple banked.[45] On the one hand, public guarantee funds and government subsidized lines of credit by reducing the asymmetric information between bank and firm can lead to better credit conditions (D'Ignazio and Menon, 2013) and to a lower credit concentration (Mistrulli et al,2011). On the other hand, during guarantee scheme, a bank may discover that firms involved in the program are not as risky and unprofitable as initially supposed and become prone to provide funds outside the program in the future (Meyer and Nagarajan, 1996), establishing a relationship lending. High social capital contexts mitigating opportunistic and anti-social behaviors may lead banks and firms to establish close banking relationship. Yet, where trust improves access to credit (Knack and Keefer, 1997), multiple relationships might materialize. Finally, highly corrupted contexts encouraging opportunistic behaviors and enhancing the degree of contractual riskiness may discourage bank-firm ties. On the other hand, corruption may "oil the wheels" of the bureaucratic procedures required to obtain credit (Weill, 2011; Fisman, 2001; Xiaolan Zheng et al., 2013), making easier establishing multiple banking relationships.

From a methodological standpoint, I employ several econometric estimators. First of all, I adopt the Probit estimator to test the effect of institutional quality on the probability of multiple banking. Secondly, since my dependent variable is a count variable, I apply the Poisson estimator to investigate the effect of institutional quality on the firm's number of bank relationships. Thirdly, I adopt the SYS-GMM estimator to allow for inertia in the choice of having multiple banking relationships (dynamic effects), as well as for firms persistent unobserved characteristics (firms

[45] In Italy SMEs are part of a large number of initiatives to foster their financing, including public guarantee funds and government subsidized lines of credit.

heterogeneity), and to account for the endogeneity of several explanatory variables.[46] The estimating equations are the following:

$$P(y_{it} = 1|X) = \Phi(\alpha + \beta_1 IQI_{jt} + \gamma X'_{it} + \sum_s \delta_s S_s + \sum_j \gamma_j P_j + \sum_t \varphi_t T_t) \quad (1)$$

$$NBANK_{it} = \alpha + \beta_1 IQI_{jt} + \gamma X'_{it} + \sum_s \delta_s S_s + \sum_j \gamma_j P_j + \sum_t \varphi_t T_t + v_{ijt} \quad (2)$$

$$NBANK_{it} = \alpha + \beta_0 NBANK_{i,(t-1)} + \beta_1 IQI_{jt} + \gamma X'_{it} + \sum_s \delta_s S_s + \sum_j \gamma_j P_j + \sum_t \varphi_t T_t + v_{ijt} \quad (3)$$

where indices *i* and *t* refer to firms and time periods, respectively. In model (1), the dependent variable is a dummy variable y_{it} that assumes value 1 if a firm *i* at time *t* maintains a number of bank relationships greater or equal two (and zero otherwise), and Φ is the cumulative density function of the normal distribution.[47] In model (2) and (3), the dependent variable NBANK is the

[46] To empirically analyze the above causal relationship, the Heckman selection model could be also employed, modeling both the probability of being multiple banked and the number of banking relationships for a firm. Unfortunately, in the dataset I use, only one firm is characterized by a number of banking relationships equal to zero, discarding the adoption of the Heckman model.

[47] Generally, a binary response model (Probit and Logit model) can be interpreted in terms of a latent model under which a latent variable process is realized. In my case, I assume for each firm it exists a latent tendency to maintain multiple bank relationships, indicated by y_i^* and generated by the following process: $y_i^* = \beta' X_i + u_i$. The vector X includes some observed characteristics and u_i is an error term capturing unobserved characteristics. A firm choices to be multiple banked if the difference in the utility between being single banked and multiple banked exceeds a given threshold that can be imposed equal to zero. Specifying by y_i the indicator function, then $y_i = 1$ if and only if $y_i^* \geq 0$ and $y_i = 0$ if and only if $y_i^* < 0$. Therefore, the probability of multiple banking is: $E(y_i|x_i) = \Pr(y_i = 1) = \Pr(y_i = 1|x_i) = \Pr(y_i^* \geq 0) = \Pr(\beta' x_i + u_i \geq 0) = \Pr(-u_i \leq \beta' x_i) = \Phi(\beta' x_i)$. In this work, I consider as multiple banked all firms maintaining a number of bank relationships greater or equal than two, corresponding to the first percentile of the distribution of the number of bank relationships variable (NBANK) in my sample. By contrast, Tirri

number of bank relationships per firm *i* at time *t* . To estimate model (2) and (3), I apply the Poisson and the SYS-GMM estimator, respectively. [48]

On the right hand side of the models, I use the IQI in province *j* at time *t* proposed by Nifo and Vecchione (2014) as the main explanatory variable and the IQI sub-indexes as regressors in place of the synthetic index in subsequent regressions.

In all equations, T, S and P are sets of time, sector and provincial fixed effects, respectively, while, for equation (2) and (3) $v_{ijt} = \eta_i + w_j + e_{it}$ is a composite error, where the individual effect η_i summarizes time-invariant unobserved firms' characteristics, w_j catches the provincial fixed effect, and e_{it} captures idiosyncratic shocks.

As concerns the control variables included in vector X, theoretical and empirical studies have shown that firms and bank-firm characteristics (such as size, age, indebtedness, credit rationing, duration of the relationship with the main bank and its share of debt), and external conditions (such as the development of the local banking market and the economic conditions of the province where firms operate) are likely to be determinants of multiple banking (Detragiache et al.,2000; Ongena and Smith, 2000; Ferri and Messori, 2000; Carletti et al. 2004; Cosci and Meliciani,2005; Pelliccioni and Torluccio, 2007). Hence, most of these determinants are considered in my empirical analysis. Concerning firm size, a positive relationship is expected with the firm's number of bank relationships. Indeed, banks may prefer to diversify the firms' credit risk inducing large firms to establish multiple banking relationships (Detragiache et al. 2000; Pelliccioni and Torluccio,2007). Besides, large firms may resort to several banks given the complexity of their activity. By contrast, small firms are discouraged to maintain multiple relationships by the existence of fixed costs (Guiso

(2007) and Cosci e Meliciani (2002,2005) consider as multiple banked a firm maintaining a number of bank relationships greater than three and seven, respectively.

[48] More details about the econometric models are reported in the Appendix A.

and Minetti 2007). Thus, to account for the firm's size, the variable EMP - measured by the number of firm's employees- is included in the model.

Besides, to gauge the degree of firm's information transparency, I include some proxies such as the firm's age (AGE); indicators of product and/or process innovation and organizational management innovations (INPP, INORG respectively); an indicator of belonging to high-tech sectors (HT); and the ratio of intangible assets on total assets (INTAS). The impact of the variable age is debated. On one hand, mature firms, survived to the critical start-up phase and with a history about their past performance, are less opaque. Thus, banks may be more inclined to grant credit to them (Diamond,1991). On the other hand, mature firms, less subjected to adverse selection, may prefer to maintain a small number of bank relationships (Detragiache et al. 2000). According to Elsas (2005), innovation activity is another proxy of informational transparency. More innovative firms might prefer close banking relationships, to avoid the diffusion of information to direct competitors (Yosha, 1995). However, they may prefer multiple relationships to prevent the *hold up* problem. Moreover, given the high opaqueness of firms belonging to Hi-Tech and innovative sectors, banks might prefer to practice a risk differentiation (Pelliccioni and Torluccio, 2007). Furthermore, leveraged firms can be induced to establish a higher number of bank relationships by the banks' practice of maximizing the number of loans and minimize the counterparts risk by diversifying their credit exposure (Carletti et al. 2004). Besides, the adverse selection problem may be more severe to leveraged firms, increasing their number of bank relationships (Detragiache et al. 2000). Thus, my empirical model includes the variable LEVER, expressed as the ratio of financial liabilities and equity, to account for the firms' indebtedness. Moreover, in order to take into account bank-firm characteristics, I consider the following three variables CRED, DURAT and MAIN measuring the firm's credit rationing, the duration of the relationship with the main bank and its share of the debt, respectively. Firms involved in close banking relationships, in order to minimize

the rationing risk associated to possible liquidity problems of the main bank in financing ongoing investment project, may be prone to maintain multiple relationships (Detragiache et al. 2000). In close lending relationships, asymmetric information is mitigated and the main bank may induce the firm to maintain a single relationship granting better credit conditions (Sharpe 1990, Rajan,1992). On the other hand, firms subjected to the main bank's bargaining power may decide to establish multiple relationships.

Additionally, the economic conditions of the province where firms operate and the development of the local banking market are accounted for, including the variables RGDPC - measured as provincial real GDP (per capita) - and the variable BRANCH - calculated as bank branches on population. Firms may maintain a small number of bank relationships in areas characterized by higher economic development, deciding to finance their investment projects with internal financial resources. However, in developed areas, firms may decide to establish multiple relationships to satisfy their needs of multiple financial services. Moreover, the presence of new banks in provincial credit markets may induce better monitoring and screening processes, increasing soft information collected by the intermediaries, inducing closeness between banks and firms (Benfratello et al., 2008). On the other hand, a closer proximity may induce higher market power that may allow banks to charge interest rates at non-competitive terms.

The past number of banking relationships of a firm may influence its actual number of banking relationships. On one hand, a firm may decide to switch to another bank if subjected to the *hold up* or the *liquidity* problem. On the other hand, a firm involved in an efficient close banking relationship may choose to maintain the relation with its main bank ("true state dependence").

Finally, other variables are included to catch other firm's characteristics. The dummy variable GROUP indicates whether firms belong to a group. According to Detragiache et al. (2000), a firm belonging to a group may have less necessity to maintain multiple relationships receiving credit from

members of its group. Similarly, financial members or a main bank may finance all firms taking part of a consortium. Thus, I include a dummy variable (CONS) whether firms belong to a consortium. As Ferri and Messori (2000) and Cosci and Meliciani (2005) state, co-operative and popular banks generally engage in close banking relationships with co-operative firms that, consequently, may establish relationships with a lower number of banks. Thus, to control for the firm's legal form, I include a dummy variable (COOP). In addition, internationalized firms may need a higher number of bank relationships to manage their foreign transitions. Hence, I include a dummy variable (EXP) coded one if a firm exports its product to foreign countries (and zero otherwise). Moreover, a lower number of bank relationships is expected for firms having more liquidity. Thus, I include the variable QUICK defined as the ratio of current asset and inventories to current liabilities. Finally, all estimations include industry dummies to control for heterogeneity at sectoral level (2-digit Ateco classification). All variables employed are described in Table 1, while Table 2 reports the relative correlation matrix. [49]

As mentioned before, estimating model (3) by adopting SYS-GMM, allows to control for NBANK inertia, unobserved heterogeneity, and the presence of endogenous (or predetermined) explanatory variables.[50] To address the endogeneity problem the SYS-GMM estimator employs (different sets of) internal instruments that the model generates. More precisely, the estimator is based on a two-step procedure, which starts transforming the data to eliminate the unobserved fixed effects and, in

[49] Incidentally, as robustness check concerning the specification adopted, I estimate also a model substituting some measures with alternative proxies.

[50] Controlling for firm heterogeneity may be particularly significant for small businesses. Indeed, as Shikimi (2013, page 128) highlights: "The treatment of unobserved firm quality is particularly important when we use data on small and medium-sized firms since less information that is observable and audited is available for them than for listed companies".

order to cope with the endogeneity problems, employs valid instruments variables (details are provided in Appendix A).[51]

The key variable (IQI) and its sub-indexes are likely to be endogenous, as variation in the error term may affect both institutional quality and the firm's number of banking relationships. [52] In the control vector X some explanatory variables - such as EMP, LEVER, QUICK - are likely to be defined simultaneously along with the firm's number of bank relationships, thus they are treated as endogenous. Moreover, it may be plausible that the current values of the variables AGE, INPP, INORG, INTAS, GROUP, CONS, EXP, MAIN, DURAT, CRED, BRANCH and RGDPC are influenced by past shocks of the number of bank relationships and, so, likely to be influenced by feedback effects. Hence, these variables are treated as predetermined. The remaining variables are treated as exogenous: HT, COOP, sector dummies, year and provincial fixed effect.[53]

Finally, it is worth highlighting that the provincial GDP of a geographical area is likely correlated with institutional quality. In particular, the institutional quality of a province may be an

[51] Under the assumption of white noise error terms, Arellano and Bond (1991) suggest a DIFF-GMM procedure exploiting the entire set of instruments generated by the model. The lagged variables used as instruments may be poor instruments if the explanatory variables are persistent over time. For this reason, Arellano and Bover (1995), Blundell and Bond (1998) propose the *System GMM* (GMM-SYS). This method, among the conditions of the DIFF-GMM, employs extra orthogonality conditions using the lagged differenced of the regressors as instruments for the equation in levels under the hypothesis that the unobserved effects are not correlated with changes in the error term. This increases the efficiency of the estimation.

[52] Among firms belonging to the same province, there could be common effects that influence both institutional quality and multiple bank relationships. These effects are captured by the error term causing endogenous variations in the dependent variable and in the explanatory variable. Within these common factors may figure out cultural factors at the local level that may influence institutional quality hindering equality, meritocracy and the real interest of the local community. These common effects could arise from the so-called *amoral familism* of Edward C. Banfield, according to which "no one will pursue the interest [...] of the community, unless it does not come back to his own advantage", in other words, people cared only for its own "members" at the expense of their fellow citizens.

[53] In performing the Probit and Poisson regressions, I take the lag of potential endogenous and predetermined variables in order to mitigate the "reverse causality", recognizing that feedback effects may arise.

effect of the economic development characterizing the same area. Consequently, GDP might tend to absorb the effect that institutional quality may have on multiple banking relationships. Therefore, trying to isolate the impact of institutional quality on multiple banking, I carry out several sensitive checks. As a first, I run all the regressions excluding the variable RGDPC (Provincial real per capita GDP). Second, I re-run all the regressions including this variable. Third, I carry out the regressions including the variable RGDPC, but considering only firms located in the North of Italy, where economic development is more homogeneous. By doing so, I try to exclude from my estimations the economic divide between North and South of Italy, which may be correlated with differences in institutional quality.

3.2. Data

The empirical analysis is based on data coming from several sources. The information about Italian manufacturing small and medium enterprises is drawn from the 9th and the 10th UniCredit-Capitalia surveys known as "*Indagine sulle Imprese Manifatturiere"*. These surveys are performed on all Italian manufacturing firms employing more than 500 workers and on a stratified sample of firms with more than 10 workers. Each surveys used is based on three years: the 9th survey offers data for 4289 firms for the period 2001-2003; the 10th survey reports data for a panel of 4126 firms for the period 2004-2006. These surveys provide qualitative data such as the year of establishment, group membership, size, sector, legal form, financial structure and the number of bank relationships.[54] Capitalia also provides balance sheet data on firms. An unbalanced panel of 5,137

[54] The information about the number of lending banks (NBANK), the length of the relationship with the main bank (DURATION), and the percentage of the firm's total bank debt held by the main bank (MAIN) is available only for the last year of each survey. Therefore, the value of the last year of each survey of NBAN has been imputed to the previous two years of the corresponding survey in order to use the whole periods of time for which the other variables are accessible. Only when DURAT of the relationships with the main bank was positive (to have an indication that the relationship with

firms for the period 2003-2006, for a total of 16,460 observations is obtained matching qualitative and budget data. Focusing on SMEs - which are more likely to seek credit from banks in the same local market where they evolve- I drop firms with more than 250 workers and those listed on the Stock Exchange.

The Bank of Italy offers, for the same time period, information on the territorial distribution of branches for each Italian bank, while ISTAT (Italian National Institute of Statistics) provides information on per capita GDP.

Finally, data on institutional quality for the period 2004-2006 are provided by Nifo and Vecchione (2014), who compute an institutional quality index (IQI) as a weighted average of some political, administrator and social indicators.[55] They construct the IQI following the structure of the World Governance Indicator proposed by Kaufmann et al.(2011) adopting a hierarchy configuration (illustrated by Fig. 1). [56] In particular, they perform the aggregation of twenty-four elementary indexes of a lower rank to derive five dimensions representing some important characteristics of a governance system at province (NUTS3) level:

- *Rule of Law* includes data on magistrate productivity, on crime against property or person, the degree of tax evasion, trial times and shadow economy.

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the main bank was in place in each imputation year), similar imputation has been adopted for MAIN, otherwise no imputation has been applied. Given that in many cases the values of DURATION were contradictory, similarly to Gambini and Zazzaro (2010) and Agostino et al. (2012), it is adopted an imputation for DURAT. In particular, taking the value of DURAT at the last year of the first survey (2000), it is added a number from 1 to 6 for the last six years, and, it is deducted a number from 1 to 2 for the first two years of the period of time examined.

[55] More details about the construction of the institutional quality index are reported in Appendix A.

[56]The values of the lower rank indexes are collected form official surveys and sources performed by nongovernmental, public and private institutions overlying the period 1991-2009. In the majority of the case, the values of the elementary index are computed considering data prior to 2004, only in some cases the data refers to periods after this year. According to Nifo and Vecchione (2014), there is not issue deriving from the heterogeneity of the time periods since changes in institutional quality take place in the medium to long term.

- *Regulatory Quality* encloses information regarding the ability of local administrators to promote and defend business activity expressed as the degree of openness of the economy and business settings.
- *Government Effectiveness* measures the endowment of economic and social arrangements in Italian provinces and the administrative capacity of provincial and regional governments on management policies, health, waste and ambience.
- *Voice and Accountability* comprises the existence of associations, the participation in public election, the number of social cooperatives and cultural liveliness gauged in terms of books and expense in bookshops.
- *Corruption* reassumes data on the number of local administrators refused by federal authorities, data on crimes committed against the public administration and the Golden-Picci Index that measures the corruption level on the basis of 'the difference between the amounts of physically existing public infrastructure […] and the amounts of money cumulatively allocated by government to create these public works' (Golden and Picci, 2005, p. 37).

[TABLE 3]

Table 3 reports the ranking of Italian provinces classified on the basis of the average firm's number of bank relationships by province and the average of the IQI by province. The identical information is offered by Fig. 2 and 3 with a geographical information system. In particular, figure 2 shows that provinces with a lower level of institutional quality seem to be characterized by a low average number of bank relationships for firms and vice versa. However, Southern provinces having low IQI are also the poorest ones, hence, the lower average number of bank relationships for firms may derive from an economic context less developed and less dynamic. Indeed, firms located in the South of Italy may need fewer banking and financial services and lower credit to finance and

realize their investment projects. Figure 3 emphasizes a clear institutional quality divide between the North and South of Italy.

4. EMIRICAL RESULTS

Table 4 reports the results obtained estimating model (1), (2) and (3) using the Probit, Poisson and SYS-GMM estimators.[57] Columns from 1 to 3 show the output obtained when not including RGDPC, with RGDPC, and the estimates concerning the North of Italy, respectively. [58] For a more immediate interpretation of estimated coefficients, I report the estimated marginal effects for the Probit and Poisson estimations. [59]

[TABLE 4]

Focusing first on the results of the regression models obtained without considering the variable RGDPC (column 1), the variable of interest IQI (defined at the provincial level) is negative and statistically significant in most of the models and it seems to confirm my research hypothesis (the

[57] All regressions are performed including provincial, year and sector fixed effects. The standard errors are clustered at province (NUTS3) level and consistent in the presence of any pattern of heteroskedasticity. To avoid the influence of potential outliers, I winsorize at 1% level some explanatory variables. This practice consists to assign the critical value of the first (last) percentile to all observations that are smaller (or greater) of the corresponding critical values.

[58] According to Roodman (2006), the GMM estimator is appropriate when N is larger than the number of moment conditions. To meet this requirement, I consider a sample over four years imputing the year 2004 figures of the variables IQI (IQI_REG and all separate dimensions) to the year 2003. This imputation may be acceptable as "*it is reasonable to assume that the processes of institutional change occur slowly, and that appreciable changes in institutional quality occur only in the medium- to long-term*" (Nifo and Vecchione, 2013, pp. 6). For consistency, I use the same sample even for the Probit and Poisson regressions.

[59] I report the estimations Probit and Poisson in pooled and panel form. To formally compare the pooled estimator with the panel estimator, I perform a likelihood-ratio test, showing that the panel (Probit and Poisson) estimators are appropriate. Moreover, to test the assumption of *equidispersion* underling the Poisson distribution, I perform the likelihood ratio test of over-dispersion by running the same regressions models using the negative binomial distribution. From the results obtained, omitted for the sake of conciseness, there is no evidence of over-dispersion.

variable IQI being not statistically significant only in the Poisson instance).[60] In particular, the results show that a better institutional quality decreases both the propensity to be multiple banked and the number of bank relationships for firms. A possible interpretation of this finding is that good institutions may foster environments where banks and firms favourably interact to exchange information and promote close banking relationships. In other words, institutions may create good conditions in mitigating asymmetric information allowing firms and banks to catch all benefits deriving from close banking relationships. In particular, institutional quality might represent an indirect form of control to avoid opportunistic and anti-social behavior leading firms to establish a small number of bank relationships.

Looking at the control variables, I found that EMP, AGE, LEVER, HT, INPP, QUICK, and EXP tend to be statistically significant at 1% level. [61] In particular, looking at the EMP and LEVER parameter, it seems that larger dimensions and higher levels of firms' indebtedness tend to increase both the propensity to be multiple banked and the number of bank relationships. Further, the parameters of the variables AGE, HT and INPP are positive and significant, suggesting that more mature firms may build good reputation, allowing them to establish new bank relationships, while innovative firms may be willing to avoid the appropriation of soft information by the main bank and/or they might attempt to finance their investment in innovations using a higher number of banks.[62] The variables INORG and INTAS are positive and statistically significant only for the Poisson regressions, suggesting that innovative and opaque firms prefer to establish a greater

[60] The Hansen test accepts the null hypothesis of validity of the over-identifying restrictions, and the difference-in-Hansen test outcome is not significant, supporting the validity of the extra instruments used by the SYS-GMM estimator. Besides, the values of the Arellano-Bond tests for autocorrelation in first and second differences (AB test AR1 and AB test AR2) tend to support the assumption of lack of autocorrelation in the errors in levels.

[61] The comments about the control variables are referred to the estimation including the variable IQI.

[62] For the SYS-GMM estimation, the variable AGE and INPP are not statistically significant.

number of bank relationships.[63] On the opposite, firms characterized by a higher level of liquidity (QUICK) seem to be less prone to maintain multiple relationships. Moreover, the EXP coefficient is positive, indicating that internationalized firms seem resorting to multiple relationships.[64] Furthermore, the variable COOP is negative and statistically significant only for the Probit (panel) regression, indicating that co-operative firms seem to be less prone to maintain multiple relationships. Looking then at the results concerning the characteristics of bank-firm relationship, the variable MAIN is negative and statistically significant only for the Poisson regressions, indicating that an increase in the share of the debt granted by the main bank decreases the firm's number of bank relationships. What is more, only for the Poisson models, the variable CRED is positive and statistically significant suggesting that rationed firms tend to maintain a greater number of bank relationships. Finally, the positive coefficient of BRANCH indicates that a more developed local banking market might induce an increase of the propensity of being multiple banked.[65] The other control variables are not statistically significant. The results above discussed are substantially confirmed when employing the IQI at the regional level (IQI_REG). Therefore, for the sake of conciseness, these results are omitted and available on request.

4.1. The impact of each IQI dimension

An interesting question is whether the negative relationship between institutional quality and multiple banking could be specifically attributed to one or more of the dimensions included in the synthetic index. To study the possible different effects of each dimension composing the IQI, I estimate five supplementary sets of regressions of the above models by using in turn one of the IQI

[63] The variable INORG is statistically significant only for the Poisson (pooled) regression.

[64] The variables QUICK and EXP are not statistically significant for the SYS-GMM estimation.

[65] The variable BRANCH is statistically significant only for the Probit regression (panel) and for the SYS-GMM regression.

dimensions as regressors instead of the synthetic index. Table 5 reports the results obtained estimating model (1), (2) and (3) using the Probit, Poisson and SYS-GMM estimators, respectively.[66] Column 1 shows the output for each sub-index obtained when not including RGDPC.

[TABLE 5]

Focusing on the potential impact of the efficiency of the legal system on multiple banking, empirically assessed through the sub-index RUL (RULE OF LAW), looking at Table 5, column 1, the marginal effect of that variable on the probability to be multiple banked is negative and statically significant.[67] In particular, the results show that in provinces with a more efficient legal system in terms of magistrate productivity and trial times, better protection of property rights and with a lower propensity to the occurrence of crime against property, the firms' propensity to maintain a large number of bank relationships decreases. A possible interpretation of this finding is that, in these contexts, asymmetric information and agency costs are mitigated leading banks and firms to establish close banking relationships.[68]

As concerns the impact of the government activity on multiple banking, the estimated marginal effect of the variable GOV (GOVERNMENT) is negative and statistically significant in most of the models, while the REG variable (REGULATORY) is negative and statistically significant only for the SYS-GMM estimator.[69] Hence, the results show that as the administrative capacity of local governments in terms of policies and public services, and the ability of local administrators to promote and protect business activity increase, the number of bank relationships and the firm's propensity to be multiple banked decrease.

[66] To economize on space, in Table 5 I present all regressions of the above models showing only the coefficients for the IQI subcomponents.

[67] This variable is statistically significant only for the Probit model (pooled).

[68] To give a numeric interpretation of this result, the probability of multiple banking decreases by about 11,5% as the rule of law indicator increases.

[69] The variable GOV is statistically significant for the Probit (panel), Poisson (pooled) and SYS-GMM estimators.

As concerns informal channels affecting bank-firm relationships, the IQI figures out synthetic aspects of informal institutions: VOICE - including proxies of social capital - and COR (CORRUPTION).[70] As the marginal effect of the variable VOICE is negative and statistically significant, the probability of multiple banking seems decreasing as social capital increases.[71] Conversely, the variable COR is not statistically significant. A possible interpretation of this finding is that a high level of social interactions may make easier the exchangeability of information between bank and firm promoting close lending relationships (Masciarelli, 2011).

Summarizing, the results of my regressions confirm that the firms' number of banking relationships and their propensity to be multiple banked is strongly affected by the institutional quality of province where they are located. This conclusion supports the view that single banking is significantly undermined by institutional weakness, which creates additional constraints on SMEs' efforts to overcome relationship lending issues.

4.2. Robustness checks

As mentioned above (section 3), institutional quality and GDP are intertwined. Development is a determinant of institutional quality: the higher is the level of development of a region the higher should be the institutional quality of the latter (Alonso and Garcimartín, 2013), and vice versa, institutional quality is expected to foster development. Hence, empirically discerning the causal effect that institutional quality may have in shaping bank-firm relationships from the effect of GDP is not a trivial task.

[70] The sub index VOICE captures dimensions such as, election participation, books published, the spread of collaborative and associative practices, and all expression of civic sense interpretable in term of social capital. While, the sub index COR captures what are called non-institutional behavior, such as clientelism and abuse of authority power to reach private interests at the expense of society.

[71] The variable VOICE is negative and statistically significant only for the Probit (panel) regression while the variable COR is not statistically significant.

However, Italian data may be suitable to distinguish the simultaneous impact of GDP and institutional quality on multiple banking as although most of Italian regions have the same central government institutions, it exists a persistent duality in the quality of Italian institutions between the Northern developed regions and Southern undeveloped ones. In the case of Italy, inter-regional differences in the endowment of institutional factors are particularly significant. However, the variation of these inter-regional difference may be smaller among Northern developed regions, where economic development is more homogeneous.[72]

Therefore, trying to isolate the impact of institutional quality on multiple banking, I carry out several sensitive checks. Table 4, column 2, reports the results obtained by re-running all the regressions including the variable RGDPC. The main results (above discussed) tend to be substantially confirmed.[73] In all models, the control variables confirm their previous sign and significance.[74] Besides, running the first robustness check, the results above discussed are substantially confirmed for the IQI at the regional level (IQI_REG) and for all control variables. [75]

Second, I re-run all the models considering only the firms located in the North of Italy (where observations are more homogeneous in term of GDP) and including the variable RGDPC. As table 4,

[72] Firms located in the North of Italy operate in dynamic markets and they may need more banking and financial services, more credit to finance investment projects, such as adopting new technologies, doing innovation in process and product. Moreover, firms located in regions having similar characteristics may face the same incentives and disincentives offered by the financial market. Indeed, in these geographical areas, firms create industrial districts operating at local level in order to stimulate the development of competitive markets (Triglia,1990). They share cultural, political and social identity in order to promote inter-firm relations (Rodrígues-Pose, 2013) creating, indirectly, homogeneity in the economic outcomes across regions.

[73] The variable IQI is not statistically significant for the Probit and Poisson (panel) regressions. In particular, for the Probit regression, the variable RGDPC probably absorbs the significance of the variable IQI being statistically significant at 1% level.

[74] In particular, with respect to the estimation not including the variable RGDPC, the variable COOP is not longer statistically significant.

[75] For the sake of conciseness, these results are omitted and available on request.

column 3 shows, the results are substantially unchanged.[76] In all models, the control variables confirm their previous sign and significance, the variable RGDPC being statistically significant only for the Probit regressions.[77]

The robustness checks so far described are also carried out for each sub-index composing the IQI. Table 5, column 2, reports the results obtained including the variable RGDPC. They appear not systematically different from the results reported in Table 5, column 1.[78] As concerns the estimations considering the North of Italy including RGDPC (table 5, column 3), with respect to the estimations without the variable RGDPC, the dimension RUL gains significance even in the SYS-GMM regression; the variable GOV maintains its sing and significance; the dimension VOICE loses significance in the Probit (panel) regression but it gains significance in the SYS-GMM regression; the variable REG loses significance, while the dimension COR becomes significant in the SYS-GMM regression showing a negative sign.

Finally, the results above discussed remain substantially unchanged when I substitute some control variables with alternative proxies (in details, INTAS is replaced with TGAS; LEVER is substituted by BANKD; the control variable LIQUI is replaced by QUICK and FIND). To economize on space, I omit the output of these last checks, making it available upon request.[79]

As final robustness check, I address concerns of endogeneity relating to the main variable IQI and its sub-indexes likely to be endogenous, as variation in the error term may affect both institutional

[76] The variable IQI is not statistically significant for the Probit and Poisson panel regressions.

[77] Again, the results above discussed are substantially confirmed also when employing the IQI at the regional level (IQI_REG). For the sake of conciseness, these results are omitted and available on request.

[78] With respect to the regressions not including the variable RGDPC, only the variables GOV and VOICE lose significance in the Probit (panel) regressions and the variables RUL and REG in the SYS-GMM regression.

[79] The estimated coefficients of the control variables are all statistically significant. In particular, the coefficient of the variable representing the firm's capitalization (FIND) is negative and statistically significant, indicating that capitalized firms resort less to multiple banking.

quality and the firm's number of banking relationships. So far, in my regressions, I have limited potential endogeneity problems by lagging the variable IQI, or its sub-indexes (when estimating the Probit and Poisson models), or by exploiting (all) internal instruments when adopting the SYS-GMM model. Here, I apply an Instrumental Variable (IV) probit, IV poisson and an IV random-effects estimators using as external instruments some variables defined at provincial level at the end of the 1800s, soon after the political unification of Italy. As historical fact, while Italy is unified in 1861, Rome and Venetia become part of the Kingdom of Italy respectively in 1866 and 1870. A significant heterogeneity in the economic development, number of illiterate people and institutional quality characterize the years around 1800s.[80] These differences at provincial level are supposed to be correlated with later institutional development, but not correlated with actual firm's choices to be multiple banked.

[TABLE 6]

Looking at Table 6 the results remain substantially unaltered when excluding the control variable RGDPC.[81]

[80] As the literature show, the accumulation of human capital may determine institutional development over time. In fact, "educated people are more likely to resolve their differences through negotiation and voting than through violent disputes. Education is needed for courts to operate and to empower citizens to engage with government institutions. Literacy encourages the spread of knowledge about the government's malfeasance" (Glaeser et al. 2004, page 272). With the above points in mind, I consider the provincial number of illiterates in 1871. Moreover, I use a dummy variable equal to 1 if the province in 1870 adopted a "geometric" (Napoleonic or Hapsburg) cadastre, and zero if the cadastre was "descriptive". Since the geometric cadastre was more precise respect to the descriptive one, it is expected that provinces adopting this cadastre were more able to assess more precise tax given the better administration.

[81]To economize on space in Table 6, I present all regressions of the model without including the variable RGDPC showing only marginal effects (IVProbit and IVPoisson models) and coefficients (IV Random Effects) for IQI, IQI_REG and subcomponents at provincial level. The Sargan test cannot reject the null hypothesis that the excluded instruments are valid instruments, in the majority of the estimations. The instruments employed in my estimations are: the number of illiterates in 1871; its squared, and the dummy "geometric" cadastre. Moreover, these instruments are strongly correlated with the IQI regressor. I cannot employ a fixed effects estimator because of the time invariant characteristic of my external instruments.

5. CONCLUDING REMARKS

The present study has analyzed the influence of institutional quality differences at the local level on multiple banking using a unique sample of small and medium-sized Italian manufacturing firms and an Institutional Quality Index (IQI) available from 2003 to 2006. Controlling for inertia, endogeneity problems, firm's heterogeneity and for a set of determinants suggested by the variegate literature on multiple banking, local institutional quality appears to exert a significant role in shaping bank-firm relationships.

According to my main findings, institutional quality seems to decrease both the number of banking relationships and the propensity of firms to be multiple banked. The observed difference in the firms' number of banking relationships across Italian provinces appears to be explained also by the institutional quality. Hence, better institutional quality, mitigating asymmetric information between banks and firms, may foster close bank-firm ties.

Further, looking at the results concerning the single dimensions of institutional quality, the quality of public services, the policies formulated and implemented by the government and the efficiency of the legal system seem to be relevant in shaping bank-firm relationships.

These results suggest that the typical close banking relationship concerns, such as the *hold-up*, the *soft budget constraint* and the *liquidity* problem may be mitigated in environments characterized by high institutional quality. Indeed, to overcome the *hold up* problem, a firm may threaten to interrupt the relationship with an opportunistic main bank moving to another bank. This could be a more credible threat in high social capital contexts and efficient legal and government systems, where it may be easier for a firm to switch as long as information asymmetries are mitigated and it is promoted the exchangeability of information. The same may apply to the *soft budget constraint* problem: where social capital is strong, firms behaving in an antisocial way (e.g. practicing strategic default) may lose

the benefits deriving from networks. Analogously, the *liquidity* problem may be overcome as other banks could have easily access to firms' information (Masciarelli, 2011).

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Table 1. Dataset variables

	Variables	Description	Years	Obs	Mean	Std.	Min	Max
	NBANK	Number of banks for firms	2003,2006	14433	4.784	2.986	0	15
Firm's characteristics	EMP	Number of firm's employees	2003-2006	14862	45.399	45.124	0	250
	AGE	Current year – year of foundation (in years)	2003-2006	14981	25.624	19.531	0	110
	INPP	Dummy =1 if firm innovations in product/ process, 0 otherwise	2003-2006	15250	.583	.493	0	1
	INORG	Dummy =1 if firm organizational innovations in product/ process, 0 otherwise	2003-2006	15250	.172	.378	0	1
	HT	Dummy =1if firm belongs HiTech sector, 0 otherwise	2003-2006	15254	.043	.203	0	1
	INTAS	Intangible Fixed Assets/ tot.assets (in %)	2003-2006	14994	2.367	4.331	0	25.45
	TGAS (r check)	Tangible Fixed Assets/ tot.assets (in %)	2003-2006	14774	20.996	15.871	.579	67.30
	LEVER	Financial liabilities/(Financial liabilities+equity) (in %)	2003-2006	14994	27.605	32.643	0	96.39
	BANKD(rcheck)	Bank debt/total debt (in %)	2003-2006	14773	20.269	24.155	0	77.16
	QUICK	Current asset - inventories/ current liabilities	2003-2006	14990	1.075	.939	.233	21.57
	LIQUI (r check)	Current asset/ current liability	2003-2006	14770	1.480	1.157	.506	26.52
	FIND (r check)	Equity/ total liabilities (in %)	2003-2006	14774	25.467	18.448	1.076	78.20
	GROUP	Dummy =1if the firm belongs to a group, 0 otherwise otherwise.	2003-2006	15250	.172	.377	0	1
	CONS	Dummy =1if firm belongs to a consortium, 0 otherwise	2003-2006	15133	.038	.192	0	1
	COOP	Dummy =1if the firm is co-operative, 0 otherwise	2003-2006	15107	.012	.111	0	1
	EXP	Dummy =1if the firm has exported in whole or in part its products to foreign countries, 0 otherwise	2003-2006	15245	.620	.485	0	1
Bank-firm relationship characteristics	CRED	Dummy =1 if the firm whished more credit at the same interest rate agreed with the bank, 0 otherwise	2003-2006	12755	.059	.237	0	1
	DURAT	Duration of the relationship with the main bank (in years)	2003,2006	12054	15.999	11.422	0	53
	MAIN	Share of the debt hold by the main bank (in %)	2003,2006	9649	24.495	24.402	0	100
Context characteristics	BRANCH	Number of branches for province/ provincial population	2003-2006	15254	6.433	1.473	2.193	10.49
	RGDPC	Provincial real GDP (per capita) (in thousands of €)	2003-2006	15254	20217.37	4033.258	9086.10	27414.37
	IQI	Institutional quality index at the provincial level	2004-2006	14368	.711	.148	0	1
	IQI_REG	Institutional quality index at the regional level	2004-2006	14368	.709	.138	.0973	.932
	ROL	IQI Dimension, Rule of Law	2004-2006	14368	.590	.164	0	1
	GOV	IQI Dimension, Government	2004-2006	14368	.422	.133	0	1
	REG	IQI Dimension, Regulatory Quality	2004-2006	14368	.620	.173	0	1
	VOICE	IQI Dimension, Voice & Accountability	2004-2006	14368	.505	.218	0	1
	COR	IQI Dimension, Corruption	2004-2006	14368	.849	.142	0	1

Table 2.Correlation Matrix

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	**NBANK**	1																								
2	**EMPLOY**	0.322	1																							
3	**AGE**	0.167	0.243	1																						
4	**LEVERAGE**	0.417	0.231	0.084	1																					
5	**INTGASSETS**	0.012	-0.048	-0.103	0.009	1																				
6	**QUICK**	-0.128	0.012	0.103	-0.245	-0.119	1																			
7	**GROUP**	0.087	0.318	0.040	0.063	0.046	0.002	1																		
8	**CONS**	0.006	-0.004	-0.021	0.015	-0.011	-0.018	0.053	1																	
9	**HIGHTECH**	0.027	-0.005	0.002	-0.007	0.071	0.021	0.005	-0.011	1																
10	**INNORG**	0.092	0.101	0.036	0.041	0.005	-0.015	0.011	0.015	0.043	1															
11	**INNO_PP**	0.128	0.126	0.097	0.089	-0.029	-0.014	0.029	0.028	0.011	0.155	1														
12	**EXP**	0.156	0.235	0.138	0.108	-0.007	0.001	0.086	0.030	0.032	0.057	0.122	1													
13	**COOP**	-0.014	-0.008	0.029	-0.012	0.000	-0.023	-0.038	0.143	-0.021	0.008	-0.012	-0.053	1												
14	**CREDIT**	0.114	0.039	-0.017	0.097	0.062	-0.061	0.016	0.013	-0.007	0.011	0.015	0.015	0.006	1											
15	**DURATION**	0.084	0.140	0.545	0.013	-0.130	0.107	-0.025	-0.026	-0.022	0.022	0.095	0.106	0.049	-0.023	1										
16	**MAIN**	-0.002	-0.030	-0.027	0.105	0.000	-0.133	0.012	0.013	-0.037	0.041	0.013	-0.048	0.002	0.023	-0.049	1									
17	**BRANCH**	0.065	0.057	0.028	0.030	-0.010	-0.030	0.007	-0.044	-0.038	0.047	-0.004	0.092	-0.021	-0.003	0.019	-0.017	1								
18	**RGDPC**	-0.013	-0.008	0.104	-0.002	0.069	0.029	0.003	-0.055	0.068	0.025	-0.019	0.134	-0.064	0.004	0.067	-0.037	0.516	1							
19	**IQI_PROV**	0.007	-0.004	0.082	-0.005	0.041	0.025	-0.035	-0.032	0.014	0.034	0.026	0.127	-0.054	-0.003	0.086	-0.052	0.526	0.674	1						
20	**IQI_REG**	0.018	0.004	0.097	-0.009	0.021	0.037	-0.043	-0.048	0.016	0.045	0.021	0.136	-0.050	0.001	0.097	-0.062	0.560	0.639	0.925	1					
21	**CORRUPTION**	0.046	0.038	0.016	0.021	-0.049	0.014	-0.039	-0.021	-0.052	0.028	0.004	0.054	0.008	-0.009	0.039	-0.018	0.587	0.198	0.452	0.489	1				
22	**GOVERNMENT**	-0.017	-0.011	0.107	-0.020	0.050	0.014	-0.020	-0.056	0.042	0.009	0.000	0.117	-0.072	-0.023	0.103	-0.051	0.379	0.671	0.695	0.611	0.162	1			
23	**REGULATORY**	0.033	0.015	0.023	0.025	-0.004	-0.027	-0.006	-0.043	-0.009	0.035	0.017	0.111	-0.021	0.011	0.026	-0.027	0.699	0.568	0.628	0.639	0.527	0.326	1		
24	**RULEOFLAW**	0.024	0.017	-0.019	-0.001	-0.032	0.009	-0.036	0.034	-0.075	0.017	0.045	0.015	0.004	0.013	0.013	-0.021	0.046	-0.259	0.347	0.349	0.306	-0.166	0.048	1	
25	**VOICE**	-0.020	-0.035	0.069	-0.001	0.086	0.035	0.003	-0.022	0.096	0.020	-0.007	0.061	-0.029	0.007	0.046	-0.011	0.228	0.745	0.492	0.409	-0.056	0.407	0.373	-0.399	1

Table 3. Ranking of provinces by Institutional Quality Index (IQI) and the number of bank relationships for firms.

Rank	Region	Province	m_NBANK[a]	m_IQI[b]	Rank	Region	Province	m_NBANK[a]	m_IQI[b]
1	Calabria	Vibo Valentia	3	.0005333	**53**	Piedmont	Vercelli	4.754098	.6753961
2	Calabria	Crotone	3.5	.0113333	**54**	Marche	Macerata	5.25	.6788333
3	Calabria	Catanzaro	2.444444	.1175667	**55**	Piedmont	Torino	4.447743	.6822645
4	Calabria	Cosenza	2.6	.1506667	**56**	Emilia-Romagna	Ferrara	4.794117	.6825666
5	Calabria	Reggio Calabria	4.666667	.1679333	**57**	Lazio	Roma	4.561702	.68383
6	Sicily	Agrigento	2.75	.1867667	**58**	Emilia-Romagna	Modena	5.015656	.6838365
7	Sicily	Caltanissetta	9.333333	.2081333	**59**	Veneto	Venezia	5.492228	.6853576
8	Sicily	Enna	2.5	.2250667	**60**	Umbria	Perugia	6.709804	.6856857
9	Sicily	Trapani	3.5	.2566333	**61**	Piedmont	Alessandria	5.034682	.6893292
10	Molise	Isernia	3.166667	.2658333	**62**	Lombardy	Pavia	5.581818	.6949781
11	Sicily	Catania	5.908163	.2728016	**63**	Emilia-Romagna	Bologna	5.655774	.6962604
12	Sicily	Palermo	3.357143	.2839	**64**	Lombardy	Lodi	3.875	.6975667
13	Sardinia	Nuoro	4	.2915667	**65**	Emilia-Romagna	Rimini	3.965517	.7037666
14	Campania	Napoli	4.267782	.2930706	**66**	Emilia-Romagna	Piacenza	5.144231	.7061
15	Campania	Caserta	4.083333	.3056	**67**	Marche	Ancona	5.473469	.7084084
16	Sicily	Siracusa	3.222222	.3131	**68**	Veneto	Vicenza	4.868601	.710726
17	Sicily	Ragusa	6	.3161667	**69**	Piedmont	Asti	3.959184	.714075
18	Sicily	Messina	4.4	.3583	**70**	Lombardy	Sondrio	3	.7163
19	Sardinia	Sassari	3.363636	.3633	**71**	Emilia-Romagna	Forlì-Cesena	6.088235	.7291667
20	Molise	Campobasso	5.1	.3648	**72**	Piedmont	Verbania	4.935484	.7294334
21	Campania	Benevento	3	.3735333	**73**	Friuli-Venezia Giulia	Gorizia	6.333333	.7299
22	Liguria	Imperia	9.5	.4015	**74**	Lombardy	Como	4.661111	.7333
23	Campania	Salerno	5.318436	.4029667	**75**	Lombardy	Brescia	5.402214	.7345442
24	Campania	Avellino	3.0625	.4058517	**76**	Veneto	Treviso	4.923077	.7410741
25	Puglia	Taranto	4	.4211667	**77**	Tuscany	Pistoia	4.897436	.7437667
26	Puglia	Foggia	6.782609	.423	**78**	Piedmont	Biella	5.588785	.74465
27	Puglia	Brindisi	3.307692	.4309667	**79**	Emilia-Romagna	Parma	5.782383	.7479782
28	Sardinia	Oristano	4.666667	.4381667	**80**	Tuscany	Grosseto	5.035714	.7547682
29	Puglia	Lecce	3	.4542333	**81**	Veneto	Padova	4.936	.7554666
30	Sardinia	Cagliari	3.84375	.4611333	**82**	Valle d'Aosta	Aosta	3.625	.7696667
31	Basilicata	Matera	3.666667	.4687333	**83**	Emilia-Romagna	Reggio Emilia	5.626087	.7698898
32	Lazio	Rieti	4.75	.4714667	**84**	Lombardy	Mantua	5.785965	.7743603
33	Basilicata	Potenza	3.387097	.4818682	**85**	Emilia-Romagna	Ravenna	7.025862	.7762653
34	Lazio	Viterbo	5.125	.5081667	**86**	Lombardy	Lecco	4.939394	.7776333
35	Puglia	Bari	4.608696	.5108942	**87**	Lombardy	Bergamo	4.895605	.791799
36	Liguria	Genoa	4.910891	.5152315	**88**	Tuscany	Arezzo	5.767857	.7979667
37	Lazio	Frosinone	4.333333	.5277666	**89**	Trentino-Alto Adige	Bolzano	4.411765	.8081
38	Lazio	Latina	3.20339	.5301338	**90**	Tuscany	Massa-Carrara	4.655172	.8097333
39	Liguria	La Spezia	4.923077	.5525333	**91**	Lombardy	Cremona	5.845	.8151333
40	Marche	Ascoli Piceno	5.328767	.5549333	**92**	Lombardy	Novara	3.893333	.8152816
41	Abruzzo	Pescara	5.5	.5733333	**93**	Tuscany	Prato	5	.8203667
42	Veneto	Belluno	3.984375	.5875667	**94**	Lombardy	Milano	4.642404	.8229629
43	Liguria	Savona	4	.5913333	**95**	Lombardy	Varese	4.959854	.8288867
44	Abruzzo	L'Aquila	4.957447	.6008781	**96**	Piedmont	Cuneo	4.752988	.8343319
45	Abruzzo	Teramo	5.408377	.6191493	**97**	Tuscany	Lucca	5.446154	.8497334
46	Veneto	Rovigo	4.55	.626	**98**	Trentino-Alto Adige	Trento	4.164474	.8715597
47	Friuli	Pordenone	5.312236	.6261688	**99**	Tuscany	Siena	5	.8789
48	Umbria	Terni	5.076923	.6355667	**100**	Tuscany	Livorno	5.076923	.8864334
49	Veneto	Verona	4.584746	.6548667	**101**	Tuscany	Pisa	6.376623	.9148333
50	Marche	Pesaro and Urbino	5.076923	.6584666	**102**	Friuli-Venezia Giulia	Trieste	6.466667	.9166333
51	Friuli	Udine	4.972222	.6692333	**103**	Tuscany	Firenze	4.547803	1
52	Abruzzo	Chieti	4.866667	.6712334					

[a] The firm's average number of bank relationships by province; [b] The average of the IQI by province.

Table 4: Effect of IQI on Multiple Banking Relationships

	COLUMN 1 (NO RGDPC)					COLUMN 2 (WITH RGDPC)					COLUMN 3 (CENTRE-NORTH WITH RGDPC)				
	PROBIT[a]		POISSON[b]		SYS-GMM[b]	PROBIT [a]		POISSON[b]		SYS-GMM[b]	PROBIT[a]		POISSON[b]		SYS-GMM[b]
	pooled	panel	pooled	panel		pooled	panel	pooled	panel		pooled	panel	pooled	panel	
Institutions															
IQI	-0.106**	-0.062***	-1.220*	-0.183	-1.710***	-0.097*	-0.022	-1.225*	-0.183	-1.525**	-0.096*	-0.002	-1.197*	-0.179	-1.608*
	0.045	*0.006*	*0.061*	*0.429*	*0.001*	*0.080*	*0.478*	*0.061*	*0.429*	*0.032*	*0.095*	*0.906*	*0.078*	*0.458*	*0.056*
Firm's characteristics															
EMP	0.048***	0.036***	0.704***	0.137***	0.243***	0.048***	0.028***	0.704***	0.137***	0.250***	0.045***	0.012***	0.720***	0.139***	0.267***
	0.000	*0.000*	*0.000*	*0.000*	*0.002*	*0.000*	*0.004*	*0.000*	*0.000*	*0.002*	*0.000*	*0.002*	*0.000*	*0.000*	*0.0008*
AGE	0.039***	0.028***	0.253***	0.051***	-0.0360	0.039***	0. 027***	0.253***	0.051***	-0.0335	0.027***	0.009***	0.195***	0.038***	-0.0526
	0.000	*0.000*	*0.000*	*0.000*	*0.551*	*0.000*	*0.000*	*0.000*	*0.000*	*0.583*	*0.007*	*0.016*	*0.005*	*0.006*	*0.384*
LEVER	0.002***	0.0009***	0.026***	0.005***	0.00779***	0.002***	0.0007***	0.026***	0.005***	0.00792***	0.002***	0.0005***	0.027***	0.005***	0.005*
	0.000	*0.000*	*0.000*	*0.000*	*0.009*	*0.000*	*0.007*	*0.000*	*0.000*	*0.007*	*0.000*	*0.000*	*0.000*	*0.000*	*0.064*
INTAS	0.002	0.0004	0.018*	0.004*	-0.0047	0.002	0. 001	0.018*	0.004*	-0.00225	0.002	0.0003	0.019*	0.004*	-0.00513
	0.168	*0.419*	*0.062*	*0.058*	*0.634*	*0.171*	*0.277*	*0.062*	*0.058*	*0.815*	*0.259*	*0.426*	*0.076*	*0.061*	*0.615*
QUICK	-0.024***	-0.008***	-0.235**	-0.039***	-0.0311	-0.024***	-0. 006***	-0.235**	-0.039***	-0.0381	-0.026***	-0.004***	-0.255**	-0.041***	-0.038
	0.001	*0.000*	*0.013*	*0.000*	*0.633*	*0.001*	*0.000*	*0.013*	*0.000*	*0.559*	*0.002*	*0.017*	*0.023*	*0.000*	*0.508*
GROUP	-0.012	-0.009	-0.091	-0.021	0.0310	-0.012	-0. 006	-0.091	-0.021	0.0599	-0.021	-0.006	-0.125	-0.028	0.0179
	0.499	*0.267*	*0.536*	*0.364*	*0.881*	*0.497*	*0.480*	*0.536*	*0.364*	*0.766*	*0.246*	*0.193*	*0.417*	*0.265*	*0.930*
CONS	-0.003	-0.009	0.146	0.019	0.0641	-0.003	-0. 009	0.146	0.019	0.0617	0.017	0.010	-0.032	-0.023	-0.0351
	0.930	*0.433*	*0.600*	*0.687*	*0.700*	*0.930*	*0.434*	*0.600*	*0.688*	*0.707*	*0.624*	*0.365*	*0.914*	*0.666*	*0.813*
HT	0.102***	0.060***	1.048***	0.151**	0.382***	0.102***	0.054**	1.048***	0.151**	0.353**	0.107***	0.049**	1.190***	0.180***	0.318**
	0.006	*0.007*	*0.000*	*0.019*	*0.007*	*0.006*	*0.024*	*0.000*	*0.019*	*0.013*	*0.004*	*0.017*	*0.000*	*0.007*	*0.026*
INORG	0.023	0.010	0.197**	0.026	0.101	0.023	0. 004	0.197**	0.026	0.0998	0.019	0.001	0.187*	0.024	0.0607
	0.247	*0.310*	*0.048*	*0.185*	*0.452*	*0.248*	*0.590*	*0.048*	*0.185*	*0.449*	*0.340*	*0.695*	*0.081*	*0.248*	*0.642*
INPP	0.028**	0.017***	0.266***	0.045***	0.194	0.028**	0. 013**	0.266***	0.045***	0.191	0.030**	0.007*	0.239**	0.042**	0.229*
	0.024	*0.002*	*0.005*	*0.008*	*0.132*	*0.024*	*0.020*	*0.005*	*0.008*	*0.134*	*0.029*	*0.089*	*0.022*	*0.020*	*0.086*
EXP	0.034**	0.030***	0.461***	0.087***	0.237	0.033**	0.027***	0.461***	0.087***	0.197	0.031*	0.012**	0.477***	0.090***	0.200
	0.049	*0.000*	*0.000*	*0.000*	*0.272*	*0.049*	*0.004*	*0.000*	*0.000*	*0.362*	*0.088*	*0.031*	*0.000*	*0.000*	*0.343*

continued

continued

COOP	-0.040	-0.031	0.051	-0.010	-0.0784	-0.040	-0.044	0.051	-0.010	-0.0346	-0.092	-0.027	-0.010	-0.010	-0.00813
	0.584	*0.142*	*0.929*	*0.910*	*0.701*	*0.583*	*0.177*	*0.929*	*0.910*	*0.863*	*0.288*	*0.238*	*0.989*	*0.919*	*0.973*
NBANK_l					0.732***					0.735***					0.762***
					0.000					*0.000*					*0.000*
Bank-firm relationships characteristics															
CRED	-0.001	-0.0003	0.644***	0.097***	0.162	-0.001	0.0008	0.644***	0.097***	0.155	-0.004	-0.002	0.595***	0.087***	0.315
	0.979	*0.978*	*0.000*	*0.001*	*0.365*	*0.981*	*0.949*	*0.000*	*0.001*	*0.383*	*0.917*	*0.707*	*0.003*	*0.005*	*0.104*
DURAT	0.000	0.000	0.002	0.0001	0.00273	0.000	-0.0001	0.002	0.000	0.00215	0.000	0.00003	0.003	0.001	0.000552
	0.867	*0.985*	*0.756*	*0.640*	*0.668*	*0.869*	*0.873*	*0.756*	*0.639*	*0.737*	*0.674*	*0.886*	*0.503*	*0.383*	*0.925*
MAIN	-0.000	-0.00003	-0.006***	-0.001**	-0.00370	-0.000	-0.00007	-0.006***	-0.001**	-0.00323	-0.000	-0.0001	-0.008***	-0.001***	-0.002
	0.418	*0.642*	*0.001*	*0.016*	*0.298*	*0.418*	*0.610*	*0.001*	*0.016*	*0.359*	*0.288*	*0.182*	*0.000*	*0.004*	*0.544*
Context characteristics															
BRANCH	-0.034	0.012***	-0.426	-0.039	0.0546*	-0.036	0.011*	-0.424	-0.039	0.0338	-0.035	0.006**	-0.407	-0.034	-0.0483
	0.576	*0.000*	*0.194*	*0.714*	*0.079*	*0.565*	*0.073*	*0.197*	*0.717*	*0.323*	*0.592*	*0.022*	*0.255*	*0.756*	*0.272*
RGDPC						-0.140	-0.070**	0.078	0.012	0.355	-0.208*	-0.050**	-0.194	-0.018	0.491
						0.225	*0.036*	*0.898*	*0.967*	*0.472*	*0.066*	*0.013*	*0.798*	*0.956*	*0.302*
Constant					0.814**					-2.673					-3.230
					0.029					*0.545*					*0.438*
PROVINCIAL FE	YES	NO	YES	YES	YES	YES	NO	YES	YES	YES	YES	NO	YES	YES	YES
N	5687	5687	5687	5687	6,381	5687	5687	5687	5687	6,381	5011	5011	5011	5011	5,611
Number of id					2,812					2,812					2,476
Log pseudolikelihood	*-2105.878*	*-1180.414*	*-12256.36*	*-11780.62*		*-2105.656*	*-1183.236*	*-12256.36*	*-11780.63*		*-1855.853*	*-1038.690*	*-10820.73*	*-10403.44*	
Likelihood-ratio test of alpha=0			*1.11*					*1.11*					*0.53*		
			0.146					*0.146*					*0.232*		
AB test for AR(1)					-8.547					-8.640					-8.623
					0.000					*0.000*					*0.000*
AB test for AR(2)					-0.967					-1.008					-0.416
					0.333					*0.313*					*0.677*
Hansen test					295.2					300.4					291.6
					0.160					*0.418*					*0.561*
Difference-in-Hansen tests					30.00					26.63					29.09
					0.224					*0.374*					*0.260*

***, **, * indicates statistical significance at the 1%, 5%, and 10% level respectively.For the description of the variables see Table 1. In italics are reported the p-values of the tests. [a] The dependent variable is a dummy coded 1 if firms maintain a number of banking relationships greater or equal two, zero otherwise. [b] The dependent is the number of banking relationships for a firm. For the Probit and Poisson regressions the marginal effects are reported. The standard errors (not reported) are clustered at province (NUTS3) level and consistent in the presence of any pattern of heteroskedasticity. To avoid the influence of potential outliers, we winsorize some variables at 1% level. In performing the Probit and Poisson regressions, all potential endogenous and predetermined variables are lagged one year. EMPLOY, AGE, and RGDPC are in logarithms. All estimations include ATECO, sector dummies and year fixed effects. We report the AB test for AR(1) and AB test for AR(2) stand for Arellano-Bond test for AR(1) in first differences and Arellano-Bond test for AR(2) in first differences, respectively. The null hypothesis of the Hansen test is that the over-identifying restrictions are valid. The null hypothesis of the difference in Hansen test is that the additional instruments used by the SYS-GMM estimator are valid.

Table 5. Effect of IQI Sub-indexes on Multiple Banking Relationships

	COLUMN 1 (NO RGDPC)					COLUMN 2 (WITH RGDPC)					COLUMN 3 (CENTRE-NORTH WITH RGDPC)				
	PROBIT[a]		**POISSON[b]**		**SYS-GMM[b]**	**PROBIT [a]**		**POISSON[b]**		**SYS-GMM[b]**	**PROBIT[a]**		**POISSON[b]**		**SYS-GMM[b]**
	pooled	panel	pooled	panel		pooled	panel	pooled	panel		pooled	panel	pooled	panel	
ROL	-0.115***	0. 027	-0.358	-0.011	-0.114	-0.100***	-0.026	-0.370	-0.018	-0.870	-0.080**	-0.001	-0.511	-0.008	-1.295*
	0.002	*0.104*	*0.328*	*0.945*	*0.601*	*0.007*	*0.176*	*0.335*	*0.913*	*0.150*	*0.028*	*0.895*	*0.256*	*0.964*	*0.074*
GOV	-0.031	-0.059**	-1.360**	-0.152*	-1.420***	-0.038	-0.025	-1.367**	-0.163	-1.850***	-0.085	-0.011	-1.376**	-0.201	-2.663***
	0.576	*0.025*	*0.012*	*0.054*	*0.0002*	*0.509*	*0.422*	*0.011*	*0.499*	*0.0003*	*0.151*	*0.617*	*0.030*	*0.453*	*1.31e-05*
VOICE	0.007	-0.080***	0.349	0.054	0.382	0.027	-0.041*	0.357	0.050	0.325	0.063	-0.005	0.149	0.112	-0.493
	0.912	*0.000*	*0.356*	*0.821*	*0.322*	*0.680*	*0.065*	*0.356*	*0.837*	*0.199*	*0.344*	*0.666*	*0.743*	*0.115*	*0.530*
REG	0.049	-0.019	0.364	-0.047	-2.187**	0.064	0.038	0.364	-0.002	-0.0386	0.106	0.014	0.189	-0.012	-0.005
	0.523	*0.392*	*0.641*	*0.883*	*0.014*	*0.409*	*0.174*	*0.641*	*0.981*	*0.929*	*0.245*	*0.463*	*0.814*	*0.881*	*0.989*
COR	-0.055	-0.003	0.477	-0.012	-0.667	-0.060	-0.007	0.477	-0.011	-0.813	-0.088	-0.010	1.019	0.029	-1.826**
	0.366	*0.853*	*0.211*	*0.954*	*0.271*	*0.332*	*0.751*	*0.211*	*0.961*	*0.200*	*0.387*	*0.620*	*0.158*	*0.933*	*0.034*
PROVINCIAL FE	YES	NO	YES	YES	YES	YES	NO	YES	YES	YES	YES	NO	YES	YES	YES

***, **, * indicates statistical significance at the 1%, 5%, and 10% level respectively.For the description of the variables see Table 1. In italics are reported the p-values of the tests. Table 7 reports only IQI sub-indexes and not full results (available upon request). [a] The dependent variable is a dummy coded 1 if firms maintain a number of banking relationships greater or equal two, zero otherwise. [b]The dependent is the number of banking relationships for a firm. For the Probit and Poisson regressions the marginal effects are reported. The standard errors (not reported) are clustered at province (NUTS3) level and consistent in the presence of any pattern of heteroskedasticity. To avoid the influence of potential outliers, we winsorize some variables at 1% level. In performing the Probit and Poisson regressions, all potential endogenous and predetermined variables are lagged one year. EMPLOY, AGE, and RGDPC are in logarithms. All estimations include ATECO, sector dummies and year fixed effects. We report the AB test for AR(1) and AB test for AR(2) stand for Arellano-Bond test for AR(1) in first differences and Arellano-Bond test for AR(2) in first differences, respectively. The null hypothesis of the Hansen test is that the over-identifying restrictions are valid. The null hypothesis of the difference in Hansen test is that the additional instruments used by the SYS-GMM estimator are valid.

Table 6. Robustness Checks. Effect of IQI and its Sub-indexes on Multiple Banking Relationships by using IV estimators.

(NO RGDPC)																				
	IVPROBIT[a]							**IVPOISSON[b]**							**IV RANDOM EFFECTS[b]**						
IQI	-0.354***							-2.576***							-2.738***						
	0.000							*0.002*							*0.000*						
IQI_REG		-0.359***							-2.404***							-2.739***					
		0.000							*0.002*							*0.000*					
GOVERN			-0.285***							-2.077***							-2.346***				
			0.000							*0.004*							*0.004*				
RULAW				0.384***							3.288							3.291			
				0.000							*0.131*							*0.113*			
VOICE					-0.263***							-2.241*							-2.366*		
					0.000							*0.077*							*0.081*		
REGUL						-0.933***							-5.760							-9.18	
						0.000							*0.106*							*0.285*	
CORR							0.103							4.735							1.742
							0.394							*0.261*							*0.45*
SARGAN TEST	*0.0417*	*0.1035*	*0.0001*	*0.0193*	*0.9001*	*0.0005*	*0.000*	*0.4173*	*0.5083*	*0.1511*	*0.233*	*0.9316*	*0.2497*	*0.2301*	*0.2714*	*0.3852*	*0.1406*	*0.261*	*0.9597*	*0.5373*	*0.1274*

***, **, * indicates statistical significance at the 1%, 5%, and 10% level respectively. For the description of the variables see Table 1. In italics are reported the p-values of the tests. [a]The dependent variable is a dummy coded 1 if firms maintain a number of banking relationships greater or equal two, zero otherwise. [b]The dependent is the number of banking relationships for a firm. For the IVProbit and IVPoisson regressions the marginal effects are reported. The standard errors (not reported) are clustered at province (NUTS3) level and consistent in the presence of any pattern of heteroskedasticity for the IVPoisson and IV Random Effect estimators. To avoid the influence of potential outliers, I winsorize some variables at 1% level. The IVPoisson estimations include ATECO sector dummies and year fixed effects. I report the Sargan test that cannot reject the null hypothesis that the excluded instrument are valid instruments, in the majority of the estimations.

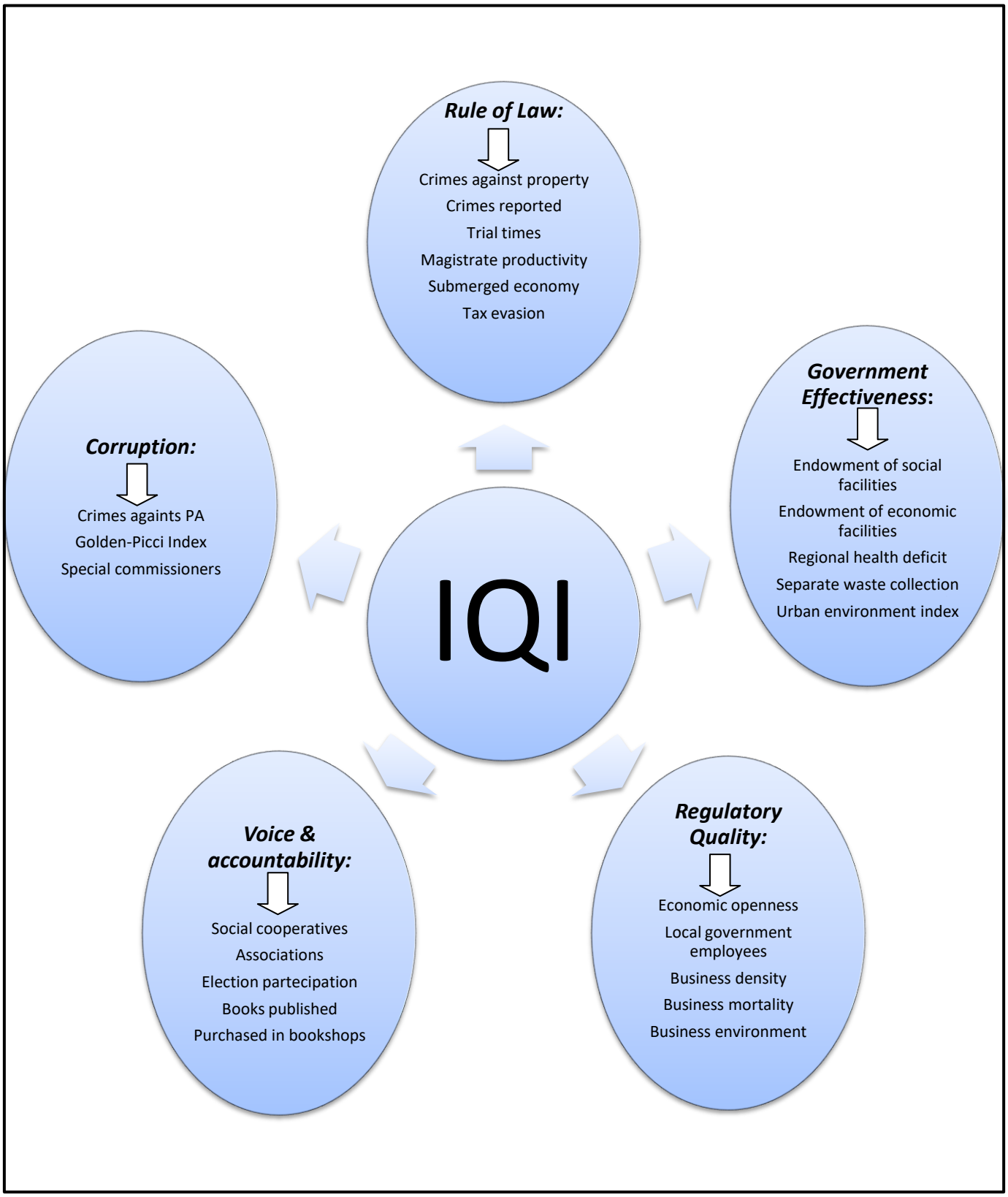


Fig. 1. Structure of the Institutional Quality Index (IQI) Note: PA, public administration

Fig. 2. Average number of bank relationships in the Italian provinces.

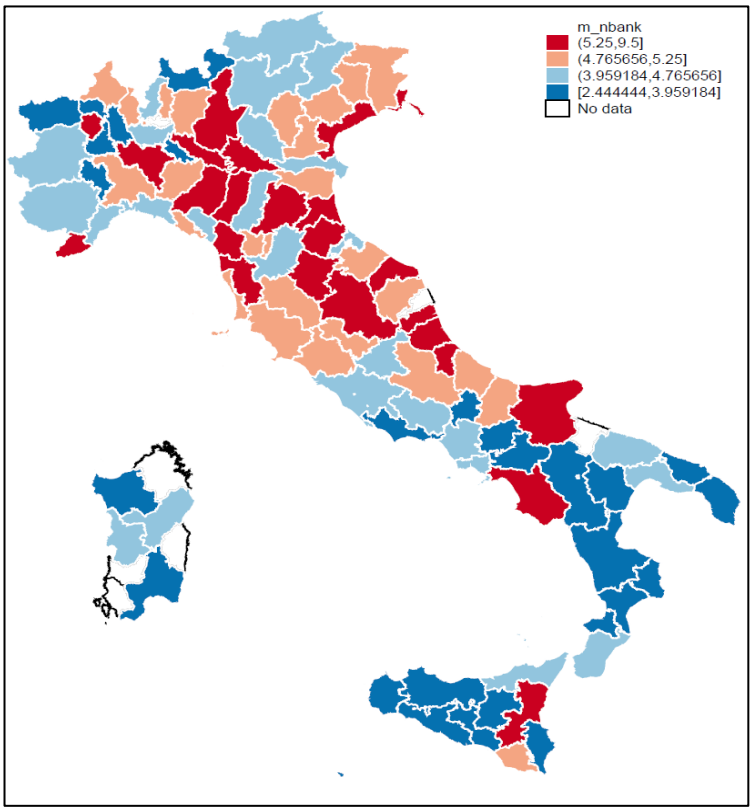
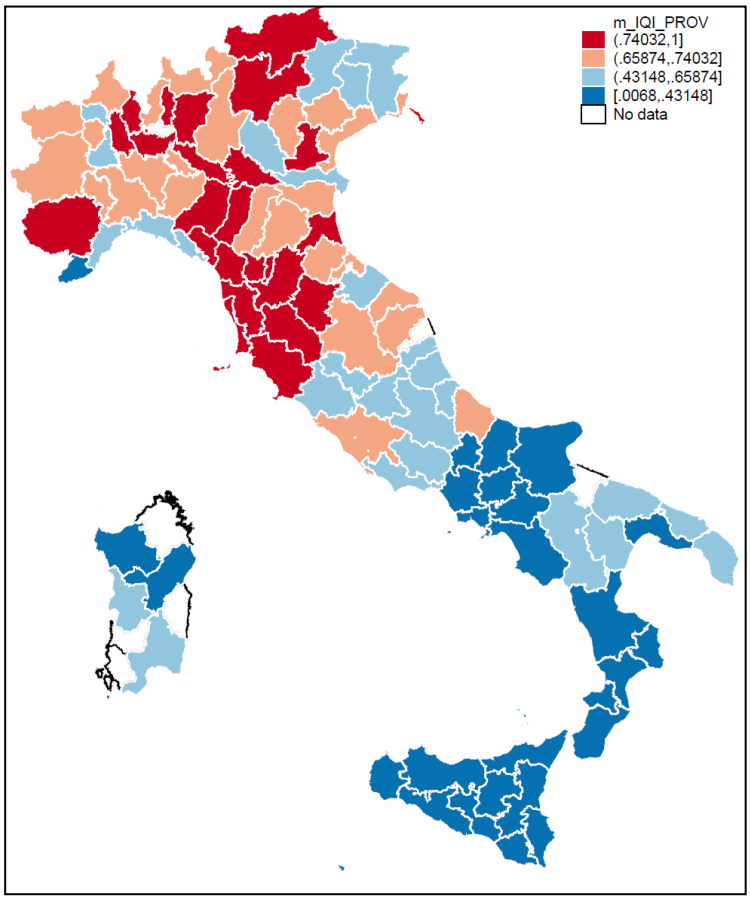


Fig. 3. Average Institutional Quality Index (IQI) in the Italian provinces.



Appendix A1

1. The determinants of multiple banking in other countries.

As indicated by Detragiache et al. (2000), the number of banking relationships appears quite higher in Italy than in US. In particular, in their sample 55.5% of US firms have more than one bank, the median number of relationships being 2. By contrast, 89% of Italian firms rely on multiple banking, the median being 5. Unfortunately, this study does not provide data about other countries, in order to analyze the variation of the phenomenon across countries and over time. Indeed, as highlighted in the previous literature review, not only firms characteristics and bank-firm relationship characteristics, but also institutional, judicial, financial peculiarities of a country where the bank-firm relationship evolve may affect the results which the literature reaches.[82] To deepen this aspect, in what follows it is performed a review some empirical studies focused on other countries.

The first group of studies analyzed regards Germany, a typical bank-based financial system, where the figure of "Hausbank" is widespread. Studying the determinants of multiple banking, Neuberger e Räthke (2009), Machauer and Weber (2000), Elsas (2005), Memmel et al.(2007) find that larger, older, riskier, less innovative firms seem to rely on many banking relationships. In addition, it appears that firms maintaining a close relationship with their Hausbank tend to have a low number of relationships. The prevalence of lending relationship in Germany is justified as: "*Due to underdeveloped equity markets in Germany. R&D-intensive firms rely more heavily on*

[82] To exemplify, a factor that may help to understand the different scope of the phenomenon across countries is their financial system, that may be "bank-based" or "market-based". Bank-based financial systems characterize countries such as Japan, Germany, Italy where banks have an important role in the economy. By contrast, market-based financial systems are those which characterize countries such as England and United States where the center stage is shared by securities markets and banks (Demirguc-Kunt and Levine, 1999). It is important to underline that the goal of this thesis is not to analyze the advantages or disadvantages of these financial systems, but only use these definitions to discover if, according to the empirical literature, the financial system of a country may explain the phenomenon of interest.

bank credits than in other countries. Relationship lending may therefore be a substitute for equity financing" (Memmel et al. 2007,pp 22).

Ogawa et al.(2009), investigating the determinants of multiple banking in Japan - another country defined as bank-based - find that the length of the relationship with the main bank and the dimension of the bank positively influences the number of banking relationships. Also they find that characteristics of firms, such as size and debt, contribute to explain the phenomenon. These results lend support to the relevance of the *hold up* problem, as firms seem to act against the main bank's monopoly power by choosing multiple relationships. Even in Japan, like in Germany, multiple banking relationships involve large and more indebted firms.

On the other hand, countries typically defined market-based are US and France.

Focusing on United States, Guiso and Minetti (2010) investigate the determinants of multiple banking considering also how firms differentiate their borrowing across banks. Using a Heckman selection model, they find a negative effect of the (average) duration of the relationship with their banks on the probability of multiple banking. According to their evidence, larger firms with more liquid assets differentiate their relationships more. They conclude that multiple banking may be used by firms as a device to discipline banks.

Applying a Poisson model to a sample of French SMEs, Ziane (2003) discovers that size and debt of firms positively affect the number of banking relationships, while firms with high profits and that concentrate their capital more have a lower number of banking relationships. In addition, the duration and the power of the relationship with the main bank seem to reduce the number of banking relationships.

To summarize, some characteristics of firms and of bank-firm relationships (such as size and debt) seem to influence the phenomenon under study across different countries. Besides, the duration of the relationship with the main bank appears exerting opposite effects in different

financial systems: for bank-market system (Germany, Japan) it tends to assume a positive sign, probably because the costs of close banking relationships are greater than the advantages as duration lengthens, whilst in marked-based system (US, France) the same variable assumes negative sign. This may lend support to the hypothesis that in bank-based markets banks may take advantage of their predominant position and practice an information capture of firms, even though other characteristics of a country may contribute to explain the different scope of the phenomenon in different countries.

As a matter of fact, Ongena and Smith (2000) considering a sample of European countries and using a Tobit model, they show that firms tend to have multiple relationships in countries where the banking system is relatively stable and not concentrated. By contrast, a strong judicial systems and a strong creditors protection seem decreasing the number of banking for firms. Moreover, in economies with stronger capital market firms rely on fewer bank relationships, while in economies characterized by active bond markets firms maintain more bank relationships.

Appendix A2

1. The Institutional Quality Index

The IQI is based on Italian provincial data and it is performed in three main phases: normalization, attribution of weights and aggregation of indexes. The first phase consists in normalizing the elementary index in such a way each index is computable in the range [0,1].[83] The normalization index I_{ij}, where *i* indicates the *i*th elementary index for the *j*th province is:

$$I_{ij}^{*} = \frac{I_{ij} - I_{imin}}{I_{imax} - I_{imin}}$$

$0 \leq I_{ij}^{*} \leq 1$, with $i = 1,2,\dots,24$ (twenty-four elementary indexes) $j = 1,2,\dots,107$ (provinces), where I_{imin} and I_{imax} are the minimum and the maximum values taken by the *i*th elementary index for the *j*th province.

The second phase assigns a weight to each normalized index through the *Analytic Hierarchy Process* (AHP) elaborated by Saaty (1980, 1992). The AHP is used in multiple criteria decision-making in different areas such as, government, business, industry, healthcare, shipbuilding. The AHP decomposes the decision problem into a hierarchy of sub-problems (elementary and aggregate indexes, Fig.1). Then, each elements is evaluated by comparing them to each other two at a time, hence, the AHP method performs comparisons between indexes of the same stratum according on a subjective evaluation representing the relative relief of each index translated, in turn, into numerical values. The following table illustrates the Saaty relative numerical scale.

[83] The authors use the method of the distance from the ideal point.

Value of w_{ik}	Interpretation
1	*i* and *k* are equally important
3	*i* is slightly more important than *k*
5	*i* is more important than *k*
7	*i* is strongly more important than *k*
9	*i* is absolutely more important than *k*

The matrix W reports all the comparisons between each dimension and the importance value of the indexes:

$$w = \begin{pmatrix} w_{11} & w_{21} & \dots & w_{1n} \\ w_{21} & w_{22} & \dots & w_{2n} \\ \vdots & \vdots & w_{ii} & \vdots \\ w_{n1} & w_{n2} & \vdots & w_{nn} \end{pmatrix}$$

This matrix W, by construction is a square matrix where the elements on the diagonal are equal to 1. The estimation process of a weight for each elementary index, showed by Saaty (1980,1992), consists to calculate the eigenvalue λ of matrix W, accounting the eigenvector related with the maximum eigenvalue, denoted by λ_{max}, and imposing the constraint so that the sum of weight is equal to 1. Then, the weights of elementary indexes are the solution of a linear system of n equations. Saaty (1980,1992) offers the following consistency index:

$$CI = \frac{(\lambda_{max} - n)}{(n-1)}$$

where if confrontations of importance are fully consistent, then $\lambda_{max} = n$ otherwise $\lambda_{max} > n$. The consistency index takes value 0 in case of maximum consistency and positive value otherwise. The adequate consistency of determinations is the threshold value $CI = 0.1$ (Saaty, 1980,1992). Applying this procedure to the elementary indexes, it is obtained the weights of these latter:

$$\sum_i h_{di} = 1$$

and the weight of dimensions k_d such that:

$$\sum_{d} k_d = 1$$

The last phase regards the aggregation of the applied functions and the construction of the IQI that assumes values over the range [0,1]. Finally, the IQI is given by:

$$IQI_j = \sum_{d=1}^{D} k_d \left(\sum_{i=1}^{n} I_{ij} h_i \right)$$

Appendix A3 - Methodologies

1. Probit Model

In many economic applications and other sciences there are different circumstances where the dependent variable is a categorical variable. In all these cases, the linear regression model is inappropriate and generally researchers use non linear regression models where the dependent variable takes on discrete values.

The binary response model can be derived by some behavioural structural assumptions and from an underlying *latent variable model* that satisfies the classical linear model assumptions.[84] Assuming the existence of a linear relation, the model indicates by y_i^* the difference in utility levels from two different status as a function of observed and unobserved characteristics, respectively indicated by x_i and u_i:

$$y_i^* = \beta' x_i + u_i \qquad u_i|x_i \sim \mathrm{N}(0, \sigma^2) \qquad (1)$$

$$t = 1,2, \dots, T$$

$$i = 1,2, \dots, n$$

A statistic unit choices an alternative if the difference in utility levels exceeds a given threshold that can be imposed equal to zero. Therefore, y is one if and only if $y_i^* \geq 0$, and y is zero if and only if y_i^* <0. Consequently,

$$E(y_i|x_i) = \Pr(y_i = 1) = \Pr(y_i = 1|x_i) = \Pr(y_i^* \geq 0) = \Pr(\beta' x_i + u_i \geq 0) = \Pr(-u_i \leq \beta' x_i)$$

$$= F(\beta' x_i)$$

where F is the cumulative density function of $-u_i$, or assuming that the distribution is symmetric, F is the cumulative density function of u_i.

[84] A latent variable is a variable which is not directly observable and it is assumed to affect response variables. For example, considering the choice of the firm to be multiple banked. For each firm *i*, the difference in utility levels from having single and multiple relations depends on observed (such as, the firm's characteristics, bank-firm characteristics and others) and unobserved characteristics.

In other words, the goal of the model is the probability $\Pr(y_i = 1|x_i)$ of the event $y_i = 1$, given a set of explanatory variables X. The probit model assumes the error term u_i in the equation (1) is distributed as *standard normal.* [85] Indicating by Φ the cumulative density function (cdf) of the standard normal distribution, the conditional probabilities in the probit model are: [86]

$$\begin{cases} \Pr(y_i = 1|x_i) = E(y_i|x_i) = f(y_i = 1|x_i; \beta_0) = \Phi(x_i'\beta_0) = \left(\int_{-\infty}^{x_i'\beta_0} \frac{1}{\sqrt{2\pi}} exp\,(-\frac{1}{2}\, z^2) dt \right) \\ \Pr(y_i = 0|x_i) = f(y_i = 0|x_i; \beta_0) = 1 - \Phi(x_i'\beta_0) = 1 - \left(\int_{-\infty}^{x_i'\beta_0} \frac{1}{\sqrt{2\pi}} exp\,(-\frac{1}{2}\, z^2) dt \right) \end{cases}$$

The probit model is estimated in an efficient way using the Maximum Likelihood Estimation (MLE). The conditional density function $f(y_i|x_i; \beta_0)$ or the likelihood function L(β) of the entire sample (i.i.d data) can be written as:

$$L(\beta) = L(y_1) * L(y_2) \dots L(y_n) = f(y_i|x_i; \beta_0) = \prod_{i=1}^{n} \left[\Phi(x_i'\beta_0)^{y_i} * [1 - \Phi(x_i'\beta_0)^{1-y_i} \right]$$

The log-likelihood for observation *i* is obtained by taking log of both size of the density $f(y_i|x_i; \beta_0)$ and replacing the true parameter value β_0 by its hypothetical value β. Explicitly:

$$\log f(y_i|x_i; \beta) = y_i \log \Phi(x_i'\beta) + (1 - y_i) \log [1 - \Phi(x_i'\beta)]$$

Under the assumption that $\{y_i, x_i\}$ are i.i.d., the log likelihood of the sample is the sum of the log-likelihood for observation *i* over *i.* Therefore, the probit objective function is:

$$log_n L(\beta) = \log[\prod_{i=1}^{n} [f(y_i|x_i; \beta)]] = \frac{1}{n} \sum_{i=1}^{n} \{ y_i \log \Phi(x_i'\beta) + (1 - y_i) \log [1 - \Phi(x_i'\beta)] \}$$

The maximum likelihood estimates of β is obtained by maximizing the log-likelihood, hence taking the f.o.c. with respect to β. Explicitly:

[85] In the probit model, it is assumed that the error term has a standard deviation 1.

[86] The cumulative density function (cdf) of the standard normal distribution is the following: $\Phi(Z) = P = \left(\int_{-\infty}^{Z} \frac{1}{\sqrt{2\pi}} exp\,(-\frac{1}{2}\, z^2) dt \right)$.

$$\frac{d}{d\beta} log_n L(\beta) = \frac{d}{d\beta} \sum_{i=1}^{n} \{ y_i \log \Phi(x_i' \beta) + (1 - y_i) \log [1 - \Phi(x_i' \beta)] \}$$

$$= \sum_{i=1}^{n} \left\{ y_i \frac{\phi(x_i' \beta) x_i}{\Phi(x_i' \beta)} + (1 - y_i) \frac{-\phi(x_i' \beta) x_i}{1 - \Phi(x_i' \beta)} \right\}$$

$$= \sum_{i=1}^{n} \left\{ \frac{y_i}{\Phi(x_i' \beta)} + \frac{(1 - y_i)}{1 - \Phi(x_i' \beta)} \right\} \phi(x_i' \beta) x_i$$

$$= \sum_{i=1}^{n} \left\{ \frac{y_i \left(1 - \Phi(x_i' \beta)\right) - (1 - y_i) \Phi(x_i' \beta)}{\Phi(x_i' \beta) \left(1 - \Phi(x_i' \beta)\right)} \right\} \phi(x_i' \beta) x_i$$

$$= \sum_{i=1}^{n} \left\{ \frac{y_i - \Phi(x_i' \beta)}{\Phi(x_i' \beta) \left(1 - \Phi(x_i' \beta)\right)} \right\} \phi(x_i' \beta) x_i = 0$$

Therefore, the maximum likelihood estimator of β, denoted by $\hat{\beta}_{ML}$, is given by the solution of the above equation that does not have analytic solution of $\hat{\beta}_{ML}$ needing to solve it by numerical computation.[87]

In the cumulative density function of the standard normal distribution:

$$Z = a + x_i' \beta$$

the probability is a non linear function of the coefficients in contrast to Z that is a function of these. Thanks to the transformation $Z = \Phi^{-1}(P)$, a linear relation between the new dependent variable (expressed in Z-scores) and the explicative variables is explained. It is important to underline that, this relation implies a non linear relation between P and x.[88]

[87] Analogously, a logit model is reproduced by choosing the logistic distribution Λ for u_i. The cumulative density function of the logistic distribution is: $\Lambda(Z) = P = \left(\frac{e^L}{1+e^L}\right)$.

[88] Marginal effects are computed in order to interpret the estimated Probit regression coefficients. The interpretation of the coefficients depends on which regressors x_i are continuous or dichotomous variables. For continuous variables $x_{k,i}$, the marginal effect is the following: $\frac{\partial E(y_i|x_i)}{\partial x_{k,i}} = \frac{\partial \Pr(y_i=1|x_i)}{\partial x_{k,i}} = \frac{\partial \Phi(x_i' \beta)}{\partial x_{k,i}} = \phi(x_i' \beta) \beta_k$. Often it is reported either the

2. Poisson Model

In many applications the goal is to analyze count data.[89] In these models the dependent variable y_i assumes integer values: $0,1,2,\ldots$. The aim is to explain the distribution of y_i or the expected value of y_i given a set of characteristics x_i. The model assumes that the expected value of y_i given x_i is defined by:

$$E(y_i|x_i) = \exp(x_i' \beta)$$

where β is a set of random parameters. In order to model a nonnegative count variable, a formal distribution that gives nonnegative conditional expected value is specified. An hypothesis in count data model is that, conditionally to a set of x_i, y_i has the Poisson distribution with the expected value $\lambda \equiv \exp(x_i' \beta)$. Hence, the probability function of y_i conditionally to a set of x_i is given by:

$$Pr(y_i = y|x_i) = \frac{\exp(-\lambda)\lambda_i^y}{y!} \qquad y = 0,1,2,\ldots,$$

where y represents a variable of count values and λ_i is the expected or predicted mean of the count variable y . $y!$ is the product of counts up to a specific count value y.

Underlying the Poisson model there are the following assumptions: the distribution of y_i has to be discrete with λ_i as a mean parameter that represents the expected number of times that an event occurs; the values of y_i are nonnegative; the data have to be independent and should not have more

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marginal effect at $\bar{x}_i$, the average x_i in the data, or the average marginal effect: $\widehat{ME} = \phi(\bar{x}_i' \hat{\beta})\,\hat{\beta}_k$ or $\widehat{ME} = \frac{1}{n} \sum_{i=1}^{n} \phi(x_i'\hat{\beta})\,\hat{\beta}_k$. By contrast, for the dichotomous variables $x_{k,i}$, the marginal effect is the following: $E(y_i|x_i^{x_{k,i=1}}) - E(y_i|x_i^{x_{k,i=0}}) = \Phi(x_i^{x_{k,i=1}}\beta) - \Phi(x_i^{x_{k,i=0}}\beta)$. Also for dichotomous variables it is reported, either the marginal effects at $\bar{x}_i$, the average x_i in the data, or the average marginal effect: $\widehat{ME} = \Phi(\bar{x}_i^{x_{k,i=1}}\hat{\beta}) - \Phi(\bar{x}_i^{x_{k,i=0}}\hat{\beta})$ or $\widehat{ME} = \frac{1}{n} \sum_{i=1}^{n} [\Phi(x_i^{x_{k,i=1}}\hat{\beta}) - \Phi(x_i^{x_{k,i=0}}\hat{\beta})]$.

[89] Examples of count data are: a count of events, a count of items verifying within a period of time or occurring in a geographical area, etc.

zero count as the mean increases; the mean and variance of the model are identical, or at least nearly the same; the Person Chi2 dispersion statistic should have an approximate value of 1.0.

Under these assumptions, the Quasi Maximum Likelihood (QML) estimation of β consists in maximizing the likelihood function of the entire sample. Indeed, substituting to λ_i the appropriate functional form, it is obtained the appropriate expressions of the probability that can be used to construct the likelihood function of the model, so-called Poisson regression model. The Likelihood function L(β) of the entire sample (i.i.d data) can be written as:

$$L(\beta) = L(y_1) * L(y_2) \dots L(y_n) = f(y_i|x_i;\beta_0) = \prod_{i=1}^{n}\left[\frac{\exp(-\lambda_i)\,\lambda_i^{y}}{y!}\right] = \frac{\exp(-\lambda_i)\,n\;\lambda_i^{\sum_{i=1}^{n} y_i}}{\prod_{i=1}^{n} y_i!}$$

Under the assumption that $\{y_i\,, x_i\}$ is i.i.d., the log likelihood of the sample is the sum of the log likelihood for observation *i* over *i:*

$$\log_n L(\beta) = \log\left[\prod_{i=1}^{n}[f(y_i|x_i;\beta)]\right] = \sum_{i=1}^{n}\{-\lambda_i + y_i \log(\lambda_i) - \log(y_i!)\}$$

$$= \sum_{i=1}^{n}\{\exp(x_i'\beta) + y_i \exp(x_i'\beta) - \log(y_i!)\}$$

The first order conditions of the $\log_n L(\beta)$ with respect to β are given by:

$$\sum_{i=1}^{n}\{[y_i - \exp(x_i'\beta)\,x_i]\} = \sum_{i=1}^{n} u_i\,x_i$$

where $u_i = y_i - \exp(x_i'\beta)$

Taking the derivative with respect to β and setting to zero for maximum, it is obtained:

$$\hat{\beta}_{ML} = \frac{1}{\mathrm{n}}\sum_{i=1}^{n} y_i = \bar{y}$$

Assuming that the hypothesis of the Poisson distribution is true, this approach gives a $\hat{\beta}_{ML}$ that is consistent, asymptotically normal and asymptotically efficient. [90]

An important assumption underline the Poisson distribution is the *equidispersion*, hence, the conditional variance of the distribution is equal to the conditional mean:

$$Var(y_i|x_i) = \exp(x_i' \beta)$$

However, many applications do not support this hypothesis. Therefore, there are other distributions that allow for *overdispersion*:

$$Var(y_i|x_i) > \exp(x_i' \beta)$$

Indeed, other alternative models for count data are NegBin I and NegBin II (Negative Binomial model - Cameron and Trivedi,1986). The first one assumes that:

$$Var(y_i|x_i) = (1 + \delta^2)\exp(x_i' \beta)$$

for some $\delta^2 > 0$ to be estimated. By applying the QML estimation, it is obtained a consistent estimator of β only if the overdispersion assumption is valid.

The NegBin II model of count data assumes a different form of overdispersion:

$$Var(y_i|x_i) = \left(1 + \alpha^2 \exp\left(x_i' \beta\right)\right) \exp(x_i' \beta)$$

[90] Marginal effects are computed in order to interpret the estimated Poisson regressions coefficients. The interpretation of the coefficients depends on which regressors x_i, are continuous or dichotomous variables . A simple way to interpret the Poisson results is to consider the conditional expected value. For continuous variables $x_{k,i}$, the impact of a marginal variation in $x_{k,i}$ on the expected value of y_i is: $\frac{\partial E(y_i|x_i)}{\partial x_{k,i}} = exp(x_i' \beta)\, \beta_k$. The impact of this marginal effect depends on the value of other x_i. Often it is reported either the marginal effect at $\bar{x_\iota}$, the average x_i in the data, or the average marginal effect: $\widehat{ME} = exp(\bar{x}_i' \hat{\beta})\, \hat{\beta}_k$ or $\widehat{ME} = \frac{1}{n} \sum_{i=1}^{n} exp(x_i' \hat{\beta})\, \hat{\beta}_k$. It is possible to transform these results in *semi-elasticity*: $\beta_k = \frac{\partial E(y_i|x_i)}{\partial x_{k,i}} \frac{1}{E(y_i|x_i)}$, where the coefficient β_k measures the relative variation in the conditional mean to changes in one unit of the *k*th regressor (ceteris paribus). For the interpretation of dichotomous variables $x_{k,i}$, the conditional mean of y_i maintaining constant the value of the other regressors x_i^* is confronted: $\frac{E(y_i|x_{k,i}=1, x_i^*)}{E(y_i|x_{k,i}=0, x_i^*)} =$ exp (β_k).

for some $\delta^2 > 0$ to be estimated. The NegBin II estimator is robust with respect to errors in the specification distribution. Consequently, providing that the conditional mean is correct specified, $\hat{\beta}_{ML}$ of the NegBin II model is consistent. However, the standard errors of the regression are valid if the distribution is correctly specified.

The Wald test allows testing the hypothesis concerning the Poisson distribution. If the null hypothesis of δ^2 and α^2 equal to zero is rejected, there is overdispersion in the data. [91]

3. Generalize Method of Moments (GMM)

A panel data set includes observations on the same cross sectional unit repeated over time. Panel data allow to overcome the unobserved heterogeneity problem, to distinguish component of variance and estimate transition probability among states, and to investigate dynamic relationships including lagged dependent variables (*dynamic panel) (*Arellano and Honoré, 2001). The data employed in this chapter meet the essential conditions for the application of the SYS-GMM model: few time periods and high number of statistic units (meaning "small T and large N" panels). In this setting, the SYS-GMM allows to control for the presence of inertia in the dependent variable; explanatory variables not strictly exogenous; and unobservable fixed effects.

The following dynamic model is considered:

$$y_{it} = \rho y_{i,t-1} + x'_{it}\beta + \mu_i + v_{it} = z'_{it}\beta + u_{it} \qquad (2)$$

$$i = 1,2,\dots N \quad t = 1,2,\dots T$$

where $z'_{it} = (y_{i,t-1}, x'_{it})$ and $u_{it} = \mu_i + v_{it}$. The term μ_i is the unobserved time constant individual characteristic of the *i*'th cross sectional unit with E(η_i)=0 and v_{it} is the unobserved error term with E(v_{it})=0 often called idiosyncratic error.[92]

[91] The Wald test formulates the following hypotheses: $H_0: \alpha^2 = \delta^2 = 0$ against $H_1: \alpha^2 > \delta^2 > 0$.

[92] Explanatory variables are no longer strictly exogenous but sequentially exogenous or predetermined:

For an econometric perspective, the presence of the lagged dependent variable makes the assumption of exogeneity of the explanatory variables fail, as the unobserved effects and the lagged dependent variable are correlated. More precisely, in the dynamic model: y_{it-1} is correlated with η_i and v_{it-1} by construction, and with current v_{it}, if the idiosyncratic errors are correlated. The coefficient ρ represents the velocity of alteration in y_{it} to changes in X'_{it} . This could cause persistence over time. When $\rho \neq 0$ the current state of y_{it} depends on last period's state. Strictly exogenous regressors are variables uncorrelated with past, present and future values of the error term. Feedback effects from lagged dependent variables (or lagged errors) to current and future values of the explanatory variables are ruled out. By contrast, both the correlation between X'_{it} and η_i and the serial correlation of the idiosyncratic errors are left unrestricted. Consequently, $y_{i(t-1)}$ may be endogenous with respect to v_{it}. In the case here considered, the assumption that current values of X'_{it} are not influenced by past values of v and y sounds implausible. The explanatory variables are likely endogenous or predetermined. The latter variables are correlated to v_{it-1}, but are not correlated to v_{it} and v_{it+1}. Explicitly,

(1PR) $$E(v_{it}|y_{it-1}, X_{it}, \eta_i) = 0$$

To take into account the inertia of the dependent variable and to address the endogeneity problem the Arellano and Bover (1995), Blundell and Bond (1998) approach *System GMM* (GMM-SYS) is adopted.[93] This model generates an internal set of instruments that allows correcting for

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$E(v_{it}|z_{i1}, \dots, z_{it}, \eta_i) = 0$ but $E(v_{it}\, z_{i,t-l}) \neq 0$ for $l > 0$

[93] In other words, the procedure starts transforming the data to drop the unobserved fixed effects and, in order to copy for endogeneity problems, valid instruments variables are employed. Under the assumption of white noise error terms, Arellano and Bond (1991) suggest a DIFF-GMM procedure exploiting the entire set of instruments generated by the model. The lagged variables used as instruments may be poor instruments as the explanatory variables are persistent over time. For this reason, Arellano and Bover (1995), Blundell and Bond (1998) propose the *System GMM* (GMM-SYS). This method, among the conditions of the DIFF-GMM, employs extra orthogonality conditions using the lagged differenced of the regressors as instruments for the equation in levels under the hypothesis that the unobserved effects are not correlated with changes in the error term. This increases the efficiency of the estimation.

endogeneity problems.[94] The explanation of the model starts by considering first the *difference GMM* (DIFF-GMM, Arellano and Bond, 1991). The model assumes that:

$$E(v_{it}v_{is}) = E(v_{is}) = 0 \qquad \text{for } s \neq t$$

Under these assumptions, lagged of y_{it} are used as instruments.

One way to remove fixed effect is to transform the data. After first differencing, the model (2) becomes:

$$\Delta y_{it} = \rho \Delta y_{it-1} + \beta \Delta X_{it} + \Delta v_{it} \qquad (3)$$

For $t = 2, \dots, T$

Let $x_{it}^{*} = (y_{it-1}, X_{it})$ be the *k x 1* a vector of explanatory variables. The equation (3) becomes:

$$\Delta y_{it} = \Delta x_{it}^{*} \delta + \Delta v_{it} \qquad (4)$$

Applying GMM estimator on (4) the entire set of internal instruments is exploited. In particular, the model formulates these assumptions:

$$E(X_{it}v_{is}) = 0 \qquad \text{for all t,s}$$

This implies:

$$E(X_{it}\Delta v_{is}) = 0 \qquad \text{for t=1,…,s}$$

Under the assumption (1PR):

$$E(X_{it}v_{is}) = 0 \qquad \text{for any } s \geq t$$

$$E(y_{it-1}v_{is}) = 0 \qquad \text{for any } s \geq t-1$$

Which implies the following orthogonality conditions:

$$E(X_{it}\Delta v_{is}) = 0 \qquad \text{for t=1,2,…,s-1}$$

$$E(y_{it-1}\Delta v_{is}) = 0 \qquad \text{for (t-1)=1,2,…,s-2}$$

which can be written as

[94] The model supposes that the data are independent identically distributed (*iid*).

$$E(Z'_{it}\Delta v_{it}) = 0$$

Where Z_{it} be a *(T-2) x L* matrix of instruments. DIFF-GMM uses the lagged level as instruments in the first differenced equation, but these are likely to be poor as the assumption of white noise errors fails. This estimator gives consistent estimations of $(\alpha\ \beta)'$ as $N \to \infty$ with T fixed. DIFF-GMM The expanded estimator (SYS-GMM) includes, along with the moment conditions of *difference GMM,* lagged differences of the explanatory variables as instruments for the equation in levels, under the main assumption that the unobserved effect are not correlated with changes in the error term. In particular, Blundell and Bond (1998) considers another additional assumption:

$$E(\eta_i \Delta y_{i2}) = 0 \qquad \text{for i=1,2,…,N}$$

that holds if the means of the y_{it} for each statistic units are constant over time. As suggested by Arellano and Bond (1995), this assumption allows the use of lagged first differences as instruments for equation in levels. Explicitly,

$$E(y_{it-1}u_{it}) = 0 \qquad \text{for i=1,2,…,N and t=3,4,…,T}$$

For the instruments is valid the assumption:

$$E(Z'_i u_i) = 0$$

Formally, let:

- $\delta = (\alpha\ \beta)'$
- Z_i be a *(T-2) x L* matrix of instruments, where *L=(T-2)(T-1)/2*, so Z_i is a *N(T-2) x L* matrix;
- $\widehat{W}$ be a *LxL* positive semidefinite weighting matrix:

$$\widehat{W} = \left[E\left(\sum_{i=1}^{N} Z_i{}'\Delta v_i\, \Delta v_i' Z_i\right)\right]^{-1}$$

- y_{it} be a *Tx1* vector of observations on y, Δy_i is a *(T-2)* vector (because Δx_{it}^* includes Δy_{it-1}) and Δy_{it} is *N(T-2) x 1*;

- since X_{it} is *T x k* matrix of observations on x_{it}, ΔX_{it} is *(T-2) x k* and ΔX_{i0} is *N(T-2) x k*;

Formally the GMM estimator with $x_{it}^{*} = (y_{it-1}, X_{it})$ solves:

$$\hat{\delta}(\widehat{W}) = arg_{\underset{\delta}{min}} \left[\left(\sum_{i=1}^{N} (\Delta y_{it} - \Delta x_{it}^{*} \hat{\delta})' \, Z_i \right) \widehat{W} \left(\sum_{i=1}^{N} Z_i' \, (\Delta y_{it} - \Delta x_{it}^{*} \hat{\delta}) \right) \right]$$

The solution of this minimization problem yields:

$$\hat{\delta} = \left[\Delta x_{it}^{*\prime} Z_i \widehat{W} Z_i' \Delta x_{it}^{*} \right]^{-1} \Delta x_{it}^{*\prime} Z_i \widehat{W} Z_i' \Delta y_{it}$$

The behaviour of GMM as the sample size gets larger can be determined by taking the probability limits:

$$\underset{N\to\infty}{plim} \hat{\delta} = \boldsymbol{\delta} + \underset{N\to\infty}{plim} \left[\left[\Delta x_{it}^{*\prime} Z_i \widehat{W} Z_i' \Delta x_{it}^{*} \right]^{-1} \Delta x_{it}^{*\prime} Z_i \widehat{W} Z_i' \Delta \boldsymbol{v_{it}} \right]$$

GMM is consistent[95]:

$$\underset{N\to\infty}{plim} (\hat{\delta}_{GMM} - \delta) = 0$$

[95] Roodman (2006) suggests a rule of thumb: GMM estimators are appropriate when N is larger than the number of moment conditions. This number is equal to $\frac{(T-2)(T-1)}{2}$. In my case, N is greater than the number of conditions.

SECOND CHAPTER

THE EFFICIENCY OF ITALIAN COOPERATIVE BANKS: THE IMPACT OF LOCAL INSTITUTIONAL QUALITY.

ABSTRACT

This paper offers new empirical evidence on the impact of local institutional quality on bank cost efficiency, by using a large sample of Italian mutual cooperative banks (*Banche di Credito Cooperativo*, henceforth, BCCs) observed from 2007 to 2012. Adopting both parametric and non-parametric techniques to retrieve measures of cost efficiencies, and accounting for bank specific factors and provincial macroeconomic and financial sector conditions, I find that better local institutions substantially influence the efficient cost operations of BCCs, giving support to the public view of the banking sector. An implication of my results is that policies enhancing local institutions may imply greater efficiency of BCCs, a fundamental financial channel for Italian small businesses and for the economic growth of the country.

1. INTRODUCTION

Mutual cooperative banks are an important part of the Italian banking system: in 2016, 4382 BCCs operate in 2676 municipalities, within 101 Italian provinces (Federcasse, 2016). Through their territorial specialization, mutualistic nature, and governance structure BCCs have promoted the economic and social development of local markets (Finocchiaro, 2002).[96] Because of the strong connection with the territory that they serve, economic, regulatory and institutional differences at local level may play a crucial role in fostering BCCs cost efficiency, and explain the heterogeneity in efficiency among BCCs in different local areas.

A considerable number of studies indicate institutional quality as a factor that decisively affects productivity and the development of economic and financial systems (La Porta et al. 1997,1998; Levine 1998; Hall and Jones, 1999; Acemoglu et al., 2001; Easterly and Levine, 2003), but less attention has been paid to the effect of institutional quality on bank efficiency. Indeed, despite the impact of institutions on banks' performance is under debate in the empirical literature, the number of studies is still small (Demirgüç-Kunt et al., 2004; Hasan et al., 2009; Lensink and Meesters, 2014), and, to the best of my knowledge, there is no evidence on the potential influence of local institutional quality on BCCs' efficiency, even though investigating this relationship has important implications for the ease of access to external finance for investments and growth.

I focus on this lacuna: using a dataset of 371 Italian BCCs observed from 2007 to 2012 and the Institutional Quality Index proposed by Nifo and Vecchione (2014), this is the first study that examines the impact of local institutional quality on BCC efficiency across Italian provinces, controlling for bank specific factors and cross-provinces differences in macroeconomic and financial sector conditions. This analysis allows testing two contrasting views: the *public interest*

[96] The mutualistic nature and the mission to provide the best possible conditions of credit and services to their members, evidence the special relation that BCCs establish with the territory that they serve.

view and the *political economic view*. According to the first, weak institutions negatively affect bank efficiency by hampering banks to attract funds in cheapest way or allocate them in an optimal way. The second view argues that weak institutions improve bank efficiency, thanks to a regulatory capture effect (Barth et al., 2006; Lensink and Meesters, 2014; ElKelish and Tucker,2015).

The Italian case represents an interesting laboratory for different reasons: first, BCCs play a fundamental role in the Italian banking market (Battaglia et al.,2010) and their function for the development of the Italian production system is crucial since they are particularly able to provide funds to determine market areas (Tarantola, 2011; Draghi, 2009). Second, the Italian cooperative banking sector is the largest in Europe after France and Germany (Battaglia et al., 2010). Third, the institutional endowment differs at the local level (Bianco et al., 2005; Nifo and Vecchione, 2014), allowing to analyze the impact of heterogeneous local institutional factors on bank efficiency.[97]

Cost efficiencies are estimated by using the Stochastic Frontier Approach (SFA) one-stage procedure proposed by Battese and Coelli (1995). As robustness checks, I also apply the True Random Effects (TRE) SFA model proposed by Greene (2005) and the two-stage double bootstrap DEA method proposed by Simar and Wilson (2007).[98] Moreover, I address concerns of endogeneity of the main variable of interest in the efficiency regression, by using the Karakaplan and Kuntlu's (2013) endogeneity test in the SFA context, and an instrumental variable panel estimator in the two-stage DEA procedure.[99]

[97] The institutional environment differs significantly across Italian provinces especially in relation to the gap between North and South of Italy. These differences may induce significant heterogeneity of bank efficiency through different channels. For instance, differences in legal systems, regulatory and government frameworks, and cultural factors across provinces, could cause important differences in firms' and households' demand for banking lending, products and services, and consequently, different impact on bank efficiency.

[98] I follow Lensink and Meesters (2014, Oxford Bulletin of Economics and Statistics) to specify the frontier (cost function) and the inefficiency model.

[99] To my knowledge, this is the first application of Simar and Wilson (2007) procedure in studying BCCs efficiency.

I find a robust negative relationship between local institutional quality and bank inefficiency, supporting *the public interest view*.

The remainder of the paper is organized as follows. The next section illustrates the evolution and the role of BCCs in Italy. Section 3 provides an overview of the literature on the relationship between institutions, financial development, firms' financial decisions and bank efficiency, and the related empirical literature on BCC efficiency. Section 4 provides the empirical question and the methodology applied. Section 5 discusses the results obtained and robustness checks performed, while Section 6 provides some concluding remarks.

2. ITALIAN MUTUAL COOPERATIVE BANKS: EVOLUTION AND STATUTORY RULES

Mutual cooperative banks under the form of "*casse rurali ed artigiane*" were born in Italy around 1880. They were localized first in rural areas and created to cater credit to marginal entrepreneurship groups (i.e., sectors of agriculture and crafts), which were excluded until then from credit granted by intermediaries. Among other advantages, their mission to finance local communities led to the growth of a culture of saving, the birth of economic activity under the form of cooperative firms and the better understanding of the mechanism of both production and market. All these aspects promoted an improvement of the living conditions of people in the rural areas and, at the same time, allowed to contrast the phenomenon of usury, widespread in many rural areas of Italy (Finocchiaro, 2002). In 1922, there were more than 3300 "*casse rurali ed artigiane*" on the territory, a number that dropped drastically after the events related to the crisis of the early thirties and the introduction of the *Testo Unico* of the 1937. The revival of "*casse rurali ed artigiane*" occurred with the introduction of the Italian Constitution, where the article 45 states "*the Republic recognizes the social function of co-operation with mutual character and without private*

speculation purposes. The law promotes and favours its growth with the most appropriate means, and ensures, with appropriate controls, its character and purposes"(Italian Constitution, art. 45). In 1993, the Italian Banking Law (that is the Italian banking regulation in force) has brought to a process of de-specialization of the activity of the renamed "*Banche di credito cooperativo (BCCs)*". This allowed them to offer all services and products of other banks and the extension of the corporate structure to all those who work or reside in the territory of operation, without losing the characteristics of mutualism and localism.

Examining the BCCs under the regulatory aspects, it is worth to underline that BCCs have specific statutory rules that characterize their activity and organization, making them particularly different from other types of banks. In details, the statutory rule "*one share one vote*" outlines their governance structure based on a democratic member control rule, with borrowers-owners as stakeholders. Moreover, according to the Italian Banking Law (art.35), cooperative banks grant credit primarily to their members, a rule that allows them to perform their mission to finance local business. Having the constraint to not distribute dividends to their stakeholders, but distribute them under the form of better credit conditions, cooperative banks have a different objective function as they maximize social utility than profits (Federcasse, 2009). Indeed, as defined in the Italian Banking Law (Art.35), cooperative banks have to allocate the 70 per cent of their net profit to reserve. They should assign a share of the profit to mutual fund for the growth and support of cooperation, while a remaining part should be devoted to charitable projects or to goals inspirited by mutualism. [100]

[100] BCCs are coordinated by 15 regional federations (Local Federations) having the goal to support, promote represent and monitor their members, and a national association (Federcasse) that gives support for legal, fiscal and organizational aspects, as well as delineate the strategic plans for the entire network. Moreover, BCCs offer a vast set of financial products and services provided by three central institutions (Cassa Centrale Banca, Gruppo Bancario ICREA and Cassa Centrale Raiffeisen), with the aim to intensify banks' efficiency and competitions in local markets.

The development of competition in the Italian banking sector and the strong changes occurred in the last decade, did not hinder the rapid growth of cooperative banks that extended their activity in a extensive part of Italian territory (Finocchiaro, 2002).[101] Italian cooperative banks, together with the other types of banks of the Italian banking industry, have been subjected to a substantial deregulation and consolidation process after liberalization started in the 1990s.[102] Through mergers and acquisitions (M&A), BCCs have experienced a significant growth in their size and a decrease in the number of intermediaries (Draghi, 2009). This process of decline in the number of banks has been affected by a rapid acceleration (Barbagallo, 2015). More in details, while at the beginning of the 1990 there were more than 700 BCCs in the Italian banking industry, in 2011 this number dropped significantly to 411, to 394 in 2012, to 376 in 2014, ending up at 337 in 2016 (Catturani, 2015; Federcasse, 2016). On the contrary, BCCs network of branches increased considerably from 2226 in 1993 to 4172 in 2009, to 4454 in 2013, before declining slightly in 2016 to 4382 (in the same year, Italian BCCs were localized in 101 provinces and 2676 municipalities (Federcasse, 2016).

It is worth underlining that after the restructuring process, BCCs became more competitive than in the past, opening branches relying on localism and mutualism. Therefore, the consolidation process involving BCCs has allowed them to continue their mission to be present in local communities and to perform their special objective function. Nowadays, a significant role is recognized to cooperative credit activity in view of the fact that "*Despite the present crisis, the strong local roots and the trust recognized by depositors have allowed BCCs to exert a stabilizing*

[101] As argued by Padoa-Schioppa (1996): *"BCC are border guards who bring banking services which would otherwise not arrive, supporting individual business initiatives, promote economic development of new communities. Contrary to popular opinion, in their habitat they show a greater ability to provide credit respect to other banks"* (page 43).

[102] The Italian banking sector is divided in three main categories of intermediaries: commercial bank, "popolari" banks and cooperative banks. According to Turati (2004), the main aspects that differentiate the three categories are: governance structure, transaction costs and "lending technology".

role of the small business financing sources, and to extend support even to medium-sized firms having difficulty to get funding from larger banks" (Draghi, 2009, p. 5). Indeed, during the recent financial crisis, BCCs continued to grant credit especially to small and medium enterprises (SMEs) recording a substantial increase of 4.8% from 2008 to 2013 (Bank of Italy, 2014), replacing the supply of other banks affected by the crisis (Tarantola, 2011). At the end of 2014, the market share of BCCs banks loans was 7.3% of the financing to the economy (Catturani, 2015). Moreover, thanks to the competitive advantages that they have in serving their members and the propensity to business models based on traditional corporate lending (Arnone, 2015), during the recent financial crisis, cooperative banks performed better than commercial banks (Cihák and Hesse, 2007; Birchall and Hammond Ketilson, 2009; Ayadi et al., 2010) and showed a greater stability in their total assets respect to big banks (Tutino et al., 2012).[103]

In the light of this scenario, there are three main challenges that BCCs have to face today: the consequences of the recent economic crisis, the evolution of regulation and supervision, and the demand for change induced by technological progress (Barbagallo, 2016,pp 2). Although these challenges are common to the entire Italian banking system, BCCs may be particularly vulnerable due to both their governance structure that restricts the ability in collecting capital, and to regulatory barriers that limit a geographical expansion and an adequate diversification (Barbagallo, 2016).

2.1. The role of BCCs

The role of mutual-cooperative banks is fundamental for the development of the Italian production system since they are particularly able to provide funds to SMEs that in some areas,

[103] Indeed, Italian BCCs chose not to reduce the credit to local business in a drastic way, although this determined a decrease in both quality of credit and financial stability.

represent the most dynamic segment of the economic activity (Finocchiaro, 2002; Draghi, 2009; Tarantola, 2011).[104]

The advantages and disadvantages of BCCs' activity can be outlined in the distinctive aspects of BCCs such as rootedness in the territory, mutualistic nature, governance structure, and different objective functions, which distinguish them from other big-banks. Considering advantages first, the rootedness in communities where "everyone knows each other's business" and the proximity between the bank's decision-making center and its members/clients make BCCs particularly able to produce those types of *close lending relationship*, using *soft* instead of *hard* information in evaluating creditworthiness (Draghi,2009).[105] This allows them to trigger a mechanism of efficient screening process on potential borrowers and to appraise qualitative aspects of medium and long-term business projects (Alessandrini at al. 2009) and hence, a better access to credit of marginal clients (Stefani et al, 2016).[106] More in detail, through their employees and their chief executives

[104] Lending to SMEs is particular important in Italy since they represent the bulk of productive structure. SMEs typically depend on bank loans, and local supply of credit is crucial to respond to their financial needs.

[105] From close lending relationship, banks are able to collect and use *soft* instead of *hard* information, reduce information asymmetries, promote the information exchange with their clients and invest in gathering information in order to obtain soft proprietary information from their borrowers (Mammel et al., 2008). On the one side, as the theoretical and empirical literature on bank-firm relationship show, from close lending relationships benefits may arise in terms of credit availability (Petersen and Rajan, 1994,1995; Berger and Udell, 1995; Cole, 1998; Harhoff and Korting, 1998; Hernandez-Canovas and Martinez-Solano, 2010), lower interest rate and collateral requirements (Harhoff and Korting, 1998; D'Auria et al., 1999; Berger and Udell, 1995; Voordeckers and Steijvers, 2006; Jimenez et al., 2006; Brick and Palia, 2007; Brick and Palia, 2007; Agostino and Trivieri, 2017). On the other side, costs may arise from close lending relationships. In particular, the main bank might take advantage from its bargaining power by exploiting rents and applying rates on loans that do not reflect the real credit worthiness of firms causing the *hold-up problem* (Sharpe 1990, Rajan,1992). What is more, during the relationship with the main bank, a firm could behave in an antisocial way practicing the *soft budget constraint problem* that induces the main bank to keep financing its unproductive projects (Carletti et al. 2004). Moreover, in a close lending relationship, the main bank might go bankrupt or might have temporary liquidity problems causing *liquidity risks* (Detragiache et al.,2000; Elsas et al., 2004).

[106] According to Cannari and Signorini (1997), local roots and the "co-operative spirit" act in three ways: local root, adverse selection and monitoring costs; co-operative spirit and peer monitoring; legal form and incentive structure.

spending their working life in the same area where the bank is located, and mechanisms of *peer monitoring* that limits borrowers' opportunistic behavior, BCCs gather particular knowledge on local activities and actors operating in the same area, minimizing the adverse selection and moral hazard problems.[107] Moreover, the mutualistic nature of BCCs makes stockholders the main costumers of the bank, implying an incentive scheme that forces stockholders to be responsible of their behavior since it may affect their individual profits and benefits deriving from the bank's activity. On the other hand, BCCs governance structure may be a strong advantage only if this is linked to a healthy community and free from intentions that betray those normally related to a typical banking activity (Babagallo, 2016). Indeed, the advantages of the BCCs deriving from their characteristics may be offset or disappear, for example in presence of improper local ties practiced by member-costumers able to "capture" the financing bank. Pushed by local political influence and higher indulgence toward local business, a bank may also grant credit to risky firms or, in order to avoid firms' default and resume all its financing, it may decide to keep financing the unproductive investment projects of the financed firm, succumbing to the so called *soft budget constraint problem*. This particular problem, most prominent in territorial contexts where the economic conditions are unfavorable, may affect particularly BCCs' activities having geographical limitations (Gobbi, 2005). Moreover, the weakness of BCCs governance structure is considered a strong limitation on their development (Labie and Périlleux, 2008) and may be caused by bodies constituted by an inadequate and not diversified skills, scant attention to the control system and lack

[107] With respect to other banks, BCCs have a higher labor-intensive structure since they invest in human capital needed to know the area of settlement where firms operate (Draghi,2009). The gathered information allows BCCs to arrange clients in different categories each of them characterized by a different risk profile.

of internal cooperation. In the majority of the cases, these deficiencies induce instability (Babagallo, 2016).[108]

3. LITERATURE REVIEW

3.1. Institutional quality, financial development and firms' financial decisions.

Defining institutions is hard since there is not a common definition provided by the literature. North (1990) defines institutions as "*the rules of the game in a society; (and) more formally, (as) the humanly devised constraints that shape human interaction*" (p. 477). However, as Amin (1999) highlights, the economy is dominated by external forces including "*formal institutions such as rules, laws, and organization, as well as informal or tacit institutions such as individual habits, group routines and social norms and values*." (Amin,1999, p. 367).[109] Thus, informal institutions such as norms, social convections, informal networks and interpersonal relationships are components of the dominant view of institutions.[110]

The idea that cultural, social and historical factors, institutions and the political and administrative context may play a crucial role in promoting development at macro and micro economic level, has been extensively studied by the economic literature. [111]

[108] To preserve the driving force that BCCs have in financing local business, it is necessary to protect the correctness of management with respect to conflicts of interest and local conditionings, which can influence the decisions of the credit allocation and investment jeopardizing prudent management (Barbagallo, 2016).

[109] A definition of informal institutions, definition frequently interchangeable with that of social capital, is offered by Helmke and Levitsky (2004, p. 727): "*We define informal institutions as socially shared rules, usually unwritten, that are created, communicated and enforced outside of officially sanctioned channels.*"

[110] Informal institutions arise from interpersonal and repeated interactions among agents (Fukuyama,2000).

[111] According to Acemoglu et al. (2004) economic institutions shape economic outcomes and determine the incentives and constraints on economic agents. Considering institutions as social decisions, the authors argue that conflicts over these social choices may arise and be resolved in favour of groups with greater political power, whose distribution is determined by political institutions and the distribution of resources. Economic institutions causing growth, appear

A large number of studies highlights the role of institutions as a determinant of financial systems development and firms' financial decisions. The law and finance theory is the first that states the link between a country's institutional environment and its financial system, underlining that historically determined legal traditions, legal and regulatory environment shaping protection of property rights, contract enforcement and accounting practices are essential for financial development. According to this literature, countries where legal systems protect the legal rights of investors and enforce private property rights, are characterized by economic environments where agents are more willing to finance economic activities promoting financial development. On the contrary, countries characterized by weak legal systems hinder financial development (La Porta et al. 1997; La Porta et al. 1998; Levine, 1998; Beck et al, 2001, 2003; Beck and Levine, 2005).[112] Most notably, La Porta et al. (1997, 1998), focusing on legal origins, highlight that French civil law countries offer weak investor protection, bad quality of institutions, more legal formalism and have the least developed capital markets. By contrast, countries with English common law origins seem to have better institutions, less corrupt governments, provide a stronger legal protection to creditors and shareholders achieving higher levels of financial development. Beck et al. (2001) substantially validate La Porta et al. (1998)'s findings, showing that the heterogeneity in legal traditions is a relevant factor explaining the differences in the development of financial markets among countries today, even after controlling for other countries characteristics such as, religious composition, ethnic diversity, political environment and so on. Among others, Mayer and Sussman (2001) argue that information disclosure, accounting standards and deposit insurance exert substantial effects on

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when political institutions recognize political power to units interested in broad-based property rights enforcement, create valid limits on power holders and when there are relatively few rents most of which to be seized by power holders.

[112] According to Levine et al. (2000) that link financial development and economic growth with legal origins of a country, legal origins are significantly related to cross-county differences in the level of financial intermediary development.

financial development. Focusing on the banking sector, Law and Azman-Saini (2008) also find a significant importance of institutions in determining banking sector development.

A growing literature identifies also in cultural and political institutions important determinants of financial development (Haber and Perotti, 2008). Values such as social capital, religion, language and societal composition may exert a significant effect on financial development through, for instance, the providing of social support and trust in the enforcement system (Stulz and Williamson, 2002; Guiso et al. 2004).[113] Calderon et al. (2001) find a positive and significant impact of trust on the degree of bond and stock market development, the efficiency of commercial banks, and on the activity of financial institutions. Moreover, existing literature recognizes that the degree of democracy, political forces and political stability significantly influence financial development and that poor political institutions may affect both stock returns and financial stability of a country (Perotti and van Oijen, 2001; Rajan and Zingales, 2003; Acemoglu et al., 2004; Haber et al, 2007; Huang, 2010). Rajan and Zingales (2003) emphasise that the more powerful are the elite groups controlling political decisions, the higher the obstacles to financial development, since they may deny access to finance to potential competitors. Huang (2010) shows that the effects of improvements of institutions impact significantly on financial development in the short-run, particularly for lower-income, French legal-origin and ethnically divided countries. More recently, using composite indicators of institutional quality (such as the World Governance Indicators, Kaufmann et al., 2011), Law and Azman-Saini (2012) find a significant relationship between institutional quality and financial development, considering both developed and developing countries.

Another strand of the literature has studied the role of institutions in influencing economic agents' financial decisions, dealing in most cases with cross-country analysis, and referring to

[113] According to Stulz and Williamson (2002) cultural differences matter in explaining financial development. Evaluating the impact of legal origins on financial development across countries, they find that country's principal religion significantly explain creditor rights.

national institutional endowments (Demirgüç-Kunt and Maksimovic, 1998, 1999; Ongena and Smith, 2000; Detragiache et al.,2000; Giannetti, 2003; Titman et al., 2003; Cheng and Shiu, 2007; Hernández-Cánovas and Koëter-Kant, 2010). However, a growing literature has focused on differences in institutional setting *at local level* (Guiso et al., 2004), since different quality of local institutions involves heterogeneity, for example, in the provision of local public goods and in the protection of local property rights (Acemoglu and Dell, 2010). Indeed, within a country, institutional differences at the local level could exist playing a crucial role in determining local financial development and in influencing firms' financial decisions. According to Pollard (2003) SMEs are influenced by different challenges, opportunities and constraints connected to the geographical context in which they operate. However, little is known about how observed differences in the local institutional environments influence the financial choices of firms and the local financial development. According to Sarno (2009), the quality of the enforcement system that differs at the local level influences local development and firms' financial choices. Focusing on Italian SMEs, La Rocca et al. (2010) show how institutional differences at regional level affect their financing decisions. In line with these results, Agostino et al. (2012) show that a more efficient local judicial system, presumably by guaranteeing a more effective credit protection, strengthens the positive relationship between financial development and firms' capital structure.

3.2. The relationship between bank efficiency and institutional quality

An "entire apparatus of political, legal, cultural and technological forces" (Barth et al., 2008, pp 7) may influence the operation of banks. Since there are different channels through which institutional quality may affect bank efficiency, on the theoretical ground, there is not a unique hypothesis on the relationship between bank efficiency and institutions. Indeed, the economic literature offers two contrasting views on this relationship: the *public interest view* and the *political*

economy view. Looking at institutions as instruments to facilitate the efficient operations of banks and to overcome market failures, the public interest view states that under institutional controls banks should allocate resource in a socially efficient way. Conversely, weak institutions that entail tight restrictions on bank activities could impede efficient bank operations (Barth et al., 2004; 2008).[114] Indeed, weak institutions - in the forms of strong political ties, poor contract enforcement, excessive regulation or government involvement - may increase the costs of intermediation, thus banks may require higher interest rates and short maturity to compensate for the additional risk (Demirguc-Kunt and Huizinga, 1999; Jappelli et al., 2005; Lensink and Meesters, 2014; Marcelin and Mathur, 2015), deteriorating their efficiency.

Moreover, weak institutions may impede the safety and soundness of financial transactions and private contracting due to inefficient governments interventions (Marcelin and Mathur, 2015), and might delay or discourage investments in new physical capital and technologies in view of the fact that in an over-regulated economy, cumbersome rules and dishonest bureaucrats tend to delay the distribution of licenses and permits (Bardham, 1997; Assane and Grammy, 2003). In addition, the misuse of entrusted power for private rents in banking - that may lead for example to finance inefficient projects of connected firms – is expected to increase cost inefficiency by amplifying the costs associated with bribery (Lensink and Meesters, 2014).[115]

A positive link between institutional quality and bank efficiency is predicted also by several contributions, recalling the asymmetric information characterizing banking contracts. Indeed, low quality institutions could limit the exploitation of scale/scope economies in collecting and

[114] According to Barth et al.(2006, 2013) tighter restrictions on bank activities are related to aspects such as higher barrier to entry and greater rent extraction by governments that result from higher capital requirements, in the degree to which regulations may impede efficient bank operations.

[115] Moreover, in highly corrupted contexts where politically connected firms get preferential treatment, access to finance (Khwaja and Mian, 2005) and lower interest rate (Sapienza, 2004; Claessens et al., 2008; Cingano and Pinotti, 2013), bank cost inefficiency may increase.

processing information about borrowers (Demirguc-Kunt et al., 2004; Laeven and Levine, 2007; Chortareas, et al., 2012; Barth et al., 2013) and might increase the probability of a banking crisis since banks might decide to engage in riskier activities to circumvent tighter restrictions (Demirguc-Kunt and Detragiache, 1997; Barth et al., 2004). Besides, civil norms that effectively obstacle opportunism and higher levels of trust, citizens' participation in social and public life, freedom of press and association can decrease the cost of monitoring and enforcing contracts (Knack and Keefer, 1997) and enhance the quality of information on local environments, allowing local banks to face lower costs in transactions, credit appraisals and monitoring activities (Pastor and Tortosa-Ausina, 2007; Lensink and Meesters, 2014).[116] In addition, other empirical studies show that more efficient judicial systems - protecting property rights and ensuring contract enforcement – may enhance bank efficiency, increasing the value of collateral, and decreasing both the cost of financial intermediation for borrowers and the costs of loans recovery for banks (Demirguc-Kunt and Huizingua, 1999; Jappelli et al., 2005; Leaven and Majnoni, 2005).[117] [118] Finally, local governments which implement policies creating place-specific forms of interactions, may have a specific function in reducing the costs of banks dealing with bureaucracy (Chen 2009; Lensink and

[116] This may be particularly true for BCCs operating in community where “everyone knows each other’s business". They may take advantages from information deriving from the strong relationship with financed costumers, from the proximity between the bank's decision-making center and its members-clients (Alessandrini at al..2009), and finally, from the labor-intensive organization since they invest in human capital needed to know the area of settlement where firms operate (Draghi,2009).

[117] Moreover, other empirical studies show that poor enforcement systems cause less lending, more non-performing loans and more loan spreads (Castelar Pineiro and Cabral, 2001; Cristini, Moya, Powell, 2001; Bae and Goyal, 2009) as well as higher mortgage interest rates and less credit for households (Meador, 1982; Fabbri and Padula, 2001).

[118] Leaven and Majnoni (2005) investigating the effect of judicial efficiency on bank interest rate spreads, find that improvements in judicial efficiency and judicial enforcement of debt contract decrease the cost of financial intermediation. According to the authors, banks extend credit to rationed costumers and reduce the cost of lending in case of large amount of recovery and shorter time to repossess.

Meesters, 2014), vital for the functionality of an efficient financial market (Marcelin and Mathur, 2015).[119]

On the other hand, the political economy view states that in weaker institutional frameworks banks will gain efficiencies thanks to stronger political ties, underling the existence of connections between banks, governments and politicians (Lensink and Meesters, 2014). The absence of political and legal institutions that induce agents to act in the public interest, may lead politicians and regulators to allocate credit to politically connected firms, or encourage banks to capture supervisors convincing them to act in the interest of the bank (Stigler, 1971; Barth et al. 2006). Consequently, weak institutions may increase bank efficiency through regulatory capture, specifically banks could use their power to remold the regulatory agencies and regulatory agenda offering private benefits to control industrial incumbents and/or shareholders without, however, leading to a better allocation of credit (Barth et al., 2006; Lensink and Meesters, 2014; ElKelish and Tucker,2015).[120] In the same vein, some scholars highlight that where political connections are particularly stronger (for instance, because politicians are members of banks' boards) and when the degree of autonomy granted to local loan officers is higher, the incentive of bank officers to engage in bribery is stronger (Xiaolan Zheng et al., 2013; Infante and Piazza, 2014). If accepting, soliciting or extorting a bribe may "oil the wheels" of the bureaucratic procedures (Weill, 2011; Fisman, 2001; Xiaolan Zheng et al., 2013), bank efficiency may increase. Moreover, greater judicial efficiency can allow worse borrowers to access credit markets increasing the average rate of default and hence, causing a negative effect on bank efficiency (Jappelli et al., 2005). What is more, banks opening branches in cities where regulatory systems promote simplified rules and better business environment conditions, with a higher income level, might face higher costs of financing due to

[119] What is more, improvements in regulatory interventions help banks, if they are associated to an adequate banking supervision (Lensink and Meesters, 2014).

[120] Feijen and Perotti (2005) show that weak democratic institutions allow politicians to capture financial regulation.

higher salary and capital expenses (Dietsch and Lozano-Vivas, 2000), losing their efficiency. Furthermore, in more stable economy where they feel less pressure to keep costs down enjoying the "quiet life" (Berger and Mester, 1997), bank cost inefficiency may increase.

3.3. Empirical Literature

Great deregulation and consolidation processes involving the Italian banking industry and other countries during the 1990s have stimulated particular attention on bank efficiency yielding hundreds of contributions in this field (e.g.: Berger and Humphrey,1997; Berger, 2007; Fethi and Pasiouras, 2010, for a review).

A number of papers has focused on cooperative banks by studying: their performance and efficiency (Ayadi et al., 2010; Barra et al., 2016), risk of failure (Fiordelisi and Mare, 2013), credit risk (Biscotti and D'Amico, 2013), governance structure and ownership (Bussoli, 2013; Gorton and Schmid, 2000; Cornforth, 2004), cooperative banks efficiency compared to that of commercial banks (Altunbas et al. 2001; Girardone et al., 2004; Hasan and Lozano-Vivas, 2002; Girardone et al. 2009; Cihák and Hesse, 2007; Groeneveld, 2012), the effect of environmental variables such as local economic and market conditions, on cost and profit efficiency of cooperative banks (Bos and Kool, 2006; Battaglia et al., 2010; Aiello and Bonanno, 2016a,2016b). Less attention has been paid to how bank efficiency is affected by local institutional quality.

Three distinct strands of literature are related to my paper. The first one including a few studies, evaluates both the efficiency of cooperative banks (or similar types of banks) and its determinants. In a single-country analysis, Glass and McKillop (2006) gauge the impact of environmental conditions such as operational, structural and contextual characteristics, on US credit unions cost

efficiency by applying SFA.[121] They find that local (regional) characteristics such as per capita income and unemployment rate, significantly explain most of the variability in cost efficiency scores. Bos and Kool (2006) focusing on 401 cooperative local banks operating in the Netherlands from 1998 to 1999 and applying SFA, show that local market and environmental factors significantly influence cost and profit efficiencies.[122] Hahn (2007) finds that environmental variables significantly matter in determining efficiency scores for a sample of 800 local Austrian banks, observed over the period 1996-2002.[123] In particular, he explains that the efficiency scores obtained by excluding the impact of environmental factors are in average lower than those obtained considering the latter. Performing a cross-country analysis, Williams and Gardener (2003) study the efficiency of regional banking systems applying SFA.[124] Recognizing that local banks are able to finance local business since they know risk and conditions of regional markets, they estimate bank cost efficiency controlling for individual bank characteristics and environmental factors, finding that the former ones significantly affect cost efficiency.

A second strand of literature estimates bank efficiency with the goal of comparing cooperative and other types of banks. According to agency theory, a break between ownership and control causes principal agent problems, leading firms to have dissimilar performance based on different ownership structure (Berle and Means,1932; Jensen and Meckling,1976; Grossman and Hart,1980; Fama, 1980; Fama and Jensen, 1983). According to this view, managers operating in mutual institutions do not have incentives to operate efficiently, in contrast to what happens to managers operating in private institutions constrained to operate efficiently, being their costs controlled by

[121] They use a sample of 1676 US credit unions observed from 1993 to 2001.

[122] They underline that many studies estimate common efficient frontier in cross-country analysis considering heterogeneous groups of banks, without considering that legal, institutional and macroeconomic conditions may influence the results.

[123] As methodology, he applies four-stage DEA incorporating the bootstrap method for the dependency problem.

[124] They use a sample of saving banks from Denmark, France, Germany, Italy, Spain and the UK for the years 1990 - 1998.

market discipline devices. Indeed, without a market mechanism able to reduce the discretionary power of managers over firm's property rights, managers may have fewer motivations to operate efficiently being free to satisfy their own interest (Girardone et al., 2009), not maximizing the shareholders value or enhance firm's efficiency (Altunbas et al., 2001). In cooperative governance structure, agency problems may potentially arise between managers and cooperative members. These aforesaid scenarios lead to the so-called *expense-preference behaviour* hypothesis, according to which utility-maximizing managers who are not owners of the firm, may undertake behaviors that satisfy their own utility such as excessive expenditures in salaries, office furniture, extra staff and other perquisites (Williamson, 1989; Mester, 1989). However, this aforementioned hypothesis finds a contrasting view. According to Fama (1980) and Fama and Jensen (1983), the monitoring of management is not dependent on a particular corporate form. Indeed, mutual shareholders can withdraw funds exercising their right in case of managerial inefficiency, making this sanction more effective than the decision of shareholders of private organizations to sell their stocks on a secondary market, leaving funds inside the firm. This makes the accountability of managers of mutual organizations greater than that of managers of private ones. Looking at the banking sector, since a real mechanism of management control for cooperative banks is virtually nonexistent (e.g. the threat of takeover) (Gutiérrez, 2008), for their characteristic "*one share one vote*", agency problems are expected to be more marked (Rasmusen, 1988).[125] Moreover, managers of cooperative banks are not motivated by performance remuneration schemes since they cannot totally use benefits deriving from their activity, and the fact of being self-referential and safe from being fired,

[125] For the Italian case, Gutiérrez (2008) argues that shareholders control over management in cooperative banks is limited by the cooperative governance structure and that the diffusion of the ownership causes owner-manager conflicts. He posits that there is no motivation to practice a real control over management since shareholders generally have small quotes.

lead cooperative banks to be less efficient than commercial ones (Rasmusen, 1988).[126] However, the empirical evidence testing these hypotheses and providing single and cross country analyses, finds contrasting results. Considering first single country analyses, Altunbas et al. (2001), studying whether banks efficiency is related to their ownership structure for a sample of German banks over the period 1989-1996, estimate cost and alternative profit frontiers for each ownership type (specifically for private commercial banks, public savings banks and mutual cooperative banks).[127] They show that cooperative banks have lower cost inefficiency than saving and commercial banks, arguing that this result is probably due to a greater homogeneity of the cooperative banking sector. Similar results are confirmed for the Italian case by Girardone et al. (2004), that study the determinants of bank efficiency over the period 1993-1996 by applying SFA.[128] Confirming what Altunbas et al. (2001) argue about the homogeneity of the cooperative banking sector, Girardone et al. (2004) argue that cooperative banks, because of the possible local monopolies, are more likely to exploit economies of scale and other efficiencies. Always for the Italian case, Aiello and Bonanno (2016a;2016b) investigating the impact of local market conditions on small mutual cooperative bank efficiency, among other results, provide evidence in favor of BCCs efficiency with respect to that of commercial and "*popolari*" banks.[129] Opposite findings are obtained by Hasan and Lozano-Vivas (2002) for the Spanish banking sector. Using SFA, they estimate efficiencies for a sample of

[126] As argued by Rasmusen (1988) the main difference between commercial and cooperative banks is who controls the bank and receives its profits, leading to different incentive schemes for managers. Indeed, while in commercial banks managers are controlled by the bank's owners that decide how to distribute profits and are free to sell their stocks at any time, in cooperative banks managers are the same owners (members-depositors) that control the bank.

[127] They use parametric and non parametric techniques to estimate efficiency scores.

[128] They consider a sample of 1598 bank observations excluding subsidiaries of foreign banks, special credit institutions and central institutions for each category of banks.

[129] In particular, they apply SFA for the first step studying both cost and profit efficiency over the period 2006-2011 for the Italian banking sector. Aiello and Bonanno (2016a) also show that BCC efficiency is affected negatively by a larger number of branches in the local banking market and positively by a higher market concentration and a higher demand density.

commercial and mutual banks observed over the period 1986-1995 to investigate the role of organizational forms in determining variability of inefficiency. Their results show that mutual banks are more non-interest cost inefficient than commercial ones, supporting the *expense-preference behaviour* hypothesis of mutual management. As concerns cross country analyses, Casu and Molyneux (2002) compare banks of different countries against the same benchmark European frontier, finding that commercial banks are not more efficient than saving and cooperative banks. [130] Likewise, Altunbas et al. (2001) analyzing a cross section of European and US banks over the period 1999-2000, find that cooperative banks are more cost efficient than commercial banks, but less profit efficient. The authors argue that their results may be due to the fact that agency costs in cooperative banks are limited since their activity is focalized on retail and small business customers. Similarly, Girardone et al. (2009) comparing cost efficiencies of different types of banks (commercial, saving and cooperative banks) across EU-15 countries over the period 1998-2003, and estimating efficiency scores by applying SFA (Battese and Coelli, 1995), find that cooperative banks are not less efficient than commercial banks. Their results strongly reject the hypothesis according to which managers of mutual banks are less cost efficient than those of private banks. Moreover, they argue that the financial system in each economy can explain heterogeneity in cost efficiency across banks types. Similar results are found by Mäkinen and Jones (2015) that test the *expense-preference behaviour* hypothesis using a sample of 521 European banks observed over the period 1994-2010. By applying SFA, they find that cooperative banks are more efficient than commercial and saving banks and the efficiency is more homogenous in cooperative banks groups. Opposite findings are obtained by Kontolaimou and Tsekouras (2010) that compare cooperative

[130] In particular, they apply a bootstrapped two step DEA to investigate whether the productive efficiency of European banking system has improved since the creation of Single Internal Market. They use a sample of about 750 commercial, cooperative and saving banks operating in France, Germany, Italy, Spain and the United Kingdom observed over the period 1993-1997.

banks efficiency with that of commercial and saving banks, analyzing a sample of European banking firms observed over the period 1997-2004.[131] Estimating technical efficiency scores using a methodology based on meta frontier, they find that cooperative banks are less efficient than commercial banks since they lie away from the European meta frontier, almost defined by commercial banks. The authors argue that the cooperative' technological gap is due to output production rather than to input use.

A third strand of literature has estimated the impact of institutions on bank efficiency, while other scholars estimate bank efficiency controlling among other factors, for the effect of institutional quality.[132] Considering the empirical research, the contribution of Demirgüç-Kunt et al. (2004) is among the first exploring the impact of institutions on bank efficiency.[133] Offering a cross-country analysis, they study the impact of bank regulations, market structure and national institutions on bank efficiency, using a sample of 1400 banks across 70 countries. They find a positive effect of the overall institutional environment on cross-bank efficiency, arguing that better property rights, good enforcement systems and higher level of judicial efficiency reduce banks' intermediation costs, since they increase the collateral value for banks loans. Hasan et al. (2009) investigate the effect of institutions on bank efficiency using a sample of Chinese banks observed from 1993 to 2006 and applying SFA. Considering institutional variables such as, rule of law and property rights, they find that institutions matter in explaining efficiency. According to their results, banks operate efficiently (in term of profits and costs) in regions characterized by a greater property

[131] Kontolaimou and Tsekouras (2010) use the Bankscope dataset that includes data on 1540 cooperative, 541 commercial and 735 savings banks localized in Austria, Belgium, France, Italy, Germany and Spain.

[132] Among these studies, Lensink et al.(2008) investigate whether the efficiency of foreign banks depends on both the institutional quality of the host country and the institutional differences between the home and the host country. They use a sample of commercial banks in 105 countries for the years 199-2003, and for the estimations they apply SFA. Their results show that both a higher institutional quality in the home country and a higher resemblance in institutional features between home and host country increase foreign bank efficiency.

[133] Demirgüç-Kunt et al. (2004) measure bank efficiency as net interest margin.

right consciousness. Lensink and Meesters (2014) investigate the role of institutions on both the adoption of technologies by banks and the efficiency of existing technologies.[134] They use a sample of 7,959 commercial banks across 136 countries observed over the period 1995-2006, an index of institutional quality based on Kaufmann et al.(2006) and apply SFA (Battese and Coelli, 1995).[135] They want to test the unclear effect of institutions on bank efficiency suggested by different views: the *public interest view* of banking and the *political economic view*. According to the first, weak institutions negatively affect bank performance, since restrictions on banks limit their ability to attract funds in cheapest way or to allocate them in an optimal way. Under the second view, a worse institutional quality can increase cost efficiency of banks, making easier for them to capture political rents, which improve cost efficiency but obstacle a good allocation of credit. Moreover, the authors hypothesize that in countries with a better institutional quality banks are more cost efficient and the effect of institutions by shifting the cost function inside, pushes banks to adopt more productive technologies.[136] They find that better institutions allow banks to apply more cost-reducing technologies and to use the technologies available more efficiently, supporting the public interest view.[137] On the contrary, other studies use measures of institutional quality as control

[134] According to Lensink and Meesters (2014) institutions might affect the efficient use of technologies by banks, as well as the technologies available for banks.

[135] Kaufmann et al.(2006) offer six indicators of regulatory environment of a country. Lensink and Meesters (2014) apply a principal component analysis to obtain a unique indicator of institutional quality.

[136] Lensink and Meesters (2014) argue that they estimate a cost function instead of a production function for several reasons. First of all, a production function approach assumes a single output in SFA, while a cost function makes easier the estimation with multiple outputs. Secondly, according to Shephard (1970), a cost function approach can be obtained from an input prices and a product function; while a production function assumes a maximization of output, a cost function assumes a minimization of costs. Finally, in a competitive setting where demand determines output and inputs prices are given, a cost function is more suitable.

[137] According to Lensink and Meesters (2014), the dimension *Voice and Accountability* of the World Governance Indicator (WGI) proposed by Kaufmann et al. (2010), capturing various aspects of political process, political rights, civil liberties and media independence, through a higher level of media independence that increases the quality of information about local development, bank costs efficiency should increase. Moreover, the dimension *Government*

variable in studying bank efficiency. Battaglia et al. (2010) evaluate the effect of environmental economic conditions such as social, institutional, demographic and economic features on the cost and profit efficiencies of Italian cooperative banks, observed over the period 2000-2005.[138] The authors argue that the riskiness of local communities and the culture of cooperation and solidarity may matter in evaluating BBCs efficiency. Among other variables at regional level, they account for some aspects of institutional quality: the level of criminality (measured as the number of bank robberies per 1000 branches) and an index of solidarity (measured as the number of blood donors within the population, proxy of social capital). They show that the level of criminality negatively influences bank profit efficiency, while solidarity seems to have a negative effect on profit and a positive effect on cost efficiency.[139] The authors conclude that a higher level of cost efficiency of BCCs, *ceteris paribus*, is potentiated by their culture of cooperation and solidarity. Moreover, they find that cooperative banks operating in the North of Italy are more cost efficient benefiting from a favorable environment, comparing to those operating at the South of Italy that are more profit efficient due to lower competitive pressures. Chortareas et al.(2013) applying the two-stage double bootstrap DEA procedure of Simar and Wilson (2007), investigate the impact of financial freedom

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Effectiveness, measuring the quality of public service provision and bureaucracy, the independence of civil service from political pressure and other factors, may affect bank efficiency. In countries where banks have problems in dealing with bureaucracy, better government effectiveness may reduce their costs. Similarly, the sub index *Regulatory Quality*, assessing inadequate bank supervisions among other factors, may increase the efficiency of banks, if they are supervised by an adequate system. Furthermore, through the factors captured by the dimension *Rule of Law* such as, the effectiveness and predictability of the judiciary, the enforceability of contracts, bank cost efficiency may be affected. For example, if the time to go to court is long, bank costs increase. Finally, the sub index *Corruption and Control* may decrease bank cost inefficiency by reducing the cost associated with bribery.

[138] Applying SFA, the authors estimate cost and profit efficiency by considering only BCCs and thus offering "within-the-group" differences instead of providing cost and profit efficiency scores computed by considering the entire national banking system. They argue that their technique allows also to "…*avoid estimation bias in efficiency scores to strong heterogeneity in the sample*" (Battaglia et al.,2010:1366).

[139] As concern the last result, the authors argue "…*in the territories where the values of cooperation and solidarity are stronger, and where cooperative banks obtain major cost efficiency, more favorable prices are applied to shareholders/customers to the detriment of higher profits*" (Battaglia et al.,2010:1375) .

on bank efficiency using a large sample of commercial banks operating in 27 European Union countries between 2001 and 2009. They control for institutional characteristics of a country by using the World Governance Indicator (WGI) proposed by Kaufmann et al. (2010). Basing on banking literature, they argue that economic, regulatory and institutional differences may play a key role in explaining bank efficiency and the heterogeneity in efficiency among banking sectors in different countries.[140] Their results indicate that higher efficiency levels are reached by banks operating in more open institutional environments characterized by better institutions and more developed and democratic systems. More in details, they find a positive and significant impact of all dimensions of the WGI, highlighting that the capacity of the government to implement and formulate good policies and regulations (*Regulatory Quality*) and the degree of freedom of expressions and free media in a country's system (*Voice and Accountability*) appear to be the dimensions more relevant in explaining bank efficiency. Barth et al. (2013) studying whether bank regulation, supervision and monitoring enhance or impede bank operating efficiency by considering a sample of 4050 banks operating in 72 countries over the period 1999-2007, control for the institutional quality of a country by using the WGI. Applying the two-stage double bootstrap DEA procedure of Simar and Wilson (2007), they find that a better institutional environment in term of law and regulations allow for more efficient banking sectors.[141]

4. EMPIRICAL QUESTION AND RESERCH HYPOTHESES

The aim of this paper is to assess the effect of local institutional quality on bank efficiency,

[140] Focusing on the relationship between financial freedom and bank efficiency, they hypothesize that the smaller are the constraints faced by banks in managing their business, the greater is the their efficiency to control their costs. Indeed, they find that the higher the degree of an economy's financial freedom, the higher is the efficiency reached by banks.

[141] As main results they find that tighter restrictions on bank activities have a negative impact on bank efficiency, while greater capital regulation stringency is positive associated with bank efficiency.

controlling for economic, banking and market features.

In comparing efficiency of banks operating in one country, the legal, institutional and macroeconomic conditions of the environment where they are located may differ and influence efficiency estimates (Bos and Kool, 2006). Indeed, according to Battaglia et al.(2010), despite cooperative banks share common features in a given country such as dimension, mutual nature and close relationships in the territory where they are located, heterogeneity may exist since social and economic conditions at the local level may influence efficiency and productivity levels.[142]

As a result, the efficiency estimates may be influenced by a mix of managerial ability and environmental factors that characterize the local area where banks operate.[143] Until now, a limited set of studies has investigated the efficiency of banks, assessing the impact of bank specific factors and market conditions, without, however, dealing with variables capturing local institutional quality. I focus exactly on this lacuna: using a unique dataset of 371 Italian BCCs observed from 2007 to 2012 and the Institutional Quality Index proposed by Nifo and Vecchione (2014), this is the first study that examines the impact of local institutional quality on BCC efficiency across Italian provinces, while controlling for bank specific factors and provincial macroeconomic and financial sector conditions. This analysis allows testing the following two contrasting views: the *public interest view* and the *political economic view*. As described in more detail in the previous section, according to the first one, weak institutions negatively affect bank efficiency by hampering banks to attract funds in cheapest way or allocate them in an optimal way. The second view argues that weak institutions improve bank efficiency, thanks to a regulatory capture effect (Barth et al., 2006; Lensink and Meesters, 2014; ElKelish and Tucker, 2015).

[142] Moreover, institutional, social and cultural factors may explain technology heterogeneity in banking (Kontolaimou, 2014).

[143] From different studies on bank efficiency, is generally accepted that banks operate at different distance from the frontier. I assume that these deviations from the frontier, measures of technical inefficiency, are function of economic and institutional factors.

4.1. Data sources

My estimation are based on bank level data and provincial data (NUTS3). Data on individual BBCs are from the Italian Banking Association (ABI) which provides balance sheet information on banks belonging to the Italian banking system. Table 1 shows the summary statistics of the variables employed to retrieve my measure of cost efficiency for a sample of 4401 branches (371 BCCs) observed from 2007 to 2012. The nominal values of banks' total cost, outputs (total customers' loan and total securities and other earning assets) and inputs (labour and customers deposits) have been deflated by using the customers price index (base-year 2010) available for Italy in the 'Consumer Prices (MEI)' dataset provided by OECD.[144] Table 1 also reports summary statistics concerning the explanatory variables entering the inefficiency model, while Table 2 reports the correlation matrix. The IQI index measuring the institutional quality at the provincial (NUTS3) level for the year from 2004 to 2012, is proposed by Nifo and Vecchione (2014). They construct the IQI following the structure of the World Governance Indicator proposed by Kaufmann et al. (2011), adopting a hierarchy configuration.[145] As concerns the variables defined at provincial

[144]As in most European countries, in Italy data at branch level are not publicly available. Thus, similarly to other studies (e.g. Carbo` Valverde et al., 2003; Agostino and Trivieri, 2010), I retrieve the variables I need for each branch office in each year as the ratio between the same variable provided by the balance-sheet of the BCC (to which the branch belongs) and the total number of branches of the same bank.

[145] In particular, they perform the aggregation of twenty-four elementary indexes of a lower rank to derive five dimensions representing some important characteristics of a governance system at province (NUTS3) level: *Rule of Law* includes data on magistrate productivity, on crime against property or person, the degree of tax evasion, trial times and shadow economy; *Regulatory Quality* encloses information regarding the ability of local administrators to promote and defend business activity expressed as the degree of openness of the economy and business settings; *Government Effectiveness* measures the endowment of economic and social arrangements in Italian provinces and the administrative capacity of provincial and regional governments on management policies, health, waste and ambience; *Voice and Accountability* comprises the existence of associations, the participation in public election, the number of social cooperatives and cultural liveliness gauged in terms of books and expense in bookshops; *Corruption* reassumes data on the number of local administrators refused by federal authorities, data on crimes committed against the public

level, gross domestic product and population are drawn from the Italian National Institute of Statistics (ISTAT), whereas the number of branches, and total deposits by square kilometer are provided by the Bank of Italy.

4.2. METHODOLOGY AND EMPIRICAL MODEL

4.2.1. Cost minimization and cost efficiency frontier

Operating in a regulated and competitive market, and having an intermediation role, a bank should be able to use its inputs efficiently to choose an optimal inputs and outputs mix. In other words, it should be technically efficient (minimum use of inputs) and allocative efficient (optimal mix of inputs given prices).[146] Indeed, an important question in studying bank efficiency is whether and by how much a bank is able to reduce costs maintaining the same level of output-services. [147] When price data are available and it is realistic to assume that a bank minimizes costs, it is possible to estimate a cost frontier in order to verify how close a bank's costs lie to the efficient cost frontier for a given technological set. In other words, relative measures of efficiency can be obtained estimating a cost frontier from real data, given that cost functions are not directly observable.

The research-efficiency literature on financial institutions, generally study both cost efficiency and profit efficiency, even though studying cost efficiency is more common (Berger and Humphrey,

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administration and the Golden-Picci Index that measures the corruption level on the basis of 'the difference between the amounts of physically existing public infrastructure […] and the amounts of money cumulatively allocated by government to create these public works' (Golden and Picci, 2005, p. 37).

[146] According to Farrell (1957) firm's cost efficiency is decomposable in two parts: *technical efficiency* (TE), which corresponds to the ability of a firm to obtain optimal output for a given set of inputs (minimum use of inputs), and *allocative efficiency* (AE) that given prices and the production technology, reflects the capability of a firm to use the inputs in optimal proportions (optimal mix of inputs given prices). The product of technical and allocative efficiency determines a measure of overall cost efficiency: $TExAE = CE$.

[147] A more technical description of cost efficiency is provided in the Appendix B.

1997).[148] Following Berger and Mester (2001) and Lensink and Meesters (2014), in this study cost inefficiency is measured as the distance between a bank's cost and a best practice cost function for producing the same output, given the existent banking technology. According to Lensink and Meesters (2014) there are several reasons to focus on studying bank cost efficiency: *i*) it can be obtained from a product function and input prices, and it makes easier the estimation of a model for multiple outputs banks in SFA context; *ii*) studying cost function is more suitable in a competitive market where demand determines output and banks are price takers. Moreover, according to Battaglia et al. (2010) cost efficiency is a primary aim of cooperative banks since an efficient structure of cost is essential to ensure a continuity of their activity and so, to avoid interruption of services offered to members/customers.

4.3. Estimation of cost efficiency frontier and inefficiency: parametric and nonparametric approaches

The response variable of my analysis is cost inefficiency, defined as the inability of banks to minimize total costs, given the inputs prices and the technology. There are parametric and nonparametric methods such as Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) to measure cost efficiency of individual banks. The main difference between these methods is how they split measures of inefficiency from random noise. Parametric approaches, such as SFA is based on the assumption of a specific cost function, typically a Cobb-Douglas or a Translog function (Battese and Coelli, 1995), and allows controlling for the presence of stochastic errors and inefficiency. In particular, it assumes that inefficiencies follow an asymmetric distribution, generally an half normal or truncated distribution, while random errors are assumed to follow a symmetrical distribution, usually the standard normal distribution. Moreover, both the random

[148] To analyze the efficiency of financial institutions, three important concepts of efficiency are generally used: cost, standard profit, and alternative profit efficiencies (Berger and Mester, 1997).

errors and inefficiencies are assumed to be orthogonal to the inputs prices, outputs and variables inserted in the estimating equation. Nonparametric methods, such as DEA does not require assuming a particular functional form for the cost function, attributing the distance from the technical cost frontier entirely to technical inefficiency without allowing for the influence of any random noise (Coelli et al.,2005). However, to overcome this limit inherent to DEA method, Simar and Wilson (2007) proposed a double bootstrap procedure.[149]

In this paper, I adopt a SFA one-stage procedure proposed by Battese and Coelli (1995) as my main method, while as robustness checks I apply the True Random Effects (TRE) SFA model proposed by Greene (2005) and two-stage double bootstrap DEA method proposed by Simar and Wilson (2007).[150] Moreover, I address concerns of endogeneity of the main variable of interest in the efficiency regression, by using the Karakaplan and Kuntlu's (2013) endogeneity test in the SFA context, and an instrumental variable panel estimator in the two-stage DEA procedure.

4.3.1. Stochastic Frontier Approach

Formally, the general stochastic cost frontier using panel data can be written as: [151]

$$\mathrm{TC}_{it} \geq c(w_{1t}, w_{2t}, , \dots, w_{Nit}, q_{1t}, q_{2t}, , \dots, q_{Mit}) \qquad (1)$$

[149] For a thorough presentation of the methods refer to Battese and Coelli (1995) and Coelli et al. (2005). As several contributions suggest, the two methodologies tend to yield consistent results (Cummins and Zi, 1998; Casu et. al., 2004; Elling and Luhnen, 2010; Cummins and Xie, 2013).

[150] A more technical description of the two-stage double bootstrap DEA method proposed by Simar and Wilson (2007) is provided in the Appendix B, while a technical description of the Karakaplan and Kutlu (2013) model is provided in the Appendix C2 of this thesis.

[151] The use of panel data is considered more appropriated in measuring technical efficiency since a richer specification of technical change is allowed, and obviously because contain more information on a statistic unit than cross-sectional data (Jin et al. 2010). Moreover, panel data allows to relax strong distributional assumptions related to the inefficiency term; it is used to obtain consistent prediction of technical efficiencies; it allows to study changes in technical efficiency assuming that it changes over time and not only across firms (Coelli et al., 2005).

where TC_{it} is the observed total cost of bank *i* at time *t*; w_{nit} is the *n*-th input price (with $n = 1,2,\dots,N$) at time *t* (with $t = 1,\dots,T$); q_{mit} is the *m*-th output (with $m = 1,2,\dots,M$) at time *t*; and *c*(.) is a cost function that is linearly homogeneous, non-decreasing and concave in prices.

In the compact form, the model is the following:

$$TC_{it} = c(q_{it}, w_{it}) \exp(v_{it} + u_{it}) \quad (2)$$

where the composite error term is constituted by v_{it} that is a random error assumed to be iid according to standard normal distribution $Niid(0, \sigma_V^2)$, independently distributed of the u_{it} and u_{it} is a non-negative random variable and inefficiency term, independent but not identically distributed according to truncated-normal distribution.

According to Farrell (1957), a measure of cost efficiency is the ratio of minimum cost of a potentially efficient bank to the observed cost:

$$CE_{it} = \frac{c(q_{it},w_{it})^{e_{vit}}}{c(q_{it},w_{it})^{e_{vit}e_{uit}}} = e^{-u_{it}} \quad (3)$$

In this study, the functional form of *c*(.) is specified as a Translog, and the input-output combination is individuated following the intermediation approach as in most recent studies (Berger and Mester,1997; DeYoung and Hasan, 1998; Isik and Hassan, 2002; Lozano-Vivas and Pasiouras, 2010; Lensink and Meesters, 2014; Aiello and Bonanno, 2016a, 2016b).[152] In particular, I follow

[152] The choice of the input-output combination that represents the best approximation of the banking production process, is the main limit that scholars meet in measuring bank efficiency. This is due to the multiproduct nature of banking production. The definition of the approaches generally applied in the literature can be linked to the typical banks' functions: the bank's monetary and lending function. Three main approaches are generally applied in the literature: the intermediation approach, the production approach and the value added approach. The first two approaches differ in defining banking activities since are based on the traditional microeconomic theory of the firm. The third one modifies the classical theory by incorporating some specific activity of banking (Sufian, 2009). Under the intermediation model pioneered by Sealey and Lindley (1977), banks act as intermediary between surplus spending agents and deficit spending ones by attracting money from the first to lend to the second. Therefore, this approach giving major attention to the bank's lending function, assumes that banks combine deposits and labor and through some transformations process, produce loans and securities. The second approach is known as production approach that looks at the bank's monetary function. Under this approach, pioneered by Benston (1965), banks are considered as a producer of services for account holders. According to this

Lensink and Meesters (2014) to specify the cost frontier function. The Translog cost frontier model in logarithm form, after taking into account the constraint of homogeneity in relation to input prices of the *n* inputs (with $n = 1,2$) ($\sum_n \beta_n = 1$) is the following:

$$\ln\left(\frac{TC_{it}}{PF_{it}}\right) = \beta_0 + \beta_1 \ln TCL_{it} + \beta_2 \ln TSOA_{it} + \beta_3 \ln\frac{PL_{it}}{PF_{it}} + \beta_4 T + 0.5\beta_5(\ln TCL_{it})^2 + 0.5\beta_6(\ln TSOA_{it})^2 + 0.5\beta_7\left(\ln\frac{PL_{it}}{PF_{it}}\right)^2 + 0.5\beta_8 T^2 + \beta_9(\ln TCL_{it})(\ln TSOA_{it}) + \beta_{10}(\ln TCL_{it})\left(\ln\frac{PL_{it}}{PF_{it}}\right) + \beta_{11}(\ln TSOA_{it})\left(\ln\frac{PL_{it}}{PF_{it}}\right) + \beta_{12}(\ln TCL_{it})\,T + \beta_{13}(\ln TSOA_{it})T + \beta_{14}\left(\ln\frac{PL_{it}}{PF_{it}}\right)T + v_{it} + u_{it} \quad (4)$$

where $\ln TCL_{it}$ is the logarithm of Total Customers Loan and $\ln TSOA_{it}$ is the logarithm Total Securities and Other Earning Assets that represent two outputs of the *i*th bank at time *t*, respectively; $\ln PF_{it}$ is the logarithm of Price of Funds and $\ln PL_{it}$ the logarithm of Price of Labor representing the inputs prices of the *i*th bank at time *t*, respectively*;* [153] T is a time trend to account for technological change; βs are parameters to be estimated. Using a Translog, it is imposed the constraint of symmetry and linear restrictions of the cost function. In particular, to assurance linear homogeneity in input prices of the cost function, I scale TC and PL by PF.[154] This implies an estimation of coefficients for PL as well as PF with the constraint that the sum of these coefficients is equal to one.

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approach, output is measured by the number of accounts or transactions, while it considers physical capital and number of employees as inputs. The value added approach originally proposed by Berger and Humphrey (1992) identifies balance sheet categories as output or inputs according to their contribution to the bank value added. In general, under this approach, loans and deposits are considered as outputs since they contribute to a significant proportion of value added.

[153] Further details about the variables used are reported in Table 1.

[154] According to Jin et al.(2010), a translog is a general functional form since is a second order approximation of any production technology.

Battese and Coelli (1995) propose a way to account for non-stochastic environmental variables by allowing them to influence directly the stochastic component of the cost frontier, offering a one-step estimation of the cost function and the identification of factors correlated to the inefficiency term.[155] Battese and Coelli (1995)'s method assumes that the inefficiency term has a truncated-normal distribution, independent but not identically distributed over different statistical units. In particular, the inefficiency term u_{it} is assumed to be a function of a set of explanatory variables, z_{it}, and a vector of coefficient to be estimated δ. More specifically:

$$u_{it} = z_{it}\delta + e_{it} \quad (5)$$

where the random variable e_{it} has a truncated-normal distribution with zero mean and variance σ^2, such that the point of truncation is $-z_{it}\delta$ and so, $e_{it} \geq -z_{it}\delta$. Consequently, the inefficiency term is $u_{it} > 0$, having a truncated-normal distribution $u_{it} \sim N^{+}(z'_{it}\delta, \sigma_u^2)$. The method of maximum likelihood is adopted to simultaneously estimate the parameter of the stochastic frontier function (4) and the model for the inefficiency (5).[156] According to the notation above, the cost efficiency for the *i*-th bank at time *t*, that takes up a value between zero and one is defined by the following equation:

$$CE_{it} = \exp(-u_{it}) = \exp(-z_{it}\delta - e_{it}) \quad (6)$$

The SFA procedure proposed by Battese and Coelli (1995) presents some limitations since does not control for the individual unobserved heterogeneity assuming that this heterogeneity is entirely

[155] Exogenous variables that characterized the environment in which banks operate may influence the capability of managers to make correct decisions on optimal mix of inputs-outputs. In considering environmental factors, it is reasonable to distinguish between stochastic variables that can exogenously affect production risk, such as weather or any type of events that may influence mangers' ability, and non-stochastic variables that are observable and may affect production's decisions (i.e. legal system and type of ownership).

[156] The likelihood function is expressed in terms of the variance parameters, $\sigma_S^2 = \sigma_V^2 + \sigma^2$ and $\gamma \equiv \frac{\sigma^2}{\sigma_S^2}$.

inefficiency.[157] According to Kumbhakar et al. (2014), the omission of the time-invariant heterogeneity might cause biased estimates of production function frontier parameters but also to an overstatement of inefficiency u_{it}, and hence an understatement of technical efficiency.[158] In a panel data where a statistical unit is observed over time, the specific unobserved variations can be taken into account through fixed or random effects. Greene (2005) proposes extensions of the stochastic frontier for panel data with the "true" fixed effects (TFE) and the "true" random effects (TRE) frontier models, accounting for both time invariant unobserved heterogeneity and time-varying technical inefficiency. Hence, in both models firm-specific effects are not parts of inefficiency:

$$lnTC_{it} = \alpha_i + \beta' x_{it} + v_{it} + u_{it} \qquad \text{(TFE 1)}$$

and

$$lnTC_{it} = (\alpha + w_i) + \beta' x_{it} + v_{it} + u_{it} \qquad \text{(TRE 1)}$$

where $v_{it} \sim N(0, \sigma_v^2)$ and $u_{it} \sim N^+(0, \sigma_u^2)$, respectively. The models differ for the assumptions about the time invariant effect. In the TFE model, α_i is a time invariant fixed effect. In the TRE model, w_i is an i.i.d. random component ($w_i \sim N(0, \sigma_W^2)$). The TRE model assumes that there is no correlation between individual specific random component w_i and the explanatory variables (inputs).[159] The

[157] In other words, Battese and Coelli (1995) model does not take into account the panel structure of the data handling them as a pooled set of observations. Yet, I apply also the Battese and Coelli (1995) estimator for comparisons purposes, as many other studies focusing on bank efficiency have adopted this method (for example, Fries and Taci, 2005; Bos and Kool, 2006; Lensink et al, 2008; Hasan et al., 2009; Battaglia et al., 2010; Lensink and Meesters, 2014 and others).

[158] Moreover, according to Kumbhakar et al. (2014), Battese and Coelli (1995) specification is restrictive since it only allows inefficiency to change over time exponentially. What is more, this model ignoring heteroskedasticity in both the two-sided error term v_{it} and the one sided technical inefficiency term u_{it} could lead to inconsistent parameters estimates.

[159] According to several studies (Farsi et al., 2005; Filippini and Hunt, 2012; Pieri and Zainotto, 2013 and Castiglione et al., 2017), it is possible to account for this correlation using the adjustment by Mundlak (1978) that requires inserting the within-group means of inputs in the production or cost frontier model. In particular, the within-group means of inputs is accounted in $w_i = \lambda' \bar{X}_i + \eta_i$, where $\bar{X}_i = 1/T_i \sum_{t=1}^{T} X_{it}$ are individual specific means, T_i is the number of time

model has two important advantages since, through the inclusion of the random component, it controls for any omitted variable biases and also, avoids heterogeneity biases in the estimates of technical efficiency.[160] The model parameters of the TRE model are estimated by applying simulated maximum likelihood procedure proposed by Greene (2005), while TFE model is estimated by applying the maximum-likelihood dummy variable (MLDV).[161] The CE_{it} scores are obtained in line with Eq. (6) as before.[162]

4.4. The technical (in)efficiency model

To test the relationship between bank inefficiency and local institutional quality controlling for both bank specific characteristics and external factors, I estimate the following benchmark inefficiency model, based on Lensink and Meesters (2014):

$$INEFF_{itj} = \alpha + \beta IQI_{j(t-1)} + \phi Z_{i(t-1)} + \varphi X_{tj} + \vartheta_1 TREND + \vartheta_2 TREND^2 + \omega_{itj} \qquad (7)$$

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periods for *i*, λ' is the corresponding vector of coefficients to be estimated and $\eta_i \sim N(0, \sigma_\eta^2)$. In this way, the stochastic component is split in two parts: the first one explicates the relationship between exogenous variables and firm specific effect and the second one, η_i, is assumed to be orthogonal to the explanatory variables (Castiglione et al. 2017).

[160] However, in the Greene (2005) models considering any time-invariant component as unobserved heterogeneity, any persistent (long term) component of inefficiency is completely absorbed (Filippini and Hunt, 2016). In other words, long term inefficiency is confounded with latent heterogeneity (Kumbhakar et al, 2014). Indeed, according to Faust and Baranzini (2014), the TRE model can lead to an underestimation of technical efficiency scores by assuming none of the unobserved persistent differences to be inefficiency.

[161] For TFE estimations the so-called incidental parameter problems may arise when the number of units is relatively large compared with the length of the panel. According to Belotti and Ilardi (2012), MLDV is appropriated when the length of the panel is larger than 10 years. Hence, α_i are inconsistent and subject to small sample bias which may impact the technical efficiency scores (Kumbhakar et al, 2014). This problem can be addressed by applying Chen et al. (2014) that estimate a fixed effect panel stochastic frontier model by applying Marginal Maximum Likelihood within and/or first difference methods. Unfortunately, this approach is highly unstable for my data.

[162] Empirical applications of Greene (2005) models can among others be found in studies about drinking water distribution efficiency (Filippini et al. 2007; Abrate et al. 2011; Faust and Baranzini, 2014), nursing homes efficiency (Farsi et al, 2005), machine tool industry efficiency (Pieri and Zainotto, 2013), energy efficiency (Filippini and Hunt, 2016), performing arts companies efficiency (Castiglione et al., 2017).

where the dependent variable is the inefficiency component retrieved by applying SFA one-stage procedure proposed by Battese and Coelli (1995), described above. According to equation (7), bank cost inefficiency (INEFF) is a function of the Institutional Quality Index (IQI), a vector Z including control variables at the bank level and a X vector including control variables at the provincial level, defined in more detailed in Table 1 and described below; the trend and its square (accounting for business cycle effects). It is worth highlighting that, to limit potential endogeneity concerns, I assume lagged values of IQI and all regressors defined at the bank-level.

My key variable is the IQI, defined at the provincial level. As argued in the literature review, two contrasting views try to predict the effect of institutions on bank efficiency: the *public interest view* and the *political economic view*. According to the first, weak institutions negatively affect bank efficiency by hampering banks to attract funds in cheapest way or allocate them in an optimal way. The second view maintains that weak institutions improve bank efficiency thanks to a regulatory capture effect.

As concerns bank specific characteristics (Z), the ROA variable - defined as after tax profit divided by total assets- is included in the model to control for management effects. The relationship between profitability and inefficiency is assumed to be negative since profitable banks may be more efficient (Mester, 1996). The variable EQTA - equity over total assets- is included in the model to control for scale inefficiency effects and to address the relationship between inefficiency and capital structure (Berger and Mester, 1997; Lensink and Meesters, 2014). The impact of this variable on cost inefficiency could be ambiguous. On the one side, it may be negative since a higher capital ratios implying lower leverage, thus lower risk taken, and lower borrowing costs (Casu and Molyneux, 2003). Moreover, higher capital ratios may prevent moral hazard, by reducing the incentive to take on excessive risk, and may entail greater shareholder control, inducing managers to be more efficient (Mester, 1996; Alhassan, 2015). On the other side, higher amount of

capital can be perceived by BCCs as a cost, since it can act as a binding restriction (Aiello and Bonanno, 2016a,b).

Moreover, I account for diversification in BCC activities including the ratio of other operating income over total assets (OI). Through diversification, banks can be independent from their major activity of lending, paying attention to other activities (corporate finance, underwriting). Indeed, exploiting more information acquiring during the relationships with their clients, banks can offer services and doing *crosselling* activities. Considering diversification in BCC activities may be relevant, however, there is no priori expectation of the impact of diversification on inefficiency.[163] More specifically, as regards to cost efficiency, the effect of diversification may be mixed depending on banks' know-how in managing services, since banks that are not able to reinforce their position may incur higher costs when decide to diversify their products (Casu and Girardone, 2004).[164] According to Rossi et al. (2009), this ambiguous prospective is supported by two alternative hypotheses. On the one hand, a major diversification may increase monitoring costs and persuade risk-adverse managers to incur additional costs for selecting and monitoring activities (*monitoring hypothesis*), decreasing cost efficiency. On the other hand, diversification may have a positive effect on cost efficiency as a result of the effect of that in reducing the idiosyncratic risk

[163] Diversification in revenue sources should have a positive effect on bank efficiency, since economies of scope may be at work (Klein and Saidenberg,1997). Empirical studies have recently evidenced that in financial turmoil, the benefits deriving from diversification are totally nullified by higher revenue volatility (Mercieca et al., 2007). Mercieca et al. (2007) investigate whether the shift into non-interest income activities improves performance of a sample of European credit institutions observed over the period between 1997 and 2003. From their results, a negative association between non-interest income and bank performance emerges. According to the authors, small banks possessing advantages in traditional lending services, can improve their performance by investing in these traditional activities than in non-interest ones, where they have less experience.

[164] In the case of profit efficiency the evidence can be mixed. On the one hand, according to Chiorazzo et al. (2008) that study the effect of diversification on Italian banks' performance, a major diversification across new types of services seems to be beneficial. On the other hand, for switching and information costs making expensive for a bank and a borrower to leave a relationship lending, gains from traditional lending activities tend to be stable over time (DeYoung and Roland, 2001).

that could lead to lower banks' efforts in monitoring activity, and thus to lower operative costs (*idiosyncratic risk hypothesis*).[165] Another variable included in the regressions is the ratio between bad loans to total customers loans (NPL), proxy of credit risk computed at the bank level. A high ratio may reflect a high risk taking or simply mismanagement (Casu and Girardone, 2004). Moreover, according to Berger and De Young (1997), a high value of this ratio may represent a situation of not sufficient strict internal controls, reflecting inefficient operations. The effect of this ratio is expected to be positive on bank cost inefficiency.

Finally, because of the special relation that BCCs establish with the territory that they serve, the vector X accounts for economic characteristics at provincial level. In particular, I include some macroeconomics variables: (the log) of gross domestic product per capita (GDPPC) and the gross domestic product growth (GDPGRW). Per capita gross domestic product is included as a proxy of local economic development. On the one hand, as development increases bank costs may decrease due to a corresponding improvements in the quality of state institutions (Fries and Taci, 2005). On the other hand, financial costs may be higher in developed areas leading banks to face higher operating and financial costs in offering services (Dietsch and Lonzano-Vivas, 2000). Furthermore, the gross domestic product growth is also included to control for business-cycle fluctuations (Demirgüç -Kunt and Levine, 2004). In fast growing economy, competitions may be higher leading borrowers' specific information to be more dispersed. Consequently, banks may face higher costs in collecting information (Hasan et al., 2009).

5. EMPIRICAL FINDINGS

[165] Rossi et al . (2009) study the effect of diversification on risk, cost and profit efficiency by using a sample of Austrian commercial banks observed over the period 1997-2003. Applying SFA to retrieve cost and profit efficiency scores, they find that diversification decreases cost efficiency giving support to the monitoring hypothesis.

The first two columns of Table 3 report the results concerning the benchmark model (equation 7), by adopting the SFA one-stage procedure proposed by Battese and Coelli (1995). Column 2 includes also provincial fixed effects.

According to my results, the IQI regressor has a significant and negative effect on BCCs cost inefficiency, even when controlling for provincial effects. These results support the public interest view of banking, according to which better institutions improve bank efficiency. This empirical result suggests that well-developed local institutions (i.e. better local legal systems, well-functioning local regulatory and government frameworks, and higher levels of social capital) may be fundamental for the efficient cost operations of cooperative banks, that in turn are crucial to finance local business.

Regarding the control variables in the inefficiency equation, most results are in line with expectations and consistent with the findings of Lensink and Meesters (2014).[166] In particular, the coefficient of the variable ROA is negative and statistical significant, suggesting that an increase in banks' profitability reduces cost inefficiency. The variable proxy of capital structure (EQTA) is positively associated with cost inefficiency, reflecting the fact that higher capital ratios may represent a constraint for BCCs. The positive and significant relationship between OI variable and cost inefficiency indicates that an increase in BCCs' diversification increases cost inefficiency. This result seems to support the *monitoring hypothesis*, according to which a major diversification increasing monitoring costs, could persuade risk-adverse managers to bear additional costs by increasing cost inefficiency. Moreover, it seems that BCCs would have higher cost efficiency by offering traditional services (loans) to their customers/members. The proxy of credit risk, NPL is positive and statistically significant, indicating that higher risk is associated with higher costs. The coefficient of the variable GDPPC is negative and statistically significant, reflecting that in more developed areas, BCCs seem to be more efficient in their costs. The relationship between

[166] The results about the control variables are qualitatively the same in the first two columns of Table 3.

GDPGRW and cost efficiency is negative and statistically significant, suggesting that in fast growing provinces BCCs face higher operating and financial costs, due perhaps to higher competitions in collecting borrowers' information (Hasan et al., 2009).[167]

5.1. Robustness checks

In this subsection, I first verify the sensitivity of my findings to the inefficiency model specification - using SFA one-stage procedure - and then I change the methodology adopted.

As a first robustness check on the specification adopted, I modify the benchmark specification by adding a dummy for the years of the recent sovereign debt crisis, 2011 and 2012 (D_CRISIS) or by adding a dummy South of Italy (D_SOUTH).[168] According to the results of Table 3 column 3 and 4, the sovereign debt crisis seems to negatively affect BCCs cost efficiency, and BCCs operating in the South of Italy face higher operating and financial costs, due probably to less favorable economic and social conditions that make BCCs activity more risky in that area (Battaglia et al, 2010).

In Table 4, I extend the specification of Lensink and Meesters (2014), including variables that capture local banking market conditions, which are particularly relevant for BCCs, since the province (NUTS3) is their geographical reference area. In particular, I include markets concentration at provincial level measured by using the number of branch in every province by year (HHI). The impact of this variable on cost inefficiency may be ambiguous. On the one hand, higher concentration causing major market power, may lead to higher prices for banking services, without inducing banks to control their costs, that prefer to enjoy the "quiet life" (Berger and Mester, 1997), determining inefficiency (Turati, 2004; Fries and Taci, 2005). On the other hand, according to the efficient-structure hypothesis, a greater concentration may emerge as a consequence of higher

[167] For the estimation including provincial fixed effects (column 2, Table 3), the variables GDPPC, GDPGRW are not statistically significant.

[168] The sovereign debt crisis breaks out after the second quarter of 2011 in Italy (Neri, 2013).

competition in the market, as the most efficient banks might increase their market shares at the expense of their less efficient competitors (Berger, 1995; Goldberg and Rai, 1996).[169] Moreover, I account for the provincial structure of the industry, considering the provincial number of bank branches per square kilometer (owned by cooperative and other type of banks). Even the impact of this variable (BRANCH) on cost inefficiency may be ambiguous. On the one hand, an increase in branching has a positive effect on bank inefficiency since banks face higher operating costs to provide financial services.[170] On the other hand, according to Battaglia et al. (2010) where banking system is more developed and more competitive, there is a higher attention to pursue cost efficiency. I include the variable (DDEP), measured as total deposits by square kilometer since banking efficiency may be also explained by demand density. Higher demand density can entail lower costs in making loans and mobilizing deposits, and hence, lower costs in finding customers (Fries and Taci, 2005).

Column 1 and 2 of Table 4 reports the results for the extended model with and without including provincial fixed effects, respectively. Looking first at the same control variables included in the benchmark model (equation 7), they are statistically significant and their estimated coefficients are generally consistent with those found above. As concern the new variables that extend my benchmark model, the results show that the variable HHI is positive and statistically related to BCCs cost inefficiency: BCCs tend to be more cost inefficient in concentrated local banking markets. The variable BRANCH is positive and statistically significant, suggesting that, *ceteris paribus*, BCCs face higher cost in local market characterized by a higher number of branches. The coefficient of the variable DDEP is negative and statistically significant, indicating that BCCs seem

[169] As argued by Aiello and Bonanno (2016a,b), higher concentration banking markets may induce banks to be more efficient, exploiting economies of scales and acquiring stronger position in the reference market.

[170] Moreover, the effect of branching could be positive on inefficiency for the local market's over-dimensioning.

to be more efficient in their operational and financial costs in provinces characterized by high level of deposits.

The results are consistent with those found above, when I add a dummy for the recent crisis years (D_CRISIS) and the dummy South (D_SOUTH), in column 3 and 4 of Table 4, respectively.

As robustness check concerning the methodology, I first apply the TRE model proposed by Greene (2005) that accounts for both time invariant unobserved heterogeneity and time-varying technical inefficiency. The results presented in Table 3 column 5 for the benchmark equation (7), seem to remain substantially unaltered when controlling for time invariant heterogeneity.

Moreover, I adopt the double bootstrap DEA approach proposed by Simar and Wilson (2007). First, I obtain the bias corrected cost efficiency scores (from a cost-minimization DEA model) and then I adopt a bootstrapped truncated estimator to estimate the relationship between bias-corrected DEA cost efficiency scores and the key variable IQI, controlling for the potential determinants, specified in the benchmark equation (7).

As column 6 of Table 3 and column 5 of Table 4 show, most of the estimated coefficients in the cost efficiency model have a significant effect on bank cost inefficiency, pointing in opposite direction respect to the one step SFA results. Indeed, a positive coefficient in this model reflects an increase of bank cost efficiency and, hence, a decrease in bank cost inefficiency. The scores of cost efficiency are positively related to the main variable IQI, which indicates that an increase in the quality of institutions leads to an increase in banks cost efficiency. The other control variables are statistically significant and their estimated coefficients are generally consistent with those found above. [171]

As another robustness check, I address concerns of endogeneity relating to my main variable IQI likely to be endogenous, as variation in the error term may affect both institutional quality and bank

[171] Apparently, the estimated coefficient of EQTA is not in line with the results based on SFA one stage procedure.

cost efficiency.[172] So far, in my regressions, I have limited potential endogeneity problems by lagging the variable IQI and all explanatory variables defined at the bank level. Here, in the context of SFA, I adopt for the benchmark and extended model a test recently proposed by Karakaplan and Kutlu (2013).[173] Moreover, when adopting the DEA two-step approach described above, I address the endogeneity of IQI by applying an IV random-effects estimator in the second step estimation. In both cases, I employ as instruments some variables defined at provincial level at the end of the 1800s, soon after the political unification of Italy. As a matter of fact, while Italy is unified in 1861, Rome and Venetia become part of the Kingdom of Italy respectively in 1866 and 1870. At that time, there are significant territorial differences in terms of economic development, literacy rates, as well as institutional quality.[174] This geographical heterogeneity is expected to be correlated with local

[172] Moreover, in stochastic frontier models endogeneity problem may arise for different reasons: the determinants of the frontier can be correlated with the two side error term and with the inefficiency term and these two latter can be correlated each other (Karakaplan and Kuntlu, 2013).

[173] Karakaplan and Kutlu (2013) is a one-step maximum likelihood based estimation methodology that allows estimating the parameters of a linear model where the error term is composed by a strictly nonnegative measure of inefficiency and a two-sided error term from a symmetric distribution. This methodology can account for endogenous variables both in the frontier and the inefficiency model. The method handle endogenous variables in the frontier and in the inefficiency model, offering estimates not affected by endogeneity and comparing them with the standard frontier estimates that ignore endogeneity. A more technical description of the Karakaplan and Kutlu (2013) model is provided in the Appendix C2 this thesis.

[174]According to a strand of the literature, human capital accumulation should foster institutional improvement over time. Indeed, "educated people are more likely to resolve their differences through negotiation and voting than through violent disputes. Education is needed for courts to operate and to empower citizens to engage with government institutions. Literacy encourages the spread of knowledge about the government's malfeasance" (Glaeser et al. 2004, page 272). Building on this literature, I consider the provincial number of illiterates in 1871. Furthermore, I code a dummy variable as 1 if the province in 1870 is characterized by a "geometric" (Napoleonic or Hapsburg) cadastre, and zero if the cadastre is "descriptive". While the former registry includes geometric description of land parcels linked to other records, and is a comprehensive register of the real estate or real property's metes-and-bounds of a country, the other type is more approximate. Hence, provinces with a geometric cadastre have a more detailed source of data in disputes between landowners, and also a means of more precise tax assessment, resulting in higher administration efficiency.

institutions development in the subsequent decades, whereas it can be considered exogenous with respect to banks' performance in current years.

Looking at the results of the Eta test (reported at the bottom of column 1, Tables 3 and 4), I can accept the null hypothesis of exogeneity at all conventional levels of significance both for the benchmark and the extended model, thus the traditional frontier models seem appropriate. Furthermore, considering the DEA procedure, as columns 7 of Table 3 and column 6 of Table 4 show, the results remain substantially unaltered, both for the benchmark and the extended model.[175]

6. CONCLUSIONS

This study empirically assesses the impact of local institutional quality on BCCs cost efficiency, using a data on Italian BCCs observed from 2007 to 2012 and the Institutional Quality Index recently proposed by Nifo and Vecchione (2014).

I estimate a stochastic cost efficiency frontier for BCCs, using the Battese and Coelli (1995) and the Greene (2005) models to simultaneously estimate the frontier and a model of inefficiency. Furthermore, my results are fairly robust when adopting non-parametric measures of inefficiencies based on the double bootstrap Simar and Wilson (2007) procedure, and when addressing potential endogeneity problems, by considering a test recently proposed in a SFA one-stage procedure (Karakaplan and Kutlu, 2013) and an IV random-effects estimator in the DEA second step estimation.

Controlling for bank specific factors, economic, and banking market features, I find a significant negative relationship between institutional quality and bank inefficiency, supporting the *public*

[175]The validity of the IVs is corroborated by two statistical tests (Wooldridge, 2002): the IVs are highly correlated with the IQI regressor (controlling for the other explanatory variables in the model), and the Sargan test cannot reject the null hypothesis that the excluded instruments are valid instruments. The set of IVs passing these tests includes: the number of illiterates in 1871; its squared, and the dummy "geometric" cadastre. As aforementioned, my external instruments are time invariant, thus I cannot employ a fixed effects estimator.

interest view. Hence, my findings mirror those of Demirgüç-Kunt et al. (2004) and Lensink and Meesters (2014) , supporting the same hypothesis.

The relevance of this negative relationship suggests an institutional failure that may lead to a market failure. Indeed, in local areas characterized by less efficient judicial systems bank efficiency may decrease as the costs of loans recovery from insolvent borrowers at the end of a trial may increase, whilst the value of collateral can decrease. Moreover, worse local governments may increase the costs of banks dealing with bureaucracy, might delay or discourage banks' investments and limit the exploitation of scale/scope economies in collecting and processing information about borrowers, decreasing bank efficiency. Besides, deteriorations in regulatory interventions may be associated to inadequate banking supervision, jeopardizing banks' efficiency. What is more, the lack of civil norms and a lower level of trust may increase the cost of monitoring and enforcing contracts (Knack and Keefer, 1997), entailing higher credit appraisal and monitoring costs and greater costs associated with bribery.

In terms of policy implications, the results indicate that better local institutions may lead to greater efficiency in banking operations. This could prove to be very important, especially in bank based financial systems, where SMEs typically depend on bank loans, and local supply of credit is crucial to respond to their financial needs. Policymakers should design and promote well-functioning institutions among Italian provinces, strengthening the role of BCCs as "territorial banks", who offer banking services to local communities, support business ideas and contribute to the economic development of the Italian local areas.

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TABLE 1 - Description and summary statistics

VARIABLE	DESCRIPTION		Mean	Std. Dev.	Min	Max	Obs
Entering the cost function							
TOTCOST [(a)]	Total cost	The sum of interest expenses, operating costs, administrative expenses, depreciation of fixed assets and commission expenses.	1570.716	528.0362	361	4579	21,129
Outputs							
TCL [(a)]	Total customer loans	Loans to customers. It includes current accounts, credit cards, repurchasing agreements, transactions relating to financial leasing and factoring, structured debt securities, personal loans and salary-backed loans, business loans, mortgages and other securities.	29135.65	10764.1	5065.4	89094	21,129
TSOA [(a)]	Total securities and other earning assets	Amount of securities and other earning assets (loans to other banks, equities and bonds)	10084.39	5410.686	1427.428	71205.49	21,129
Price of Inputs							
PF[(e)]	Price of founds	Ratio of interest expenses over debts to customers	3.69207	1.7566	0.58197	11.09614	21,129
PL[(a)]	Price of labour	Ratio of personnel expenses to the number of employees	69.01821	6.435244	39.11373	113.4	21,129
Entering the (in)efficiency model							
IQI	Institutional Quality Index	Institutional Quality Index at provincial level	0.688914	0.161625	0	1	20,965
ROA[(e)]	Return on assets	Net income over total assets	0.446945	0.452844	-1.96162	1.739116	21,129
OI[(e)]	Other operating income over total assets		0.759976	0.258815	0.197753	2.548425	21,129
NPL[(e)]	Non Performing Loans on Customers Loan	Bad loans over total customers loans	1.987817	1.372269	0	6.545795	21,129
EQTA[(e)]	Equity over total assets		0.547806	0.996252	0.001791	14.45599	21,129
HHI	Hirschman–Herfindahl index	The Hirschman–Herfindahl index calculated by using the number of branches per bank in every province by year.	0.105249	0.03466	0.046261	0.323134	21,129
DD	Demand density	Total deposits by square kilometer	9.519005	11.30739	1.882461	105.1959	21,129
BRANCH	Branch density	Number of bank branches per square kilometer	0.194511	0.205173	0.020017	1.483195	21,129
GDPPC[(a)]	Gross domestic product per capita	Gross domestic product over provincial population	29487.3	6141.771	14222.37	52080.75	21,100
GDPGRW[(e)]	Gross domestic product growth	Gross domestic product growth	-1.93696	4.020673	-11.4194	12.92788	16,280

(a) in thousands of Euro; (b) in log; (c) in years, (d) in units, (e) in percentage

TABLE 2 - Correlation matrix

	IQI	ROA	OI	NPL	EQTA	GDPPC	GDPGRW
IQI	1						
ROA	-0.077	1					
OI	-0.089	-0.152	1				
NPL	-0.188	-0.45	0.299	1			
EQTA	0.009	-0.066	0.152	0.074	1		
GDPPC	0.714	-0.044	-0.088	-0.233	0.029	1	
GDPGRW	0.085	-0.044	-0.088	-0.0009	0.04	0.22	1

For the description of the variables see Table 1.

TABLE 3 - Estimation results: benchmark model and robustness checks (Battese and Coelli (1995), Greene (2005), bootstrapped truncated regression , 2SLS random effects estimator).

	Dependent variable: **COST INEFF and COST EFF**						
	1	*2*	*3*	*4*	*5*	*6*	*7*
	BENCH	Adding provincial fixed effects	Adding Dummy CRISIS	Adding Dummy SOUTH	BENCH TRE	BENCH SW	BENCH 2SLS
IQI	-0.1426***	-0.114***	-0.1177***	-0.1129***	-0.0569***	0.1363***	1.0888***
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.*008*
ROA	-0.0881***	-0.0800***	-0.0943***	-0.0905***	-0.0218***	0.0329***	0.0965*
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.*074*
EQTA	0.021***	0.0152***	0.02106***	0.0194***	0.0185 ***	0.0044***	-0.0148
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.*731*
OI	12.342***	8.837***	13.6***	12.831***	3.3334***	-10.467***	-17.0865*
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.*057*
NPL	1.574***	1.3731***	1.5093***	1.4086***	1.4172***	-1.3551***	-5.3839**
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	0.*019*
GDPPC	-0.1117***	-0.0185	-0.1226***	-0.0695***	-0.1749***	0.0268***	0.0094
	0.000	0.*395*	*0.000*	*0.000*	*0.000*	*0.000*	0.*972*
GDPGRW	0.0011***	-0.0001	0.00105***	0.0005**	0.0010***	-0.0005***	0.0001
	0.000	0.*686*	*0.000*	*0.014*	*0.000*	*0.000*	0.*988*
D_CRISIS			0.0884***				
			0.000				
D_SOUTH				0.0549***			
				0.000			
Sigma^2	0.0082***	0.0053***	0.00797***	0.0081***	0.00252***		
	0.000	*0.000*	*0.000*	*0.000*	*0.000*		
Gamma	0.0228***	0.00414***	4.68E-08***	1.60E-07***			
	0.000	*0.000*	*0.000*	*0.000*			
TREND	*YES*	*YES*	*NO*	*YES*	*YES*	*YES*	*YES*
N.obs	16203	16203	16203	16203	16203	16203	12723
LRT(a)	7042.8	14478	7588.8	7218.3			
	0.000	*0.000*	*0.000*	*0.000*			
LRT(b)	1574.7						
	0.000						
Eta test	0.160						
	0.686						
Model test						*3535.08*	102.748
						0.000	*0.000*
Sargan-Hansen test							3.370
							0.185

For the description of the variables see Table 1. In Italics are reported the p-values of the tests. Superscripts ***, ** and * denote statistical significance at the 1, 5 and 10 percent level, respectively. IQI, ROA, EQTA, OI and NPL variables are lagged once. GDPPC is in logarithmic form. In columns 1-4, reporting Battese and Coelli (1995) Stochastic Frontier Analysis (SFA) regressions, and column 5 reporting Greene (2005) true random effects (TRE) SFA regression, the dependent variable is COST INEFFICIENCY (COST INEFF). In column 6, reporting bootstrapped truncated regression (Simar and Wilson, 2007, SW), and column 7, showing 2SLS random effects estimator results, the dependent variable is COST EFFICIENCY (COST EFF). Eta Test is the Karakaplan and Kuntlu's (2013) endogeneity test on IQI. LRT(a) is a Likelihood Ratio Test comparing the fitted model (H1) with a corresponding model without inefficiency, estimated by OLS (H0). LRT(b) compares the Translog (H1) with the Cobb-Douglas cost function (H0); Model test is the test of joint significance of all explanatory variables (Wald chi2 test). Under the H0 of the Sargan-Hansen test the over-identifying restrictions are valid.

TABLE 4. Estimation results: Extended model and robustness checks (Battese and Coelli (1995), bootstrapped truncated regression, 2SLS random effects estimator).

	Dependent variable: **COST INEFF and COST EFF**					
	1	*2*	*3*	*4*	*5*	*6*
	EXTENDED SPECIFICATION	Adding provincial fixed effects	Adding Dummy CRISIS	Adding Dummy SOUTH	EXTENDED SPECIFICATION SW	EXTENDED SPECIFICATION 2SLS
IQI	-0.0870***	-0.1642***	-0.059***	-0.0819***	0.0916***	1.0058**
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.026*
ROA	-0.0904***	-0.0792***	-0.0965***	-0.0912***	0.0404***	0.0807
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.133*
EQTA	0.0178***	0.0143***	0.0179***	0.01685***	0.0064***	-0.0202
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.627*
OI	12.002***	9.1345***	13.282***	12.3***	-10.347***	-16.4742**
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.046*
NPL	1.3021***	1.2632***	1.238***	1.2334***	-1.0297***	-5.483**
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.021*
HHI	0.454***	0.26383***	0.4415***	0.4593***	-0.3553***	-0.8705
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.35*
BRANCH	0.119***	0.124***	0.1242***	0.10001***	-0.1158***	-0.2025
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.604*
DD	-0.00018**	0.00286***	-0.0003***	0.00001	-0.0004***	0.0316
	0.05	*0.000*	*0.000*	*0.904*	*0.000*	*0.257*
GDPPC	-0.192***	0.00205	-0.2089***	-0.14455***	0.0983***	-0.0074
	0.000	0.934	*0.000*	*0.000*	*0.000*	*0.977*
GDPGRW	0.0017***	-0.0004	0.0017***	0.0012***	-0.0011***	0.0004
	0.000	0.*234*	*0.000*	*0.000*	*0.000*	*0.914*
D_CRISIS			0.0877***			
			0.000			
D_SOUTH				0.0348***		
				0.000		
$Sigma^2$	0.0077***	0.0053***	0.007***	0.0077***		
	0.000	*0.000*	*0.000*	*0.000*		
Gamma	1.07E-08***	1.00E-08	5.77E-07***	2.58E-06***		
	0.000	0.*994*	*0.000*	*0.000*		
TREND	*YES*	*YES*	*NO*	*YES*	*YES*	*YES*
N.obs	16203	16203	16203	16203	16203	12723
LRT	8088.4	14179	8659.5	8150.2		
	0.000	*0.000*	*0.000*	*0.000*		
Eta test	2.440					
	0.118					
Model test					4056.55	115.09
					0.000	*0.000*
Sargan-Hansen test						*3.592*
						0.166

For the description of the variables see Table 1. In Italics are reported the p-values of the tests. Superscripts ***, ** and * denote statistical significance at the 1, 5 and 10 percent level, respectively. IQI, ROA, EQTA, OI and NPL variables are lagged once. GDPPC is in logarithmic form. In columns 1-4, reporting Battese and Coelli (1995) Stochastic Frontier Analysis regressions, the dependent variable is COST INEFFICIENCY (COST INEFF). In column 5, reporting bootstrapped truncated regression (Simar and Wilson, 2007,SW), and column 6, showing 2SLS random effects estimator results, the dependent variable is COST EFFICIENCY (COST EFF). Eta Test is the Karakaplan and Kuntlu's (2013) endogeneity test on IQI. LRT is a Likelihood Ratio Test comparing the fitted model (H1) with a corresponding model without inefficiency, estimated by OLS (H0). Model test is the test of joint significance of all explanatory variables (Wald chi2 test). Under the H0 of the Sargan-Hansen test the over-identifying restrictions are valid.

APPENDIX B

1. Cost efficiency: technical and allocative efficiency

Efficiency can be profit or cost efficiency, depending on whether the objective function of a firm is cost minimization or profit maximization. Considering a multiple-inputs, multiple outputs and a perfectly competitive firm (it takes prices as given), its cost minimization problem can be written as:

$$c(w,q) = \min_x w'x \text{ such that } T(q,x) = 0 \quad \text{(B1)}$$

where $T(q,x)$ is the transformation function that summarizes the technological possibilities set of a firm that use N inputs to produce M outputs, $q = (q_1, q_2, , \dots, q_M)'$ is a Mx1 vector of outputs and $w = (w_1, w_2, , \dots, w_N)'$ is a Nx1 vector of inputs prices. This minimization problem says that a firm should search optimal combinations of input-output and find the inputs quantities that minimize the cost of producing q. This minimum cost varies with variation in w and q (Coelli et al., 2005). [176]

Given input prices is possible to obtain a measure of firm's cost efficiency. According to Farrell (1957) firm's cost efficiency is decomposable in two parts: *technical efficiency* (TE), which corresponds to the ability of a firm to obtain optimal output for a given set of inputs (minimum use of inputs), and *allocative efficiency* (AE) that given prices and the production technology, reflects the capability of a firm to use the inputs in optimal proportions (optimal mix of inputs given prices). The product of technical and allocative efficiency determines a measure of overall cost efficiency.

$$TExAE = CE \quad \text{(B2)}$$

The distance from points of cost minimization due to lacks in both technical or allocative efficiency (or either) leads to inefficiency. To give an illustration of Farrell' ideas, it is reported a figure (Fig.B1)

[176] The cost function satisfies the following properties: non-negativity; non-decreasing in w and q; homogeneity; concave in w.

of a simple example involving two firms that use two inputs (x_1 and x_2) to produce a single output (q), under the assumption of constant return to scale. Let w the vector of input prices and let x the observed vector of inputs associated with point of technical inefficiency P. Let $\hat{x}$ and x^* the input vector associated with a technical efficiency point Q and the cost-minimizing input vector at Q' , respectively.

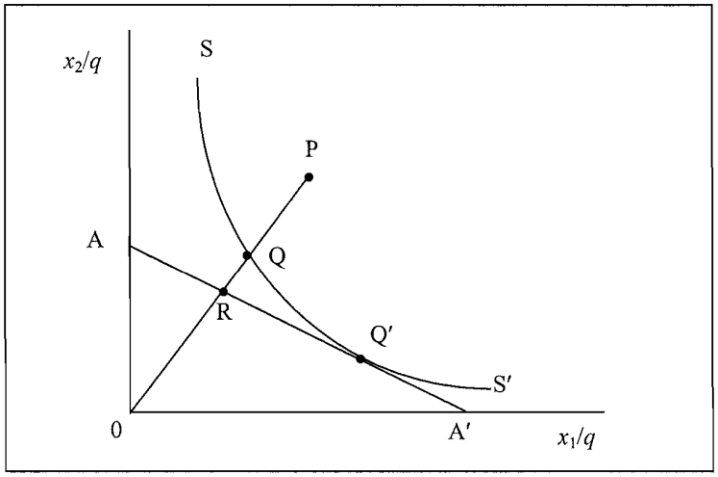

Fig.B1: Technical and Allocative Efficiency (Coelli et al. 2005, pp 52)

The firm's cost efficiency is given by the ratio of inputs costs associated with input vectors, x and x^*at point P and Q'. Hence:

$$CE = \frac{w'x^*}{w'x} = OR/OP \tag{B3}$$

If the slope of the isocost line AA' (the input price ratio) is known, then it is possible to use the isocost line to retrieve measures of technical and allocative efficiency, as the following:

$$AE = \frac{w'x^*}{w'\hat{x}} = OR/OQ \tag{B4}$$

$$TE = \frac{w'\hat{x}}{w'x} = OQ/OP \tag{B5}$$

In particular, the distance RQ in the Fig.B1 gives the reduction of production costs that would occur if the firm produced at the allocative and technically efficient point Q', instead of at the point Q where is technically efficient, but not allocative efficient.

2. Data Envelopment Analysis (DEA)

Based on distance function from a benchmark production frontier, the DEA method is applied to determine nonparametric measure of Decision Making Unit (henceforth, DMU - such as banks, firms, countries, institutions, sectors) efficiency through which, given the existent technology, at any point of time, I can draw a piece-wise surface (or frontier) locus of technically efficient input-output combinations. The distance between observed values and an estimated production function possibility frontier (best practice frontier) is a measure of DMU's technical inefficiency.

The model may be either input or output orientated, and allow measuring DMUs' efficiency. In particular, in an *input*-oriented model, technical inefficiency is identified as a proportional reduction in input usage, with output level held constant corresponding to Farrell's input-based measures of technical inefficiency. The selection of an *input* oriented models occurs in studies that focus on DMUs having particular orders to fill and the input quantities appear to be the primary decision variables. On the other hand, in an *output* oriented model, technical inefficiency is measured as a proportional increase in output production, with input level held fixed. An output orientation is adopted in studies where DMUs, given a fixed quantity of resources, have the goal to produce as much output as possible. [177]

Following Färe et al. (1985 and 1994) I assume that a DMU *I* employs *N* inputs denoted by the column vectors $x_i = (x_1, \dots, x_N) \in R_+^N$ to produce *M* outputs denoted by the column vector $q_i =$

[177] For the empirical application of this paper, I compute input-oriented DEA cost efficiency scores with variable return to scale (VRS) as many other studies concerning bank efficiency (Casu and Molyneux, 2003; Chortareas et al. 2013; Sufian 2009; Sufian et al, 2016). VRS encompass increasing, constant, or decreasing returns to scale, hence, this assumption allows modeling the entire range of technology (Assaf et al., 2011).

$(q_1, \dots, q_M) \in R_+^M$. The (N×I) input matrix X, and the (M×I) output matrix, Q, represent the data of all *I* DMUs. The technology set or production possibilities set T, which is a set of all feasible input and output combinations, i.e., $T = \{(x, q) \in R_+^N \times R_+^M | \, x \, can \, produce \, q\}$.

The Shephard input distance functions (Shephard,1970), measuring the largest proportional contraction of the input vector, conditional on given output levels in period t is defined as:

$$D^t(x_t, q_t) = max\{\theta : (x, q/\theta) \in T\} \tag{B6}$$

where T is the production possibilities set for the technology available in period t. The minimum value of the parameter θ is equal to unity for all combinations on the frontier (when production is technically efficient, in Farrell's 1957 terminology), while is lower than one for all other combinations belonging to the production set *T*. Assuming variable returns-to-scale (VRS), the general linear programming problem that has to be solved for each firm is:

$$\begin{gathered} \min_{\lambda,\phi} \phi, \\ st: -q_i + Q\lambda \geq 0, \\ \phi x_i - X\lambda \geq 0; \\ I1' \lambda = 1; \\ \lambda \geq 0 \end{gathered} \tag{B7}$$

where λ is a Ix1 vector of constants, ϕ is a scalar between 1 and ∞, and $\phi - 1$ is the proportional contraction in inputs that could be achieved by the *i-th* DMU, with outputs held fixed. It is possible to determine $[D^t(x_t, q_t)] = 1/\phi$, which defines the efficiency scores that varies between 0 and 1 and according to the input-based Farrell (1957) is reciprocal to the input distance function (Färe et al., 1994), hence $1/\phi$ measures the distance between a DMU and the efficiency frontier. The efficiency score for the *i-th* DMU can be lower or equal to unity, with a value of 1 corresponding to a point on the frontier.

Having price data available and assuming that a DMU minimizes its costs, it is possible to measure not only technical efficiency but even allocative efficiency. To do this, two sets of linear programs are required, one measuring technical efficiency and the other economic efficiency. For the case of VRS cost minimization, the input-oriented DEA model, defined in (B7), is resolved to obtain technical efficiencies (TE). The next step requires the solution of the following cost minimization DEA:

$$\begin{aligned} &\min_{\lambda, x_i^*} w_i^{'} x_i^*, \\ &st: Q\lambda - q_i \geq 0, \\ &x_i^* - X\lambda \geq 0; \\ &I1' \lambda = 1; \\ &\lambda \geq 0 \end{aligned} \tag{B8}$$

where w_i is a Nx1 vector of input prices for the *i-th* DMU and x_i^* (which is computed by the linear programming) is the cost-minimizing vector of input quantities for the *i-th* DMU, given the input prices w_i and the output level, while the other notation are described above.

The total cost efficiency (CE_i) of the *i-th* DMU is defined as a ratio of minimum cost to observed cost, hence calculated as:

$$CE_i = \frac{w_i^{'} x_i^*}{w_i^{'} x_i} \tag{B9}$$

The allocative efficiency is calculated as:

$$AE_i = \frac{CE_i}{TE_i} \tag{B10}$$

all three measures are between 0 and 1, where 1 indicates full efficiency.

2.1. The bootstrap approach: Simar and Wilson (1998)

The DEA approach has been criticised for being a non-statistical or deterministic technique. To overcome this limit Simar and Wilson (1998) show how to adopt a ‘‘bootstrap’’ approach to obtain

statistical properties for DEA. They initially provide a homogeneous bootstrap procedure to correct for the statistical limitations of DEA. The idea underline their approach is to resample from an original data set to generate pseudo samples used to get inferences on the measures of interest. As a result, the data generating process (DGP) underline the observed data is reproduced by a bootstrap method that approximates the sample distribution. According to Simar and Wilson (1998) there are difficulties in accurately simulating the DGP when bootstrapping DEA. This is due to the fact that efficiency DEA scores are between 0 and 1. For this reason, Simar and Wilson (1998) offer a solution by using a smoothed bootstrapping procedure. In the case of input-oriented DEA model the bootstrap procedure is the following:

1. DEA efficiency scores $\widehat{\phi_\iota}$ are computed using the linear programming procedure described above;
2. The smoothed bootstrapped procedure is used to generate a random sample of size N from $\widehat{\phi_\iota}, \dots, \widehat{\phi_N}$ with $i = 1, \dots, N$ providing a bootstrap replica $\hat{\phi}^*_{1b}, \dots, \hat{\phi}^*_{nb}$ where *b* is the *b*-th interaction of the bootstrap;
3. A pseudo data set $\left\{(x^*_{ib}, q^*_{ib}) = \left(x_i \left(\frac{\widehat{\phi_\iota}}{\hat{\phi}^*_{ib}}\right) q_i\right), i = 1, \dots, N\right\}$ is computed to construct the reference bootstrap technology;
4. The estimation of the bootstrap input-oriented efficiency scores $\hat{\phi}^*_{ib}$ of $\widehat{\phi_\iota}$ (for each $i = 1, \dots, N$) then follows a solution of the linear programming model in to Equation (B8);
5. Steps 2-4 are repeated B times to create a set of vector bootstrap estimates $\{\hat{\phi}^*_{ib}; b = 1,\dots,B$;

The bias-corrected estimates of the DEA scores, are obtained from:

$$\hat{\hat{\phi}}_\iota = \widehat{\phi_\iota} - \widehat{bias^*_N} = 2\widehat{\phi_\iota} - \bar{\phi}^*_N \tag{B11}$$

where the bootstrap estimate of the bias is:

$$\widehat{bias}_N^* = \frac{1}{B}\sum_{b=1}^{B}\hat{\phi}_{ib}^* - \hat{\phi}_\iota = \bar{\phi}_N^* - \hat{\phi}_\iota \quad \text{(B12)}$$

Following this procedure, it is possible to compute confidence intervals and make statistical inferences about DEA scores. The bootstrap procedure was also later extended by Simar and Wilson (2007) to account for the impact of environmental variables on efficiency.

2.2. Two stage DEA models: Simar and Wilson (2007)

Exogenous variables that characterized the environment in which DMUs operate may influence their efficiency. A method that allows accommodating environmental variables in a DEA analysis is the two-stage method. In the first stage, involving only the traditional outputs and inputs, the DEA linear programming problem is solved. In the second stage, the efficiency scores computed are regressed upon the environmental variables. The estimated coefficients and their sign indicate the magnitude and the directions of the impact of environmental variables on DMU's efficiency. Formally, in the second stage:

$$\hat{\phi}_i = z_i\beta' + \varepsilon_i \quad \text{(B13)}$$

where z_i is a matrix of environmental variables, β a vector of coefficients to be estimated and ε_i is an error term with the distribution $\varepsilon_i \geq 1 - z_i\beta'$.

However, this approach may entail serious problems as the true DEA efficiency estimates are unobserved and replaced by the estimates $\hat{\phi}_i$, which are serially correlated. Moreover, ε_i may be correlated with z_i since outputs and inputs can be correlated with explanatory variables.[178]

To overcome these problems, Simar and Wilson (2007) provide a statistical model where truncated regression yields consistent estimates and develop a bootstrap approach to provide valid inference in the second stage regression. In particular, they propose two types of algorithm: the algorithm 1 of

[178] Yet, in the second stage, many studies have used a tobit, or a linear model by ordinary least square (OLS) (Dietsch and Weill, 1999; Ray, 1991; Sexton et al., 1994; Stanton, 2002).

Simar and Wilson (2007) consists obtaining estimates of $\hat{\phi}_i$ in the first step and then regress them on environmental variables z_i, using a bootstrapped truncated regression; the algorithm 2 involves: i) bootstrapping DEA scores in the first step, in order to obtain bias corrected efficiency scores, ii) regressing bias corrected efficiency scores on environmental variables z_i, using a bootstrapped truncated regression at the second step. More formally, the algorithm 2 consists:

I. Compute the DEA input-oriented efficiency scores $\hat{\phi}_i$ for DMU, using the linear programming problem in Equation (B7);

II. Use the maximum likelihood method to estimate the truncated regression of $\hat{\phi}_i$ on z_i, to provide an estimate $\hat{\beta}$ of β, and an estimate of $\hat{\sigma_\varepsilon}$ of σ_ε;

III. For each DMU $i = 1, \dots, n$ repeat the next four steps (1-4) B times to obtain a set of bootstrap estimates $\{\hat{\phi}_{ib}^*; b = 1, \dots, B\}$.

1. Draw ε_i from the $N(0, \hat{\sigma}_\varepsilon^2)$ distribution with left truncation at $1 - \hat{\beta} z_i$;

2. Compute $\phi_i^* = \hat{\beta} z_i + \varepsilon_i$;

3. Construct a pseudo data set (x_i^*, q_i^*) where $x_i^* = x_i$ and $q_i^* = q_i \hat{\phi}_i / \phi_i^*$;

4. Compute a new DEA estimate ϕ_i^* on the set of pseudo data set (x_i^*, q_i^*);

IV. For each DMU, calculate the bias corrected estimate $\hat{\hat{\phi}}_\iota = \hat{\phi}_\iota - \widehat{bias}_i$ where $\widehat{bias}_i = \frac{1}{B} \sum_{b=1}^{B} \hat{\phi}_{ib}^* - \hat{\phi}_\iota$.

V. Use the maximum likelihood method to estimate the truncated regression of $\hat{\hat{\phi}}_i$ on z_i, to provide an estimate $\hat{\hat{\beta}}$ and $\hat{\hat{\sigma}}$ of β and σ_ε;

VI. Repeat the next three steps (1-3) B_2 times to obtain a set of bootstrap estimates $\left\{\left(\hat{\hat{\beta}}_b^*, \hat{\hat{\sigma}}_b^*, b = 1, \dots, B_2\right)\right\}$;

1. For $i = 1, \dots, n$, ε_i is drawn form $N(0, \hat{\hat{\sigma}})$ with left truncation $1 - \hat{\hat{\beta}} z_i$;

2. For $i = 1, \dots, n$, compute $\phi_i^{**} = \hat{\hat{\beta}} z_i + \varepsilon_i$;

3. The maximum likelihood method is again used to estimate the truncated regression of ϕ_i^{**} on z_i, providing estimates $\left(\hat{\hat{\beta}}^*, \hat{\hat{\sigma}}^*\right)$;

VII. Use the bootstrap results to construct confidence intervals.

THIRD CHAPTER

LASTING LENDING RELATIONSHIPS AND TECHNICAL EFFICIENCY. EVIDENCE ON EUROPEAN SMEs.

ABSTRACT

This paper empirically assesses the impact of lasting lending relationships on SMEs technical efficiency. The research hypothesis - inspired by the literature on lending relationships and that on managerial incentives - is that the equilibrium between advantages and disadvantages of enduring banking relationships might be different depending on the level of firms' indebtedness. The empirical investigation is conducted on a sample of European manufacturing SMEs, observed over the period 2001-2008. Measures of firms' efficiency are retrieved by adopting both parametric and non-parametric techniques. Findings indicate that as firm's indebtedness increases, the overall positive effect of long term lending relationships tends to decline, signaling that the interaction of moral hazard problems may jeopardize firms' technical efficiency.

1. INTRODUCTION

An increasing number of studies show that lending relationships may have various effects on the financing and performance of firms, both positive and negative. According to Montoriol Garriga (2006) lasting banking relationships generate value and increase economic efficiency. However, little is known on the effect of enduring banking relationships on firms' technical efficiency, to the best of my knowledge the only paper dealing with this topic being Yildirim (2017).

This article aims to contribute to the above literature by investigating whether and to what extent lending relationships - measured as the length of the relationship with the main bank - explain small and medium sized firms (henceforth SMEs) technical efficiency. I assess this relationship by allowing the impact of lending relationship to be conditional on different levels of the firm's indebtedness. Indeed, my research hypothesis is rooted on both the theoretical predictions of the research on costs and benefits of banking relationships (for reviews, see Boot, 2000; Elyasiani and Goldberg, 2004; Udell, 2008) and on those of the literature on agency costs and managers' incentive (e.g.: Jensen and Meckling, 1976; Jensen, 1986; Nickell et al., 1997; Schmidt, 1997; Nickell and Nicolitsas, 1999).

According to Jensen and Meckling (1976) managers of indebted firms may behave opportunistically at the expense of debtholders, undertaking riskier investment projects after contracting a debt. Managers decide to take this opportunistic behavior, to offset the adverse effects of greater financial pressure, or due to the asymmetry of gains and losses from hazardous investments. Keeping these conclusions in mind, I hypothesise that depending on the level of the firm's indebtedness, the advantages and disadvantages of lasting lending relationship may have mixed consequences on managers' incentives, and thus, on firm's technical efficiency.

My empirical analysis is based on both qualitative and quantitative information on manufacturing firms operating in three European countries (France, Italy and Spain). Employing the EU-EFIGE/Bruegel-Unicredit dataset, I focus on SMEs for two main reasons. First, they represent the bulk of the majority of European countries' productive structure.[179] Second, SMEs tend to be bank dependent, as informationally opaque, thus lending relationships are of crucial relevance for them, because they cannot easily obtain external finance from markets (Petersen and Rajan, 1994 and 1995; Boot and Takor, 1994; Berger and Udell, 1995; Cole, 1998; Elsas and Krahnen, 1998; Harhoff and Korting, 1998; D'Auria et al., 1999; Cole et al., 2004; Berger and Udell, 2006; Udell, 2009).[180]

To measure efficiency and model the relationship between efficiency and its determinants, I adopt both non-parametric and parametric methods. I first employ a (2-step bootstrapped) Data Envelopment Analysis (DEA) procedure, proposed by Simar and Wilson (2007), then a Stochastic Frontier Approach (SFA) (one-step) model, suggested by Battese and Coelli (1995). To address potential endogeneity problems, I apply a test proposed by Karakaplan and Kutlu (2013), within a stochastic frontier framework.

According to my evidence, as firm's indebtedness increases, the positive impact of long lasting lending relationships on firms' technical efficiency tends to decline in absolute value. This suggests that as firm's debt increases, the costs of enduring credit relationships may increase, worsening moral hazard problems related to indebtedness and, thus, encouraging managers' opportunistic behaviour. Indeed, higher firm's debt might aggravate managers' moral hazard behaviour, thus jeopardizing firms' technical efficiency.

[179] For example, in Italy and Spain the vast majority of firms (more than 95%) are SMEs.

[180] This happens especially in bank-based financial system, like the system of France, Italy and Spain here considered.

The remainder of the paper is organized as follows. The next section presents a review of the related theoretical and empirical literature. Section 3 illustrates the methodology adopted. Section 4 discusses the research hypothesis and introduces the empirical model. Section 5 describes the dataset. Section 6 discusses the results obtained and some robustness checks, while Section 7 provides some concluding remarks.

2. LITERATURE REVIEW

2. 1. Theoretical Literature: lending relationships and incentive mechanisms.

The existent literature on banking relationships has shown that lending relationships' characteristics, such as concentration and duration, may have favourable as well as detrimental effects on the financing and performance of firms. Considering benefits first, by establishing long-lasting relationships banks are able to mitigate information asymmetries and agency problems (e.g.: Diamond, 1984,1991; Boot and Thakor, 1994) by gathering soft information from repeated interactions with their financed firms, leading at the same time, to more valuable monitoring and screening processes (Bhattacharya and Chiesa, 1995; Diamond, 1984). Moreover, close lending relationships discourage firm's strategic default (Bannier, 2007) by alleviating the incentive of firms to hide their distressed financial situation and encourage greater borrowers' discipline (Foglia et al., 1998). What is more, in a close lending relationship characterized by mutual trust among parties, a main bank may be disposed to increase the amount of credit (e.g.: Petersen and Rajan, 1994,1995; Berger and Udell, 1995; Cole, 1998; Harhoff and Korting, 1998; Hernandez-Canovas and Martinez-Solano, 2010; Kano et al., 2011), renegotiate the credit line or reduce loan interest rate of its clients even when the latter ones are in financial distress (e.g.: Harhoff and Korting, 1998; D'Auria et al., 1999; Brick and Palia, 2007; Bharath et al., 2011). In addition, it may be inclined to provide funding

for firms' long term projects probably not profitable in the short term (Boot, 2000) and require lower collateral (e.g.: Berger and Udell, 1995; Harhoff and Korting, 1998; Voordeckers and Steijvers, 2006; Chakraborty and Hu, 2006; Jimenez et al., 2006; Brick and Palia, 2007; Steijvers et al., 2010; Bharath et al., 2011; Agostino and Trivieri, 2017). Moreover, in a close lending relationship, a firm may get higher amount of credit by outside lenders using its reputational gain obtained by new credit offered by its main bank (Fama, 1985; James, 1985). Accordingly, close banking relationships should allow bank dependent SMEs to catch every opportunity to increase their productivity and efficiency. However, firms involved in close lending relationships not only get the benefits, but also face certain risks. They may face several issues deriving from the *hold up*, the *soft budget constraint* and the *liquidity* problems (Boot, 2000). In a close banking relationship the main bank might take advantage from its bargaining power by applying rates on loans that do not reflect the real credit worthiness of the financed firm, causing the *hold-up problem* (Sharpe 1990, Rajan,1992). What is more, the so-called *soft budget constraint problem* could appear, namely the main bank's practise of keeping financing unproductive projects of the firm (Carletti et al. 2004).[181] Moreover, in a close lending relationship, the main bank might go bankrupt or might have temporary liquidity problems (Detragiache et al.,2000) generating liquidity risks (Elsas et al., 2004).[182]

In investigating the relationship between the duration of credit relationships and firms' technical efficiency, I need to link the theoretical predictions of the research on costs and

[181] The goal of this practice is to avoid the firm's default and resume all its financing.

[182] In addition, given the constraints that banks have to meet, such as the regulatory and managerial requirements, they may prefer to minimize the counterpart risk avoiding to finance long-term investment projects even if profitable, or they may persuade the manager of the firm to engage in less risky investment projects. Moreover, in order to minimize negative externalities to other clients, banks may decide to spread firm's private information to direct competitors at the expense of the firm (Agarwal and Elston 2001).

benefits of lending relationships with those of the literature on agency costs (e.g.: Jensen and Meckling, 1976; Jensen, 1986; Nickell et al., 1997; Schmidt, 1997; Nickell and Nicolitsas, 1999).

The literature on agency theory largely focuses on principal-agent relationship and the relative incentive problems.[183] Jensen and Meckling (1976) elaborate a model that focuses on both the implications of separation between property and control and the opportunistic behavior of managers, showing that equity financing as well as debt financing lead to different agency distortions.[184] The theory show that the relative conflicts of interests

[183] The agency theory is developed in the same period in which transaction cost theory has been developed. It is inspired by the theory of incomplete contracts whose decisive factors are *moral hazard* (*ex post*-opportunism) and *adverse selection* (*ex ante* opportunism). Although Adam Smith in his contribution "*Wealth of Nations*" (1776), already paid attention to the problems associated with the company's internal organization such as the possible negligence of managers in managing the interests of business owners, Berle and Means (1932) as first authors, noted that many joint stock companies were controlled by managers who served in the company and held only a minor part of equity shares. Berle and Means (1932) wondering whether managers in the joint stock companies acted in the interests of the shareholders, introduce two mechanisms: delegation processes and authority relationships. The firsts are mechanisms through which decision-makers entrust tasks to agents. In particular, delegation mechanisms are characterized by imperfect information: some features of the agent (talent, propensity to work, etc.) are not known to the principal and, moreover, there could be no transparency in agents' actions. Seconds, relate to the relationships that arise among subjects that operate within the enterprise.

[184] The dispersion of business ownership in a multitude of stakeholders creates a clear separation between ownership and control. Consequently, it is very difficult for a single shareholder to directly control the tasks of managers to verify that they are in line to the business interests. Often, managers are interested in maximizing sales, increasing business size, and all the extra amount benefits associated with their position. These interests are totally different from the interests of shareholders aimed at minimizing costs and maximizing profits. Jensen and Meckling (1976) formalize the agency theory, showing that separation between ownership and control usually leads to agency costs. Considering that in an agency relationship managers do not necessarily have the primary goal of maximizing the value of the enterprise, the authors define that principals will elaborate appropriate incentive mechanisms to deter managers' opportunistic behaviors. However, incentive and surveillance activities imply a burden of resources and introduce a trade-off between limiting opportunistic behaviors and enhancing firm value. Therefore, the introduction of these incentives will be beneficial for owners only if the related costs are lower than the higher profits they obtain from reducing the amount of non-monetary

between shareholders, debtholders and managers may lead to suboptimal investments and inefficient managerial decisions, causing *overinvestment* and *underinvestment* problems. On the one hand, having a direct control over business activity, manager may act in their own interests such as by using the firm's resources inappropriately and allocating them in an inefficient way, and by making suboptimal and low risk investment projects that do not reflect shareholders preferences of riskier projects and do not give a satisfactory return.[185] On the other hand, managers may act in the shareholders' interests, taking strategic decisions that do not maximize the firm value but the equity value, damaging debtholders (La Rocca et al, 2008).[186] In particular, a manager may exert its decision-making power approving riskier investments projects than the ones originally planned before contracting the debt (*risk-shifting* or *asset substitution*), thus moving earnings from debtholders to shareholders, they behave opportunistically increasing firm's leverage, risk distress and the likely of bankruptcy (Jensen and Meckling 1976, Galai and Masulis 1976, Jensen 1986, Stultz 1990).[187] Thus, the

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benefits get by the agent. The optimal level of external financing for the enterprise will be determined by the intersection between external financing demand and marginal agency costs.

[185] Commonly, managers are more "adverse to risk" than shareholders, and in choosing between high and low risk projects, they prefer low risk investment projects that are most likely to be successful, even because managers' personal earnings depend also on firm's fate (La Rocca et al. 2008).

[186] According to Brito and John (2002) that offer a multi-period theoretical model, managers' choice to take *risk shifting* depends on both firm's leverage and firm's growth opportunities. Managers of firms with high leverage and low growth opportunities operating in mature sectors, are encouraged to overinvest in risky projects (*risk shifting*). By contrast, managers of firms with good growth opportunities are stimulated to underinvest and avoid risky projects (*risk avoidance*). This is different to what Jensen and Meckling (1976) argue on incentive for risk shifting, since their theoretical model are based on finite period, without taking into account the presence of growth opportunities.

[187] Due to the limited liability of equity, managers have all the interests to take riskier projects than the ones originally presented before contracting the debt (Jensen and Meckling 1976). This is based on the fundamental difference between equity and debt that helps explain the opportunistic behavior of managers, that also depends

benefits deriving from successful investments projects are for the most part earned by shareholders, while the costs of unsuccessful projects are not totally borne by shareholders but transferred to debtholders, thanks to their limited liability (Jensen and Meckling 1976). All these distortions are due to the presence of risky debt such as high debt level difficult for firms to manage, that may cause financial distress or firms' crisis (La Rocca et al. 2008).[188] Hence, managers may behave opportunistically to offset the adverse effects of greater financial pressure, or due to the asymmetry of gains and losses from hazardous investments.

2.2. Empirical literature: lending relationships and firm efficiency

The idea that strong ties between banks and firms generate effects on the firm's value has been extensively considered by the economic literature, both from the perspective of firms' performance and profitability, firms' growth, and that of firms' innovation investment.[189]

A very broad strand of literature has focused on the ties between bank-firm relationships and firm performance providing puzzling predictions: while some studies (Degryse and Ongena, 2001; Castelli et al. 2012; Thanh and Ha, 2013) find a negative effect of banking

on the firm's level of risk. According to Jostarndt (2002), the debt values decreases as volatility of the firm's activities increases, while the equity value grows as risk increases.

[188] As Jensen (1986) and Stulz (1990) argue, an increase in leverage may be used to discipline manager's behavior since they are obligated to pay interest rate and respect deadlines in presence of debt. This should discipline their behavior to take decisions that can increase firm efficiency. However, a higher debt could persuade managers to rejects investments projects with positive net present value in favor of excessively risky projects. Therefore, information asymmetries, incomplete contracts, conflicts of interest between managers, shareholders and debtholders may lead to unproductive investment choices both when there is a high and a low level of debt (La Rocca et al. 2008).

[189] Various measures of relationship lending have been adopted by different empirical contributions: the number of banking relationships (among others, Detragiache at al. 2000; Castelli et al., 2012), temporal length (e.g., Petersen and Rajan, 1994,1995; Berger and Udell, 1995; Angelini, P. et al., 1998; Scott and Dunkelberg, 1999; Ongena and Smith, 2000), and banking services (Degryse and Cayseele, 2000).

relationships on firm performance, other studies find opposite evidence (Hiraki et al., 2003; Montoriol Garriga, 2006). Castelli et al. (2012) considering a sample of Italian manufacturing firms over the period from 1998 to 2000, emphasize that the negative effect of multiple banking relationships on firm performance is particularly stronger for small firms.[190] Similarly, Degryse and Ongena (2001) find that single banked firms are more profitable than firms having multiple lenders for a sample of Norwegian publicly listed firms for the period 1979-1995. Thanh and Ha (2013) examining a sample of 465 companies listed in Vietnam for the period 2007-2010, point out that long-term credit financing relationships increase firm performance, while a short-term credit relationship reduces it.[191] By contrast, Montoriol Garriga (2006) focusing on Spanish SMEs observed over the period 1999-2004, and comparing firms having close banking relationships with multiple banked firms, find that the number of banking relationships has a positive impact on the performance of multiple banked firms, while firms maintaining a singular relationship with a bank perform less than firms having multiple banking relationships.[192] They argue that a main bank able to extract rent

[190] By applying an OLS estimator, they consider as dependent variable some proxies of firm profitability, among these ROA and ROE. As explanatory variables, they include the firm's number of banking relationships, firm's characteristics, bank-firm characteristics, time and industry fixed effects.

[191] By applying a random effect estimator, they use ROA and ROE variables to measures firm performance. They consider banking relationships as the firm's number of bank relationship and the credit financed distinguished by short-term, long-term and overall credit financing. As control variables, they consider the firm's characteristics- such as- age, size, intangible asset and state ownership. The authors take a quadratic function of the firm's number of bank relationships arguing that firms increase their number of bank relationships in order to reduce the hold-up costs, to get more loans, to increase the power of renegotiation, to instigate competition with related banks and improve the liquidity to increase their performance. On the other hand, firms having a higher number of bank relationships may have the opposite effect being higher the transaction and the representative costs. These last effects may overshadow the positive ones.

[192] He uses different measures of banking relationships: the firm's number of bank relationships, a dummy variable for one relationship versus multiple bank-relationships and the share by bank variable (computed as

from single banked firms, may informationally capture them, hindering their performance. Similarly, Hiraki et al. (2003) using a panel data of companies listed on the Tokyo Stock Exchange for the period from 1991 to 1998, show that a close banking relationship between bank and firm negatively affects firm profitability, giving support to the theory according to which multiple banking relationships reduces the hold-up costs (Rajan, 1992).[193]

Among the scholars investigating the effects of long lasting lending relationships and firms' growth, Gambini and Zazzaro (2013) considering a sample of Italian manufacturing firms from 1998 to 2004, find that bank-independent firms grow more, on average, than small firms holding a stable credit relationship with a main bank. However, for medium-large firms, a close lending relationship with a main bank has a modest effect on their growth performance.[194] By contrast, Agarwal and Elston (2001) do not find a significant relationship between close bank-firm relationships and both firms' growth rates and profitability for a sample of German large firms observed over the period 1970-1986.

1/the firm's number of banking relationships). By applying a GMM estimator, he regresses measures of firm performance controlling for the firm's characteristics, the firm's specific fixed effect, and other financial characteristics of the firm.

[193] They apply an OLS estimator, and use the variable ROA as a measure of firm profitability.

[194] They estimate the Gibrat's model by using OLS, and in order to resolve for endogeneity problems, they apply an instrumental variable estimator. In their models, as a main explanatory variable, the authors use the duration of the lending relationship to proxy the closeness between bank and firm. As control variables, they include variables such as, the firm's size and age, a set of financial and nonfinancial firm's characteristics such as, cash flow and leverage. Then, they also control for the firm's propensity to export and innovate and include other variables controlling for characteristics of judicial and banking markets (such as, the concentration of the local banking market, credit rationing, multiple banking and the efficiency of the enforcement system). Finally, they control for industry, time and geographical fixed effects. The authors highlighted the endogeneity problems relating to their main variable (length of the relationship), likely to be correlated with the error term. They argue that a firm may decide to change its main bank when a threat of hold up problem exists or, on the contrary, it may decide to establish a close relationship with its main bank granting soft information to the bank. Moreover, unobserved factors may contemporaneously influence both the length of the relationship and the firm's growth.

Assessing the effect of lending relationship on firm innovation, Herrera and Minetti (2007) find that firms having a strong and long relationship with their main bank have a higher probability of innovating.[195] However, looking at the channels through which tight credit relationships benefit innovation, they show that the relationships offer funds for the introduction and acquisition of new technologies rather than foster internal research. The authors argue that banking relationships do not provide special expertise to the assessment and development of new technologies but simple financial support to costs of the introduction of these. Similarly, Giannetti (2009) distinguishing the effect on the discovery, introduction and adoption phases of new technologies and analyzing a sample of Italian manufacturing firms over the period 1998-2003, show that a higher share of debt and a longer relationship with a main bank have a positive effect on the innovation capacity of high-tech firms, turning out an important role in the discovery and introduction phases. Analogously, Cosci et al. (2016) find a significant relationship between close banking relationship and both the propensity of firms to be innovative and their innovation intensity.[196] The authors argue that through the financial channels, the presence of a soft-information intensive relationship allows firms to innovate without any credit constraints. However, a stable relationship between bank and firm, in term of perceived duration, has a positive but not robust effect on firm innovation. Their results give support to the hypothesis that the relation channel pushes a main bank to offer credit to the potential innovative vein of the borrower firm. Yu and Tong

[195] They analyze a sample of Italian manufacturing SMEs and for their empirical analysis apply an OLS, an instrumental variable and a probit estimator.

[196] They measure bank-firm relationships by using different proxies: the perceived duration of the relationship with the main bank and the use of soft information to evaluate the firm's creditworthiness. They adopt a probit and a tobit model analyzing a sample of manufacturing firms in European countries (France, Germany, Italy and Spain- EFIGE dataset).

(2015) find that relationships with one or two banks influence firm's innovative investment making easier firm's growth opportunities, for a sample of Chinese-listed firms observed from 1999 to 2008.

Despite the extensive research so far reviewed, the relationship between lending relationships and firm technical efficiency - the firm's ability to minimize the amount of inputs required to produce a given output level - has been largely neglected so far, to the best of my knowledge the only paper dealing with this topic being Yildirim (2017). Considering a sample of 4286 U.S. firms observed from 1990 to 2013 and using both parametric and non-parametric measures of efficiency, Yildirim (2017) finds that the existence of banking relationship increases efficiency for high default firms.[197] Thus, to reduce the firm's default probability and decrease the loan's loss given default, a main bank gives more importance to monitoring activity of firms that are more likely to default, and acts to improve their technical efficiency. However, this effect is decreasing in the years after the relationship takes place. By contrast, the author finds that main banks hold up low default risk financed firms deciding to not invest in improving their efficiency, showing that given the high main banks' monopoly rents and monitoring costs included in interest rates, low default risk firms experience a decrease in their efficiency.

3. METHODOLOGY

[197] In particular, she adopts both data envelopment analysis (DEA) and stochastic frontier analysis (SFA). She applies a two step analysis using DEA and SFA scores as dependent variables for the two-stage lest square estimator and bootstraps at the firm level to correct standard errors.

Pure technical efficiency (EFF) is measured relatively to an efficient technology (represented by a production function). The frontier can be retrieved by both DEA or stochastic frontier methods (SFA). In this paper, I adopt a two-step DEA estimator as my main method, and a SFA one-stage procedure as robustness check (Battese and Coelli, 1995; Karakaplan and Kutlu, 2013). In particular, to improve statistical efficiency and valid inference in the second stage, I implement the algorithm 2 of Simar and Wilson (2007), the so-called double bootstrap method, in which, in the first stage, DEA scores are bootstrapped to get pure technical efficiency (EFF), defined as the ability of firms to maximize their output given their technology and productive resources (or vice versa, the ability to minimize the amount of inputs required to produce a given output level), that becomes the dependent variable of my analysis. Then, in the second stage, applying a bootstrapped truncated regression, I estimate a model to evaluate the impact of the contextual variables on technical efficiency, paying particular interest on the explanatory variables duration of the relationship with the firm's main bank and leverage. [198] When computing the bias corrected efficiency scores, I perform separate computations at the NACE-Clio classification level, to allow for different technologies in different sectors.

3.1. *Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA)*

The development of nonparametric and parametric methods such as Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) has resulted in a rapid growth of literature on efficiency assessments of decision-making units (DMUs) across different

[198] The potential determinants of firm's performance are usually referred to the so-called "contextual variables" identified as external operational environment and internal firms characteristics expected to affect firm's productivity and efficiency (Johnson and Kuosmanen, 2012).

industries.[199] While DEA is a linear programming method (introduced by Charnes et al., 1978) to construct a nonparametric frontier and to determine measures of efficiency over the sample examined, SFA is an econometric method based on the assumption of a specific production function, typically a Cobb-Douglas or a Translog function (Battese and Coelli, 1995).[200]

3.2. *Data Envelopment Analysis (DEA)*

Based on distance function from a benchmark production frontier, the DEA method is applied to determine nonparametric measure of efficiency. Considering samples of DMUs (decision making units such as firms, countries, institutions, sectors), and given the existent technology, at any point of time, one can draw a piece-wise surface (or frontier) locus of technically efficient input-output combinations. The distance between observed values and an estimated production function possibility frontier (best practice frontier) is a measure of a DMU's technical inefficiency.

The model may be either output or input orientated, and allow to measure firms' efficiency without imposing assumptions on firms' behavior, such as profit maximization or cost minimization. In particular, in an *input*-oriented model, technical inefficiency is identified as a proportional reduction in input usage, with output level held constant corresponding to Farrell's input-based measures of technical inefficiency. The selection of an input-oriented model occurs

[199] For a thorough presentation of the methods refer to Battese and Coelli (1995) and Coelli et al. (2005). As several contributions suggest, the two methodologies tend to yield consistent results (Cummins and Zi, 1998; Casu et. al., 2004; Elling and Luhnen, 2010; Cummins and Xie, 2013).

[200] DEA is non parametric method because does not require assuming a particular functional form for the production function, attributing the distance from the technical frontier entirely to technical inefficiency without allowing for the influence of any random noise (Coelli et al.,2005). On the other hand, SFA methods require assuming a particular functional form for the production function, which allows controlling for the presence of stochastic errors and inefficiency.

in studies that focus on firms having particular orders to fill, the input quantities appear to be the primary decision variables. On the other hand, in an *output* oriented model, technical inefficiency is measured as a proportional increase in output production, with input level held fixed. An output orientation is adopted in studies where firms, given a fixed quantity of resources, have the goal to produce as much output as possible.

Since in manufacturing firms managers have most control over output quantities, hence, they tend to maximize output for given input combinations, an output oriented models is used in my analysis.

Following Färe et al. (1994) I assume that firms *I* employ *N* inputs denoted by the column vectors $x_i = (x_1, \dots, x_N) \in R_+^N$ to produce *M* outputs denoted by the column vector $q_i = (q_1, \dots, q_M) \in R_+^M$. The (N×I) input matrix X, and the (M×I) output matrix, Q, represent the data of all *I* firms in each sector. The technology set or production possibilities set T, which is a set of all feasible input and output combinations, i.e., $T = \{(x, q) \in R_+^N \times R_+^M | \, x \, can \, produce \, q\}$.

The Shephard output distance functions (Shephard,1970), measuring the largest proportional expansion of the output vector, conditional on given input levels in period t is defined as:

$$D^t(x_t, q_t) = min\{\theta : (x, q/\theta) \in T\} \quad (1)$$

where T is the production possibilities set for the technology available in period t. The minimum value of the parameter θ is equal to unity for all combinations on the frontier (when production is technically efficient, in Farrell's 1957 terminology), while is lower than one for all other combinations belonging to the production set *T*. Assuming variable returns-to-scale (VRS), the general linear programming problem that has to be solved for each firm is:

$$\max_{\lambda,\phi} \phi,$$
$$st: Q\lambda - \phi qi \geq 0,$$
$$x_i - X\lambda \geq 0;$$
$$I1'\lambda = 1;$$
$$\lambda \geq 0 \qquad (2)$$

where λ is a Ix1 vector of constants, ϕ is a scalar between 1 and ∞, and $\phi - 1$ is the proportional increase in outputs that could be achieved by the *i-th* DMU, with inputs held fixed. It is possible to determine $[D^t(x_t, q_t)]= 1/\phi$, which defines the efficiency scores that varies between zero and 1, and according to the output-based Farrell (1957) is reciprocal to the output distance function (Färe et al., 1994), hence $1/\phi$ measures the distance between a DMU and the efficiency frontier. The efficiency score for the *ith* firm can be lower or equal to unity, with a value of 1 corresponding to a point on the frontier.

3.2.1. *Two stage DEA models*

To empirical investigate the relationship between pure technical efficiency and its determinants, several studies use a DEA two-step approach, i.e, the DEA method is adopted to compute efficiency estimates in the first stage, while in the second stage the efficiency scores are regressed against some covariates (so called environmental variables). Formally, in the second stage:

$$\hat{\phi}_i = z_i\beta' + \varepsilon_i \qquad (3)$$

where z_i is a matrix of environmental variables, β a vector of coefficients to be estimated and ε_i is an error term with the distribution $\varepsilon_i \geq 1 - z_i\beta'$.

However, this approach posits serious problems as the true DEA efficiency estimates are unobserved and replaced by the estimates $\hat{\phi}_i$, which in turn are serially correlated. Moreover,

ε_i is correlated with z_i since outputs and inputs can be correlated with explanatory variables.[201] The most important assumption underlining two stage analysis is the global separability condition: the vector of environmental variables in the second step cannot affect the support of the input-output variables in the first step. In other words, it is assumed that the contextual variables do not affect the range of attainable values of the input-output (x,y), such that z only influences average efficiency scores but not the efficient boundary (see Simar and Wilson 2007, 2011). [202]

Simar and Wilson (2007) provide a statistical model where truncated regression yields consistent estimates and developed a bootstrap approach as a valid inference in the second stage regression. [203] In particular, they propose two types of algorithm: 1) the algorithm 1 of Simar and Wilson (2007) consists obtaining estimates of $\hat{\phi}_i$ in the first step and then regress them on environmental variables z_i, using a bootstrapped truncated regression; 2) the algorithm 2 of Simar and Wilson (2007), instead, involves a double bootstrap procedure: i) the bootstrapping of DEA scores in the first step, in order to obtain bias corrected efficiency scores,

[201] Many studies have used a censored tobit for the second stage, but several have applied a linear model by ordinary least square (OLS) (Dietsch and Weill, 1999; Ray, 1991; Sexton et al., 1994; Stanton, 2002). However, by applying the OLS estimator to evaluate the relationship between technical efficiency and environmental variables, a serial correlation problem of DEA estimates may arise. In particular, as described in Simar and Wilson (2007), the estimated DEA's efficiency scores may be correlated each other since, for the computation of the efficiency scores of one DMU, the procedure needs observations of all other DMUs in the estimation sample. Consequently, for the dependency of efficiency scores, the OLS estimator is not appropriated. Moreover, in small samples, the environmental variables may be correlated with the output and input variables used to compute the efficiency scores, violating one of the classical linear assumptions of absence of correlation between error term and explanatory variables (Assaf, 2011).

[202] Recently, Daraio et al. (2016) have developed a formal empirical testing procedure for the separability condition based on the central limit theorem. Unfortunately, the routine of this test is not available yet, therefore I leave the test application for future research.

[203] A technical description of the homogeneous bootstrap procedure, proposed by Simar and Wilson (1998) is provided in the Appendix B of this thesis.

ii) the regression of bias corrected efficiency scores on environmental variables z_i, using a bootstrapped truncated regression at the second step. More formally, the algorithm 2 consists:

VIII. Compute the DEA output-oriented efficiency scores $\hat{\phi}_i$ for each firm, using the linear programming problem in Equation (2);

IX. Use the maximum likelihood method to estimate the truncated regression of $\hat{\phi}_i$ on z_i, to provide an estimate $\hat{\beta}$ of β, and an estimate of $\widehat{\sigma_\varepsilon}$ of σ_ε;

X. For each firm $i = 1, \dots, n$ repeat the next four steps (1-4) B times to obtain a set of bootstrap estimates $\{\hat{\phi}^*_{ib}; b = 1, \dots, B\}$.

1. Draw ε_i from the $N(0, \hat{\sigma}^2_\varepsilon)$ distribution with left truncation at $1 - \hat{\beta} z_i$;

2. Compute $\phi^*_i = \hat{\beta} z_i + \varepsilon_i$;

3. Construct a pseudo data set (x^*_i, q^*_i) where $x^*_i = x_i$ and $q^*_i = q_i \hat{\phi}_i / \phi^*_i$;

4. Compute a new DEA estimate ϕ^*_i on the set of pseudo data set (x^*_i, q^*_i);

XI. For each firm, calculate the bias corrected estimate $\hat{\hat{\phi}}_i = \hat{\phi}_i - \widehat{bias}_i$ where $\widehat{bias}_i = \frac{1}{B} \sum_{b=1}^{B} \hat{\phi}^*_{ib} - \hat{\phi}_i$.

3.3. *Stochastic Frontier Analysis (SFA): Battese and Coelli (1995)*

Another method to retrieve firm efficiency measure is SFA. The single-stage estimation procedure proposed by Battese and Coelli (1995) offers a model to simultaneously estimate the parameters of the stochastic frontier and the coefficients of various potential determinants of (time-varying) technical inefficiency. [204]

[204] There are several advantages of this approach: the simultaneous estimation of both the frontier and the technical inefficiency, the distinction between a firm's specific inefficiency and statistical noise, the hypotheses can be tested with statistical rigor, and relationships between inputs and outputs follow known functional forms.

In particular, it considers the following stochastic production function for panel data:[205]

$$y_{it} = \exp\left(x_{it}\beta + V_{it} + U_{it}\right) \quad (4)$$

where y_{it} indicates the production at time t (t=1,2,…,T) for the *i*-th firm (i=1,2,…N); x_{it} is a (1xk) vector of inputs; β is a (kx1) vector of unknown parameters to be estimated; V_{it}s are assumed to be iid N(0, σ_V^2) random errors, independently distributed of the U_{it}s; U_{it}s are non-negative random variables, gauging technical inefficiency of production. They are obtained by truncation (at zero) of the normal distribution with mean, $z_{it}\delta$, and variance, σ^2, where z_{it} is a vector (1xm) of explanatory variables, and δ a vector (mx1) of parameters to be estimated. The distribution of the inefficiency terms are not the same, but are explicated as functions of explanatory variables. In this case, the inefficiency terms are independently but not identically distributed. The technical inefficiency effect, U_{it}, in the stochastic frontier model (4) could be specified in

$$U_{it} = z_{it}\delta + W_{it} \quad (5)$$

where the random variable, W_{it}, is defined by the truncation of the normal distribution with zero mean and variance, σ^2. The method of maximum likelihood is adopted for simultaneous estimation of the parameters of the stochastic frontier and the model of the technical inefficiency effects where the likelihood function is expressed in terms of the variance parameters, $\sigma_S^2 = \sigma_V^2 + \sigma^2$ and $\gamma \equiv \frac{\sigma^2}{\sigma_S^2}$. The technical efficiency of production for the *i*-th firm at time t, that takes on a value between zero and one is defined by the following equation:

On the other hand, this method does not control for the unobserved heterogeneity of firms. Greene (2005) has revisited this aspect accounting for both unobserved heterogeneity and time-varying technical inefficiency in the stochastic frontier model for panel data. I tried to apply on my data the "true" random effects model proposed by Green (2005), but I registered severe convergence problems. However, an empirical application of Green (2005) model is provided in the second chapter of this thesis.

[205] More technical details about stochastic frontier models for panel data are provided in the Appendix C2.

$$TE_{it} = \exp(-U_{it}) = \exp\left(-z_{it}\delta - W_{it}\right) \quad (6)$$

Within this general framework, I choose a Translog production function specified as follows [206]:

$$\begin{aligned} \ln Y_{it} = {} & \beta_0 + \beta_K \ln K_{it} + \beta_L \ln L_{it} + \beta_R \ln R_{it} + 0.5\,\beta_{KK} \ln K_{it}^2 + 0.5\,\beta_{LL} \ln L_{it}^2 \\ & + 0.5\,\beta_{RR} \ln R_{it}^2 + \beta_{KL} \ln K_{it} * \ln L_{it} \\ & + \beta_{KR} \ln K_{it} * \ln R_{it} + \beta_{LR} \ln L_{it} * \ln R_{it} + \sum_{j=1}^{m-1} \lambda_j Sector_j + \theta_{it}\, YEAR + (V_{it} \\ & - U_{it}) \end{aligned} \quad (7)$$

in which ln Y is the logarithm of sales of the firm *i*-th at time t ($i = 1, \dots, N\ ;\ t = 1, \dots, T$) and the three production inputs are the logarithm of capital (lnK), the logarithm of the number of worker (lnL) and the logarithm of the cost of production (lnR). Since each sector has different technologies, in order to account for this heterogeneity I include dummies sector.

Finally, as illustrated in the robustness checks section, to address endogeneity problems I adopt a test provided by Karakaplan and Kutlu (2013), within the framework of an endogenous

[206] The choice of the appropriate specification that best represents the data requires a test. After estimating a number of alternative models, I selected a preferred production function model Translog using the likelihood ratio test (LR test) as suggested by Coelli (1996). In particular, the LR test statistic is: $\lambda = -2\{\log[L(H_0) - \log\mathit{L(H1)}$ where $\log\mathit{L(H0)}$ and $\log\mathit{L(H1)}$ are the values of the log likelihood function under the specification of the null hypothesis H_0 and the alternative hypothesis H_1. The LR test has approximately χ_q^2 distribution with q equal to the number of parameters assumed to be zero in the null hypothesis.

stochastic frontier, and a 2SLS estimator, applying the logit transformation to the dependent variable EFF. [207]

4. RESERCH HYPOTESIS AND THE TECNHICAL (IN)EFFICIENCY MODEL

I empirically investigate whether and to what extent relationships lending, captured by the duration of the relationship with the main bank, affect SMEs' technical efficiency - by allowing the impact of duration to be conditional on different levels of firm's indebtedness. By linking the theoretical predictions of the research on costs and benefits of banking relationships with those of the literature on agency costs and managers' incentive discussed above, I hypothesise that depending on the level of the firm's indebtedness, the advantages and disadvantages of lending relationship may have mixed consequences on managers' incentives, and thus, on firm's technical efficiency. For low level of firm's debt, long lasting lending relationships might imply a positive impact on a firm's technical efficiency: easier credit access should help managers to smooth the production process, while *soft budget constraint* and *hold-up* problems should be minor. Conversely, as the firm's indebtedness increases these last problems are expected to increase, and consequently, one of two following scenarios may arise. On the one hand, if managers are willing to keep the advantages of a credit relationship, higher *hold-up* costs could strengthen disciplined behaviour, prevailing on moral hazard temptations related to higher indebtedness and softer budget constraints. In this scenario, the effect of

[207] Karakaplan and Kutlu (2013) is a one-step maximum likelihood based estimation methodology that allows to estimate the parameters of a linear model where the error term is composed by a strictly nonnegative measure of inefficiency and a two-sided error term from a symmetric distribution. Further, it provides a test of endogeneity, relying "on ideas similar to the standard Durbin-Wu-Hausman test for endogeneity" (Karakaplan and Kutlu, 2017, page 6). A technical description of the Karakaplan and Kutlu (2013) model is provided in the Appendix C2.

enduring credit relationships on firm's technical efficiency could be positive because of the managers' interest to achieve higher efficiency in the production process. On the other hand, managers' incentives may be distorted, and the positive effect of longer banking relations on firm's efficiency could decline or even vanish if opportunistic behaviours associated to easier debt renegotiation, as well as higher *hold-up* costs, aggravate moral hazard incentives due to higher firm's debt level. To verify these hypotheses, I estimate the following benchmark (in)efficiency equation:

$$EFF_{it} = \alpha + \beta_1 DURAT_{i(t-1)} + \beta_2 LEV_{i(t-1)} + \beta_3 DURAT * LEV_{i(t-1)} + \phi X_{i(t-1)} + \theta_{it}\, TREND + \sum_s \delta_s S_s + \sum_c \varphi_c C_c + \upsilon_{it} \quad (8)$$

where the dependent variable is the measure of technical efficiency based on (bootstrap) DEA, described in sub-section 3.2. According to equation (8), firm's technical efficiency (EFF) is a function of the duration of the relationship with the main bank (DURAT), firm's indebtedness (LEV), calculated as total debt to total assets, the interaction between the latter two (DURAT * LEV), a vector X including the control variables defined in more detailed in Table 1 and described below; the vectors S and C are sets of sector and country dummies, respectively.

In what follows, I illustrate both observable firm-specifics and market characteristics that enter in my estimating equation as control variables, along with the variable of interest DURAT. It is worth noting from the outset that data availability has conditioned my choices.

To test my conditional hypothesis, I include the variable total debt (LEV- defined as a ratio of firm's total debt to total assets) and an interaction term between DURAT and LEV. [208] The literature offers opposite predictions on the relationship between leverage and firm's performance. On the one hand, the binding nature of debt by reducing the moral hazard behaviour may exert a pressure on managers with less "free cash-flow" available (Jensen, 1986; Weill, 2008). Therefore, high leveraged firms may better exploit their productive capacity by using greater liquidity that may help to smooth the production process. On the other hand, debt may cause conflicts between creditors and equity holders as these latter may decide to take choices that do not increase firm efficiency and value, acting in an opportunistic way at the expenses of debtholders (causing agency costs). Moreover, soft-budget constraint problems may arise for the main bank's practise of keeping financing inefficient projects of client firms, to avoid firms' default and resume all its financing (Carletti, 2004).

Furthermore, firm's age and size - measured by the logarithm of the firm's age and total assets respectively- are taken into account, together with their squares to control for potential non-linear effects. Given that my dependent variable is technical efficiency purged from scale efficiency, the variable (SIZE) is included to take into account that, for example, larger firms may attract qualified workers and managers, obtain better credit, and be more inclined to export. However, inefficient hierarchical structures in the management of larger firms may cause negative effect on firm's efficiency (see Wiliamson, 1967; Margaritis and Psillaki, 2007). Furthermore, the variable AGE is included in the model to control for the ability of firms to take advantage of the experience built up over time and get more credit. Yet, younger firms

[208] To avoid imputation, I use the variable LEV (total debt to total assets) as a good proxy of bank debt (to total assets), which is available one year only. In fact, the the median value of the percentage of bank debt on total liabilities in my sample is 100%, the 75% of firms displaying a percentage higher than 90%. I use the imputed variable bank debt ratio in a robustness check (Table 4).

may be able to absorb new innovative techniques and be more motivated to build reputation. Moreover, the variable INV is included to control for the inventory requirement of each firm. A relatively higher rate of inventories (to sales) might be a sign of inefficient inventory management, and vice versa (Fisman, 2001). Finally, I take into account the degree of industry concentration by the Herfindahl-Hirschman index (HHI, based on total sales). The effect of this variable on firm's efficiency could be ambiguous. On the one hand, considering the *Structure-Conduct-Performance paradigm*, I would expect the effect of this variable on efficiency to be negative, as competition forces firms to operate efficiently. On the other hand, according to the *Efficient-Structure hypothesis*, higher concentration does not necessarily indicate lower competition but it may reflect market selection and consolidation through survival of more efficient companies bringing it to have a positive effect on efficiency (Margaritis and Psillaki, 2007). Finally, I limit potential simultaneity bias by assuming lagged values of all regressors defined at the firm-level.

Using the equation (8) estimates, the partial effect of DURAT is computed conditional on the level of LEV as:

$$\frac{\partial EFF}{\partial DURAT} = \widehat{\beta_1} + \widehat{\beta_3} * LEV \tag{9}$$

and the relative standard errors as:

$$\hat{\sigma}_{\frac{EFF}{DURAT}} = \sqrt{var(\widehat{\beta_1}) + var(\widehat{\beta_3}) * LEV^2 + 2\, cov(\widehat{\beta_1}\widehat{\beta_3}) * LEV} \tag{10}$$

Since (9) and (10) are dependent on LEV, the marginal effect of DURAT may change sign and gain or lose significance according to the values of the variable.[209]

5. DATA

I use the European Firms in a Global Economy (EFIGE) Bruegel-Unicredit dataset. The EFIGE dataset, containing survey information on 14,759 firms, includes all manufacturing firms employing more than 10 workers operating in seven European countries: Austria, France, Germany, Hungary, Italy, Spain and the United Kingdom.[210] Qualitative and quantitative information are collected in 2010, although some questions cover the period 2007–2009 or to one year only (either 2008 or 2009). By contrast, accounting data concerning the same sample of firms are sourced from Bureau Van Dijk's Amadeus databank, and are available from 2001 to 2009.[211] Therefore, an imputation process should be undertaken for several survey variables to exploit the panel structure of the data, with undesirable consequences in terms of errors in variables bias. In particular, this is the case for group membership, graduate employees (measure of human capital) and bank debt, all theoretically relevant for the present analysis. To safeguard my estimates, I exclude imputed regressors from my benchmark model, adding them in my robustness check regressions. It is worth noting that,

[209] Analogously, when considering the variables AGE and SIZE, I compute the partial impact of AGE and SIZE on EFF, conditional on their level. For instance for the variable AGE: $\frac{\partial EFF}{\partial AGE} = \widehat{\phi_{AGE}} + 2\,\widehat{\phi_{AGE^2}} * AGE$ and relative standard error is: $\hat{\sigma}_{\frac{EFF}{AGE}} = \sqrt{var(\widehat{\phi_{AGE}}) + 4AGE^2 * var(\widehat{\phi_{AGE^2}}) + 4\,AGE * cov(\widehat{\phi_{AGE}}\widehat{\phi_{AGE^2}})}$.

[210] For more detailed information on the EU-EFIGE dataset, see http://bruegel.org/2012/10/the-eu-efigebruegel-unicredit-dataset/

[211] The survey provides both qualitative information (such as the year of establishment, group membership, sector, legal form, financial structure and the number of banking relationships) and balance sheet data on firms.

despite my key variable DURAT is reported for 2009, I can easily retrieve its values for the previous years (2001-2008), by subtracting from the 2009 entry a number from 8 to 1.[212]

Finally, the present study focuses on France, Italy and Spain, as several variables employed in the econometrics analysis display numerous missing values for the other countries. It should be also recalled that the EFIGE dataset neglects firms with less than 10 employees, thus implying that my results may not be generalized to the smallest of firms.[213]

Focusing on SMEs (i.e., firms with less than 250 employees), I consider the 2001-2008 period to rule out the consequences of the great financial crisis in Europe. Matching survey and balance sheets data, an unbalanced panel from 2001 to 2008 of 7,924 firms and a total of 54,693 observations is obtained. Summary statistics are reported in Table 1, while Table 2 reports the correlation matrix.

6. EMPIRICAL RESULTS

Table 3 reports the results concerning the benchmark model (equation 8), hence, the estimates of technical efficiency equation obtained by adopting a bootstrapped truncated estimator.

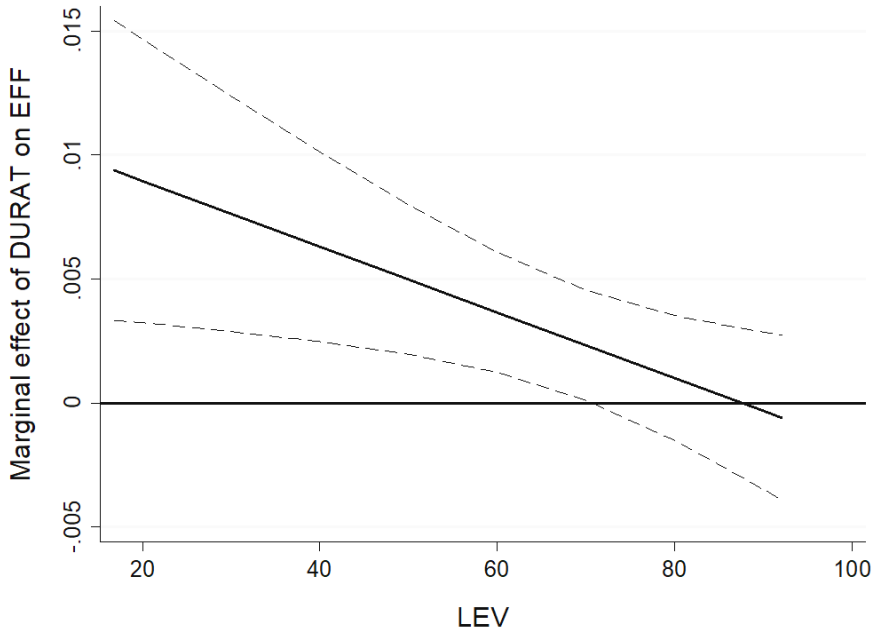
[TABLE 3]

[212] When this subtraction results in negative numbers (or when the 2009 record is missing), I treat the (previous years') observations as missing, as in these cases I do not know whether firms had not established any kind of relationships or they had a relationship with another main bank. Incidentally, the EFIGE survey does not provide the identity of a firm's main bank, and that information concerning other lending relationships' characteristics – such as the percentage of the firm's total bank debt held by the main bank, and the number of lending banks (e.g.: Petersen and Rajan, 1994; Ferri and Messori, 2000; Ongena and Smith, 2000; Agostino et al., 2012) – is available only for the last year of the EFIGE survey).

[213] Furthermore, accounting information refers to firms that are surveyed in 2010, thus defaulted entities are excluded. Hence, my findings are conditional on survival (as in other works based on the same source of data, such as Barba Navaretti et al., 2014; Agostino and Trivieri, 2017).

According to the results in column 1 Table 3, while my key variable DURAT has a significant and positive effect on firm's efficiency, the interaction term parameter is negative and statistically significant. Hence, these estimates seem to support the hypothesis that longer lending relationships may enhance technical efficiency, and that their positive effects depends on the amount of financing. However, the estimated coefficient of my key regressor does not give complete information on the sign, the magnitude and significance of the effect of DURAT on firm's efficiency. Thus, I evaluate the estimated marginal impact of DURAT for different LEV values. Being LEV a continuous variable, I adopt a graph (Figure 1) where the marginal effect of DURAT- and the relative confidence intervals - is showed across the LEV regressor values, applying the formulas specified in the methodology section (equations 9 and 10).

FIGURE 1 – Marginal effect of DURAT on EFF as LEV changes
(--- 95% confidence interval)



The continuous line in Figure 1 shows the DURAT marginal impact for all the values of the modifying variable reported on the x-axis, while the dashed lines delimit 95% confidence

intervals. According to Figure 1, the effect of DURAT on EFF seems dependent on LEV values. At low levels of firm's indebtedness, the DURAT estimated marginal effect is positive and statistically significant (the confidence band does not include the zero line). When such indebtedness increases, the impact of DURAT decreases, becoming not statistically significant beyond a leverage value of about 72%. A possible interpretation of this finding is that, for low firm's indebtedness, the benefits of longer lending relationships might prevail on their costs, thus increasing manager's incentive to achieve efficient technical practices. However, as indebtedness increases, the costs of credit relationships may overcome the benefits, exacerbating moral hazard problems related to a firm's debt and, eventually, reducing managers' incentives to pursue higher production efficiency.

Looking at the other control variables, most of them are statistically significant and their estimated coefficients are consistent with the expectations. The results in column 1 Table 3 show that the variable LEV has not significant effect on efficiency, appearing to be not relevant when DURAT is zero (which occurs for 874 observations in my estimation sample). However, being the interaction term (DURAT*LEV) statistically significant, it seems that the effect of LEV on EFF is different in magnitude and significance as DURAT changes, held the other variables fixed.[214] For what concerns the explanatory variables AGE and SIZE, since their effects on EFF are different in magnitude and in significance according to their level, I compute the estimated marginal impact of AGE and SIZE and their confidence intervals for all their

[214] From the graph of the marginal effect of LEV (Fig. C1.1. reported in the Appendix C1), it emerges that at low level of DURAT, the LEV estimated marginal effect is positive but not statistically significant, while when DURAT increases, the impact of LEV decreases, turning to be negative and statistically significant beyond a threshold value of about two. About the 65% of my sample observations fall within the significant area. Put in a nutshell, the results suggest that the amount of firm's indebtedness is a statistically significant determinant of firm's efficiency.

values. From the graph of the marginal effect of AGE (Fig. C1.2. reported in the Appendix C1), it emerges that for younger firms (about the 12% of my sample observations), the AGE estimated marginal effect is positive and statistically significant. When AGE increases, the impact of AGE decreases, turning not statistically significant for about the 46% of my sample observations, and turning negative and statistically significant for firms older than 27 years. The majority of my sample observations (42%) fall within the negative significance region. Moreover, according to the graph (Fig. C1.3. reported in the Appendix C1), the effect of SIZE on EFF is negative and statistically significant for smaller firms (about the 7% of my sample observations), while after a small region where it is not statistically significant (where fall about the 3% of my sample observations), it turns to be positive and statistically significant as SIZE value increases. The majority of my sample observations (about 90%) fall within the positive significance region. Summarizing, it seems that firm's size has a positive effect on efficiency, probably because larger firms may be able to attract qualified workers and obtain credit, be more diversified and better managed (Margaritis and Psillaki, 2007). Finally, the coefficients of both INV and HHIs are negative and statistically significant (Table 3, columns 1,2 and 4) suggesting that higher inventories and higher concentration in the operating sector may negatively affect firms' efficiency.

6.1. Robustness Checks

In this subsection, I first verify the sensitivity of my findings to the efficiency model specification, using bootstrapped DEA, then I change the methodology adopted and I control for the potential endogeneity issue concerning my key regressors.

In column 2 of Table 3, I substitute the variable LEV with BDEBT, computed as total bank debt to total assets. As described in the Data section, since BDEBT is available only for 2009, I

impute the latter value to all other years. In column 3, I add the (imputed) variable GROUP (coded 1 if firms belong to a group, and zero otherwise); I compute HHI on assets rather than on sales; and INV is replaced with INVR, the ratio of firm's inventories to the annual mean inventory requirement computed at the sector level.[215] In column 4, year fixed effect are included instead of the trend regressor. In column 5, sectorial dummies (individuating 11 NACE-Clio manufacturing sectors) are substituted with sector fixed effects defined at a higher disaggregation level (NACE-Clio classification, 2-digit level). Finally, since Yildirim (2017) finds evidence that banking relationships improve the efficiency of firms having high default probabilities, in column 6 I add the variable ZSCORE, an indicator of financial health employed by several authors (e.g.: Laeven and Levine, 2009; Houston et al. 2010; Kanagaretnam et al. 2012; Mihet, 2012; Jin et al., 2013). Since it gauges the distance from insolvency, higher ZSCORE values indicate more stable and financially healthy firms.[216] My results seem robust to all the specification's amendments mentioned above.

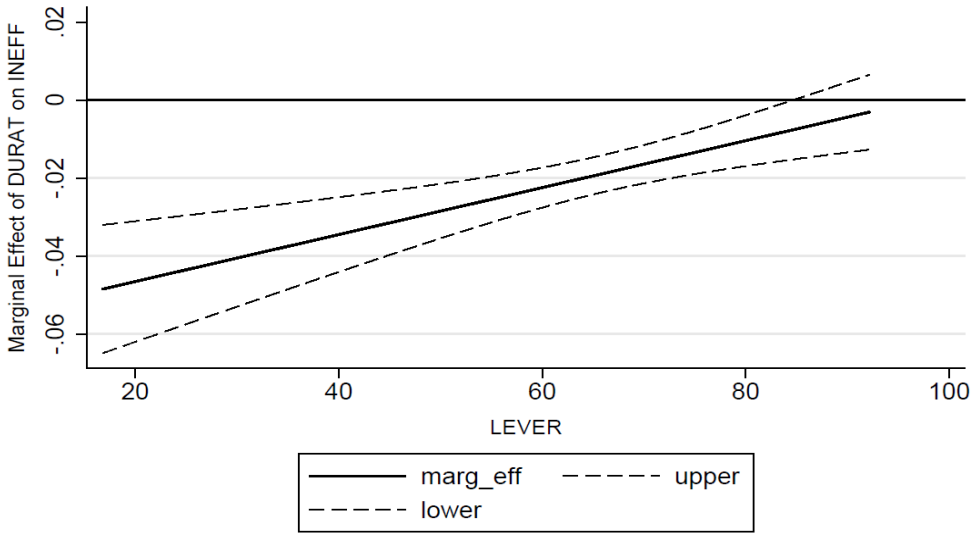
Moreover, I adopt a parametric method proposed by Battese and Coelli (1995) to simultaneously estimate the degree of firm inefficiency and the relationship between inefficiency and my key variable DURAT and other various potential determinants, specified in the benchmark equation 8. As Table 3 column 7 shows, most of the estimated coefficients in the inefficiency model have a significant effect on firm's inefficiency and they tend to point in

[215] I do not add the percentage of graduate employees, proxy of human capital, as defined on a limited number of observations (even after imputing).

[216] The Z-score is the sum of return on assets plus the capital asset ratio divided by the standard deviation of return on assets, the latter being computed over 3-year rolling time windows (Schaeck et al., 2012; Panetta and Pozzolo, 2010; Agostino and Trivieri, 2017). In the literature, this Z-score is employed as a measure of distance from insolvency, as it can be shown that – if profits follow a normal distribution – its value is negatively associated with the probability of insolvency.

opposite direction respect to the DEA two stage results.[217] It is noteworthy to underline that a negative coefficient in this model reflects a reduction of firm's inefficiency and, hence, an increase in firm's efficiency. The scores of technical inefficiency are negatively related to my key variable DURAT which indicates that an increase in the duration of the relationship with the main bank leads to a decrease in firm's technical inefficiency. [218] Again, to have complete information on sign, magnitude and significance of the effect of DURAT on firm's inefficiency, I retrieve the effect of DURAT for all values of LEV, holding the other variables fixed.

FIGURE 2 – Marginal effect of DURAT on INEFF as LEV changes
(--- 95% confidence interval)



[217] The maximum likelihood estimates of the parameters in the translog stochastic frontier production function model defined by the equation (7) are performed by using R-software (package FRONTIER).

[218]In order to determine whether the inefficiency effects should be included in the model, I perform the likelihood ratio test. Since γ takes values between 0 and 1, any LR (likelihood ratio) test involving a null hypothesis that includes the restriction that γ has been shown to have a mixed $\chi 2$ distribution, with appropriate critical values (Kodde & Palm 1986). Under the null hypothesis, the test supposes that $\gamma = 0$, indicating that a SFA is not an adequate representation of the data since the technical inefficient is not present and that an OLS is sufficient. If γ is close to the unity, the frontier model is appropriate. From my results (Table 3, column 7), the null hypothesis is rejected indicating that inefficiency effect are present in the model and that SFA is an appropriate representation of the data. The fit of this model is significantly better than the fit of the OLS model (without Z explanatory variables).

According to the Fig. 2, at low levels of firm's indebtedness the DURAT estimated marginal effect is negative and statistically significant. When such indebtedness increases, the impact of DURAT increases, becoming not statistically significant beyond a leverage value of about 85%. The majority of my sample observations (74%) fall within the negative significance region. The other control variables are statistically significant and their estimated coefficients are generally consistent with those found above. [219]

To further corroborate my main conclusion, I also allow for different maturity of indebtedness. In Table 4, columns 1-2, I distinguish short from long-term debt (LEV_{ST} and LEV_{LT}).

[TABLE 4]

Consistently with the evidence so far presented, the DURAT parameter is positive and significant, while the interaction term coefficients are negative and significant. Yet, the interaction term parameter is smaller in absolute value when considering short-term debt (0.0001) than when conditioning on long-term debt (0.0004). Therefore, long-term debt seems exerting a higher (conditional) influence. Indeed, a longer duration of debt is expected to put less constraint on firms, likely entailing higher moral hazard problems, reinforcing the negative effects associated with higher debt. [220]

[219] Apparently, the estimated coefficients of AGE and SIZE are not in line with the results based on bootstrapped DEA. Yet, when looking at the relative graphs, SIZE appears always negative (when statistically significant), consistently with the positive effect detected for the 90% of the sample, described in the previous subsection.

[220] It worth mentioning that the LEV_{ST} parameter is positive, while the LEV_{LT} coefficient is negative. Thus, the different debt structure seems to have an opposite influence on efficiency. Results are confirmed also when I consider all possible interactions among the constitutive terms (LEV_{ST}, LEV_{LT}, and DURAT), simultaneously (see column 3 of Table 4).

FIGURE 3 – Marginal effect of DURAT on EFF as LEV_ST changes
(--- 95% confidence interval)

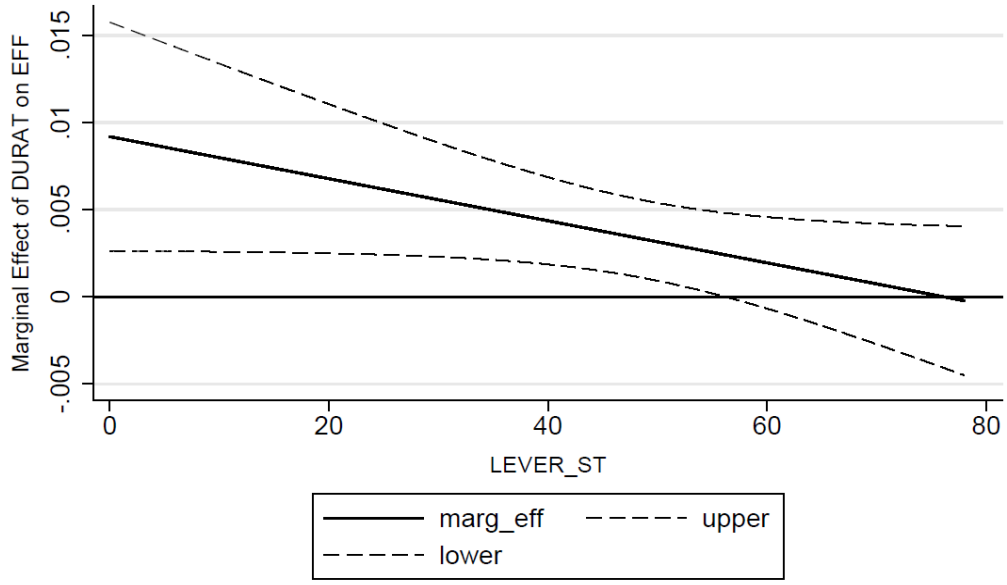
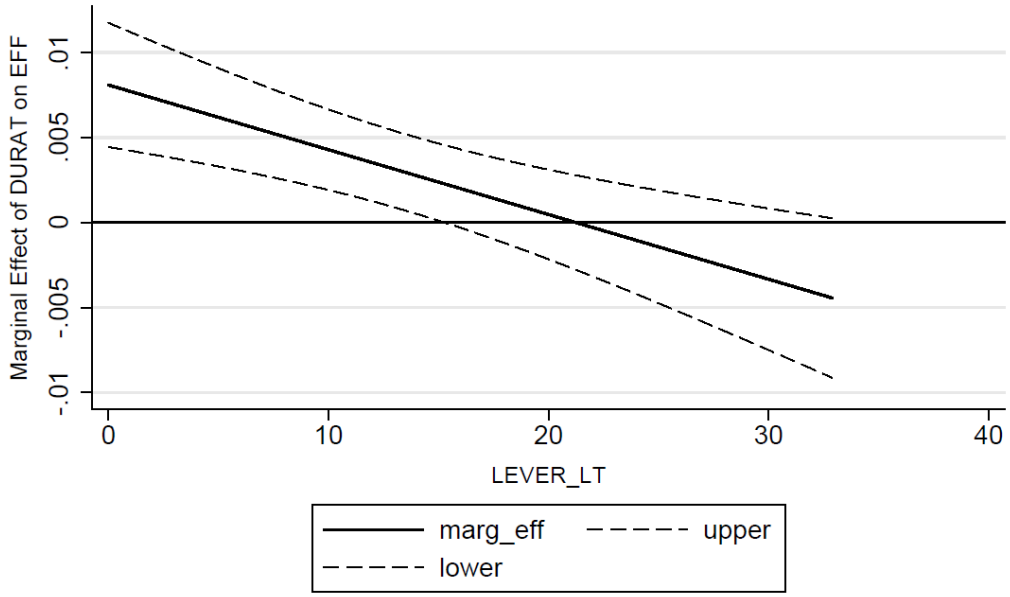


FIGURE 4 – Marginal effect of DURAT on EFF as LEV_LT changes
(--- 95% confidence interval)



Therefore, Figures 3 and 4, based on columns 1 and 2 estimates, respectively, confirm the pattern portrayed by Figure 1. In addition, comparing these figures, the continuous line appears steeper in Figure 4: long term debt seems exerting a higher (conditional) influence, completely offsetting the positive influence of DURAT when taking on values beyond 15%.[221] Thus, the significance and magnitude of this negative link depend on the configuration of firm's indebtedness, being greater as firms borrow at long term respect to the short term.

These findings are confirmed when adopting the Battese and Coelli's (1995) model (see columns 4 and 5 of Table 4): the influence of DURAT tends to decrease in absolute value as the conditioning variable (either LEV_{ST} or LEV_{LT}) increases, yet the detrimental impact of long-term debt is higher.

Finally, I address concerns of endogeneity relating to my key variable DURAT likely to be endogenous, due to simultaneity with firm's technical inefficiency.[222] So far, in my regressions, I have limited potential endogeneity problems by lagging all explanatory variables defined at the firm level. Here, I first adopt a test recently proposed by Karakaplan and Kutlu (2013), to assess the endogeneity of DURAT.[223] To perform this test, I instrument DURAT and the

[221] In detail, according to the Fig. 3, evaluating the estimated marginal impact of DURAT for different LEV_ST values, at low levels of short firm's indebtedness, the DURAT estimated marginal effect is positive and statistically significant. As LEV_ST increases, the impact of DURAT decreases, becoming not statistically significant beyond a LEV_ST value of about 58%. The majority of my sample observations (about 57%) fall within the positive significance region. On the other hand, according to Figure 4, at low levels of long firm's indebtedness, the DURAT estimated marginal effect is positive and statistically significant, becoming not statistically significant beyond a LEV_LT value of about 15%. The majority of my sample observations (about 62%) fall within the positive significance region.

[222] Moreover, in stochastic frontier models endogeneity problem may arise for different reasons: the determinants of the frontier can be correlated with the two side error term and with the inefficiency term and these two latter can be correlated each other (Karakaplan and Kuntlu, 2013).

[223] Karakaplan and Kutlu (2013) is a one-step maximum likelihood based estimation methodology that allows estimating the parameters of a linear model where the error term is composed by a strictly nonnegative measure of

interaction term with the mean value of DURAT computed over the other firms operating in the same region, along with its square and cube terms. The rationale is that the average duration within a region should be correlated to the single firm's duration, but exogenous with respect to the single firm's efficiency. Since the test (reported at the bottom of Table 3, column 7) is not significant at conventional levels, the traditional frontier models seem appropriate.

To support this finding using external instruments, I replicate this test on the subsample of Italian firms, by employing as instrumental variables some indicators of the geographical distribution of banks and branches in 1936 in Italy, as suggested by Guiso et al. (2004, 2007), and several other studies, such as Alessandrini et al. (2009), De Bonis et al. (2015), Herrera and Minetti (2007), Agostino et al. (2011). Indeed, Guiso et al. (2004) show that the territorial structure of the Italian banking system in 1936 – the year in which, in response to the crisis of 1930–36, strict banking regulations were introduced (that remained substantially unchanged until the second half of the 1980s) – 'was the result of historical accidents and forced consolidation, with no connection to the level of economic development at that time' (p. 946). Moreover, the 1936 regulation, were not driven by different regional needs, 'but it was random' (p. 943). Therefore, the geographical distribution of banks and branches in 1936 can be considered exogenous with respect to firm performance in subsequent years, while – as found by Guiso et al. (2004, 2007) – the geographical distribution of banking is significantly correlated with local banking development in the 1990s.

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inefficiency and a two-sided error term from a symmetric distribution. This methodology can account for endogenous variables both in the frontier and the inefficiency model. The method handle endogenous variables in the frontier and in the inefficiency model, offering estimates not affected by endogeneity and comparing them with the standard frontier estimates that ignore endogeneity. Further, it provides a test of endogeneity, relying "on ideas similar to the standard Durbin-Wu-Hausman test for endogeneity" (Karakaplan and Kutlu, 2017, page 6). A technical description of the Karakaplan and Kutlu (2013) model is provided in the Appendix C2.

Looking at the Karakaplan and Kutlu (2013) test result reported in column 8, Table 3, again I cannot reject the null hypothesis of exogeneity.[224] Finally, column 8 of Table 3 shows the estimates obtained adopting a 2SLS estimator, applying the logit transformation to the dependent variable EFF, and using the same set of IVs just mentioned (which satisfies the Sargan test of overidentifying restrictions). These results appear to be in line with the main findings discussed above, although they are obtained by using the Italian subsample and a different estimator.[225]

7. CONCLUDING REMARKS

This paper has investigated the impact of long lasting lending relationships on SMEs technical efficiency. Relying on considerations drawn from the banking literature and the literature on managerial incentives, the hypothesis underlying my research is twofold. First, the equilibrium between advantages and disadvantages of enduring banking relationships might be different depending on the level of firms' indebtedness. Indeed, the costs of lending relationships are supposed to be more relevant as firms' debt increases. Second, these costs might modify managers' incentives associated with debt, pushing them toward either virtuous or opportunistic behaviour, and so the *net* effect of long lasting lending relationships on firms' technical efficiency is an open empirical question.

I retrieve measures of technical efficiency on a sample of manufacturing SMEs operating in three European countries (France, Italy and Spain), by adopting a non-parametric DEA

[224] This result is based on instrumental variables defined in 1936 at regional level: the number of branches per million inhabitants (p.m.i); the number of saving banks (p.m.i).; the number of mutual cooperative banks (p.m.i).; the share of branches owned by cooperative Popolari banks, and the share of branches owned by large banks.

[225] Since my IVs are time invariant, a fixed effect estimator cannot be employed. Furthermore, as the endogenous variable DURAT is discrete, I cannot apply an IV Tobit.

double bootstrap approach, proposed by Simar and Wilson (2007). Furthermore, my results are fairly robust when adopting parametric measures of inefficiency based on a Stochastic Frontier Approach (SFA) one-stage procedure proposed by Battese and Coelli (1995), and when addressing potential endogeneity problems (Karakaplan and Kutlu, 2013).

According to my findings, lending relationships seem exerting a positive effect on SMEs' efficiency. Since lending relationships are crucial for SMEs, which tend to establish ties with local banks, the tendency of banks to continuously move bank officers from one bank's decision-making center to another reducing the possibility to gather soft information, may have a negative effect on firm efficiency. Moreover, restructuring process (i.e. mergers and acquisitions) could weaken these relationships, thus affecting firm's technical efficiency.

Furthermore, my evidence suggests that the positive effect of enduring lending relationships tends to decrease as firm's debt level increases. This evidence is confirmed when I perform different estimations distinguishing between short and long run debt. Indeed, consistently with my research hypothesis, a longer duration of debt seems reinforcing the negative effects associated with higher debt.

Finally, my work could inspire promising future research. Since the dataset employed excludes firms with less than ten employees, future works could consider the smallest of firms to evaluate whether my results are confirmed. Besides, when more recent data will be available, one could evaluate whether the influence of lasting lending relationships has been affected by the last great financial crisis.

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TABLE 1 - Description and summary statistics of the variables in the benchmark model

VARIABLE	DESCRIPTION	Mean	Std. Dev.	Min	Max	Obs
Entering the production function						
TOTREV [(a)]	Total sales	53.90	69.36	3.14	671.03	54,693
KAP [(a)]	Tangible plus intangible assets plus depreciation	13.73	22.40	0.15	253.35	54,693
RAWM [(a)]	Expenditure for raw materials	27.13	43.48	0.17	416.52	54,693
EMPLO [(b)]	Number of employees	35	33	10	248	54,693
Entering the efficiency model						
EFF	Pure technical efficiency based on bootstrapped DEA (Simar and Wilson 2007)	0.45	0.18	0.02	0.97	44,135
DURAT [(c)]	Duration of the relationships with the main bank	12.37	9.77	0	45	26,584
AGE [(c)]	Current year minus firm's year of establishment	26.09	20.90	1	111	53,093
SIZE [(a)]	Total assets	3943	4951	245	28072	53,525
LEV	Total debt to total assets	65.77	20.05	16.80	92.16	44,135
LEV_{ST}	Short-run debt to total assets	51.30	18.26	0.00	78.47	44,135
LEV_{LT}	Long-run debt to total assets	13.03	10.73	0.00	32.88	44,135
INV	Raw materials inventories to total assets	42.63	18.64	4.24	85.63	44,135
HHIs	Herfindahl-Hirschman index on firms' sales	0.02	0.05	0.00	0.34	44,135

(a) in thousands of Euro; (b) in units; (c) in years.

TABLE 2 - Correlation matrix

	DURAT	LEV	LEV_{ST}	LEV_{LT}	AGE	SIZE	HHIs	INV
DURAT	1							
LEV	-0.133	1						
LEV_{ST}	-0.110	0.748	1					
LEV_{LT}	-0.025	0.391	-0.270	1				
AGE	0.365	-0.221	-0.175	-0.044	1			
SIZE	0.025	0.011	-0.008	0.052	0.197	1		
HHIs	-0.019	-0.021	-0.008	-0.019	0.007	0.044	1	
INV	-0.090	0.153	0.179	-0.036	-0.067	0.318	0.064	1

For the description of the variables see Table 1.

TABLE 3 - Estimation results and robustness checks (bootstrapped truncated regressions, and Battese and Coelli 1995).

	1 Benchmark	*2* BDEBT instead of LEV	*3* Changing specification	*4* Year fixed effects	*5* Nace 2-digit dummies	*6* Adding ZSCORE	*7* BC 1995 Benchmark	*8* 2SLS ITALY
DURAT	0.0112***	0.0081***	0.0112***	0.0114***	0.0131***	0.0106**	-0.0586***	6.9577***
	0.004	*0.001*	*0.008*	*0.006*	*0.001*	*0.015*	*0.000*	*0.000*
LEV	0.0001		0.0001	0.0001	0.0001	0.0001	-0.0013***	0.1934***
	0.466		*0.55*	*0.472*	*0.34*	*0.478*	*0.000*	0.003
BDEBT		0.00004						
		0.646						
DURAT*LEV	-0.0001**		-0.0001**	-0.0001**	-0.0002**	-0.0001**	0.0006***	-0.0752***
	0.019		*0.035*	*0.029*	*0.011*	*0.038*	*0.000*	0.005
DURAT*BDEBT		-0.0001**						
		0.01						
AGE	0.0153***	0.0157***	0.0158***	0.0153***	0.0186***	0.0149**	0.0589***	-0.3912
	0.008	*0.006*	*0.004*	*0.006*	*0.001*	*0.013*	*0.000*	0.32
AGE^2	-0.2658***	-0.0028***	-0.2647***	-0.2657***	-0.0033***	-0.0029***	-0.0084***	0.0049
	0.000	*0.000*	*0.000*	*0.000*	*0.001*	*0.005*	*0.000*	0.914
SIZE	-0.0028***	-0.2601***	-0.0028***	-0.0028***	-0.2580***	-0.2602***	-0.5273***	-1.4476***
	0.004	*0.000*	*0.003*	*0.004*	*0.000*	*0.000*	*0.000*	*0.000*
$SIZE^2$	0.0209***	0.0205***	0.0207***	0.0209***	0.0203***	0.0205***	0.0256***	0.1128***
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
INV	-0.0006***	-0.0006***		-0.0006***	-0.0006***	-0.0006***	0.0229***	-0.0034***
	0.000	*0.000*		*0.000*	*0.000*	*0.000*	*0.000*	0.002
INVR			-0.0216***					
			0.000					
HHIs	-0.0720***	-0.0705***		-0.0572**	-0.0671***	-0.0001	0.1998***	-0.6599
	0.002	*0.002*		*0.024*	*0.003*	*0.998*	*0.000*	0.152
HHIa			-0.4049***					
			0.000					
GROUP			0.0088***					
			0.002					
ZSCORE						-0.00001		
						0.162		
TREND	-0.0009*	-0.0009*	-0.0016***		-0.0010**	-0.0017***	-0.0061***	-0.0032
	0.064	*0.077*	*0.000*		*0.02*	*0.005*	*0.000*	0.775
N.obs	21 519	21 944	21 519	21 519	21 047	18980	21 519	8652

(continued)

TABLE 3 (continued) - Estimation results and robustness checks (bootstrapped truncated regressions, and Battese and Coelli, 1995).

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
	Benchmark	BDEBT instead of LEV	Changing specification	Year fixed effects	Nace 2-digit dummies	Adding ZSCORE	BC 1995 Benchmark	2SLS ITALY
Model test	15772	15266	14394	15954	14062	12574		53.1
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*		*0.000*
LRT(a)							8176	
							0.000	
LRT(b)							30155	
							0.000	
Eta test							3.180	1.03
							0.075	0.309
Sargan test								4.359
								0.2252

For the description of the variables see Table 1. In Italics are reported the p-values of the tests. Superscripts ***, ** and * denote statistical significance at the 1, 5 and 10 percent level, respectively. Constant, country and sectorial dummies always included but not reported. In columns from 1 to 6 and in column 8 the dependent variable is efficiency, whilst in column 7 is inefficiency. Columns 1-6 report marginal effects of bootstrapped truncated regressions (Simar and Wilson, 2007). In all the columns, DURAT, AGE and SIZE are in logarithmic form. In column 2, BDEBT is total bank debt to total assets. In column 3, INV is replaced by INVR, HHIs is replaced by HHIa, and the dummy GROUP (equal to 1 if the firm belongs to a group, 0 otherwise) is added. In column 4, TREND is substituted with annual fixed effects, and in column 5 sectorial dummies (individuating 11 NACE-CLIO manufacturing sectors) are substituted with sector fixed effects defined at a higher disaggregation level, NACE-CLIO classification (2-digit) level. In column 6, ZSCORE is the sum of return on assets plus the capital asset ratio divided by the standard deviation of return on assets, the latter being computed over three-year rolling time windows. In column 7, BC1995 stands for Battese and Coelli (1995) Stochastic Frontier Analysis. In column 8, the 2SLS estimator is applied on the subsample of Italian firms, using the following instruments, defined in 1936 at regional level: the number of branches per million inhabitants (p.m.i); the number of saving banks (p.m.i.); the number of mutual cooperative banks (p.m.i.); the share of branches owned by cooperative Popolari banks, and the share of branches owned by large banks. Model test is the test of joint significance of all explanatory variables (Wald chi2 test). LRT stands for Likelihood ratio test. LRT(a) compares the Translog (H1) with the Cobb-Douglas production function (H0); LRT(b) compares the fitted model (H1) with a corresponding model without inefficiency, estimated by OLS (H0); Eta Test is the Karakaplan and Kuntlu's (2013) endogeneity test on DURAT and DURAT*LEV. The null hypothesis of the Sargan test is the validity of the over-identifying restrictions.

TABLE 4 - Estimation results: long and short term. Bootstrapped truncated regressions, and Battese and Coelli (1995)

	Dependent variable: **EFF and INEFF**				
	1	*2*	*3*	*4*	*5*
	DURAT*LEV_{ST}	DURAT*LEV_{LT}	ALL INTERACTIONS	BC 1995 (DURAT*LEV_{ST})	BC 1995 (DURAT*LEV_{LT})
DURAT	0.0089***	0.0078***	0.0152***	-0.0602***	-0.0036**
	0.006	*0.000*	*0.000*	*0.000*	*0.034*
LEV_{ST}	0.0008***	0.0005***	0.0010***	-0.0027***	-0.0009***
	0.000	*0.000*	*0.000*	*0.000*	*0.000*
LEV_{LT}	-0.0025***	-0.0017***	-0.0010***	0.0028***	0.0005**
	0.000	*0.000*	*0.004*	*0.000*	*0.044*
DURAT*LEV_{ST}	-0.0001*		-0.0001**	0.0007***	
	0.06		*0.045*	*0.000*	
DURAT*LEV_{LT}		-0.0004***	-0.0004***		0.0001
		0.000	*0.000*		*0.573*
LEV_{ST}*LEV_{LT}			-0.00001***		
			0.009		
AGE	0.0119**	0.0106**	0.0120**	-0.0839***	0.0215***
	0.032	*0.038*	*0.032*	*0.000*	*0.000*
AGE^2	-0.2444***	-0.2437***	-0.0021**	0.0171***	-0.0032***
	0.000	*0.000*	*0.029*	*0.000*	*0.000*
SIZE	-0.0021**	-0.0019**	-0.2524***	-0.2038***	-0.6878***
	0.031	*0.035*	*0.000*	*0.000*	*0.000*
$SIZE^2$	0.0197***	0.0196***	0.0203***	-0.0018	0.0386***
	0.000	*0.000*	*0.000*	*0.573*	*0.000*
INV	-0.0010***	-0.0010***	-0.0011***	0.0119***	0.0224***
	0.000	*0.000*	*0.000*	*0.000*	*0.000*
HHIs	-0.0776***	-0.0770***	-0.0792***	-0.1718	-0.0394
	0.001	*0.001*	*0.000*	*0.288*	*0.428*
TREND	-0.0006	-0.0006	-0.0006	-0.0128***	0.0139**
	0.159	*0.159*	*0.189*	*0.000*	*0.008*
N.obs	21 519	21 519	21 519	21 519	21 519
Model test	18496	17631	17029		
	0.000	*0.000*	*0.000*		
LRT				12445	32902
				0.000	*0.000*

For the description of the variables see Table 1. In Italics are reported the p-values of the tests. Superscripts ***, ** and * denote statistical significance at the 1, 5 and 10 percent level, respectively. DURAT, AGE and SIZE are in logarithmic form. Constant, countries and sectorial dummies always included but not reported. For the truncated regressions marginal effects are reported. Columns 1, 2 and 3 report bootstrapped truncated regressions (Simar and Wilson, 2007). In columns 4 and 5, BC1995 stands for Battese and Coelli (1995) Stochastic Frontier Analysis. In columns from 1 to 3 the dependent variable is efficiency (EFF), whilst in column 5 and 6 is inefficiency (INEFF). Model test is the test of joint significance of all explanatory variables (Wald chi2 test).LRT stands for Likelihood ratio test that compares the fitted model (H1) with a corresponding model without inefficiency, estimated by OLS (H0).

Appendix C1

FIGURE C1.1. – Marginal effect of LEV on EFF as DURAT changes
(--- 95% confidence interval)

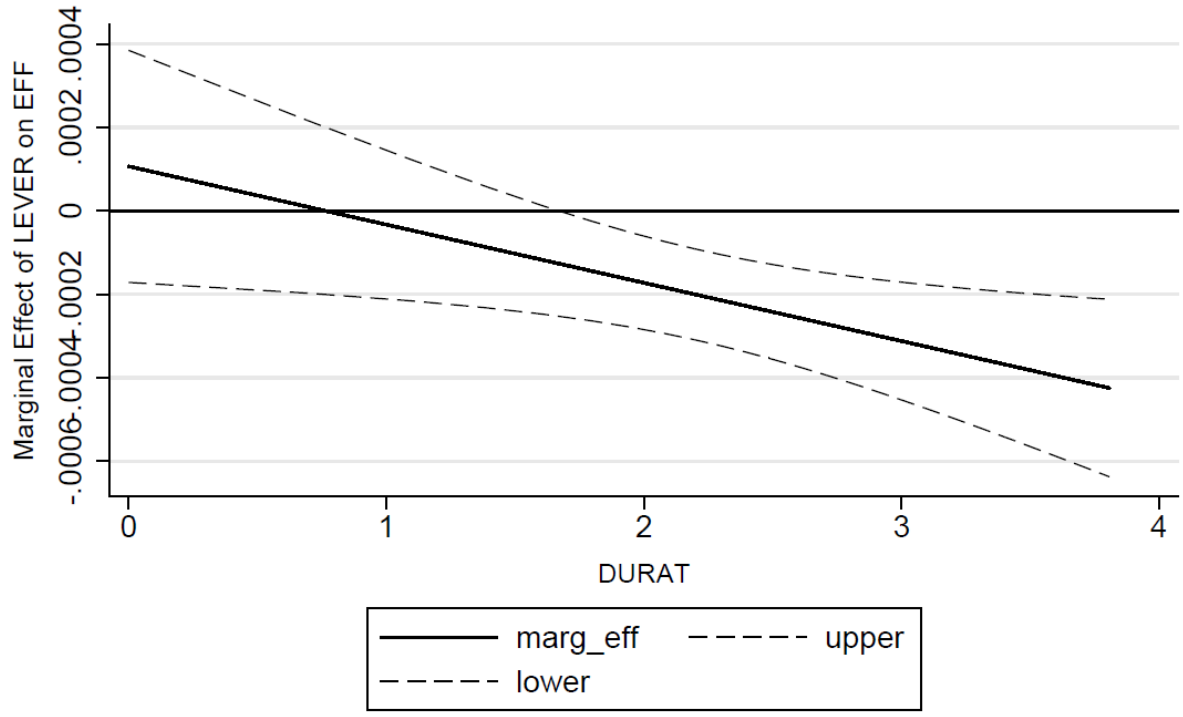


FIGURE C1.2. – Marginal effect of AGE on EFF as AGE changes
(--- 95% confidence interval)

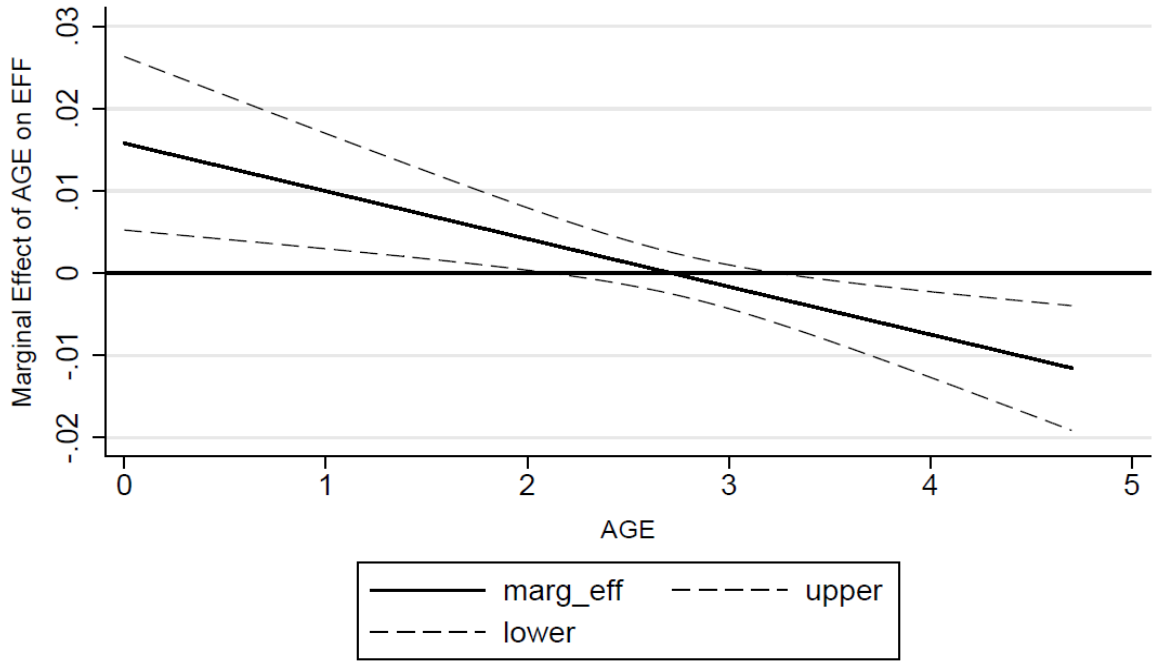
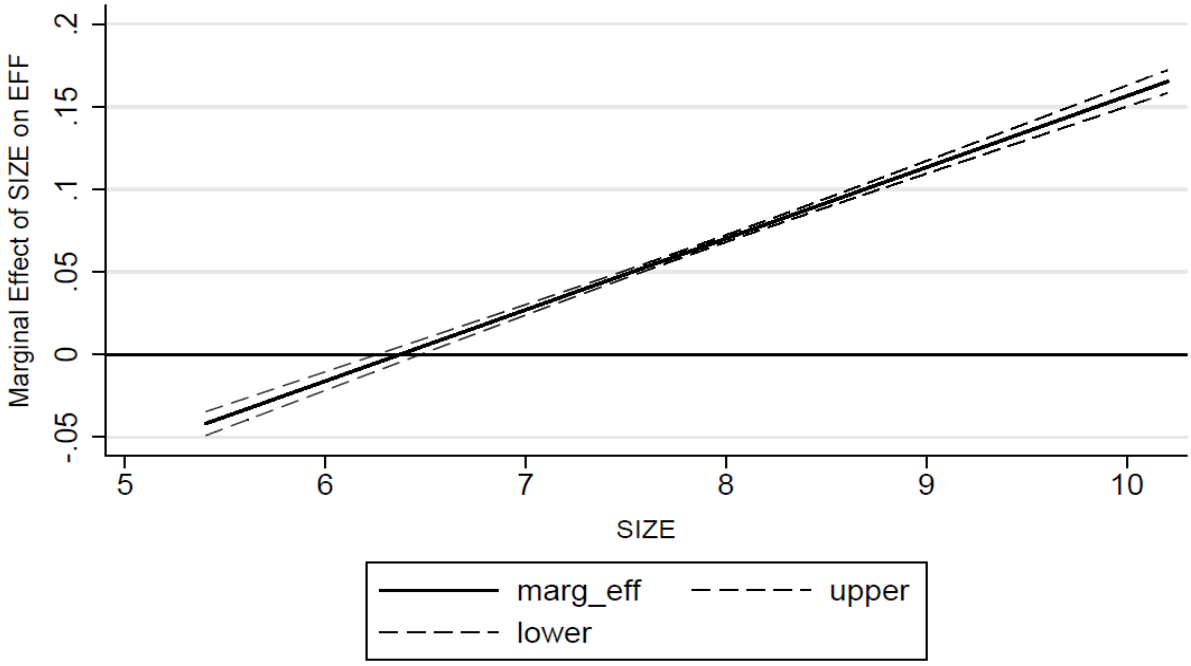


FIGURE C1.3.– Marginal effect of SIZE on EFF as SIZE changes
(--- 95% confidence interval)



Appendix C2

1. Stochastic frontier models for panel data

A stochastic frontier model for panel data in log linear form can be written as:

$$y_{it} = f(x_{it};\beta) + \epsilon_{it} = \alpha + \beta' x_{it} + \varepsilon_{it} \quad \text{(C1)}$$

where y_{it} is the log of output for firm *i* at time *t*; $f(x_{it};\beta)$ is the production technology; x_{it} is the vector of N inputs; β is the associated vector of technology parameters to be estimated; ε_{it} is the composite error term, where:

$$\varepsilon_{it} = v_{it} - u_{it} \quad \text{(C2)}$$

combining equation (1) and (2), and assuming a linear form for *f*:

$$y_{it} = \alpha + \beta' x_{it} + v_{it} - u_{it} \quad \text{(C3)}$$

where $v_{it} \sim N(0, \sigma_v^2)$ is a random two-sided noise term; and $u_{it} \sim N^{+}(0, \sigma_u^2)$ is the non negative one-sided inefficiency term. The parameters of the model (C3) can be estimated by maximum likelihood and the inefficiency term is computed as the conditional mean of the inefficiency using the technique of Jondrow et al (1982) so that $E(-u_{it}|v_{it} - u_{it})$. The technical efficiency TE_{it} for firm *i* at time *t*, is obtained by the ratio of the observed production over the maximum technical output obtainable for a firm, defined by the frontier production function:

$$TE_{it} = \frac{f(x_{it};\beta)\exp(v_{it} - u_{it})}{f(x_{it};\beta)\exp(v_{it})} = \exp(-u_{it}) \quad \text{(C4)}$$

The SF model for panel data (such as Pitt and Lee, 1981; Schmidt and Sickles, 1984; Battese and Coelli, 1992, 1995) present some limitations since do not control for the individual unobserved

heterogeneity assuming that this heterogeneity is entirely inefficiency. According to Kumbhakar et al. (2014), the omission of the time-invariant heterogeneity might cause biased estimates of production function frontier parameters but also to an overstatement of inefficiency u_{it}, and hence an understatement of technical efficiency.[226] In a panel data where a statistical unit is observed over time, the specific unobserved variations can also be take into account through fixed or random effects. Green (2005) proposes extensions of the stochastic frontier for panel data with the "true" fixed effects (TFE) and the "true" random effects (TRE) frontier models accounting for both time invariant unobserved heterogeneity and time-varying technical inefficiency. Hence, in both models firm-specific effects are not parts of inefficiency:

$$y_{it} = \alpha_i + f(x_{it};\beta) + v_{it} - u_{it} \qquad \text{(TFE C5)}$$

and

$$y_{it} = (\alpha + w_i) + f(x_{it};\beta) + v_{it} - u_{it} \qquad \text{(TRE C6)}$$

The models differ for the assumptions about the time invariant effect. In the TFE model, α_i is a time invariant fixed effect. In the TRE model, w_i is an i.i.d. random component ($w_i \sim N(0, \sigma_W^2)$). The TRE model assumes that there is no correlation between individual specific random component w_i and the explanatory variables (inputs).[227] In both cases, the assumptions of the stochastic frontier

[226] Moreover, according to Kumbhakar et al. (2014), the Battese and Coelli (1995) specification is restrictive since it only allows inefficiency to change over time exponentially. What is more, this model ignoring heteroskedasticity in both the two-sided error term v_{it} and the one sided technical inefficiency term u_{it} could lead to inconsistent parameters estimates.

[227] According to several studies (Farsi et al., 2005; Filippini and Hunt, 2012; Pieri and Zainotto, 2013 and Castiglione et al., 2017), it is possible to account for the possible correlation using the Mundlak correction (1978) that requires inserting the within-group means of inputs in the production or cost frontier model. Formally, $w_i = \lambda' \bar{X}_i + \eta_i$, where $\bar{X}_i = 1/T_i \sum_{t=1}^{T} X_{it}$ are individual specific means, T_i is the number of time periods for *i*, λ' is the corresponding vector of

model are preserved. [228] The model parameters of the TRE model are estimated by applying simulated maximum likelihood procedure proposed by Green (2005), while TFE model is estimated by applying the maximum-likelihood dummy variable (MLDV).[229] The TE_{it} scores are obtained in line with Eq. (C4) as before. Empirical applications of the Greene (2005) models can be found in studies about drinking water distribution efficiency (Filippini et al. 2007; Abrate et al. 2011; Faust and Baranzini, 2014), nursing homes efficiency (Farsi et al, 2005), machine tool industry efficiency (Pieri and Zainotto, 2013), energy efficiency (Filippini and Hunt, 2016), performing arts companies efficiency (Castiglione et al., 2017).

2. Handling endogeneity in stochastic frontier analysis: Karakaplan and Kutlu (2013) model

Karakaplan and Kutlu (2013) is a one-step maximum likelihood based estimation methodology that allows estimating the parameters of a model where the error term is composed by a strictly nonnegative measure of inefficiency and a two-sided error term from a symmetric distribution. The

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coefficients to be estimated and $\eta_i N(0, \sigma_\eta^2)$. In this way, the stochastic component is split into two parts: the first one explicates the relationship between exogenous variables and firm specific effect and the second one, η_i, is assumed to be orthogonal to the explanatory variables (Castiglione et al. 2017).

[228] However, in the Green (2005) models considering any time-invariant component as unobserved heterogeneity, any persistent (long term) component of inefficiency is completely absorbed (Filippini and Hunt, 2016). In other words, long term inefficiency is confounded with latent heterogeneity (Kumbhakar et al, 2014). Indeed, according to Faust and Baranzini (2014), the TRE model can lead to an underestimation of technical efficiency scores by assuming none of the unobserved persistent differences to be inefficiency.

[229] For TFE estimations the so-called incidental parameter problems may arise when the number of units is relatively large compared with the length of the panel. According to Belotti et al. (2013), MLDV is appropriated when the length of the panel is larger than 10 years. Hence, α_i are inconsistent and subject to small sample bias which may impact the technical efficiency scores (Kumbhakar et al, 2014). This problem can be addressed by applying Chen et al. (2014) that estimate a fixed effect panel stochastic frontier model by applying Marginal Maximum Likelihood within and/or first difference methods. Unfortunately, this approach is highly unstable in practice for my data.

method allows handling endogenous variables both in the frontier and in the inefficiency model, offering estimates not affected by endogeneity and comparing them with the standard frontier estimates that ignore endogeneity.[230]

Karakaplan and Kutlu (2013) consider the following stochastic frontier model with endogenous explanatory variables:

$$y_i = x_{1i}'\beta + v_i - su_i \qquad \text{(KK C7)}$$

where y_i is the logarithm of output of *i*th producer, while x_{1i} is a vector of endogenous and exogenous variables, and $s = -1$ for cost functions (or $s = 1$ for production functions);

$$x_i = Z_i\delta + \varepsilon_i \qquad \text{(KK C8)}$$

is a $p \times 1$ vector of endogenous variables (excluding y_i), while $Z_i = \mathrm{I}_p \otimes z_i'$ is a $q \times 1$ vector of all exogenous variables, v_i and ε_i are two-sided error terms; $u_i \geq 0$ is the one-sided error term capturing inefficiency. Here,

$$\begin{bmatrix}\tilde{\varepsilon}_i \\ v_i\end{bmatrix} = \begin{bmatrix}\Omega^{-\frac{1}{2}} & \varepsilon_i \\ & v_i\end{bmatrix} \backsim N\left(\begin{bmatrix}0\\0\end{bmatrix}, \begin{bmatrix}I_p & \sigma_{vi}p \\ \sigma_{vi}p' & \sigma_{vi}^2\end{bmatrix}\right) \qquad \text{(KK C9)}$$

Ω is the variance-covariance matrix of ε_i, σ_{vi}^2 is the variance of v_i, and p is the vector representing the correlation between $\tilde{\varepsilon}_i$ and v_i.

Let x_{2i} be a vector of exogenous and endogenous variables. The model assumes that the inefficiency term, u_i is a function of x_{2i} and an individual specific random component, u_i^*. More in details:

[230] In stochastic frontier models endogeneity problems may arise for different reasons: the determinants of the frontier can be correlated with the two side error term and with the inefficiency term and these two latter can be correlated each other.

$$u_i = \sigma_u(x_{2i}; \varphi_u)u_i^* \geq 0 \qquad \text{(KK C10)}$$

where $\sigma_{ui} = \sigma_u(x_{2i}; \varphi_u) > 0$ and $u_i^* \geq 0$ is independent from v_i and ε_i. Hence, u_i is not independent from x_i, yet u_i and v_i are conditionally independent given x_i and z_i. Similarly, u_i and ε_i are conditionally independent given x_i and z_i.

By a Cholesky decomposition of the variance-covariance matrix of $(\tilde{\varepsilon}_i',\ v_i)'$, Karakaplan and Kutlu (2013) write the frontier equation as follows:

$$y_i = x_{1i}'\beta + \sigma_{vi}p'\tilde{\varepsilon}_i + w_i - su_i = x_{1i}'\beta + \sigma_{wi}\eta'(x_i - Z_i\delta) + e_i \qquad \text{(KK C11)}$$

where $e_i = w_i - su_i$, $w_i = \sigma_{vi}\sqrt{1 - p'p\widetilde{w}_i} = \sigma_{wi}\widetilde{w}_i$, and $\eta = \Omega^{-\frac{1}{2}}p/\sqrt{1 - p'p}$. e_i is conditionally independent from the regressors given x_i and z_i. They directly assume that v_i is normally distributed with mean $\sigma_{wi}\eta'(x_i - Z_i\delta)$ given x_i (and exogenous variables). According to the control function approach, $\sigma_{wi}\eta'(x_i - Z_i\delta)$ is a correction for bias. Indeed, Karakaplan and Kutlu (2013) base their analysis on this assumption. They also assume that:

$$u_i^* \backsim N^+(0,1) \qquad \text{(KK C12)}$$

$$\sigma_{ui}^2 = exp(x_{2i}'\varphi_u) \qquad \text{(KK C13)}$$

$$\sigma_{wi}^2 = exp(x_{3i}'\varphi_w) \qquad \text{(KK C14)}$$

where $\varphi = (\varphi_u', \varphi_w')'$ is the vector of parameters capturing heteroskedasticity and x_{3i} is a vector of exegenous and endogenous variables which can share the same variables x_{1i} and x_{2i}. This implies that $u_i \backsim N^+(0, \sigma_{ui}^2)$. One of the important features of their model is that $Cov(u_i, \varepsilon_i) = \sqrt{2/\pi}\, Cov(\sigma_{ui}, \varepsilon_i) \neq 0$. Let $\lambda_i = \sigma_{ui}/\sigma_{wi}$ and $\sigma_i^2 = \sigma_{wi}^2 + \sigma_{ui}^2$. Then, the probability density function of e_i is given by:

$$f_e(e_i) = \frac{2}{\sigma_i}\phi\left(\frac{e_i}{\sigma_i}\right)\Phi\left(\frac{-s\lambda_i e_i}{\sigma_i}\right) \quad \text{(KK C15)}$$

where ϕ and Φ are the standard normal probability density function and the cumulative distribution function, respectively. Let $y = (y_1, y_2, \dots, y_n)'$ be the vector of dependent variables and $x = (x_1, x_2, \dots, x_n)'$ be a matrix of endogenous variables in the model, and $\theta = (\beta', \eta', \varphi', \delta')'$ is the vector of coefficients. The log-likelihood of (y, x) is given by:

$$\ln L(\theta) = \ln L_{y|x}(\theta) - \ln L_x \quad \text{(KK C16)}$$

where

$$\ln L_{y|x}(\theta) = \sum_{i=1}^{n}\left\{\ln 2 - \frac{1}{2}\ln\sigma_i^2 + \ln\phi\left(\frac{e_i}{\sigma_i}\right) + \ln\Phi\left(\frac{-s\lambda_i e_i}{\sigma_i}\right)\right\}$$

$$= \sum_{i=1}^{n}\left\{\frac{\ln\frac{2}{\pi} - \ln\sigma_i^2 - \frac{e_i}{\sigma_i}}{2} + \ln\Phi\left(\frac{-s\lambda_i e_i}{\sigma_i}\right)\right\} \quad \text{(KK C17)}$$

$$\ln L_x = \sum_{i=1}^{n}\left\{\frac{-p\times\ln\frac{2}{\pi} - \ln(|\Omega|) - \varepsilon_i'\Omega^{-1}\varepsilon_i}{2}\right\} \quad \text{(KK C18)}$$

$$e_i = y_i - x_{1i}'\beta - \sigma_{wi}\eta'(x_i - Z_i\delta) \quad \text{(KK C19)}$$

$$\varepsilon_i = x_i - Z_i\delta \quad \text{(KK C20)}$$

$$\sigma_i^2 = \sigma_{wi}^2 + \sigma_{ui}^2 \quad \text{(KK C21)}$$

$$\lambda_i = \frac{\sigma_{ui}}{\sigma_{wi}} \quad \text{(KK C22)}$$

In particular, with respect to traditional stochastic frontier model, they also add $\ln L_x$ to the log-likelihood and adjust e_i term by the $\sigma_{wi}\eta'(x_i - Z_i\delta)$ factor. The inclusion of this bias correction term solves the problem of inconsistent parameter estimates due to endogenous regressors in x_{1i}, and due to the endogenous variables in x_{2i}. The efficiency, $EFF_i = \exp(-u_i)$, can be calculated by:

$$E[\exp(-su_i|e_i]^s = \left(\frac{1-\Phi\left(s\sigma_i^* - \frac{\mu_i^*}{\sigma_i^*}\right)}{1-\Phi\left(-\frac{\mu_i^*}{\sigma_i^*}\right)} \exp\left(-s\mu_i^* + \frac{1}{2}\sigma_i^{*2}\right)\right)^s \qquad \text{(KK C23)}$$

where $\mu_i^* = \frac{-se_i\sigma_{ui}^2}{\sigma_i^2}$ and $\sigma_i^{*2} = \frac{\sigma_{wi}^2\,\sigma_{ui}^2}{\sigma_i^2}$.

In addition, they offer a test for endogeneity relying "on ideas similar to the standard Durbin-Wu-Hausman test for endogeneity" (Karakaplan and Kutlu, 2017, page 6). They propose a test of joint significance of the components of the η term. If the components are jointly significant, then it is possible to conclude that there is endogeneity in the model. When the components are not jointly significant, this would indicate that the correction term is not necessary and the inefficiency can be estimated by the traditional frontier models.