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Essays on the Dynamics of Productivity at the Firm Level: the Role of Finance

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To Ernesto, who desired it and
to Lorenzo, who believed in it.

"Ció che oggi scriviamo sulla lavagna, domani lo cancelleremo."
Bertold Brecht, Vita di Galileo.

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Vita

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Abstract

During the last ten years, Italian growth has lagged behind other European countries. This delay has been mainly attributed to a slowdown in Italian firms productivity. A large body of literature has deepened the role of finance, among other factors, in spurring economic growth. The present work investigates some of these processes, through three different frameworks.

Chapter 1 is an application of the Rajan Zingales (1998) approach to the Italian case. In this application a proxy for financial development at regional levels was built up using qualitative information. The results point out that the Italian financial market is still segmented at regional levels, in particular for smaller firms that are more dependent on the proximity of financial services. Moreover, it suggests that the effect of financial development could be even higher assuming the external dependence computed on German and not U.S. listed firms.

Chapter 2 focuses on the effectiveness of financial systems in allocating the resources to the most efficient firms. In this chapter, we test whether firms' financial strategies explain the distance of a sample of Italian firms to the efficiency frontier. The results point out that a tighter relationship with banks or a higher contendibility of corporate control are correlated to a more efficient production.

Chapter 3 focuses on the effects that different financial instruments have on R&D strategies and on productivity. As the results suggest, in fact, the nature and duration of different financial instruments could have an impact on firm innovation strategies.

Introduction

During the last ten years, Italian growth has lagged behind other European countries. This delay has been mainly attributed to a slowdown in Italian firms productivity[1].
There are a number of reasons why Italy displayed such a bad performance during the last period. First, the small dimensions of the Italian firms, the scarce innovation and the specialization in traditional sectors have often been quoted as causes for the hold-up.
Furthermore, Italy is still a country divided in two: the convergence process that involved Southern regions towards Northern regions and to more productive areas, stopped in 2002. This affected the overall productivity, generating a structural lag for the entire country: spurring productivity in the Southern area is a priority at a national level.
Nonetheless, the lack of competitiveness of Southern Italy seems only to be amplifying problems common to the whole country.

Recently, empirical evidence on micro data has pointed out several features regarding the distribution of productivity of Italian manufacturing firms. Firstly, it has been relatively stable in rankings over time; in spite of this, there seems to be a polarization process that has increased the distance between the best and the worst performing firms on the market.

In the last years, hence, a bulk of excellent cases left behind a bunch of

[1] see Daveri, F., *Perché la produttivitá ha smesso di crescere nell'economia italiana*, Quaderni di Ricerca Centro Studi Confindustria, n.2 Dicembre, 2006.

firms. However, the positive results of these firms had no influence at an aggregate level.
As suggested in a recent paper by Giannangeli and Gomes-Salvador (2008) the contribution to aggregate productivity of individual firms' efficiency improvement is negative, thus implying that they are enlarging their distance from the efficiency frontier. Furthermore it is shown that more efficient firms are not rewarded with an increase in their market shares. This suggests that there is no relationship between productivity levels and firms' growth, evidence already described also in Bottazzi, Secchi and Tamagni (2006). Overall, the cited analysis indicates that Italian industries may be structurally affected by a lack of "virtuous" competitive mechanisms able to provide incentives for firm innovation and to the adoption of new technologies or diffusion of best practices.

A large strand of literature has highlighted the role of institutions in representing a key factor for improving productivity also at an aggregate level. A large body of literature has deepened the role of finance, among other factors, in spurring economic growth. As Rajan and Zingales (1998) have written, "economists have emphasized the role of financial development in better identifying investment opportunities, reducing investment in liquid but unproductive factors, mobilizing savings, boosting technological innovation, and improving risk taking".
All these activities can certainly contribute to generate a positive dynamic at a micro level, having an effect also on macro results.
There are different channels through which this process takes place; the present work investigates some of these processes, using three different frameworks.

First of all, financial development can spur economic growth enhancing the amount of resources available to satisfy firms financing needs. The existence of credit barriers can, in fact, reduce the opportunity for incumbent firms to exploit their potential through investments or innovation [2].

[2]for a comprehensive review of the literature on finance and growth see Papaioannou, E. *Finance and Growth: a Macroeconomic assessment of the Evidence from a Europeand Angle*,

Moreover, credit constraints can also hinder new entrants, reducing the contendibility of the market (Aghion, Phally and Scarpetta, 2007).

The financial system not only provides the market with liquidity, but it also handles the task to allocate to the market the collected resources. The correct function of this process implies that the system provides more funds to the more productive units. This increases competition and, in principle, it should induce all firms to approach their efficiency frontier, rising aggregate productivity.

However, an efficient allocation of the resources is not straightforward, especially when the typical market failures, as asymmetric information and moral hazard that affect the financial markets, are particularly significant. Transparency is necessary on the market as it is the ability to evaluate and monitor firms by the financial system, a task which can be particularly hard in satisfying specific needs as financing innovation (Hall 2002).
Certainly in these instances the presence of public sector is necessary, though, in these cases, finance can be used as an instrument for stimulating innovation. Public sector can in fact provide funds to innovative firms, either directly or by facilitating the condition for financing R&D (for example through public guarantees).

This thesis analyses these different channels, looking not at financial development *per se*, but at the way in which firms approach it. In fact, the effects finance has on firms' performances are determined by the existing relationship between the real and the financial sector.

The first chapter is an application of the Rajan Zingales (1998) approach to the Italian case. They have proposed a test to be applied in verifying the effectiveness of the mechanisms through which finance affects growth. As outcome, the authors provide evidence that whenever an industry is more dependent on external finance, its growth is higher in

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more financially developed countries. Usually this approach has a cross-country application, as it is easier to proxy financial development at international levels. In this application a proxy for financial development at regional levels was built up using information coming from qualitative data. This proxy, generated by the principal component analysis, combines different information to summarize the level of financial development of different Italian regions. Clearly, it brings in a proxy for the quantity of credit provided to the market (firms not financially constrained). But it also includes an indicator of capitalization (firms listed or intending to go public) and information on the development of innovative financial instruments. The results point out that the Italian financial market is still segmented at regional levels, in particular for smaller firms that are more dependent on the proximity of financial service suppliers. Moreover, it suggests that the effect of financial development could be even higher considering a more realistic setting, for example assuming the need of external finance computed on German listed firms and not U.S. listed ones.

Chapter 2 focuses on the effectiveness of financial systems in allocating the resources to the most efficient firms in the market. In this work, after having shown some evidence confirming the weakness of competitive pressures, we investigate this issue looking at the distance from the efficient frontier (Acemoglu, Aghion and Zilibotti 2003) of a wide sample of Italian firms. Furthermore, I will assess the historical movement of this distance and try to give an interpretation of the role played by the financial system.
In principle, the selection activity of financial markets should, in fact, induce firms to work as closely as possible towards the efficiency frontier. However, this process works only if the relationship firms share with the financial sector is sufficiently strong in order to allow financial institutions to evaluate and monitor the business activity.
In this paper, we test whether firms' financial strategies explain their distance to the efficiency frontier. In principle, either a bank based system or a market based system can produce positive effects in terms of growth:

as some authors highlight, there is in fact no clear ranking in terms of efficiency between the two (Levine 1999). Through the above mentioned process of resource reallocation, finance can thus provide the right incentives to the corporate sector.
Hence, in this work both the relationship with banks or with capital markets are taken into account as variables driving firms' efficiency.
The results point out that a tighter relationship with banks or a higher contendibility of corporate control are correlated to a more efficient production. From a policy point of view, this suggests that the relationship of Italian firms with financial markets are still characterized by asymmetric information that do not facilitate the monitoring on performances. Increasing the transparency of firm activity and better enabling the selection role of financing activity, can be a way for fostering efficiency in the market, and through this, aggregate productivity.

The last Chapter focuses on the effects that different financial instruments have on R&D strategies and, hence, on productivity. In this case, finance is evaluated as a policy tool to increase firms competitiveness. In a period during which the policy aiming at promoting innovative activity are considered a priority, also at international levels, it is particularly important to understand how financial instruments impact R&D strategic choices.
The effect of different financing instruments on the innovative activity is, in fact, not straightforward. The nature and duration of different financial instruments could have an impact on firm innovation strategies. In the presence of financial barriers, the instruments become a driver for the firms' choices in terms of R&D.
The analysis has been carried on through a two step approach: first, the role of financial instruments on R&D choices is assessed, second, the different impact of these strategies on productivity is evaluated.
Once a firm has decided to invest in research, it has, indeed, to decide whether to produce internally or to outsource the research activity. In the second step, the effect of alternative strategies on productivity distribution is assessed, using quantile regression to evaluate the impact on

different percentiles.
All in all, the results suggest that different financial instruments have an impact on the firms' R&D choices and, as a consequence, on productivity. As seen, alternative instruments can provide incentives to different sectors. Being aware of this could be relevant for choosing policy tools for spurring innovation.

In conclusion, the overall work shows that a direct, transparent and stable relationship with financial market can be particularly helpful in increasing the productivity of the real economy. A well tailored relationship, could indeed help to remove barriers and constraints that could prevent the firms from operating with the best possible structure in terms of technology, size etc. On the other hand, if the financial market could at best play a monitoring role, it could allow a correct systemic allocation of resources (to their best possible uses). The typical financial system intermediary action favours the matching between available savings and financial needs. Moreover it could provide the right incentives to the firms in order to maximize performance and long term value. Finally, longer financial instruments allow firms to use the innovation strategy more suitable for both the idiosyncratic and the sectoral characteristics.

Chapter 1

The Italian Financial Development and the Regional Impact on Growth

1.1 Introduction

The role of financial development in spurring economic growth has been at the center of economic debate for many years. In particular, until the seminal contribution of Rajan and Zingales (1998, RZ henceforth), one of the key questions was the definition of the causality direction of the finance-growth nexus. RZ proposed a test to assess the effectiveness of the mechanism through which finance affects growth, and provided evidence that whenever an industry is more dependent on external finance (because of technological reasons), its growth increases disproportionatly when the financial system is more developed.

This finding has encouraged many researchers to use micro data in evaluating the impact of financial development on aggregate growth.

Studies on this topic are typically based on cross country data. Financial markets are, in fact, becoming more and more integrated at international level, increasing the interest in understanding the effect of this process on different economies. The adoption of unified international rules

can, in fact, contribute not only to making the internationalization process easier, but also to raising growth in less financially developed countries, therefore, promoting at large international convergence.

However, even in markets that are rapidly becoming global, local financial development still matters, as Guiso Sapienza and Zingales (2004) clearly show in a study focusing on the Italian market. In Italy, in particular, local development seems to play a relevant role since firms are smaller on average and depend on the proximity of financial institution for satisfying their financing needs. During the last years, the differences among Italian regions have gradually increased, at least in terms of economic growth. The aim of the paper is to understand how much of this gap is to attribute to different levels of local financial development, and whether the process of concentration in the banking industry during the 90's has spurred financial development within regions.

To this end, I first applied the RZ methodology to a sample of firms located in all Italian regions. In particular, I tested whether firms operating in financially developed regions are causally related with higher growth rates in the sectors more dependent on external finance. The proxy for regional financial development has been built up using survey data from the UniCredit database (ex MedioCredito Centrale): this allows us to consider not only the quantity of credit on the market, but also other aspects such as the use of innovative financial instruments or the role of capital markets.

I used a model well fitting the effect of financial development on firms growth also to test whether the process of concentration that took place in banking industry during the nineties has improved the financial integration and development of Italian regions and has positively affected economic growth. Then, I removed the RZ hypothesis that U.S. listed firms financial dependence represent well the need of external finance of different industries across countries. The characteristics of Italian firms are, in fact, significantly different from those of U.S. firms, in terms of adopted technology as well as average firms' size. The structural differences between the two economies can affect the financial dependence of Italian

industries. Using a variable for external dependence that better approximates the financing needs of Italian firms - in particular the external needs of German firms- may better capture the role of financial development in spurring economic growth. Finally, following Guiso Jappelli Padula and Pagano, I quantified the effects of an increase in the financial development on the different Italian regions and on the different industries, to understand the policy implications that the analysis provides.

The paper is structured as follows: Section 2 briefly reviews part of the literature related to the finance and growth nexus; Section 3 describes the Italian financial system and its origins, in the light of the policy effects on regional financial development; Section 4 finally describes the empirical results of the analysis.

1.2 Review of the Literature

There is a long debate in the economic literature on how financial development affects economic growth: from Shumpeter onwards (1911), in fact, many economists concentrated their attention on this topic. In this section I will survey some relevant contributions.

As suggested by Goldsmith (1969), the main difficulty in the analysis of the finance-growth links is to assess the causality direction. The difficulty is to establish whether financial development spurs economic growth, or, vice versa, economic growth gives an impulse to financial institution, which have to adequate their supply to the demand of financial services.

All in all, the empirical evidence suggests that finance can contribute positively to economic growth.

There are many empirical works, analyzing the finance-growth nexus at country-level, industry-level and firm-level, using different econometric techniques to control for the possible feedback effect indicated by Goldsmith.

One of the first papers that tried to consider the endogeneity problem is written by King and Levine (1993a). They studied whether financial de-

velopment has a significant impact on economic growth using data from 80 countries over the period from 1960 to 1989.
They obtained two sets of findings. Firstly, financial development is strongly and robustly correlated with growth, even using different measurement of financial development; secondly, financial system development stimulates growth not just by increasing the physical capital accumulation, but also improving the efficiency in credit allocation.
To overcome the reverse causality problem they used data for financial development taken at the beginning of the period of analysis to explain the subsequent growth and the sources of it. However, this technique does not solve the endogeneity problem completely. In fact both variables can be driven by omitted factors. For example, we can think about the household's propensity to save: if this is high, then it affects both the long run growth and the financial development, becoming the a driver for both the variables.
Moreover it is not completely convincing that temporal precedence necessarily implies causality: in fact, it could also be that financial markets are simply anticipating economic growth.

Also Levine and Zervos (1998) studied the topics analyzing a cross section of countries. They empirically investigated the relationship between stock market liquidity, size, volatility, and integration with world capital markets and current and future growth, capital accumulation and productivity. Their paper extends the King and Levine analysis of banking and growth to include measures of the financial market functioning. The idea is to find out whether with growth there is a correlation between both banking and stock market indicators: this implies that banks and stock markets have an independent empirical connection with contemporaneous and long run economic growth.

However, even this work cannot avoid the possible criticism made to the King and Levine analysis. In the cross country based analysis, the key point is to find instruments that can be considered completely exogenous: Beck et al. (2000), following La Porta et al. (1998), use the legal origin of the financial system to find out the relationship with the eco-

nomic growth. Again they find that the size of the financial system is positively and robustly correlated with economic growth.

Another approach was instead conducted by Jayaratne and Strahan (1996); to avoid the omitted variable problem they considered a situation in which an institutional reform changes the financial market structure keeping everything else constant.
Thus they studied the intrastate branch banking reform that took place in the United States between 1972 and 1991. They found that this was a big improvement in the efficiency of the banking system because less efficient banks were removed in favor of larger organizations. This led to a reduction of costs associated with a better monitoring of loans.
Once more, their methodology does not avoid the causality problem; however, the authors argued that in case growth causes financial development, a large increase in the loan lending after the deregulation should have occurred. But this was not the case. Thus it turns out that the quality of the loans increased after deregulation, not the quantity and it suggests that the economic growth followed the intrastate branch reform and not vice versa.

A part of the most recent literature, however, has focused attention not on the country-level, rather on the industry-level or firm-level data to understand the impact and the channels through which financial markets development spurs economic growth.
One of the most relevant papers in this literature is written by RZ (1998): they analyzed the differential effects of various measures of financial development on economic growth from different sectors.
Moreover, they argued that a more financially developed system helps to avoid the problem of asymmetric information and adverse selection reducing the firm's costs to raise funds. So, in principle, industries that are more dependent on external financing should grow more in financially developed countries.
This kind of methodology has two big advantages:

- It looks at the mechanism through which financial markets affect the industry growth, and this prevents any question about causality;

- It controls the countries fixed effects and, as in Jayarathne Strahan, avoids the problem of possible omitted variables.

The test is constructed as follows. First of all, assuming that the United States market is the one characterized by the smallest number of frictions, a measure for the need of U.S. firms external finance is created.
Then, assuming the existence of technological reasons - common to every country - such that some industries depend more on external finance than others, the authors examine whether in more financially developed countries these industries develop more rapidly.
One possible problem with this methodology is that financial development can affect the industrial specialization of the country, creating a bias in estimating the rate of growth of an industry in which the country is specialized.

The inclusion of the industry share of value added at the beginning of period can be sufficient in accounting for this bias. Guiso, Iappelli, Padula and Pagano (2004), for example, use this corrected methodology to estimate the European growth dividend generated by financial integration at an industry-level and a firm-level data. Overall the results confirm the previous researches indicating that financial development is positive and significant correlated with growth differentials. Moreover the authors try to evaluate the benefits reached by the countries simulating two possible future scenarios that differ depending on the level of financial integration achieved.
The results indicate that financial integration will have a positive effect on countries and sector's growth, but the magnitude of this effect will not be equal for every country.

However, even if in the last decades this pace of integration has been very fast, a work by Guiso, Sapienza and Zingales (2004, from now GSZ) suggests that local financial development still matters for growth. While in Guiso, Iappelli, Padula and Pagano (2004) the key point is to evaluate the differential in terms of growth, generated by an increase in the integration process inside the European Union, GSZ (2004) shows that also the EU's national financial development will matter in the foreseeable future.

To understand the relevance of national financial institution GSZ (2004) concentrates the analysis on regions inside a single country, Italy, which has been unified from both a regulatory and a political point of view for the last 140 years. Since the level of integration reached in this country can be considered an upper bound, it is interesting to verify whether, in Italy, there is relevance of financial development for regional growth or not. To test the proposition, the authors constructed an indicator for local financial development and they found it has a strong effect on growth. To deal with endogeneity of financial development, they instrumented this indicator with variables that described the regional characteristics of the banking system as of 1936. All the evidence suggests that local financial development plays an important role in determining the growth of Italian regions.

1.3 Italian Banking System

As suggested in Guiso, Sapienza, Zingales (2004), the Italian market has many peculiarities and it is interesting to extend the finance-growth nexus analysis to this country. This section describes the legal evolution of the Italian financial system and its main characteristics.

1.3.1 Historical Evolution

From an historical point of view there have been four phases in the evolution of the Italian banking system from the unification of Italy (1861) onward:

- 1860-1926, from the unification to the first general banking law;
- 1926-1936 from the first to the second general banking law
- 1936-1985 no structural changes affected the banking system until the communitarian directive 350/1985, which imposed a reform over the sector
- From 1985 a renovation of the entire financial system has taken place, due to the transposition of the Communitarian directive in

the Italian juridical system that started the liberalization up of the entire financial system.

Below the principles introduced in this last period with respect to the previous ones are described.

The second general law was introduced to protect the financial system from the possible instabilities and market failures. Therefore banks were not considered as productive firms, but as institutions which had to be controlled by political authorities who would be able to prevent an economical crisis[1]. This implied an extremely high level of political intervention in this field of the economy.

The institution demanded to control the sector was, in fact, the CICR (*Comitato Interministeriale per il Credito e il Risparmio*), a special committee formed by economic ministries and the Bank of Italy governor. This institution had to decide on the entry of new firms in the market and to verify their organizational structure as well as their dimensions in the country. During the 1940s these tasks were definitively given to the Bank of Italy. Anyway the authority maintained the political role and so the market had the characteristics of an oligopoly in which competition just had a marginal importance, while the political power had a really strong influence.

Moreover the market was limited due to the high level of specialization of the banks:

1. Short term and long term loans could not be provided by the same bank, and these two types of operations were regulated by different laws;

2. There were territorial limitation due to the very rigid rules for opening new branches; moreover just a few categories of banks could operate at country level. In particular, national banks could open branches only in the main cities, cooperative banks only within the province and saving banks within the region in which they operated (Guiso Sapienza Zingales, 2004);

[1]See Costi (2001)

3. Some banks were specialized in providing credit just for one particular industrial sector. For example the Casse Rurali and Casse dell'Artigianato were supposed to finance the agricultural and the artesian sectors;

During the 1980s new financial instruments were developed and the European directive introduced an higher level of competition due to the mutual recognition of the bank licenses regulated by the European Community. For the first time the d.l. no 350, 27 June 1985 applied the directive in the Italian legal system and it has been be definitively implemented in the *Testo Unico dell'intermediazione Finanziaria* (T.U.F.) introduced in 1993.

One of the fundamental principles is the mutual acknowledgment, stating that any communitarian bank can establish a branch in Italy, granted that they continue to remain under the supervision of their original authority.
Since this implies an higher level of competition in the sector, the state had to deregulate the financial system to permit Italian banks to compete at an international level.

First of all, the T.U.F. eliminated the political aims of the regulatory institution and their possible discretionary applications of the law. The institutions have to adequate their activity to the decisions taken at EU level. This permits an instantaneous application of the communitarian regulation in the Italian system.

Moreover, the T.U.F. deregulated the sector by eliminating the specialization of bank activities and introducing the liberalization of the branch location.
In fact, from that moment onward there was no longer distinction between long and short credit and the banks could enlarge their business.
Furthermore, with the second banking law, rigid limits were imposed to the opening of new branches and extending credit. While with the introduction of 1985's law, the authorization became granted unless explicitly denied, so the number of branches on the territories could grow by 79 percent in ten years.

1.3.2 Effects of Law Evolution on Financial Efficiency

The changes with financial laws during the last century have affected the development of financial systems for the entire country.
The banking structure of 1936 was the result of the policy applied after the economical crisis of 1930 -1931, so it was not determined by market forces. As we have already seen, the 1936 law introduced the task for Bank of Italy to permit banks to enter the market. However, the bank of Italy used this authority to evaluate the market stability rather than market efficiency.
Therefore the number of branches for inhabitants was not due to the actual necessity of the area, but to the political decision of the central bank [2].

In summary, the financial system regulation that was introduced in 1936 stopped the natural evolution of the system preventing the progression with the banking market structure. This implied that regions in which there was a higher presence of bank branches, grew more than others [3].

Moreover Guiso Sapienza and Zingales (2004) showed that not only the quantities, but also the typology of banks implied different level of growth: regions in which local banks were operating tended to grow less than region with an higher diffusion of national banks.

In particular the second general law favored more saving banks than the others, and this determined that this typology could extend more of its business. This also determined the level of financial development and the growth in the provinces in which the banks operated.
Furthermore, this effect had a long-term ramification: in more financially developed regions in 1936, the cost of credit in 1985 was lower than in other regions[4].

[2] It is easy to show that this number was not correlated with the economic development, as shown in Guiso, Sapienza and Zingales, 2004.

[3] In fact if we look at the banking structure in 1985 we notice that it was determined by that of 1936. For example, the number of branches per inhabitants in 1985 were correlated with that of 1936 (Guiso, Sapienza and Zingales, 2004).

[4] The results are confirmed if we consider the availability of the credit: consistently with what we just argued more loans were provided in more financially developed regions, cre-

Hence the different local specialization of financial institutions determined a different level of regional growth; in particular, the Southern area was penalized by its financial structure [5]. Moreover the market segmentation has remained a characteristic of the Italian market. In fact, local financial development still matters in determining the level of growth. In particular, Guiso Sapienza, Zingales (2004) showed that local financial development not only has affected a firm's creation, but also the firm's growth. Hence, even after 140 years from the Italian unification local financial development matters, determining the regional differentials in terms of growth.

1.4 A Look at Regional Growth and Current Financial Trends

Regional data, either aggregate or at firm level, confirm that within Italian regions market differences are still present. The Southern regions, which were converging to the Northern growth results, are, from 2002 onward, again widening the distance with respect to the most productive regions. After a particularly favorable 2001 (during which the Mezzogiorno growth was 2.3% versus a 1.8% national growth), in the following four years the annual growth in the South of Italy was 0.3% versus 0.6% in the North and a 1.2% in the Centre. Data for 2006 confirm this trend, and recently updated data relative to 2007 show an even increasing gap, with a growth rate of 0.7% in the South and a growth rate of 1.5% for Italy. This process reflects an increasing lack of competitiveness also at firm levels. Firms profitability, in fact, has been reducing: from the balance sheet data of a sample composed by around 5000 firms[6] it shows that from 2002 Return on Equity in the South and the Islands was around 7.7% against 9.4% in the Center, 16.3% in the North East and 13% in the North West. Furthermore in the South this index has been decreasing quite rapidly.

Structural balance sheet indicators suggest that, on average, southern firms financial structure is weaker than in other areas. Even if leverage is

ating relevant differences within the country. See Guiso, Sapienza, Zingales (2004)

[5] As Guiso Sapienza and Zingales (2004) argue 'the entire gap of Southern Italy can be

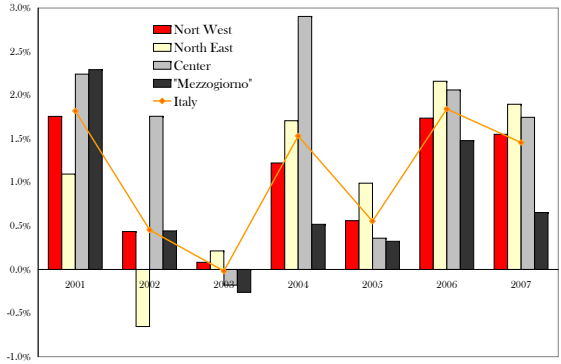

Figure 1: GDP growth rate by area

more balanced, it does not seem to indicate an explicit firms' choice: other financial indices, in fact, reveal a unbalanced structure. Banking debt in this area is particularly unbalanced, i.e. most of the debt is short term. Between 2004 and 2007, for example, in the South short term banking debt was 71.4% of banking debt versus a 65.8% of Italy. The relationship with banking systems seems, hence, not to be a long term process, in which long term business projects are evaluated for determining the financing needs of firms. On the contrary, trade debt, in the South, is particularly high, indicating that a use of the intra-firms relationship is more similar to a financing source: trade debt increased in the South from 35.6% of total debt in 2003 to 47.6% in 2007. This suggests that financing needs are satisfied in this area using alternatives to financial systems. Effectively, even if the growth rate of funding is higher in the South of Italy (between 2004 and 2007 the non financial corporation loans have been 12% versus

explained by the effects of banking restriction imposed in 1936'.

[6]This sample reflects the universe of Italian firms. The herein described balance sheet indices are calculated on Aida database.

a total of 8.6%), the total quantity still remains well below other areas in the country. These evidences suggest that some differences still remain at regional level and affect growth rate in the areas. Part of this differential can be explained by the development of Italian financial system, and by its recent evolution.
How much this impacts the increasing divergence is one of the question this paper intends to answer.

1.5 Estimating within Country Effects of Financial Development

The purpose of this work is to analyze the relationship between Italian financial systems and economic growth, as well as responding to various questions. Are growth differentials due - at least partly - to the financial development equal between regions, or does a market segmentation still exist, implying differences in regional growth rates?
What part of the gap between North and South can be attributed to the structural characteristics of the regional financial system?
And finally, has the concentration process during the 1990s induced any change within the country's financial development? The Rajan Zingales methodology is used to test whether regional financial development is statistically significant for explaining growth differentials between regions.

1.5.1 The Rajan and Zingales Method

The Rajan and Zingales methodology intends to find a test which quantifies the effect of financial development on growth, while examining the mechanism through which this can be affected.
In particular they test whether industries that are more dependent on external financing grow more rapidly in more financially developed countries. To test the hypothesis the following regression is run:

$$y_{i,c} = \beta_0 + \beta_1 X_i + \beta_2 X_c + \beta_3 D_i F_c + \beta_4 Share + \epsilon_{i,c} \tag{1.1}$$

The endogenous variable $y_{i,c}$ is the value added in industry j in country i in the period from 1980 to 1990.
The explanatory variables are:

- X_i represents the industry's dummies;
- X_c represents the country's dummies;
- D_i is a variable indicating the industry's need for external finance; it is multiplied by F_c which represents the country's level of financial development;
- Finally, a term which indicates the industry's share of manufacturing of industry i in 1980 is added;

The critical term in the regression is β_3; if it is positive and statistically significant this means that in countries with a more financially developed system, the sectors more dependent on external finance, that are typically more innovative, show a positive differential in productivity growth.
The basic assumption of this approach is that financial dependence is determined by technical reasons, that are equal across countries. The technological frontier, hence, is determined at international levels.

The proxy for the need of external finance is then calculated for the US capital market, considering it the more frictionless, and therefore not affected by financial constraints. The computation is done on Standard and Poor's compustat data on 1980s: industries' need for external finance is calculated as the median of capital expenditure minus cash flows from operations over capital expenditure. This variable is thus considered the best proxy for financial development, and it represents the financial needs for each industry in order to embody the activity of all available technology.

The RZ approach, has numerous advantages:

- It eliminates the causality feedback problem, because it takes into consideration the mechanism through which finance development

can affect growth. In fact, if financial markets only anticipate future growth, the coefficient β_4 would not be statistically different to zero.

- It avoids the possibility of omitted variables bias or model specification, because the country or industry variables that could affect both growth and financial development are considered in the fixed effect
- The industry's share at the beginning of the period avoids the effects of the causality relationship between financial development and countries' sectoral specialization

1.5.2 How to apply Rajan and Zingales Methodology to the Italian Case: Building up a Proxy for Financial Development

Generating a proxy for financial development is one of the main open problems in applying the Rajan and Zingales method in a within country analysis.
Building up a variable for financial development at national level is, in fact, not straightforward. Many structural indicators used in international analysis, such as market capitalization, do not exist at regional levels.
One possible proxy can be represented by the number of bank branches per inhabitants in each region. In Jarathne and Strahan (1996) analysis this variable represents the availability of credit in different regions, since numerous States relaxed restriction on intrastate branching between 1970 and 1991, generating a structural break in the financial market development.
However, they use this variable to assess the effect of a regulatory change that produced an increase in the number of banks branches, but the indicator per sé does not have clear cut impact. An high number of bank branches not necessarily, in fact, reflects a more efficient financial system.

Moreover, financial development should consider more aspects than exclusively the quantity of liquidity banking systems provide. In this

analysis we also want to include in the financial development proxy the role of alternative funding.
An indicator was generated using the UniCredit survey on Italian Manufacturing industries, from the information collected in a section entirely dedicated to the relationships between firms and financial systems. The survey, that every three years involves around 5000 firms representative of the universe of Manufacturing Italian firms, collects information on the entire corporate activity.

Five questions, contained in section F (finance), seem particularly useful in identifying a variable, representing the financial development for each region:

1. Did the firm need more credit during the last three years?
2. Did the firm use innovative financial instruments during the last three years?
3. Would the firm use financial instruments in the near future?
4. Is the firm listed?
5. Will the firm be listed in the near future?

These questions provide information not only on the level of financial constraints in each region, but also on their use of innovative financial instruments (such as private equity and venture capital) as well as their openness in terms of social capital. While the first question is a proxy representing at large the quantity of banking loans in the market, the other four questions gather information on the diffusion of other funding instruments. The variable representing regional financial development collects all these information, exploiting many aspects of financial services useful in enhancing their business.

The method used in generating this proxy is the Principal Component Analysis, that helps in identifying common patterns in multiple variables, using a procedure which reduces the dimensionality of the dataset. Principal components are obtained by projecting the multivariate data matrix on the space spanned by the eigenvectors of the covariance matrix.

Within these, the eigenvector with the highest eigenvalue explains most of the variability in the dataset. The first component is then extracted to generate an indicator keeping into account different characteristics of firms behavior of our sample, that explains the development of financial institution for each area.

Let X_t be the matrix containing the data: each line refers to one region and each column refers to one specific variable. The entries are composed by the percentage of positive responses over the total number interviewed, except for the first question that was included as proportion of negative responses over the total. Define $\Gamma = cov(X_t)$, λ_i the i-th eigenvalue (in descending order) of Γ and V_i the corresponding eigenvector. Principal components were computed as:

$$PC(X_t) = X_t * V_1.$$

The result is a variable that seems to well represent differences between geographical areas. To evaluate its representativeness, it is compared with other variables which can partly proxy the Italian financial system. Finally, the simple average of the variables used in the financial development construction is shown as a benchmark case.
Looking at Table 1, the first variable is the one considered in Guiso Sapienza and Zingales (2004), generated using the Survey on Households Income and Wealth (Bank of Italy SHIW), the second is the total non financial corporation loan over GDP by region: the pairwise correlation coefficient is in both cases high and significant. The correlation with GSZ variable is 0.644 and is significant at 1%, while the correlation with loans over regional GDP, is at 74.6%, and is again significant at 1%.
The first variable used in generating our proxy is, effectively, strictly related with the other two, since it represents the number of firms in each region which are not financially constrained[7]. Hence it can easily be assimilated to the total supply of credit in the area, and also, to the financial constraints of the household sector, as in Guiso Sapienza and Zingales (2004). However, the variable used herein has the advantage of being

[7]The principal component analysis moreover, suggest that the presence of financial constraints is the variable that explains most part of the total variance.

Regions	Principal Component	Simple Average	Guiso et al. (2004)	Loans /GDP
Abruzzo	0.791	0.192	0.359	186.2
Basilicata	0.608	0.138	0.347	133.74
Calabria	0.592	0.161	0	72.796
Campania	0.664	0.220	0.027	146.49
Emilia Romagna	0.884	0.213	0.523	335.48
Friuli	0.818	0.215	0.41	244.54
Lazio	0.777	0.198	0.067	375
Liguria	0.723	0.217	0.586	184.34
Lombardia	0.844	0.214	0.435	399.18
Marche	0.869	0.215	0.587	210.15
Molise	0.691	0.189	0.248	186.2
Piemonte e Valle d'Aosta	0.821	0.221	0.472	260.03
Puglia	0.759	0.200	0.165	133.74
Sardegna	0.687	0.194	0.374	154.61
Sicilia	0.605	0.204	0.214	118.31
Toscana	0.838	0.218	0.36	241.43
Trentino	0.839	0.259	0.457	217.03
Umbria	0.768	0.215	0.398	213.39
Veneto	0.858	0.209	0.516	278.6
Average	*0.760*	*0.205*	*0.344*	*215.33*
Variance	*0.0942*	*0.0248*	*0.1793*	*86.45*
Pwcorr	*1*	*0.644***	*0.638***	*0.746***

Table 1: Comparison among different financial development proxies

Notes: ** indicate that the pairwise correlation coefficient is statistically significant at 1% level.

complemented by the other information in the survey, limiting the effects of the cyclical financial trends and accounting for aspects of financial development other than simply banking system lending.

As expected, the least developed area is the South and the Islands (usually known as Mezzogiorno), while the Central and Northern parts display an higher level of financial development. Moreover, it is interesting to point out that Southern regions are less homogeneous in terms of financial development than other areas, probably because this area is composed of heterogeneous regions with more pronounced differences

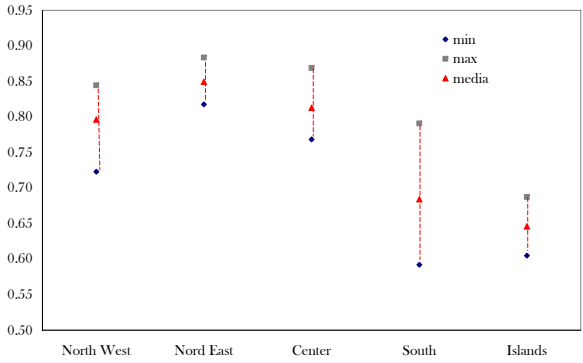

Figure 2: Financial development in different areas

than other areas.

1.5.3 The Dataset: a manufacturing sample

This work investigates the productivity growth of the Italian manufacturing sector. The analysis is performed at a firm level, using individual balance sheet data provided by Bureau Van Dijck, which has been gathering information on firms' balance sheets since 1998. To avoid possible problems relative to groups, the balance sheet are unconsolidated, and firms belonging to groups are hence considered as individual units [8]. The database used in the further analysis includes 10,877 firms, observed every year from 1998 to 2006. It is the result of a data cleaning process aimed at keeping only those firms containing both the value added and the num-

[8]This seems to be relevant in order to have a correct sectoral based analysis. In fact, it could be difficult to attribute a group to a specific sectors, as it can be composed by different firms.

ber of employees [9], which are strictly needed to calculate productivity. This sample, including firms reporting results on the entire period, allows to calculate each firms' productivity growth during the period with the same interval. In this way we avoid outliers generated by different initial observations. Moreover, it is also useful to check the results using instead of compounded annual growth rate, also average annual growth. This should in principle guarantee, that the analysis is not influenced by cyclical effects due to the chosen starting point of the interval.

Firm labour productivity is measured as firm's deflated [10] value added divided by its number of employees. From this variable the compounded annual growth rate is calculated. Since the analysis is performed at sectoral as well as individual levels (at least for the more general robustness test result), the compounded annual growth rate is then aggregated as the median of compounded annual growth rate on each sector in each region.

1.6 Results

The first question to address is whether the Italian financial market is still segmented in recent years.
As already stated the Rajan and Zingales methodology was applied within Italian regions, using the financial development variable calculated from the information from Capitalia Database.
In order to avoid the risk of endogeneity, regional financial development was estimated on the three year period 1995-1997, immediately before the period of this analysis.

As Table 2 clearly shows the results at sectoral level confirm the hypothesis that there still exist a role for financial development in explaining the regional growth differentials during the period considered. The interaction term between regional financial development and need of external finance, computed by Rajan and Zingales on U.S. listed firms, is in fact

[9] Value added and employees are taken only when positive, assuming that negative values are effect of data entry errors.

[10] Nominal value-added weightings from the Groeningen Growth and Development Center 60-industry database are used to calculate the average industry figures.

	I	II
Share of Value Added	-.065*	-.063*
	(0.022)	(0.027)
Need of external finance USA * Regional financial development (Principal Component)	0.030**	
	(0.008)	
Need of external finance USA * Regional financial development (Guiso Sapienza and Zingales)		0.043*
		(0.025)
Constant	-0.015	-.013
	(0.111)	(0.140)
Obs		
R^2	0.224	0.221

Table 2: Effect of financial development on Productivity growth at sectoral level

Notes: The dependent variable is compounded annual growth rate in each firm of the sample during 1998-2006, all regression include sectoral and regional dummies.
* indicate that the coefficient is statistically significant at the 5% level, while **that the coefficient is statistically significant at the 1% level.

positive and significantly (P-value of 0.01) related to the compounded added growth value. The share of value added at the beginning of the period is negative and significantly different from zero, as expected. Relaxing financial constraints, industries with less market share at the beginning of period have the chance to grow faster than firms with a larger share at the beginning of period. As said, regional and sectoral dummies have been considered, to account for omitted variables common to part of the observations. Most of them, even if not included in the table, are significantly different to zero. The results are confirmed also using different proxies for financial development. Comparing the results with those obtained using Guiso Sapienza and Zingales financial development we obtain pretty similar results.

The R-square is in both cases not particularly high, but it is in line with previous similar research.

The robustness check estimating productivity at firm level data (see Table 3) confirms that financial development is determinant also on individual productivity growth, affecting the differential in the results of

	All firms	Constant	Obs.	R^2
Need of external finance USA *				
Regional financial development	.017**	0.0008	10877	0.0225
(Principal component covariance)	(0.000)	(0.876)		
Need of external finance USA *				
Regional financial development	0.025**	0.0016	10877	0.0221
(Guiso Sapienza and Zingales)	(0.001)	(0.768)		

Table 3: Finance and growth using individual firms data

Notes: The dependent variable is compounded annual growth rate in each firm of the sample during 1998-2006, all regression include sectoral and regional dummies.
* indicate that the coefficient is statistically significant at the 5% level, while **that the coefficient is statistically significant at the 1% level.

firms belonging to different sectors and regions. However, in this case, the coefficient associated to the interaction term is lower than before and R square is very low, because the idiosyncratic component is more relevant in explaining individual performance.

Small versus Medium and Large firms. Moreover, as expected, the relationship is not significant for at least part of the sample: dividing the sample in small and medium large firms[11]. The evidence indicates that only the first group productivity growth is affected by geographical supply of financial services. The medium and larger firms, which are in Italy a minority with respect to the number of Italian firms, are not dependent on the financial development of the area. The coefficient of the interaction term is neither significant with our proxy for financial development nor for the GSZ one.
This result is in line with previous literature, confirming that size matters in looking for the best financial condition. A larger structure, in fact, allows for a more accurate research of the financial services, even if the supplier operates in more distant geographical areas.

[11]The segmentation considers the beginning of period number of employees and divide the sample in small firms whenever they have less than 50 employees, and medium-large firms, when they have at least 50 employees.

Small firms (< 50 employees) (less than 50 employees)	**I**	**II**
Share of Value Added of small firms	.018 (0.622)	.019 (0.621)
Need of external finance USA * Regional financial development (Principal Component)	.029** (0.008)	
Need of external finance USA * Regional financial development (Guiso Sapienza and Zingales)		.035 (0.062)
Constant	-0.011 (0.265)	-.010 (0.323)
R^2	0.2169	0.2096

Table 4: Small firms productivity effects.

Medium-Large firms (> 50 employees)	**I**	**II**
Share of Value Added of medium and large firms	-.0743** (0.014)	-.0715** (0.018)
Need of external finance USA * Regional financial development (Principal Component)	0.011 (0.226)	
Need of external finance USA * Regional financial development (Guiso Sapienza and Zingales)		0.015 (0.520)
Constant	.0024 (0.843)	0.003 (0.765)
R^2	0.165	0.162

Table 5: Medium and Large firms productivity effect.

Notes: The dependent variable is compounded annual growth rate in each firm of the sample during 1998-2006, all regression include sectoral and regional dummies.
* indicate that the coefficient is statistically significant at the 5% level, while **that the coefficient is statistically significant at the 1% level.

The regression results in Table 4 indicate that financial development, interacted with need for external finance, impacts on the productivity of small firms (less than 50 employees): the coefficient is, in fact, positive and significant. Vice versa, the share of value added is not significant since small firms belong in the same extent to different sectors. The share of value added in this case, is more concentrated in the lower part of the distribution, and the results suggest that there is still room for growth in most sectors.
Hence the relative dimension of sectors is not significant. On the contrary, the share of industries value added for larger firms is more dispersed (see Table 5): medium and large firms can generate bigger industries, reducing their potential growth. In this case the variable is, in fact, significant and negatively correlated to growth. Those industries that have a larger share of value added grow less than those smaller at the beginning of period.

Analysis on different subperiods. The previous analysis suggests that during the period from 1998 to 2006 regional financial development played a significant role in explaining the differential in terms of productivity growth among industries operating in different regions of the country.
However, we can imagine that the evolution of financial systems produced effects still not evident in the first part of the period analyzed. The concentration of the industry, for example, is a process that needs a relatively long period to be completely accomplished. To account for this possibility, the exercise above is repeated over two subperiods: 1998-2002 and 2002-2006. Surprisingly, the results suggests that the importance of geographical supply of credit has increased during the period of analysis.

The first equation, shown in table 6 indicates that during 1998-2002, neither the industry share of value added nor the interaction term between the need for external finance and financial development are significant in explaining differential results in terms of productivity growth among industries operating in different regions. This is confirmed using both the principal component variable and the variable calculated by Guiso Sapienza and Zingales (2004).

1998-2002	I	II
Share of Value Added in 98	-.0736	-.0751
	(0.166)	(0.157)
Need of external finance USA *		
Regional financial development	.004	
(Principal Component)	(0.833)	
Need of external finance USA *		
Regional financial development		.026
(Guiso Sapienza and Zingales)		(0.460)
Constant	.0175	.017
	(0.350)	(0.367)
Obs	472	472
R^2	0.2113	0.212

Table 6: Subperiod 1998 2002

Notes: The dependent variable is compounded annual growth rate in each firm of the sample during 1998-2002, all regression include sectoral and regional dummies.

The results in the second subperiod, shown in table 7 on the contrary, indicate that during 2002-2004 the regional financial market was an important factor in explaining productivity growth: market segmentation has, hence, increased from the previous period of analysis. The interaction term is now significant and the coefficient associated to this term is hence higher than the value on the overall period. This is confirmed both using the variable generated through principal component and the one generated by Guiso Sapienza and Zingales.
Moreover in this case, the hypothesis is tested also on the variable generated by principal component method, through the UniCredit survey over the period 1998-2001. This should, in principle, capture the recent changes in the regional financial markets that could have produced effects on productivity growth. The results are even more striking than the previous, as the coefficient of the interaction term is in this case higher than before, indicating that the recent evolution of the financial system has not increased the real integration of regional financial system.
The share of value added is, in this setting, not significant, but this can

2002-2006	I	II	III
Share of Value Added in 2001	-.059	-0.047	-.049
	(0.270)	(0.380)	(0.361)
Need of external finance USA *			
Regional financial development	.075**		
(Principal Component 97)	(0.000)		
Need of external finance USA *			
Regional financial development		0.23**	
(Principal Component 01)		(0.000)	
Need of external finance USA *			
Regional financial development			0.095**
(Guiso Sapienza and Zingales)			(0.010)
Constant	-.036	-.036	-.034
	(0.061)	(0.057)	(0.079)
Obs	474	474	474
R^2	0.21	0.22	0.20

Table 7: Subperiod 2002 2006

also be the effect of the sample characteristics. Being that firms operating along the whole period, we can suppose that they are increasing in size during the period considered. As seen before a larger size implies a larger share of value added not significant.

This evidence can be both the effect of the financial system recent evolution or a change in the technological innovation used that affects the industries' need of external finance. The hypothesis that the need of external finance is the same between different countries is, to some extent, questionable. This assumption is, in fact, based on the idea that financial dependence is determined by technological reasons, that in the long run are the same within different countries.
However, the Schumpeterian economic evolution assumes that innovation is a discontinuous process meaning that different countries can be at different stages of the technological evolution. This implies that industries' needs for external finance can be at international levels, depending on the country's technological stage.
Before concluding that the segmentation in the Italian financial markets has been increasing during the last years, we should avoid the possibility

of a change in the firms needs for external financing, implied by a diffusion of more innovative techniques.
It can be necessary to test if the role of financial development has changed due to the diffusion of more innovative techniques. This could imply that the financial supply is now less adequate to the financial needs of Italian firms.

Using German need for external finance. To test if the change in the impact on productivity growth is due to a change in the need of external finance of Italian firms, it is necessary to calculate a new financial dependence variable, that reflects more accurately the technology implied in the production process. This variable is, then, computed for German listed firms: Germany has, in fact, a productive structure pretty similar to that of Italy, in terms of size of firms, relationships with banking system and technologies adopted. All in all, we can consider this economy better approximating the economic development stage of Italian manufacturing industries.

As in RZ(1998), the variable is generated from the balance sheet of German listed manufacturing firms[12] as capital expenditure less self financing over capital expenditure. Self financing is calculated as cash flow from operation plus increases in inventories, and trade debt variation.

The results on the entire period are significant using our proxy for financial development: the Guiso Sapienza and Zingales variable is no longer significant. The interaction term using the principal component method in estimating regional financial development is, on the contrary, significant and its coefficient is now higher than before, suggesting that the importance of regional financial development is even more relevant if we consider a more realistic benchmark for an industry need for external financing.

However, again dividing in two subperiods the sample, the results are similar to what was suggested above. The interaction between the need

[12]The number of firms used to generate the variable are 119, and the financial dependence is generated following RZ(1998) and using Bloomberg information on balance sheet of German listed firms.

	I	II	III	IV
Share of Value Added	.011	.008	-0.48	0.54
	(0.694)	(0.407)	(0.382)	(0.175)
Need of external finance DE * Regional financial development (Principal Component)	0.205** (0.014)			
Need of external finance DE * Regional financial development (Guiso Sapienza and Zingales)		.033 (0.407)		
Need of external finance DE * Regional financial development 98 (1998-2002)			.260 (0.101)	
Need of external finance DE * Regional financial development 01 (2002-2006)				.257* (0.039)
Constant	-0.1	-.013		
	(0.009)	(0.140)		
Obs	282	282		
R^2	0.202	0.185		

Table 8: German need for external finance

Notes: The dependent variable is compounded annual growth rate in each firm of the sample during 1998-2006, all regression include sectoral and regional dummies.
(*) indicate that the coefficient is statistically significant at the .5 % level, while (**) that the coefficient is statistically significant at the 1% level

of external financing and financial development is significant only in the second period.
This exercise suggests that in the period in the analysis the changes in financial system have increased the distance among regions, negatively contributing to the convergence process at country level.

All in all, the use of the German need for external financing shows, firstly, that the USA industries financial dependence reduces the effect of financial development on growth, since it implies the use of technologies that are still different on the Italian market. Using another European industries financial development can at least partially correct this, since the techniques are similar within the European countries. Then, it confirms that the increase in market segmentation is not attributable to a change in the technology used in the production process.

1.7 Simulation Results

To assess the differential growth implied by a more homogeneous financial services supply, a simulation analysis, based on Guiso Jappelli Padula and Pagano (2001), is performed. The simulation results are obtained through the following formula:

$$\sum_i [\frac{x_{i,r}}{\sum_i x_{i,r}} * \widehat{\gamma} * D_i * (F_{ER} - F_r)] \tag{1.2}$$

Where F_{ER} is the financial development level for Emilia Romagna, which turned out to be the highest level in Italy. Here we are not assuming to increase the Italian financial development, but we consider an homogeneous financial developed system in all Italian regions. The results indicate that during the period 1998-2006 the annual growth differential that would be spurred by an increase of financial development at the highest Italian level (which is in the principal component variable Emilia Romagna and in the Guiso Sapienza Zingales variable Trentino Alto Adige) is between a minimum of 0.02% and a maximum of 0.27%, yearly. The South and the Islands show a yearly increase of respectively, 0.16% and 0.17%.

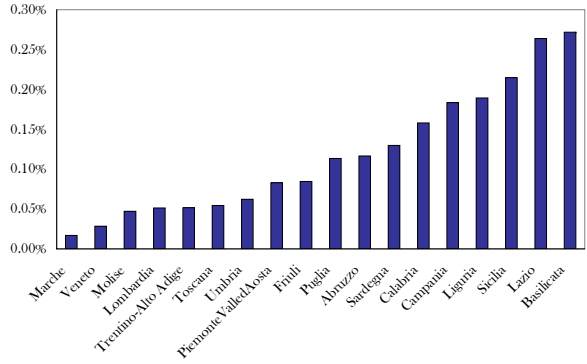

Figure 3: Regional Differential Growth

The contribution in reducing the gap is, hence, quite relevant, if we consider that the growth rate has been particularly low in the last years, as already described above.

It is interesting to notice that not only the less financially developed regions are those that would have the major benefits in increasing the diffusion of financial services, but also those more specialized in innovative industries. It is, for instance, the case of Lazio, which is one of the regions benefiting more from an eventual increase of financial development. This is due to the fact that the drugs industry, which is one of the more financially dependent, represents around the 25% of total value added of the region. An increase in the total amount of financing resources can generate a better condition for the production in this industry.

Another effect of differences in financial development is in the industrial specialization. Less financially developed regions are in fact, usually more specialized in sectors less dependent on external financing.
At an aggregate level this can produce an over specialization. One of the typical Italian characteristic is to be specialized in traditional sectors, less

Regione	principal component	GSZ variable
Abruzzo	0.12%	0.10%
Basilicata	0.27%	0.14%
Calabria	0.16%	0.06%
Campania	0.18%	0.04%
Emilia-Romagna	0.00%	0.06%
Friuli	0.08%	0.07%
Lazio	0.26%	0.18%
Liguria	0.19%	0.06%
Lombardia	0.05%	0.07%
Marche	0.02%	0.06%
Molise	0.05%	0.02%
Piemonte e Valle d'Aosta	0.08%	0.06%
Puglia	0.11%	0.06%
Sardegna	0.13%	0.05%
Sicilia	0.21%	0.05%
Toscana	0.05%	0.06%
Trentino-Alto Adige	0.05%	0.00%
Umbria	0.06%	0.03%
Veneto	0.03%	0.07%
North West	0.11%	0.06%
North East	0.05%	0.04%
Center	0.10%	0.08%
South	0.16%	0.07%
Islands	0.17%	0.05%
Total	0.11%	0.07%

Table 9: Simulation of regional productivity growth assuming an higher level of financial development

Notes: the financial development benchmark in the principal component variable is Emilia Romagna, while in the Guiso Sapienza Zingales estimate the most financially developed region is Trentino Alto Adige.

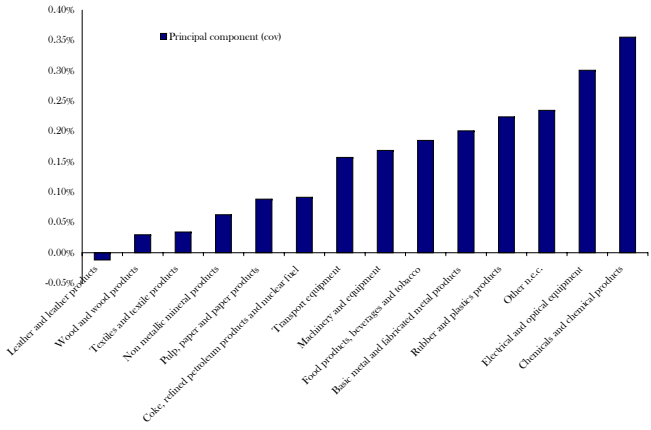

Figure 4: Sectoral Differential Growth

innovative and, hence, less productive[13]. How the financial development impacts sectoral productivity growth is valuable using the same simulation as above, to quantify at large the potential sectoral annual growth increasing financial development at the highest Italian level.

As before, it is possible to analyze what sectors would benefit more from a financial development increase. Again, as in Guiso et al. (2001), the effect is quantifiable through the following formula:

$$\sum_r [\frac{x_{i,r}}{\sum_r x_{i,r}} * \widehat{\gamma} * D_i * (F_{ER} - F_r)] \tag{1.3}$$

From the simulation it turns out that the differential is higher for those sectors characterized by high added value such as chemicals or electrical and optical equipments, which are typically very innovative. Thus,

[13]On the Italian specialization dynamic see Faini, R. and Sapir, A. *Un modello obsoleto? Crescita e specializzazione dell'economia Italiana*, in Oltre il declino, il Mulino,2005.

a more efficient relation between firms and financial institutions could overcome one of the most cited limits of Italian manufacturing sectors, i.e. the overspecialization in low skilled labor intensive (traditional) industries.

1.8 Conclusion

The aim of this paper was to describe the nexus between finance and growth within Italy. By using the Rajan and Zingales methodology and applying a new proxy for within the regions financial development, the analysis highlights that financial market is still segmented in Italy. The financial globalization process, in fact, does not rule out the specificity of different areas. Hence, even though the last financial crisis clearly showed that common rules and policies are needed, this analysis confirms the importance of local banking markets. Operating in different areas has a significant impact on firms productivity, as financial services differ from region to region. This is not exclusively a problem on the supply side, but also on the demand side. Firms are, in fact, not able to look for the best financial service. On the one hand, this is related to the size of the firms present on the Italian market, which are still too small.

As the evidence shows, not all firms are affected by local financial development; on the contrary for medium and large ones, local financial development does not determine their productivity growth. This is also an issue of financial literacy: the size is in fact determinant in terms of finding financial support, since it allows for a more complex structure entirely dedicated to this activity. But important is also the capacity of the firms to understand the best financial instrument for their needs. Increase in the competence in this direction is, certainly, an important task for firms in the near future.

On the other hand, financial institutions should provide a better supply to the markets. As the analysis in different sub-periods demonstrate, the process of concentration of the last ten years did not increase the inte-

gration in the market. On the contrary, while local financial development was not significant in explaining productivity growth in the period from 1998 to 2002, it becomes relevant in the following four years (2002-2004). In this respect, we also tested the hypothesis that Rajan and Zingales need for external finance (calculated on the USA market) can affect the analysis since it could reflect a different stage of the development, which Italian market reached later on: the relation become significant, because of a change in the firms financial needs.
With this aim, I took into account the same variable calculated for Germany. It is interesting to notice that the sub-period analysis confirms the results of the previous case, but with this specification it increases the effect on the productivity, suggesting that the specification of more realistic needs of external dependence, increase the role of financial development on growth.
All in all, it turns out from the analysis, that part of the diverging process from 2002 onward affected the Italian Economy is explained by the different local financial development of Italian regions. From the simulation exercise, in fact, we showed that, increasing financial development in the highest Italian level (in our case Emilia Romagna), the differential growth would vary from a minimum of 0.03% to a maximum of 0.28%, which is not irrelevant when compared to the effective productivity increase.
In exploiting all of the Italian market's potential, different territorial specificity should be taken into consideration, with the objective to generate an homogeneous market: the banking system could be part of this process.
The concentration of the banking system during the last years, even if it took beneficial effects on the general efficiency of the banking system, could have a role in explaining the increasing distance in local development. In fact, it reduced the presence of local banks (as banche popolari etc.), reducing the direct relationship with firms. Furthermore, the introduction of objective criteria and risk analysis in financing firms, which is important for stability and liquidity issues, can introduce a distance in the bank firm relationship if done at centralized levels.
This analysis, in my opinion, gives a hint to the relevance, in maintaining the direct contact with firms within banking system. This is important, as

seen, in exploiting local potential in terms of growth, through the financing of more innovative industries, renewing the productive sector and the specialization of the economy.

1.9 Appendix: Robustness Analysis

The robustness analysis is performed both on different methodology for proxying regional financial development and on productivity growth calculated as mean of annual growth rates.

Different Methods for Proxying Financial Development A possible alternative in extracting the principal component of the financial variables is to calculate the eigenvalue on the correlation matrix, instead of covariance. This different procedure normalizes all variables before extracting the common component and can be determinant when the distance within the considered variable is significant. A benchmark case is added here, which is the simple average of the 5 variables relevant for financial development. The results, however are always in line with the previous analysis, both using U.S. need for external financing and German need for external financing.

	I	**II**
Share of Value Added	-.063*	-.064*
	(0.026)	(0.024)
Need of external finance USA * Regional financial development (Principal Component correlation)	0.098** (0.008)	
Need of external finance USA * Regional financial development (Simple Average)		0.111** (0.007)
Constant	-0.012	-.014
	(0.169)	(0.128)
Obs		
R^2	0.224	0.221

Table 10: Alternatives methodologies in proxying financial development

Notes: The dependent variable is compounded annual growth rate in each firm of the sample during 1998-2006, all regression include sectoral and regional dummies* indicating that the coefficient is statistically significant at the 5% level, while **that the coefficient is statistically significant at the 1% level.

Small firms (less than 50 employes	**I**	**II**
Share of Value Added of small firms	-.020	.019
	(0.592)	(0.607)
Need of external finance USA* Regional financial develpment (Principal Component Correlation)	.11** (0.003)	
Need of external finance USA* Regional financial development (Simple Average)		.116** (0.004)
Constant	-.009	-.011
	(0.351)	(0.228)
Obs		
R^2	0.2208	0.2192
Medium and large firms (more than 50 employes)	**I**	**II**
Share of Value Added of m. l. firms	-.0735 **	-.0740**
	(0.015)	(0.015)
Need of external finance USA* Regional financial development (Principal component correlation	.054 (0.233)	
Need of external finance USA* Regional financial development (Simple Average)		.062 (0.215)
Constant	.003	.003
	(0.015)	(0.015)
Obs		
R^2	0.165	0.165

Notes: The dependent variable is compounded annual growth rate in each firm of the sample during 1998-2006, all regression include sectoral and regional dummies.
* indicates that the coefficient is statistically significant at the 5% level, while **that the coefficient is statistically significant at the 1% level.

Table 11: Small versus Medium and Large firms: alternative methodology for proxying financial development

	I	II
Share of Value Added in 98	-.053	-.0736
	(0.316)	(0.166)
Need of external finance USA *	0.025	
Regional financial development	(0.710)	
(Principal Component correlation)		
Need of external finance USA * Regional		0.019
financial development (Simple Average)		(0.797)
Constant	.0178	.0175
	(0.340)	(0.347)
Obs	472	472
R^2	0.2115	0.2114

Table 12: Subperiod 98 02: alternative methodology for proxying financial development

Notes: The dependent variable is compounded annual growth rate in each firm of the sample during 1998-2006, all regression include sectoral and regional dummies.
* indicates that the coefficient is statistically significant at the 5% level, while **that the coefficient is statistically significant at the 1% level.

Using as Dependent Variable Annual Growth Average In this robustness analysis I tested if the chosen temporal interval strongly affects the results of the analysis. I then used the annual growth rate and not the compounded annual growth rate. This means that I calculated the productivity growth rate in each year and then I took the average in the analysis. This avoid the possible problems coming from cyclical effects, and related to the fact that in calculating CAGR, we only take into account the initial and the end of the period value added, that can be sensitively affected by the chosen interval. The results of these new regressions confirmed what was said above. The less comforting signal is relative to the share of value added which doesn't remain significant in all specifications.

2002-2006	I	II	III
Share of value added in 2001	-.054	-.047	-.057
Need of external finance USA* Regional financial	.24**		
development (Principal component corr. 97)	(0.000)		
Need of external finance USA* Regional financial		.273**	
development (Principal Component corr. 01)		(0.000)	
Need of external finance USA* Regional financial			.281**
development (Simple Average 97)			(0.000)
Constant	-.030	-.037	-.034
	(0.109)	(0.055)	(0.067)
Obs	474	474	474
R^2	0.21	0.21	0.21

Table 13: Subperiod 02 06: alternative methodology for proxying financial development

	I	II
Share of Value Added in 98	-.005	-.005
	(0.014)	(0.838)
Need of external finance DE *	0.4*	
Regional financial development	(0.021)	
(Principal Component correlation)		
Need of external finance USA * Regional		1.32 **
financial development (Simple Average)		(0.000)
Constant	-.059	-.016
	(0.014)	(0.000)
Obs	282	282
R^2	0.200	0.225

Table 14: Germany's need for external financing: alternative methodology for proxying financial development

Notes: The dependent variable is compounded annual growth rate in each firm of the sample during 1998-2006, all regression include sectoral and regional dummies.
* indicate that the coefficient is statistically significant at the 5% level, while **that the coefficient is statistically significant at the 1% level.

Average annual growth rate	**I**	**II**	**III**	**IV**
Share of value added	.032	.034	-.064	-.035
	(0.219)	(0.207)	(0.026)	(0.185)
Need of external finance USA* Regional financial development (Principal comp.)	.026* (0.011)			
Need of external finance USA* Regional financial development (Principal component correlation)		.093* (0.014)		
Need of external finance USA* Regional financial development (Simple average)			.098** (0.008)	
Need of external finance USA* Regional financial development (Guiso Sapienza and Zingales)				.039* (0.027)
Constant	-.015	-.012	-.014	-.013
	(0.111)	(0.169)	(0.128)	(0.140)
Obs				
R^2	0.15	0.15	0.17	0.15

Table 15: Using as dependent variable average annual productivity growth

Notes: The dependent variable is compounded annual growth rate in each firm of the sample during 1998-2006, all regression include sectoral and regional dummies.
indicate that the coefficient is statistically significant at the 5% level, while **that the coefficient is statistically significant at the 1% level

Chapter 2

Role of the Financial System in Firm Efficiency

2.1 Introduction

The period from 1995 to 2005 witnessed a further deepening in the slowdown of productivity for the Eurozone in general and for Italy in particular. Aggregate data show a negative growth for both labour productivity and total factor productivity during the period 2001-2005 suggesting to an unreasonable technical regression in the Italian economy.

An in depth analysis on Italian firms can actually help in understanding whether in the last years firms have lost their ability to innovate or if they have passed trough a restructuring in the production process in order to compete at global level.
If we look below the surface, in fact, it seems that an aggregate level analysis hides the existence of a group of firms that apparently did not lose their competitiveness even during recessions. Data indicates that during the last years there has been a progressive polarization between two groups of firms: one that keeps the levels of productivity high and the other that is unable to find a way to maintain its competitiveness.
Hence, the problem seems to be related to the lack of incentives for the

less productive firms to reach the efficiency of the group of firms that perform better. The analysis on microdata, in fact, suggests the fact that the basic competitive mechanisms in the Italian market do not work. This is partially explained considering that a lack of contendibility of corporate control contributes to the lack of dynamism of the whole economic system. It is well known that an efficient market for ownership is simply absent: the stock exchange is particularly weighted in financial institutions while the bulk of industrial and non financial service firms' shares are not publicly traded. This means that the takeover process could fail in transferring the corporate control to a more productive management, because it is not exclusively determined by market forces.
In economic literature it has been shown that the financial system, and banks in particular, sometimes represent the way through which they stimulate a selection of an efficient management (Hanazaki, Horiuchi 2000). The relationship between the corporate sector and the financial system can affect the aggregate efficiency through different channels. In this work, after having shown some evidence confirming the weakness of competitive pressures, we will investigate further this issue looking at the distance from the efficient frontier (Acemoglu, Aghion and Zilibotti 2003) of a wide sample of Italian firms, assessing the historical movement of this distance and trying to give an interpretation of the role played by the financial system.

The rest of the paper is organized as follows: in the first part we will describe the main evidences coming from a micro level analysis. This part aims at describing empirical evidence of Italian productivity both using literature and evidence from a kernel density distribution analysis. In Section 3 we indicate the motivation and main goal of the study. In Section 4 we describe the efficiency frontier analysis methodology and the database used in the analysis. In Section 5 the specification and its main results are illustrated, while in Section 6 a robustness analysis is provided. In Section 7 we provide a conclusion.

2.2 A Look at Firms' Behaviour

As already suggested by numerous empirical studies (Foster et al. 2001, Aghion and Howitt 2006), aggregate productivity is the result of micro processes of the reallocation of resources from the less productive units in the market to the more productive ones.
The Shumpeterian Theory of Creative Destruction implies that this reallocation is due to the effects of new entrant firms, which embody new capital, and then basically replace the less productive units. Through the contribution of new entrants, this process contributes to the adoption of new technologies in the system, replacing vintage capital. Nonetheless, also the existing plants could, in principle, contribute to aggregate productivity. The introduction of new techniques in their activity - through new processes or new products - impose a retooling of the existing activity, both in physical and human capital within and between plants. Vintage models (Caballero and Hammour 1994) suggest that retooling activity caused by new capital can introduce also retooling in employment: new techniques can, in fact, employ more skilled workers, generating change within and between plants.

A part from the effects of replacing technology, new entrants also have an indirect effect on incumbents' productivity: as Bartlesman et al (2004) suggest, the creative destruction affects productivity through both reallocation and market increased contestability, that promoting productivity and enhancing strategies of incumbents.

Hence, aggregate productivity is the contribution of both new entrants and incumbents. As several empirical works well resumed by Foster Haltiwanger and Krizan (2001) clearly show, aggregate productivity derives from the combined result of entering and exiting plants, productivity growth of existing plants (within component), changing in shares of most productive existing plants (between component), and a cross term representing the covariance of the two cited effects.

This kind of decomposition helps in understanding the official statistical evidences, and also the cross countries differences in terms of aggregate productivity. Bartelsman, Haltiwanger and Scarpetta (2004) provide international comparison on microeconomic evidence of creative destruction process over industries. One of the conclusions they reach is the role of post entry growth in productivity differential between Europe and U.S.. The evidence suggests that part of the gap in terms of productivity Europe faced in the last decade is due not to entry and exit rate, which are pretty similar across industrial countries, but mainly to post entry productivity growth.
These differences in post entry growth have also been pointed out in a quite recent work by Philippon and Véron (2006). As the evidence on FT Global 500 ranking of the world largest companies shows, the European firms are generally old, and basically there are not many changes in their composition. After 1975 only three European firms entered in the 500 global largest listed firms. This number is much more relevant for the U.S., for which 26 firms born after 1975 are in the FT list. This suggests, again, that in Europe there are relevant barriers to firms' growth.

Looking at the productivity decomposition within European incumbents can be an interesting way to better understand where this gap comes from and which are the countries showing the largest differences. On this topic a recent work by Giannangeli and Gomes-Salvador (2008) provides some interesting evidence. The analysis aims at disentangling the contribution of learning, selection and cross terms to aggregate productivity compared across countries in different industries.
Their results confirm the large heterogeneity of productivity at firm level, as productivity enhancement are to be attributed mainly to within firms effects, rather than to reallocation in terms of market share. The selection effect, captured by the term representing the increase of market share of most productive firms, is negative for each country, suggesting that no premia, in terms of shares, is given to the best performers.

This evidence, that reiterate the lack of competitive selection forces in

the European market, also suggests an important issue on the Italian market: in fact, among the considered European countries[1], Italy is the only one displaying a negative learning effect.
The learning or within effect, in this kind of decomposition, represents the process through which firms approach the efficient frontier, since it is the contribution to aggregate productivity of each firm's increase in productivity. In the case of Italian market both the selection and the learning effect are negative, suggesting that aggregate productivity is both due to a scarce reallocation of market share to the most productive unit and to an increase of distance from the efficient frontier. These results in the Italian market are still confirmed for the period 1998-2006, as shown in a further analysis by d'Alfonso and Giannangeli (2008).

However, a recent research (De Nardis 2007) seems to suggest that not all Italian firms suffer from this bad performance: a bulk of enterprises seem to have found their own way to compete. However, this good performance (also in terms of productivity) is not reflected at an aggregate level. However, if this statement is true, the productivity distribution should in principle show a peak of best performers. To have an immediate view of the evolution of productivity in time, one possible approach is to calculate its stochastic distribution.

2.2.1 Italian Productivity Distribution: a Stochastic View

The present analysis is based on a sample of 10,800 Italian balance sheet data from Aida database of firms operating during the period from 1998 to 2006, for which the relative productivity has been calculated. In order to calculate the relative efficiency of firms, following the Baily et al. (1992) approach, we subtract the average value for the industry from each firm's labour productivity value. The industry average is calculated by taking an average of the firms' productivity levels weighed by their market shares.

[1]This study is based on the Bureau Van Dijck Amadeus database, and it is performed on the period 1993 2003.

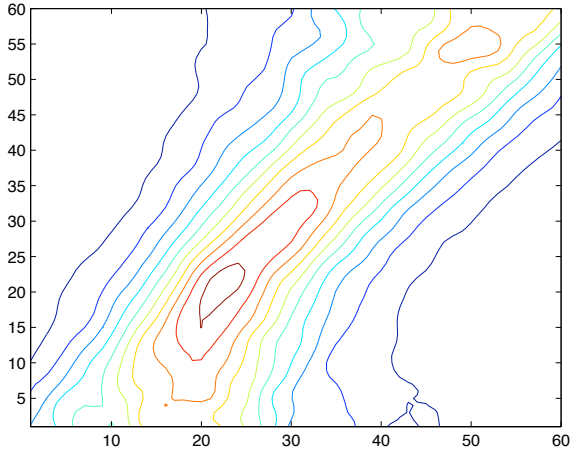

Figure 5: Relative productivity kernel density

$$\tilde{p}_{it} = p_{it} - \Sigma_{it} s_{it} p_{it} \tag{2.1}$$

Where p is labour productivity calculated as deflated value added[2] over total employees. For each firm the relative productivity is calculated as its productivity less the average weighed for each firm's share of value added s.

It is natural to give a non parametric representation of the distribution of firms' productivity by recurring to kernel density estimates (Silverman 1986). But the availability of a panel structure suggests to extend the analysis to the distribution dynamics. The main references in this field can be found in the literature on growth and convergence (Quah, 1996, or for a very recent application Di Cecio and Gascon, 2008). In these works it has been shown that a very suggestive representation of distribution dynamics can be obtained by mean of a stochastic kernel. This object is a sort of

[2]The Groeningen database has been used to deflate value added: prices index have been calculated for 3-digit ateco sector.

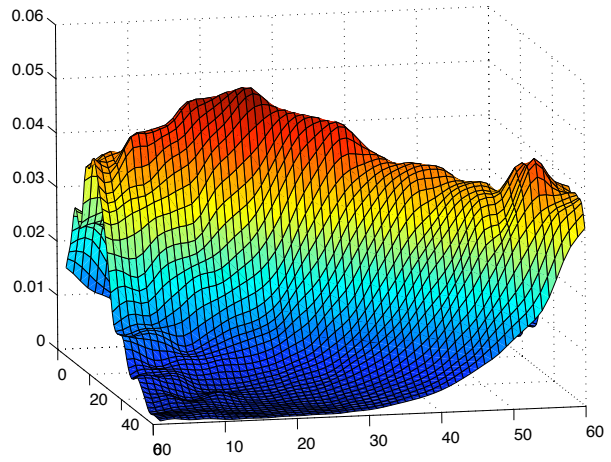

Figure 6: Relative productivity kernel density

non-parametric transition matrix in a continuum: it is obtained calculating the joint distribution of a phenomenon at time t and $t+k$ and then marginalizing it by dividing the joint distribution for the marginal distribution at time t. With this process one obtains the distribution of the phenomenon at time $t+k$ conditional on the distribution itself at time t. The final product is a surface with time t and $t+k$ on the abscissas and a conditional probability on the ordinates. As for the interpretation, it is clear that cutting the surface with planes orthogonal to the t axis gives the probability distribution at time $t+1$ of the values of the phenomenon of interest, for an individual that is placed on that point in the t distribution. Accordingly, looking at the whole surface a concentration of the mass of probability along the principal diagonal suggests that the phenomenon is pretty stable in terms of rankings (individuals that are placed at the bottom of the distribution at time t have a high probability of remaining there at time $t+1$) just like in a transition matrix; if there a tendency of polarization towards specific values of the distribution it shows up with a high peak in the surface.

The distribution confirms the results mentioned above, showing an high persistence during the whole period, since firms are all concentrated on the diagonal of distribution. Furthermore, as figures illustrate, a bulk of firms remain in the lower part of the distribution, suggesting that less productive firms remain in the market without significantly increasing their productivity.
However, a smaller group of firms displays a behaviour different from the others, outdistancing the mass of enterprises. This excellent group has not enticed other firms to increase their productivity in order to compete at the same level.
The absence of spillover from this group to the rest of the population is further evidence indicating that good performers, as already pointed out in other recent works[3], exist at micro levels, but are still insufficient to affect aggregate results, as they do not impact the performances of their competitors.

2.3 What's Lacking?

The absence not only of a selection process, but also of a learning effect, suggested by existing literature, seems to offset completely the positive results of the group of Italian firms that lie in the higher level of the kernel density estimation described before. This evidence confirms a lack in the mechanisms forcing less productive firms to increase their efficiency to compete with the best performers in the market. Thus the technology of more innovative firms is not transferred to the rest of the population, since less productive units are not being pushed by market forces.
A big strand of literature has been concentrated on the role of institutional factors in enhancing productivity growth.
Recent evidence suggests, for example, that the differences in productivity growth within OECD countries are attributable to the differences in regulation, for instance differences in the stringency of product market or

[3]See also De Nardis, 2006.

labour market regulation (Arnold, Nicoletti Scarpetta 2008).

Among others, an important institutional factor is the financial system, as it impacts both entry and post entry growth barriers (Aghion, Fally, Scarpetta 2008).
Financial development has an impact on productivity through the quantity of funding it provides to the economy, but it also enables competition through its selection in allocating these resources. In this way, financial systems guarantees that firms receive the right incentives to produce on the efficiency frontier (using all technology disposable in the market). This role can be played either through capital market reallocation (typical of arm's lenght economies) or financing decision (typical of bank based system).
In an arm's length based financial system, the incentive to reach technical efficiency comes, from performances in terms of firm value on the stock markets: there is, in this kind of financial system, a sort of 'punishment' to the management in operating far from the frontier.
In a bank based economy the process should be the result of the financing selection: banks, that typically have a more direct information on firms, should select through its credit choices (see Bencivenga and Smith, 1993). Through a more intense relation with firms they are, in fact, able to evaluate and monitor firms and to allocate credit in more productive ways.
Hence, both mechanisms should, in principle, be part of the external incentives that induce the management to adopt the existing technology to perform better.

As Habib and Ljunqvist (2000) specify, the managerial incentives for firm efficiency are both internal and external: internal incentives are controllable by the board of directors, and are for instance related with the managerial stockholders and option plans. Conversely, external incentives are determined principally by market forces.
Numerous papers have been concentrated mainly on internal incentives: the ownership-control relation, as well as the managerial wage system, have been at the center of corporate governance research.

Less developed is the analysis on the effectiveness of external incentives on firms' performances. The role of the market in stimulating management to pursue efficiency is, however, not negligible. This paper aims at understanding if a firms' behaviour in their relationship with the financial system is effective in enticing firms to increase their efficiency. Answering this question should also suggest what kind of relationship between firms and financial systems should be enhanced to increase market competitive forces. To evaluate the role of financial system in boosting competition, an efficiency frontier approach has been followed.

2.4 Efficiency frontier: model and data for the analysis

2.4.1 Stochastic Frontier Analysis: Methodological Issues

It is necessary to evaluate inefficiency in order to test for the role of financial system in explaining firms performances. To estimate the distance from the efficiency frontier there are two main important techniques: the non parametric one, called Data Envelopment Analysis (DEA) and the parametric approach, which relies on regression analysis. The first method advantage is that it does not imply any hypothesis on the production function, while the parametric approach needs a functional form of production relationship to provide the estimate. Anyway, this second method allows us to model factors explaining the inefficiency term, which is fundamental for testing the role of financial systems, which is the principal goal of this work.

The stochastic frontier approach, firstly proposed by Aigner, Lovell and Smith (1977), introduces the possibility of a non random error, which represents the distance from the efficiency frontier not attributable to measurement errors.
During the eighties, the estimation of the determinants affecting the inefficiency terms were usually provided using a two stage approach: firstly

the distance to the efficiency frontier was estimated, and then this term was regressed on the variables explaining inefficiency. This approach was however partially misleading, since this procedure contradicts the assumption of the inefficiency effects independence in the two stage of the analysis.
Several authors have hence addressed this issue allowing for a simultaneous estimate of the distance to the frontier and the error term specification. In this paper the Battese and Coelli (1995) approach will be used: their specification, in fact, permits the parametrization of the one sided error term also in panel data estimates.

The general form of panel data production frontier can be expressed as:

$$y_{it} = x_{i,t}\beta + \epsilon_{it} \tag{2.2}$$

where

$$\epsilon_{it} = V_{i,t} - U_{i,t} \tag{2.3}$$

with $U_{i,t} \sim |N(m_{i,t}, \sigma_u^2)|$ and $V_{i,t} \sim N(0, \sigma_v^2)$. V is, therefore a two sided error term normally distributed with mean zero and variance σ_v^2, while U is a one sided error that permits the identification of the frontier, by distinguishing the efficient firms for which $U_i = 0$ from the inefficient ones for which $U_i > 0$. The U_i are independently, but not identically distributed as non negative terms of a truncated normal, in which it is possible to model the average as:

$$m_{it} = Z_{it}\delta \tag{2.4}$$

Where Z_i is a set of variables that influence the inefficiency. In this case maximum likelihood allows for the simultaneous estimate of all relevant parameters.

The Battese Coelli (1995) model, implemented through their program Frontier 4.1, ran the entire estimation and it also incorporated the basic test for the analysis, as the likelihood ratio, which tests for restrictions on the inefficiency term. A key parameter in the analysis is $\gamma = \sigma_u^2/(\sigma_u^2 + \sigma_v^2)$, which represents the relevance of inefficiency term in explaining the overall variance. This parameter is bounded between zero and one: when it is close to zero the inefficiency term is null or negiglible. Vice versa, the closer it is to one, the more appropriate is the stochastic frontier approach.

Finally, the technical efficiency term of firm i at time t is calculated as:

$$TE_{i,t} = E(Y_i^*/U_i, X_i)/E(Y_i^*/U_i = 0, X_i) \tag{2.5}$$

which measures the observed output with respect to the efficiency frontier. In stochastic terms this means to calculate the expectation of Y^* (effective output) conditional on input and the error term U_i over the expectation of Y^* conditional on input and assuming no inefficiency term.

2.4.2 Sample and Variables in Analysis

In this framework, we want to test whether firms with a more direct financial market relationship operates closer to the efficient frontier or not. We then estimate the previous model, using, as inefficiency's explanatory variable, data coming from the 'UniCredit Survey on Italian Manufactur-

ing Sector' [4]. This database allows to link soft information, coming from the questionnaire, to the data on the balance sheet.
The analysis is carried out on a sample of firms participating in the last two surveys, covering the period from 2001 to 2006: the firms participating in both editions are 1,047, of which 1,044 disposed of all relevant observations for productivity function estimates for at least one year. Some data cleaning had, in fact, to be pursued in order to cancel out problems of missing values and outliers attributable to data entry errors.
The Frontier 4.1 procedure allows for missing values in the panel: the sample, in fact, does not contain 1,044 firms each year, but the observations vary between 927 and 967, since data necessary to complete k, l and y are not available in all observations.

To estimate the production function we use as capital total asset and as labour the total number of employees [5]. Total output has been considered total sales. The production function assumed for the estimate is a Cobb Douglas, but - as a test for robustness - a translog has been also carried out.

To explain the role of finance in contributing to firms efficiency we want to consider both the effect of capital market and the role of bank-firm relationship. In principle, in fact, both systems could obtain the best allocation of savings in the economy, spurring productivity growth at firm level: through the UniCredit Survey, we tried to evaluate all questions directly related to these issues.
In particular, in order to evaluate the openness in ownership - that means allowing for competitive mechanisms on capital markets - three variables are considered: being listed, intending to go public in the future and the level of concentration in ownership (C1, share of the main owner). In a certain way here we are testing if mechanisms, typically working in arm's

[4] This survey has a long tradition, being before carried out by MCC and Capitalia, since late 80s.

[5] To keep in count most number of firms for all years considered, whenever in the balance sheet would be not specified the number of employees it has been substituted with that specified by firms during the interview.

Variable	year	Obs.	mean	St. Dev.
Output	2001	927	15.24	1.27
	2002	953	15.27	1.31
	2003	991	15.28	1.29
	2004	967	15.30	1.27
	2005	983	15.30	1.24
	2006	944	15.32	1.29
Capital	2001	927	15.11	1.71
	2002	953	15.12	1.69
	2003	991	15.06	1.65
	2004	967	15.05	1.65
	2005	983	15.03	1.65
	2006	944	15.00	1.65
Labour	2001	927	4.49	1.13
	2002	953	4.53	1.13
	2003	991	4.43	1.16
	2004	967	4.43	1.14
	2005	983	4.40	1.12
	2006	944	4.39	1.15

Table 16: Production function variables

Note:Variables are in logarithms.

length economy, have an effect also on Italian market.
When the market for corporate control is developed firms managers and ownership are motivated to reach the efficiency frontier. In general, the Italian corporate sector is characterized by high levels of concentration, and a tiny market for corporate control, a feature that could reduce the effectiveness of competitive forces. If the hypothesis is true, then, firms listed or more propens to open capital to a larger number of shareholders should be in principle characterized by an higher efficiency.

It is well known, however, that Italy has a financial market principally based on a banking system: understanding how the basic bank-firm relationship works, in providing correct incentives to the market is an important tool for understanding the better evolution for financial system relations. By all means the role of banking system in Italy is not directly

	Obs	Mean	Std. Dev.
Multiple Banking Relation	5768	6.38	3.75
C1	5768	59.71	28.40
Share of Main Bank Debt	5216	33.83	23.22
Long Run Debt for Investment ($\geq$ 50%)	5768	14.10%	
Listed or intending to go public firms	5768	4.23%	

Table 17: Explanatory Variables Descriptive Statistics

related to firm choices (i.e. banks do not usually sit in the firms' board of director as in other economies), but it acts through the bank' funding decision. The intensity of the relationship can have, through this channel, an indirect impact on the firms strategical decision.
With this aim other variables are considered in the analysis: first of all, the number of banks that have a stable relationship with firm, as in principle the less the banks are involved in activity, the stronger is the relationship with the bank. Moreover, the share of debt provided by the first bank should suggest the intensity in the relationship and it also should reduce the effect of multiple bank-firm relationship. If, for instance, a firm is used to raise funds through an high number of banks in order to find the best condition of the market, but only one bank is the partner in the main part of the activity, then it has a direct control of managements behaviour. Finally, also the long term financing for the investment (both in tangible or intangible assets) is, in some ways, a proxy for indicating a long term relationship. We expect when the relationship is more intense - less number of lending banks, a larger share of debt in the main bank, and long term debt - firms have smaller inefficiency.

The analysis tests for the correlation between inefficiency term and firm relation with financial market. We are looking, in fact, not at the effect of financial system on efficiency in general terms (i.e. quantity of funding allocated to the corporate sector), but the analysis concentrated on the behaviors of firms in relation with the financial sector.
A positive relationship between efficiency and intensity with the financial market's relationship can be interpreted as the effect of more strict control

on firms performances, as well in the capital market as in the bank lending decision. This would imply a effectiveness of market forces, fostering firms efficiency. Even if the causality direction would be the inverse, the study would suggest that financial sector has an effect on the selection of best performers. Firms, creating a more direct relation with finance are signaling their efficiency to the market in order to obtain the best financing condition with respect to their business.

2.5 Results on Total Manufacturing Data

In the specification we will provide, all firms in the database are jointly considered, to evaluate whether the issue we are testing is relevant for the general firms. To take into account differences implied by different techniques and results, dummies for sectors are introduced in the analysis.

The results of the analysis, in Table 18 show the significance of Cobb Douglas coefficients, suggesting a constant return to scale of production (sum of capital and work coefficient are close to 1). The results confirm that the distance of firms to the frontier is not negligible: γ is significant and close to one (0.96), and likelihood ratio test rejects the null hypothesis.

The mean of technical efficiency, shown in Table 20, is increased during the six years from 80.7% to 82.8%; however the mean of the period remains quite low, since on average firms are producing at 81.8% of total efficiency.

A part from the constant term, all variables described above are significant. In detail, the number of firm-banks relationship is divided by size (calculated as employees), and it is introduced in the regression both in linear and in quadratic form. Introducing the variable in a quadratic form, allows to evaluate if there exists a relation between number of banks and size, under which reducing the number of credit institutions creates a "trap effect" for firms. Conversely, as already suggested in Vulpes (2005),

	coefficients	standard-error	t-ratio
β_0 Constant	9.17	0.06	161.09
β_1 Capital	0.16	0.01	31.32
β_2 Labour	0.86	0.01	115.58
δ_0 constant	-10.82	0.73	-14.72
δ_1 share of principal bank/employees	-0.01	0.01	-1.73
δ_2 listed firm	-1.43	0.20	-7.06
δ_3 C1	0.01	0.00	8.80
δ_4 long term investments	-0.33	0.18	-1.78
δ_5 banks relationship/employees	-3.02	0.36	-8.50
δ_6 banks relationship/employees^2	0.83	0.10	8.07

Table 18: Frontier efficiency estimates

Notes: In the regression sectoral dummies are included to consider technical specificity of different sectors: all of them are significant.

σ^2	2.60	0.15	16.89
γ	0.96	0.00	309.21
LR test	1618.7		
Restrictions	8		

Table 19: Results of basic tests on inefficiency

Notes: The LR test is under the null hypothesis of one side error. The distribution is a mixed χ^2 as calculated by Kotte and Palm. The value of 2.71 rejects the null at 5% level of significance.

above this threshold multiple banking relationship could be related with the low formalized model of corporate governance adopted by the firms and hence the multiple bank lending relationship could represent a sort of insurance mechanisms for the banks in overcoming the difficulties of assessing their customers firms. The number of firm-banking relationships are, however, a proxy for the ability banks have in monitoring the efficiency of the firm: in fact, if the firm has a low number of bank relationship, it means that banks could better value its business and performance.

As expected this variable has a negative sign on the linear term , and a

	Technical efficiency
2001	0.807
2002	0.803
2003	0.820
2004	0.821
2005	0.827
2006	0.828
Overall Mean	0.818

Table 20: Technical efficiency during the period

positive sign on the quadratic one, implying that the effect of multiple lending relationships has a u-effect on inefficiency: it decreases until the minimum, and then it starts increasing again. From our estimates it turns out that the turning point is reached when the number of firm-banks relationships is 0.13: above this value firms inefficiency starts increasing.

Clearly, the number of lending relationships a firm has, does not describe the intensity of the bank-firm relationship. This is better suggested by the share of debt of the principal lending institution. Again this variable is divided by firm size, as dimensions could imply different behaviours in terms of indebtness choices and also in terms of bank firm relationships, as seen before.
This variable is significant and negative, indicating that the more intense is the relationship with the first-lending bank, the more efficient is the firm.

In describing the characteristics of bank-firm relationships a relevant issue is the lending term: a long term relationship gives, in fact, more stability to a firm's activity allowing for long run strategies. On the banking side, it represents a more in-depth evaluation of firm's investment. A variable indicating long term banking debt for financing investments is, hence, added into the analysis of inefficiency terms. This term is included in the analysis as a dummy equal to one when firms finance investment with long term banking debt at least for the 50% of total investment ex-

penditures.
The coefficient is significant (even if at 0.08%) and negative: a larger share of long term banking debt in financing investments reduces the distance to the frontier.
The results on these variables seem to indicate that a more direct relationship with banking system positively impacts firms efficiency.

Furthermore, the other variables in the analysis suggest that less ownership concentration implies an higher level of efficiency. The share of first owner (C1), is, in fact, positively correlated with the inefficiency term. Moreover, when a firm is listed - hence controlled by the equity market- or intends to go public in the near future - i.e. when firm is disposed to share equity, enlarging the ownership structure - inefficiency is reduced.

2.6 Robustness Analysis

To check the robustness of the previous specification some tests are provided.
First of all, it has been carried on a likelihood ratio test under the null hypothesis of each explanatory variable being equal to zero. The likelihood ratio has been calculated as:

$$LR = -2[LLF_0 - LLF_1] \sim \chi^2 \tag{2.6}$$

where LLF_0 is the value of log likelihood function under the null hypothesis and LLF_1 represents the log likelihood function value under the alternative hypothesis.
For any explanatory variable, the likelihood ratio test largely rejects the null hypothesis of being equal to zero.

For the variable representing multiple banking relationship, we tested both the relevance of multiple banking relation (both the linear and the quadratic term are equal to zero) and the quadratic relation with inefficiency (the hypothesis is that only the square term is equal to zero). In both cases the test rejects the null hypothesis, confirming the role and the path of the number of banks is relevant in explaining the inefficiency term.

Furthermore, to keep in account the possible existence of a time trend in explaining firms' inefficiency, we add this term as explanatory variable, and test for its relevance. The test rejects the null hypothesis of no time trend, but including this term in the analysis the results previously described are confirmed, with the exception of the dummy for listed companies which lose significance.

The test on translog specification seems to indicate this production function adequate for the data in the analysis. The results, however, are not far away from the general specification. The variables that lose significance, showing lower robustness than the other variables in the analysis are two: the dummy for listed companies, which is not significant with a positive sign, and the dummy on long term banking relationship which maintain the same sign, but lose in significance.
All other variables are significant, confirming at large the results on the Cobb Douglas specification.

All in all the analysed specification seems to be reasonably strong. The variable which shows less robustness is the dummy for listed or firms intending go public, which however represents on average only the 4.2% of the observations in the sample. In this case the scarce number of firms can affect the robustness of the variable.

	Hypothesis	H0	H1	LR
No Share of Main Bank Debt	D1=0	-3034.10	-3021.01	26.18
No Listed Dummy	D2=0	-3034.69	-3021.01	27.36
No C1	D3=0	-3033.50	-3021.01	24.98
No Long Run Debt for Invesment	D4=0	-3031.60	-3021.01	21.17
No Multiple Banking Relation	D5=D6=0	-3028.55	-3021.01	15.08
No Quadratic MBR	D6=0	-3039.38	-3021.01	36.74
Time Trend	D7=0	-3021.01	-3026.06	-10.09
Translog	B11=B22=B12=0	-3021.01	-2871.89	298.25

Table 21: Likelihood Ratio Test

Notes: Test have a χ^2 distribution under the null.

2.7 Conclusion

The study focuses on the relationship of firms with financial markets. To proxy for it we used soft information coming from the UniCredit survey on manufacturing firms, and we grouped two kinds of proxies.

On one side the variables indicating the attitude the firm has in terms of openness to corporate control. The variables in the analysis represent the presence of a firm in the stock market (or the intention to go public) and the concentration index C1 (share of firms controlled by the first owner). The results indicate that the firms more prone to open the corporate control are generally more efficient.
These results do not clearly work out the causality direction: it can also imply that being the best firms on market, they tend to go public or to share capital among a larger number of shareholders with the aim of increase their financing sources. Certainly, in capital markets the control on the firms' performances is more effective, directly reflected on capitalization value. Analogously, even outside the stock market, a worsening in the efficiency should imply a lower firm value. The changing in shareholder composition, and then in management, can be more difficult for highly concentrated companies.
As the Italian market for corporate control is small, as well in terms of

stock market capitalization and shareholders modification [6] it is also necessary to consider in the analysis variables which represent the main characteristics of firm bank relation.

The results of the analysis indicate that firms which have a stricter relationship with the main bank are generally more efficient. This is evaluated trough the share of banking debt financed by the main bank (the higher is the value, the lower the inefficiency) and the share of investment financed with long term banking debt. When this is higher than 50% of total investment it means that firms can rely on banks to enforce their long term strategies: it generally charachterizes more efficient firms. The last term used in explaining inefficiency is the number of relationships firms have with banks, which deserve attention. The Italian banking relationship model is pretty different to the German *haus banks* or to the Japanese ones. In these systems banks are directly involved in the firm activity, even at the in the board of directors, their role is clearly to substitute the stock market in allocating capital. This means that, whenever a firm is not efficiently managed, they can directly signal it to the market.
On the contrary, the Italian system is characterized by multiple banking relationships and generally banks are not involved in the operating activity of the firms. This generally relaxes the intensity in the relationship with firms and increases the opacity of the system. However multiple banking relationships do not lower the efficiency level in a linear form: depending exclusively on one bank can in fact reduce the financing opportunity for firms. There is, however, a maximum level of banks (considered not in absolute value, but in terms of firm size) above which increasing the number of banks becomes inefficient.

This last set of explanatory variables suggests that also firms that rely more heavily on their banking relationships are generally more efficient

[6] As numerous study on the Italian corporate sector indicate one of its characteristics is to be highly concentrated: see Bianco (2003). Also in terms of stock market capitalization the number of listed Italian firms is well below other industrialized economies.

than others. This again, can be interpreted as a signaling phenomenon of efficient firms that are interested in sharing their activities with banks in order to get better financing solutions for their businesses. This also means that, whenever banks are in condition of share information with firms, their selection and monitoring activity is good. On the contrary efficient firms should not have any interest in tightening their relationships with the banks as they could simply look for the best financing conditions.
Alternatively, this evidence can also been interpreted as the effectiveness of banks' control mechanisms on firms (with respect to their performances) when the relationship is more tightened. Firms with a more intense relationships with the banking system receive an incentive to perform better. All in all this suggests, in both cases, that when firms disclose information, banks are efficient in allocating resources to the most productive unit in the market.

However, the stock market or, more in general, a market for corporate control seems to be still underdeveloped in the Italian economy, where listed firms represent a minority, ownership concentration is very high and consequently, there is not a large contendibility of corporate control. On the banking side, the typical opacity of firm-banking relationship (already mentioned in the matter of multiple banking relationship) has been probably overdrawn by a relaxing in the bank-firm relationship. The results of the "'X UniCredit Manufacturing firms"' [7] suggests, for example, that during the last years firms reduced, on average, the share of debt with their main banks with respect to total debt. This is probably attributable to the effect of banking concentration process, which could have affected the perception of firms on their banking activity.

From a policy point of view, the suggestion is that the relationships of Italian firms with financial markets are still characterized by a distance which do not facilitate the monitoring on performances. Increasing the transparency of firm activity and enabling better the selection process of

[7] *Rapporto Corporate. Decima indagine sul settore manifatturiero Italiano.* UniCredit 2008.

lending activity can be a way for fostering efficiency in the market, and through this, aggregate productivity.

Chapter 3

Effect on Productivity of R&D Financing Strategies

3.1 Introduction

The downturn in European labour productivity has been at the center of economic debate in the last ten years: the increasing gap with respect to U.S. has, in fact, been widening as time goes by.
Economists have identified part of the problem to the scarce innovativeness of European firms, inducing Policy Makers to introduce strategies - also at EC level (i.e. Lisbon Strategy) - aiming at spurring innovation.
The loss of competitiveness with Italian firms in terms of productivity has been even worse than other European economies, suggesting an higher gap in terms of firms innovative activity.
Data on research and development investments confirm that Italian expenditure for innovative activity is lower than the majority of other countries: in 2006 Italian gross domestic expenditure on R&D was 1.16% of GDP against 2.1% of France, 1.75% of UK and 2.48% of Germany[1].
Policies oriented to increase innovation are usually based on direct financing of research activity or reduction in financing costs.
A typical barrier to innovation is, in fact, determined by R&D financial

[1]Source of the data: Eurostat

needs. As suggested by economic literature, financing research activities (Hall 2002) is more complicated than financing ordinary activities. There are plenty of reasons why those investments are more difficult to finance. The most relevant being the existence of higher asymmetries on research project or the higher uncertainty of the risk associated with the project.
The effect of different financing instruments on the innovative activity is, however, not straightforward. The nature and duration of different financial instruments could have an impact on firm strategies in terms of innovation. In the presence of financial barriers, in fact, the instruments become a driver for the firms' choices in terms of research and development.
Being aware of the effect of R&D strategic choices on firm's performances can be important in evaluating the role of different policies in spurring innovation and then productivity.

The objective of this paper is, first of all, to understand the impact of financing instruments on different R&D strategies: in particular the alternatives to buying externally (BUY) or internally (MAKE) R&D activity will be considered.
Then, we want to evaluate the the impact of different strategies on productivity: with this aim a quantile regression approach is used to estimate the effect of internal and external R&D on different percentiles of the value added for employee distribution.

The paper is organized as follows: in the first Section a brief review of the different strand of literature is provided; the second Section will illustrate the data used, followed by the analysis of model and relative results described in steps and finally the main conclusions will close the paper.

3.2 Literature Review and Statement of the Analysis

The analysis that will be presented further on follows different strands of literature. First of all this work is related to the literature on innovation and productivity linkages, that has been an important area of research for a long period. In particular, the micro economic evidence on this topic has received a lot of attention, thanks also to a relevant number of cross countries comparable surveys on firms innovation activities. One of the seminal works in applying a R&D model, innovation and productivity interrelation is the Crepon, Duguet and Mairesse (1998), which reaches the main goal of pulling together the largely separated research on this topic at a micro level.
They propose a model in three steps: in the first stage firms decide whether to invest in R&D or not, the second step explains innovation output using innovation input, such as R&D intensity and other factors, finally, the third step interrelates innovation with firms' productivity through a Cobb Douglas production function.
From this moment onwards, many empirical works followed this approach in analysing the innovation-productivity linkages using survey data for different countries [2]. In the Italian case, one of the main important contribution is given by Parisi et al. (2006), who estimated the effect of innovation on productivity and that of R&D on innovation using a panel data from the UniCredit (ex MCC) survey. Their findings suggest that innovation has a significant effect on productivity and R&D spending is strongly associated to the introduction of a new product, but not of a new process.
Recently a paper by Hall, Lotti and Mairesse (2008) continues with the analysis on Italian firms innovativeness, focusing in particular on the SMEs activity.

In the present study, however, we want to test whether different R&D

[2] For an extensive survey see Hall, B. and Mairesse, J. *Empirical Studies of Innovation in the Knowledge Driven Economy*, NBER Working Papers 12320, 2006

financial instruments affect productivity. To this aim we apply a two stage approach partially different from the above cited approaches.

The first stage of the analysis aims at understanding how different financial instruments impact on the firms choices in terms of productivity. The innovation projects are, in fact, particularly difficult to finance. As Hall (2002) describes in her article, one of the main problems of financing innovation is related to the uncertainty of the returns on investment. The investor's required rate of return is higher in financing R&D. These investments are, in fact, affected by market failures which generate a gap between external and internal cost of capital. In particular there are three important failures: asymmetric information between investors and researchers, moral hazard of managers and, finally, the effect of tax incentives on innovation activity. All these factors make it difficult to correctly evaluate and monitor firms by the financial sectors, limiting firms' innovation activity.

The existence of constraints can induce firms to behave in their R&D activities driven by the characteristics of different financial funds they get. As suggested by Magri (2007) in the Italian market, small innovative firms are generally financially constrained, because of informational problems. Larger firms can innovate thanks to the use of traditional financial instruments. This suggests that the market suffers from financial constraints on innovativeness, since there are not instruments sufficiently developed for this activity. The traditional funding used by innovative firms, which are typically private equity and venture capital, are, in fact, not very developed on the Italian market.
One of the main relevant characteristics of financial instruments is, for example, the duration and nature of the investment. For creating internal R&D, for example, a firm needs to structure a department, hiring new high skilled employees. This is clearly a project that involves the entire life of the firm and its long term strategies. In such projects, the uncertainty on returns are typically high, also because that are often related to the knowledge embedded in the human capital of the employees that could be lost if they would leave the firm. Clearly, this requires the in-

vestors an higher rate of return which could induce the firms to privilege internal financial source. On the contrary, outsourcing a part of the activity can be less uncertain and associated to shorter run projects, and external banking loans, for instance, could be a satisfying solution. Moreover this allows to make investments over time, considering step by step the new information at risk.

However, different R&D strategies have different implication on the innovation activities. In the second step, then, we analyse the effect that different strategies (MAKE or BUY) have on the firms' productivity.

One of the main problems in deciding whether to carry on research externally relates with appropriability of its returns. In fact, internal research reduces the risk of imitation or the purchase of the same innovation by other competitors. This, as the survey confirms, can induce firms to produce R&D exclusively internally. However, the possibility of complementarities should not to be excluded.
A large part of literature (see Arora and Gambardella, 1990, Piga and Vivarelli, 2004, Lockshin et al., 2006), in fact, has tried to assess the importance of complementarities versus substitutability effects of external and internal research, without reaching a unique conclusion in the context of firm performance framework. Even if the theoretical literature considers the two strategies as complementary, there are a number of arguments stressing the complementarities between the two. The external innovation is in fact more productive if a firm is able to absorb it through an internal structure. Moreover, an internal structure seems to be necessary in understanding when the firm needs the external R&D and to monitor their activity and results.

The last part of the model, will hence try to evaluate the effects of the use of different R&D strategies on a firm's productivity. Through this two stage approach it is possible to evaluate if financial instruments or tax incentives for R&D can be a driver in a firm's performance, in order to understand whether policy makers should take into account the effects of different tools for financing innovation.

3.3 Data

The analysis is run using the UniCredit (ex MCC) database, that provides both survey and balance sheet information from a sample of manufacturing Italian firms carried out for the period 2001-2003.
This sample contains 4,289 firms representative of the universe of the manufacturing sector; of these the 37.4% (1,609) invested in R&D within the period. Since we are working on the choices in terms of Research and Development investments, in further analysis, we will consider only this subsample.
As expected, firms that invested in R&D are generally larger: small firms (from 11 to 20 employees) investing in R&D are 27.7% and this share increases to 85.5% for larger firms (more than 500 employees). The average dimension of the firms in the sample we are employing is larger than the average of the whole sample. The overrepresentation of larger firms affects in particular low tech sectors, where R&D is less diffused. In high tech sectors, on the contrary, R&D investments are diffused on the generality of firms.

The questionnaire asks for the amount of expenditure in research and development in each of the three years in the examined period. Table 22 shows that the percentage in terms of total investments is 34.7% in 2001, 33.9% in 2002 and 36.1% in 2003.
Not surprisingly, the percentage of R&D invested in high tech sectors is higher (40.7% 40.8% 42.8% respectively in 2001 2002 and 2003) than in low tech sectors (30.5% 29.2% and 31.5%).
Clearly, investments in physical capital show the opposite relationship: these are, in general, higher in low tech industries than in high tech sectors.

The second information relevant for the analysis is the way the investments in R&D are implemented. In particular we investigated whether

	Total		High tech		Low tech	
	Mean	σ	Mean	σ	Mean	σ
$R\&Dinv01$	0.347	0.317	0.407	0.314	0.305	0.313
$R\&Dinv02$	0.339	0.299	0.408	0.305	0.290	0.285
$R\&Dinv03$	0.361	0.309	0.428	0.304	0.315	0.304
$R\&D_{ext}$	0.802	0.302	0.826	0.268	0.785	0.322
$R\&D_{int}$	0.198	0.302	0.174	0.268	0.215	0.322
$R\&D_{risk}$	0.007	0.077	0.009	0.087	0.006	0.069
$R\&D_{Selffin}$	0.796	0.345	0.776	0.350	0.810	0.340
$R\&D_{BankDebtmktr}$	0.059	0.205	0.059	0.206	0.059	0.206
$R\&D_{BankDebteasyterm}$	0.034	0.153	0.040	0.164	0.030	0.144
$R\&D_{Public}$	0.062	0.183	0.068	0.178	0.057	0.187
$R\&D_{Fiscalincentive}$	0.029	0.126	0.032	0.127	0.027	0.125
l	4.30	1.12	4.38	1.18	4.24	1.07
k	12.66	1.85	12.63	1.91	12.67	1.81
Observations	1607		671		937	

Table 22: Descriptive Statistics of variables

Note: Investments in R&D are in terms of total investments. R&D Strategy choices (external versus internal) and financing instruments are expressed in terms of total R&D expenditure. Labour and capital are in logarithms.

firms invest in internal or external structures. In general firms are more inclined to use internal structures, and in fact, the share of external use of R&D is on average 19% of total expenditure. This share increases for low tech industries at 21.5%, while in high tech sectors, the preference for the external sources of innovation is lower (17.4%).

Finally, firms are asked for the financial sources to R&D expenditure: the possible alternatives are risk capital, self financing, long term banking debt at market rate, long term banking debt on easy terms, public financing and fiscal incentives.
The use of different financial instruments confirms that external funding is scarcely used for R&D activities: around 79.6% of total expenditure is self financed, 0.7% is financed by an increase of risk capital - evidence mainly related to the scarce attitude of Italian firms to enlarge their shareholders composition - and only the remaining 18.3.% by external funds. Whithin these, the main resources used are public financing and long term banking financing.

3.4 Model and Results

In order to analyze the relationship between financing choices for R&D and its effects on productivity we follow a two stage approach. With respect to Crepon, Duguette and Mairesse (1998), we are not interested here in focusing on the R&D effect on innovation. Their model, in fact, aims to overcome the possible underestimation of the impact of innovation on productivity, as firms can even innovate without investing in R&D.
Conversely, here we are wondering whether there is an impact of R&D financing choices on firms strategies that can affect productivity.
This question implies two steps: given that all firms decided to invest in research, in the first stage of this model firms have to choose among investing their disposable amounts in external or internal structure and what percentage of this amount to allocate to the different strategies. Given that firms are financially constrained, we assume that they are not able to

choose between different financial instruments. Conversely we test in this stage whether obtaining different financial instruments has an effect on the R&D strategic decision.

In the second stage, the nexus between productivity and R&D choice is investigated (such as investing externally or internally in research) using a quantile approach.

3.4.1 Decision on R&D Strategy and Expenditure

Once a firm has opted to invest in research, the management should decide how to allocate this expenditure. Our hypothesis is that the different financing solutions used for R&D expenditure affect in some way the strategic choices on how to carry on research activity.
One could argue that financing instruments are chosen in order to best satisfy research choices. However, a large strand of literature (Hall, 2002) suggests that financial constraints on innovative activities are tighter than the ones to ordinary activities, as R&D investments implies larger information asymmetries and more uncertainty on the results.
Assuming that firms are financially constrained in terms of R&D expenditure, implies that they have no chance to choose the best financing instrument for their research activities. Conversely, whenever they want to introduce an innovation strategy, they are subjected to the quantity and typology of the financial resources they get.
This would mean that, once they have decided to invest in innovation through R&D expenditure, they must decide how to allocate this resources, depending on the nature of the funds they receive.

The research activity can, in fact, be carried out by external structures (i.e. university, research centers, other firms) or internal departments. This part of the analysis aims at determining the factors that facilitate one choice versus the other.
With respect to this decision, firms have to choose first of all between the

different options and then, on the combination of total expenditure to allocate on each of them.
Literature has debated on the substitutability of these two options. Even if a large part of the literature considers making or buying technology as substitutes strategies, there are ample arguments stressing the complementarity of the two.
Hence the firm decides both whether to allocate externally the research or not and how much to allocate in each of the alternative strategy. This necessitates a two stage approach. First of all, using a discrete choice model, we will investigate on the determinants of opting for producing technology or for sourcing it externally.

Following Piga and Vivarelli (2004), we will consider the decision to enter in an external R&D relationship. This can be simply modeled as a selection model:

$$R\&D_{ext} = \begin{cases} 1 & \text{if} \quad R\&D_{ext}/R\&D_{tot} > 0 \\ 0 & \text{if} \quad R\&D_{ext}/R\&D_{tot} < 0 \end{cases} \tag{3.1}$$

where $R\&D_{ext}$ is a variable that takes value one if the firm carried out research using external structures and takes value zero when research is produced exclusively by internal structures.
The estimation is performed using a probit model; as independent variables are included, the firm size and a dummy indicating whether a firm is used to outsource part of its activity; a dummy for groups and sectoral dummies have been firstly included, but then removed as not significant in this stage of the decision. Finally we included financial instruments as decomposition of total expenditure expressed in logarithms.

The results (see Table 23) indicate that long term banking debt, at market rate as well as on easy term, are significant and increase the probability of using external sources for technology.
Among public incentives for R&D expenditures, the one that has an ef-

fect on the external production of research is free grant; fiscal incentives, conversely, seem not to be significant in pushing the BUY strategy.
Also self financing and risk capital are not relevant in explaining external R&D choices. These kinds of financial instruments, representing an internal growth, should be more appropriate for MAKE strategies, that imply a more structured R&D activity within the firm.
The other two control variables, sizes and attitudes of a firm in outsourcing part of the activity, are both relevant and positive in explaining R&D choices. Firms that are, in fact, used to externalize part of their production are more prompt to outsource research.

Main results are confirmed even when running the regression on the two subsamples for the low and high technological firms, as classified by OECD[3]. Some differences, however, deserve to be mentioned: size, for example, is not relevant in explaining low tech firms behaviors, but it becomes significant for high-tech industries.
This suggests that, as R&D is not a core activity for low tech business, firms operating in these sectors are more prone to invest all their R&D expenditure on external structures. Conversely, in high-tech industries, where innovation is a relevant part of the business, a BUY strategy is convenient only if a firm has already structured its activity, also in dimensional terms.

The different financial instruments seem to have a direct effect on the strategic choice of firms in terms of R&D. However, as already discussed, also a R&D mix can be a relevant decision for firms who want to use external support in producing research.
The effect of financing sources have to be, then, evaluated also on the share of external R&D on total R&D expenditure. We then estimate this intensity as a linear model, by using the Heckman procedure, to account for the above described selection effects (see table 24).

[3]See appendix for OECD classification, grouping the high and medium-high technology sectors versus the medium-low and low-tech sectors.

	Total	High tech	Low tech
Outsourcing	0.247	0.227	0.275
	(0.001)	(0.045)	(0.009)
Size	0.087	0.178	0.017
	(0.003)	(0.000)	(0.670)
Risk Capital	0.004	-0.010	0.018
	(0.888)	(0.803)	(0.655)
Self-financing	0.010	0.004	0.015
	(0.249)	(0.738)	(0.188)
Long term bank debt (mkt rate)	0.027	0.043	0.017
	(0.008)	(0.006)	(0.215)
Long term bank debt (special term)	0.041	0.028	0.052
	(0.001)	(0.117)	(0.003)
Public Funds	0.041	0.032	0.049
	(0.000)	(0.004)	(0.000)
Tax Break	0.012	0.006	0.017
	(0.268)	(0.693)	(0.281)
Cons	-0.706	-0.995	-0.494
	(0.000)	(0.000)	(0.007)
Loglikelihood	-1069.19	-437.00	-625.37
LR	88.25	55.66	41.19
	(0.00)	(0.00)	(0.00)
R^2	0.0396	0.0599	0.0319
Obs	1607	671	935

Table 23: Probit estimate results

Note: Group and sectors dummies have been excluded as not significant.

Firstly, we have considered as independent variables different financial instruments; none of the alternatives are, however significant in explaining the share of external R&D on total expenditure. This points out that different financial instruments have a role on the decision to use external R&D, but not on its expenditure in relative terms.
These variables have, therefore been dropped, maintaining as explanatory variables of this second step the following: the total amount of R&D expenditure, again the size, the relative role in the group (two dummies are introduced in the analysis considering firms belonging to groups in intermediate positions and one for subsidiaries) and a dummy equal to

one for listed firms.

	Total	High tech	Low tech
Intermediate group position	0.100	0.121	0.081
	(0.004)	(0.005)	(0.136)
Subsidiary	0.078	0.070	0.096
	(0.006)	(0.059)	(0.026)
R&Dexpenditure	-0.055	-0.048	-0.052
	(0.000)	(0.000)	(0.000)
Size	-0.033	-0.023	-0.047
	(0.007)	(0.208)	(0.007)
Listed	0.193	0.162	0.243
	(0.010)	(0.082)	(0.042)
Cons.	1.090	0.931	1.166
	(0.000)	(0.000)	(0.000)
ρ			
σ			
Wald χ	106.26	50.11	59.63
	(0.000)	(0.000)	(0.000)
Obs	1581	658	922

Table 24: Heckmann estimate

Note: Group and sectors dummies have been excluded as not significant.

Total expenditure in research is negatively correlated to the external shares of R&D. Firms that have lower funds to invest in are probably constrained in terms of innovation strategies, as the resources to create or enlarge an internal structure are more expensive than outsourcing the R&D activity.
Interestingly, a firm's size is negatively correlated with the share of external R&D used in production: being larger increases the probability of "entering" in external R&D (they prefer at least a combination of internal and external research), but increasing dimension decreases the share invested in external R&D.
This evidence seems to suggest that larger firms are more prompt to use external sources of innovation, but the external research is mainly considered complementary to the internal activity. As already suggested by

descriptive statistics, firms are usually more inclined to produce innovation internally. Clearly, internal R&D needs a structured activity, that can be difficult to create in a small firm. In smaller firms with even bigger financial constraints, external research can be the only way for producing innovation.

The dummies representing the role of firms within the group, highlight that firms in intermediate positions or subsidiary have an higher share of external research. This suggests that in our sample, in group activities the research department is generally in the holding company.
Finally, the dummy for listed firms is significant and affects external R&D shares positively.
Once more the results are confirmed in both subsamples.

3.4.2 Effect on Productivity of Different R&D Strategies

In the next step of the model we want to evaluate the effects of different R&D strategies on firms' productivity levels. Assuming a Cobb Douglas production function we estimate the following equation:

$$y = \alpha + \beta_0 k + \beta_1 R\&D_{ext} + \beta_2 R\&D_{int} + \beta_3 Share_{extR\&D} + \\ + \beta_4 Share^2_{extR\&D} + \beta_5 group + \beta_{6...n} SD + \epsilon \qquad (3.2)$$

where y is labour productivity (calculated as value added divided by employee) of firm i, k is the investment in fixed capital, $R\&D_{ext}$ and $R\&D_{int}$ are respectively the expenditure for internal and external research and development. All these variables are expressed in logarithms.
Moreover a variable representing the used mix of internal and external R&D, i.e. the share of external R&D expenditure over the total, is introduced in the analysis. This term enters the equation in quadratic form, assuming there exists a maximum share of external research, above which the relation with productivity invert its effect.

Finally we introduced some control variables: the sectoral dummies and a dummy for firms belonging to groups.

The estimation is based on a quantile regression approach. This kind of methodology provides estimates on the linear relationships between regressors and different quantiles of the dependent variable. This procedure has many advantages: first of all it allows to consider the effect of our independent variables on different levels of productivity and hence to identify differences within productivity classes.
In this way it, furthermore, accounts for the heterogeneity of firms data, which is another main advantage of this approach [4]. In fact, as a methodology which considers the entire distribution, it doesn't throw away the outliers, but conversely, it gives information also on the more extreme classes of productivity.

Quantile regression, introduced firstly by Koenker's and Bassett (1978), can be written as:

$$y_i = x_i' \beta_\theta - \epsilon_{i,\theta} \tag{3.3}$$

with y_i value added per employee, x_i is a vector of regressors, β is the vector of parameters associated to the θ^{th} quantile and ϵ_i the vector of residuals.

The θ^{th} conditional quantile of y_i given x_i is:

$$Q_\theta(y_i / x_i) = x' \beta_\theta \tag{3.4}$$

The necessary assumption is, thus, that $Q(\epsilon_{i,\theta} / x_i) = 0$. The θ^{th} regression quantile , $0 < \theta < 1$, solves the following:

[4] On the advantages of using quantile regression in microdata see also Coad and Rao (2007): they suggest, moreover, that relaxing the identical distribution of error terms allows to acknowledge firm heterogeneity.

$$min \frac{1}{n} \left\{ \sum_{i:y_i \geq x_i'\beta} \theta |y_i - x_i'\beta| + \sum_{i:y_i < x_i'\beta} (1-\theta)|y_i - x_i'\beta| \right\} \tag{3.5}$$

In the regression described herein there is a lag introduced between the investments (both in R&D and physical capital) and firm's productivity level. We assume that the investment strategies for the period from 2001 to 2003 (on average terms) have a relevant effect only on the productivity level of some periods later, hence for the estimation 2004 is chosen. A lag, in fact, is needed to make the strategies effective on the production results.

The results in Table 25 on the median suggest that both physical and intangible investments are relevant in explaining firms productivity levels. Looking at the decomposition of research both externally and internally, it turns out that the MAKE strategy has an higher impact on productivity.
In terms of mix between the two choices, the quadratic effect is significant, pointing out the existence of a maximum level of external research over the total, above which increasing the outsourcing of research has a negative effect on productivity. This confirms the complementarity effect of MAKE and BUY strategies. The external research becomes optimal when there is an internal structure able to implement the innovation in the production.
Finally the group dummy suggests that being part of a group has positive effects on productivity.

Dividing the sample into high and low tech industries, some differences in terms of innovation sources turn up. In high tech sector neither the physical capital investments nor the external research investments are relevant in explaining differences in terms of productivity. Only the internal R&D is the significant parameter in explaining firms' performances.
Conversely, for low tech industries both the expenditure level in external R&D and the chosen mix of strategies are significant in explaining the

firms productivity levels.

	Total	High tech	Low tech
$R\&D_{int}/l$	0.026	0.034	0.021
	(0.003)	(0.014)	(0.019)
$R\&D_{ext}/l$	0.001	0.001	0.02
	(0.051)	(0.869)	(0.013)
share	-0.392	-0.185	-0.575
	(0.124)	(0.621)	(0.05)
$share^2$	0.610	0.537	0.715
	(0.019)	(0.191)	(0.012)
k/l	0.0491	0.017	0.071
	(0.00)	(0.293)	(0.00)
Group	0.098	0.13	0.128
	(0.00)	(0.001)	(0.00)
Pseudo R^2	0.108	0.073	0.095

Table 25: Quantile estimate: results on median

Note: Sectoral dummies (Nace 2 digit level) have been included in estimate, and are all relevant.

When we consider the results on different productivity percentiles (Table 26), it turns out that the relevance of external R&D increases for the most productive part of the distribution (those above the median). It seems that complementing internal research with external activity is particularly important for higher productivity levels. This suggests that firms having higher productivity levels have internal structures sufficiently developed to catch all possible spill-overs coming from external ones.

As suggested by the regression on the median percentile, this effect is true only for low tech industries, while high-tech industries productivity is affected only by internal R&D and eventually physical investments in all percentiles of the distribution, except for the lowest level for which only physical investments are relevant.
In the low-tech industries, using also external sources of innovation is important for all intermediate classes: lowest productive units, as before, are

affected exclusively by physical capital, and the same happens for most productive units.

3.5 Conclusion

The paper investigated the role of financing instruments on firms productivity. The nature of financial instruments, in terms of duration and implication on organizational structure, have effects on the firms' choice in terms of R&D production. Instruments as self financing or risk capital could imply, in fact, a change in dimensional or corporate governance structures. Conversely, external sources of financing, being fixed in duration, can induce firms to allocate the resources in order to obtain the results within the period in which they receive the funds.

The way in which firms invest in R&D can affect their results in terms of performance (here evaluated in productivity levels). From the literature it is not clear what kind of strategy (whether internal R&D, external R&D or a mix of the two) is more relevant in terms of productivity. Some authors have, in fact, pointed out the complementarity effect and others the substitutability.
However, in a period during which the policy for spurring innovation is considered a priority, it is relevant to evaluate in-depth both the role of the different strategies on productivity and the effect on financing instruments on their strategies. In fact, the way through which policy makers usually stimulate innovation through the direct financing of innovative activities or the indirect financing through fiscal incentives or public guarantees to long term banking debts [5]. It is, hence, particularly important to understand what kind of behaviours these policies are encouraging in order to better understand their effects on the market.

From this analysis it turns out that internal R&D has an higher effect

[5] An example of this kind of guarantees has been introduced in U.K. with the SLBG programme

on productivity than outsourcing innovation. This is true, in particular, in high tech industries. In low tech industries, however, the relevance of external sources of innovation increases. The differences in quantile regression, in fact, suggests that introducing also external R&D is determinant for being in the most productive part of the distribution.
The conclusion is that complementarities between different strategies are particularly important for those sectors, where research is not a core activity. In these cases, although an internal structure is essential to catch the spillover from the external research, the nature of business make producing it internally less imperative.
Even if the role of innovation in these industries is less crucial than in high tech ones, nevertheless it is a driver for increasing competitiveness at international levels also in traditional sectors, as some case of Italian excellence has shown.

In terms of effects of financial instruments on R&D strategic choice, this work suggests that long term banking debt (either at market rate or on easy terms) and public financing induce firms to use also external R&D. On the contrary, solutions such as increase of risk capital, self financing and tax breaks are mostly used for internally structuring a research department. These instruments, in fact, imply a longer commitment for the firm in terms of innovative activity.
The analysis points out that the role of different fundings have impacted the decision of whether to enter in a BUY strategy or not, even if it has no impact on the mix of the two strategies (represented by the share of external research in total).

All in all, the results suggest that different financial instruments have a different impact on the R&D firms choices and, as a consequence, on productivity. As seen, alternative instruments can provide incentives to different sectors. Being aware of this can be relevant for choosing policy tools for spurring innovation.

Total	q20	q40	q60	q80
$R\&D_{int}/l$	0.024	0.026	0.034	0.021
	(0.003)	(0.00)	(0.00)	(0.005)
$R\&D_{ext}/l$	0.004	0.008	0.012	0.013
	(0.476)	(0.187)	(0.02)	(0.016)
share	-0.111	-0.269	-0.561	-0.803
	(0.743)	(0.446)	(0.041)	(0.036)
$share^2$	0.209	0.368	0.826	1.152
	(0.557)	(0.318)	(0.002)	(0.007)
High tech				
$R\&D_{int}/l$	0.048	0.036	0.033	0.028
	(0.024)	(0.016)	(0.012)	(0.154)
$R\&D_{ext}/l$	-0.003	-0.002	0.008	0.009
	(0.780)	(0.789)	(0.235)	(0.260)
share	0.270	-0.056	-0.567	-1.073
	(0.624)	(0.825)	(0.132)	(0.055)
$share^2$	0.007	0.289	0.833	1.285
	(0.991)	(0.386)	(0.065)	(0.088)
low tech				
$R\&D_{int}/l$	0.018	0.025	0.029	0.019
	(0.124)	(0.01)	(0.001)	(0.183)
$R\&D_{ext}/l$	0.015	0.017	0.017	0.02
	(0.152)	(0.015)	(0.001)	(0.018)
share	-0.556	-0.561	-0.583	-0.794
	(0.398)	(0.153)	(0.099)	(0.097)
$share^2$	0.515	0.593	0.792	1.122
	(0.41)	(0.106)	(0.021)	(0.017)

Table 26: Effects of quantile regression by percentiles

3.6 Appendix: OECD Classification of technological sectors

OECD classification	
High-technology	NACE Revision 1.1
1. Aerospace	35.3
2. Computers, office machinery	30
3. Electronics-communications	32
4. Pharmaceuticals	24.4
5. Scientific instruments	33
Medium-high-technology	
6. Motor vehicles	34
7. Electrical machinery	31
8. Chemicals	24-24.4
9. Other transport equipment	35.2+35.4+35.5
10. Non-electrical machinery	29
Medium-low-technology	
11. Rubber and plastic products	25
12. Shipbuilding	35.1
13. Other manufacturing	36.2 through 36.6
14. Non-ferrous metals	27.4+27.53/54
15. Non-metallic mineral products	26
16. Fabricated metal products	28
17. Petroleum refining	23
18. Ferrous metals	27.1 through 27.3+27.51/52
Low-technology	
19. Paper printing	21+22
20. Textile and clothing	17 through 19
21. Food, beverages, and tobacco	15+16
22. Wood and furniture	20+36.1

Notes: Source OECD.

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