Banks and Innovation: Microeconometric Evidence on Italian Firms*

Luigi Benfratello (Università di Torino)

Fabio Schiantarelli (Boston College)

Alessandro Sembenelli (Università di Torino)

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Abstract

A direct empirical investigation of the effect of local banking development on firm's innovative activities is carried out in this paper. We use a rich data set on innovation at the firm level for a large number of Italian firms over the 90's. There is some evidence that banking development affects the probability of process innovation, particularly for high tech firms and for small firms. There is also evidence that banking development reduces the cash flow sensitivity of fixed investment spending, particularly for small firms.

*Extremely preliminary and incomplete version. Do not quote without permission from the authors. We thank Luigi Guiso and Giorgio Gobbi for respectively providing us the data on the 1936 instruments and the data on the evolution of the structure of the Italian banking industry in the nineties.

1 Introduction

Does banking development stimulate the introduction of innovations? This is a fundamental question that one needs to answer in order to understand how financial development and its nature affects a country growth prospects. The effect of financial development on real development has been investigated in many recent papers and the empirical evidence suggests a positive effect of financial development on GDP and TFP growth, while its impact on the quantity of aggregate investment and on saving is instead more debatable.[1] This suggests that the effect of financial development on the efficiency with which resource are allocated may be what matter most. The ability of the financial system to allocate funds to the highest return projects has characterized the theoretical literature, but there is little direct evidence on this issue.[2] Most importantly for us, we do not know much on how banking development affects the pace of technological progress, although the role of financial intermediaries in selecting more capable innovators is the key channel of transmission through

[1] Many studies are based on cross sectional growth regressions (see, for instance, King and Levine (1993a), King and Levine (1993b), Levine (1997), Levine and Zervos (1998)), others on pooled time series-cross sectional country level data (see Beck et al. (2000) and Levine et al. (2000)). For a different approach see Rajan and Zingales (1998) who rely on industry level data to show that industries with the greater need of external finance, grow faster in more financially developed countries. Guiso et al. (2004) confirm this result for a larger set of countries. They use also firm level data to show that smaller firms benefit more than large ones from financial development. Demirguc-Kunt and Maksimovic (1998) show that firms grow at a faster rate, relative to a benchmark growth rate that would hold in the absence of external finance, in countries with a more developed financial system. See Bekaert et al. (2001) and Henry (2000) for evidence on the effect of stock market liberalization on growth and investment respectively.

[2] See, for instance, the theoetical contributions of Greenwood and Jovanovic (1990), Bencivenga and Smith (1991), Saint Paul (1992). Empirical evidence on this issue is limited. Beck et al. (2000) find that measures of financial development have a positive effect on aggregate TFP growth. Wurgler (2000) and Galindo Schiantarelli and Weiss (2003) present evidence on the beneficial effect of financial development or reform on the allocation of investment funds, using respectively industry or firm level data.

which GDP growth may be affected, as emphasized by King and Levine (1993) in the context of product variety endogenous growth models.

A direct empirical investigation of the effect of banking development on firm's innovative activities is exactly what we will carry out in this paper. We will use a rich data set on innovation at the firm level collected by Capitalia's Observatory of SMEs for a large number of Italian firms over the 90's that contains detailed categorical information on the introduction of process and product innovation. Moreover, the data set contains quantitative information on inputs of the innovation process and their financing at the firm level (such as R&D spending, fixed investment, human capital), in addition to standard firm balance sheet variables. The availability of direct input and output measures of the innovation process allows us to address the effect of banks on innovation head on, instead of relying on the consequences of the (unobserved) innovative process on TFP and GDP growth.

Focusing on Italy is very informative because there is considerable spatial diversity in the degree of financial development and it is reasonable to assume that "distance" matters in banking relationships, particularly for certain types of firms that may experience more difficulties in accessing security markets. A large fraction of the spatial diversity observed has been generated by the nature of banking regulation in effect from 1936 to the end of the 80's.[3] Moreover, the process of regulatory reform in the late 80's and 90's has led to important changes both in its size and in its structure. The different initial conditions in

[3] See Guiso et al. (2003a), (2003b)

the banking market resulting from the pre-existent regulations, have also had an effect on the pace of change in the local credit markets. The partly exogenous geographical variation in banking development and its differential evolution may help in identifying the effect of the size and structure of the banking sector on innovation.

Certainly we are not the first ones to investigate the real consequences of changes in the financial system at the local level. Several recent contributions have greatly enhanced our understanding in this area.[4] However, this is the first paper that investigates the complex link between development of the banking sector and innovation at the firm level, either within countries or across countries. Evidence on this issue is potentially very important in understanding one of the main channels through which financial development affects growth.

The structure of the paper is as follows. In Section 2 we will describe the data sets we will use and provide descriptive evidence on the evolution of the banking sector in Italy in the 90's and on the innovative activities of Italian firms. In Section 3 we will discuss the potential channels through which banking development may affect the introduction of innovations. In Section 4 we present the econometrics results. Section 5 concludes.

[4] Petersen and Rajan (1995) look at the effect of concentration in US local markets on lending relationships. Jayaratne and Strahan (1996) analyze the effect of banking deregulation in the US on growth, while Black and Strahan (2002) focus on its effect on entrepreneurship and credit availability, and Cetorelli and Strahan (2004) on the relationsip between bank competition and industry structure. There are several contributions for Italy. Angelini and Cetorelli (2000) study the effect of regulatory reform on banks' markups.Bonaccorsi di Patti and Gobbi (2001), investigate the effect of competition on the availability of credit. Bonaccorsi di Patti and Dell'Ariccia (2003) focus on firms' creation. Guiso, Sapienza and Zingales (2003a) present evidence of the effect of local financial development on a wide set of outcomes, such as business formation and firm entry and growth. Guiso, Sapienza and Zingales (2003b) study the effect of banking regulation on the cost and access to credit.

2 Data and Descriptive Statistics

The data used in this paper come from two main sources. Provincial data on the number and the concentration of bank branches come from the Bank of Italy whereas firm level data come from the most three recent surveys "Indagine sulle Imprese Manifatturiere" published every three years by Capitalia's Observatory of SMEs.

In Table 1 we report the evolution of branch density (number of branches divided by population) by province. This is a plausible measure of banking development and we will use extensively in our empirical work, also because it is available on a homogeneous basis for long periods of time. There are instead brakes in the series for total deposit or total loans, due to the reclassification, of "Istituti di Credito Speciale" that makes these two series less useful. The mean and the median of branch density both display large increases during the 90's, with the median increasing from 0.346 in 1991 to 0.489 in the 1998-2000 period. These increases are made possible by the process of banking deregulation that has allowed entry of new domestic actors in each local market, starting from the second part of the 80's. The density variable also displays a large interprovincial dispersion, as measured by the standard deviation or the interquartile range. Moreover, the dispersion has been increasing with time. In the last column we describe the distribution of the rate of change of branch density between 2000 and 1991. We observe that there is dispersion in the level of banking development: the median rate of increase in branch density is 43%, while the first and third quartiles are 29.1% and 55.7% respectively. Looking at the period

1991-2000 as a whole, the data suggest that the between (provinces) variation is more important than the within (over time) variation.

In the last line of the table we report the correlation between branch density in the 90's with branch density in 1936, the year in which the Italian banking system was reorganized and regulation put in place that basically determined the structure of the banking market until the beginning of deregulation. The correlation between bank distribution in 1936 and in the nineties is rather large (above 0.628) and significant and has changed rather slowly over the years, although one notices a small decrease as time goes by. The correlation of the rate of increase during the 90's with the initial value is negative (and significant), suggesting that banking development was faster in provinces where the banking sector was initially less developed.

In Table 2 we also describe the evolution of the branch based Herfindhal index. The data suggest that the level of average concentration, measured by the mean or the median, was rather stable, showing only a small decrease over time. Again, there is dispersion across provinces in the degree of concentration.

Firm level data come from the 6th, 7th and 8th surveys "Indagine sulle Imprese Manifatturiere" by Capitalia's Observatory of SMEs, OSMEs from now on.[5] These are three surveys conducted in 1995, 1998 and 2001 through questionnaires administered to a sample of manufacturing firms within the national borders and supplemented with standard balance sheet data. Questionnaires

[5] The surveys are run by the "Osservatorio sulle Piccole e Medie Imprese" (*Observatory over SMEs)*, an institution associated with Capitalia, an Italian bank. More detailed information about the surveys can be found at the web site www.capitalia.it.

collect information over the previous three years (1994-1992, 1997-1995 and 2000-1998). In each wave the sample is selected (partly) with a stratified method for firms with up to 500 workers, whereas firms above this threshold are all included. Strata are based on geographical area, industry and firm size. It is not clear however, that the stratification criteria have remained constant over time. Moreover some firms are added to the sample outside the stratification criteria. This may explain why one observes a large decline in the average size of the firms included in the sample, which makes it impossible to use aggregate wave statistics to track the evolution of relevant variables at the economy level. Each survey contains respectively 5415, 4497 and 4680 manufacturing firms, although many of them do not provide complete information on some of the variables relevant to our research. For this reason we were forced to exclude from the sample firms with incomplete information or with extreme observations for the variables of interest. Details of the sample selection procedures are contained in Appendix 1.

Table 3 summarizes information about the introduction of innovations by our sample of Italian firms and about the nature of the innovations. The first four rows report, separately for each wave, the frequencies of product innovations, of process innovations, of either a process or a product innovation, or of both. In the next two rows, the frequency of product (process) innovation is instead calculated conditional to having introduced a process (product) innovation. The last two rows report the probabilities of introducing a product (process) innovation conditional on performing R&D activity.

Some observations are in order. First, these descriptive statistics show that process innovation is more frequent than product innovation. Pooling the three waves, only 36.7% of firms declare to have introduced at least one product innovation. The share of firms introducing process innovation is instead higher (58%).

Second, the first four lines show an apparent decrease of the innovative activities of Italian firms, particularly in the 1998-2000 period. However, such conclusion would be probably misleading and, at least, premature since, as we have argued, the nature of the sample has changed and smaller firms have a greater weight, particularly in the last wave. For instance, the percentage of firms with less than 250 employees has increased from 84.33% in 1992-1994 to 87.64% in 1995-1997, to 93.25% in 1998-2000 (see Table A1). Similarly the average size of the total capital stock has decreased by approximately 24% between the first and second wave, and by almost 37% between the first and third wave of the survey (see last line of Table 4).

Third, the probability of introducing a product innovation is higher for firms that have also introduced a process innovation in the same time period. This is not surprising since the introduction of a new product may well require a new production technique or at least the updating of an existing one. However, process innovation does not necessarily imply product innovation. In fact, conditional on having introduced a new process, only around 47% of firms introduce a new product over the three waves.

Finally, the last two rows report the probabilities of introducing a product (process) innovation conditional on performing R&D activity. As it can be seen, the conditional probabilities are higher than the corresponding unconditional probabilities for both types of innovations. This suggests that R&D spending is positively correlated with both types of innovation. However, the share of firms introducing a process innovation is higher than the share of firms engaged in at least some R&D activity. This suggests that there are other determinants of the probability of introducing a new process, besides the own R&D conducted by the firm. For instance, new technologies may be embodied in the new capital goods purchased by the firm, in which case the firm avails itself of the technological improvements achieved in the domestic or foreign investment goods sectors.

Table 4 reports the mean (and standard deviation) for different measures of R&D intensity, expressed as a percentage of the total capital stock (fixed capital plus R&D capital), TK_t. For comparison, measures of intensity of investment in fixed capital are also reported. The R&D intensity measures are computed both for the total sample of firms and for those that are engaged in formal R&D activities. The most important information contained in Table 4 is the large percentage of firms characterized by zero formal R&D activity. For instance, approximately 57% of the firms display zero average R&D spending within each wave.

3 Product and Process Innovation and Banking Development

A useful way to organize our analysis is to think in terms of an innovation production function. In this context, the probability of introducing an innovation depends upon inputs internal to the firm (R&D, fixed investment, human capital) and external to the firm. The degree of development of the banking sector is one of the external inputs that affect the innovation output because it affects either the quantity of internal inputs or their quality and effectiveness. The degree of development of the banking sector will affect the amount of internal inputs chosen by the firm by determining the cost of external finance and/or its access to credit. For any given measured quantity of internal inputs, their quality may also be improved by an enhanced ability to screen and monitor projects. All these effects are likely to be stronger for informationally more opaque firms (such as small firms) and for types of projects that are more difficult to evaluate and are less collateralizable.

The idea that the development of financial intermediaries reduces the cost of acquiring information and it allows a better assessment and selection of investment project is central in explaining the role of banks in the growth process. The ability of financial intermediaries to improve information collection, with the resulting increase in the efficiency of resource allocation and hence growth, lies at the center of the theoretical contribution of Greenwood and Jovanovic (1990). More importantly for our purpose, King and Levine (1993) emphasize the role of intermediaries in reducing the resource cost of identifying those entrepreneurs more capable to generate an innovation. The fostering of innovations is therefore the key channel through which financial development affects growth.

We have seen that there are variations at the provincial level both in the level and the pace of banking development. Following banking deregulation in Italy, one can think of several channels through which local banking development may affect firms' innovative activities. To start with, it is likely that changes in our measure of banking development based on branch density reflects in large part the entry of new intermediaries in the local markets. This, plausibly, generates an outward shift in the supply of credit, leading to lower rates for all investment project, including those involving product or process innovations. The evidence contained in Angelini and Cetorelli (2003) suggests indeed that banking deregulation in Italy has lead to a decrease in the mark-up applied by banks over the cost of funds. Conversely, Guiso et al (2003a) show that the tightness of banking restrictions in 1936 increases the cost and lowers the availability of credit.

It is also possible that new entrants, in order to gain market shares, may be willing to finance riskier and more informationally opaque projects that were not being financed by the incumbents. To the extent that the introduction of product or process innovations is an inherently riskier business than a mere expansion of existing activities, the innovation activities in a province may benefit.

The lower cost or greater access to credit would have an effect on product or process innovation through its effect on the firm level inputs in the innovation process (R&D, fixed capital, etc.). Obviously all these considerations matter more for firms that are more dependent upon local banks for financing. There is indeed evidence that distance matters particularly for small firms that are likely to find it harder to establish relationships with credit suppliers in other provinces or to access funds in the open market.[6]

Equally importantly the new entrants may introduce better and more advanced practices in the screening, selection, evaluation, and monitoring of projects and entrepreneurs. Competitive pressure will also create an incentive for the incumbents to adopt such practices. These practices could include looking more carefully and with better tools to borrowers' future prospects, as opposed to relying purely on firms' marketable assets as collateral, which characterizes standard operating behavior in many cases. All this will have an effect on the cost and access to credit. However, the probability of introducing innovations may be effected, even for a given level of R&D or fixed capital spending, insofar as their quality or effectiveness is improved by the enhanced screening and monitoring practices.

It has been argued that the turmoil brought about by the entry of new banks in the local markets may hurt small firms. Petersen and Rajan (1995), for instance, argue that more competitive and less concentrated credit markets may make it more difficult for borrowers and lenders to intertemporally share surplus. The paper also present evidence for small US firms that the cost of credit decreases with concentration, while its availability increases.

[6]See Berger et al. (2001) and Petersen and Rajan (2003).

Cross country evidence on the effect of bank competition suggest that bank concentration decreases the likelihood of bank finance, with the impact decreasing in size (see Beck et al. (2002)). Bonaccorsi di Patti and Gobbi (2001) find that measures of concentration are positively and significantly associated with the quantitity of credit going to small firms in local provincial markets in Italy, while the association with measures of entry is negative for all firms. Branch density exerts, instead a positive effect to the credit flow to all firms. Bonaccorsi di Patti and dell'Ariccia (2003) find that bank competition is less favourable to the emergence of new firms in sectors where informational asymmetries are greater.

Estimates of growth regressions yield mixed results regarding the effect of competition in banking, although one mostly finds a positive effect.[7] Estimates of investment equations on micro data for developing countries suggest that the process of financial liberalization has decreased in most cases the severity of financing constraints for firms that are more likely a priori to suffer from informational asymmetries.[8] Similarly, micro investment equations suggest that the level of financial development lessens financing constraints for this type of firms.[9] Be as it may, whether the positive impact of banking development is counteracted by the effects emphasized by Petersen and Rajan is ultimately an empirical issue.

[7] See Cetorelli and Gambera (2001), Deidda and Fattouh (2002), Claessens and Laeven (2005).

[8] This is the case for Indonesia in the 80's (see Harris et al. (1994)), but not for Ecuador (see Jaramillo et al. (1994)). See also Gelos and Werner (1999) for Mexico and Gallego and Loayza (2000) for Chile. See Laeven (2003) for micro evidence for several countries.

[9] See Love (2003).

4 Econometric Results

In assessing the effect of local banking development on innovation, we will first model the probability of introducing product or process innovations as a function of local (provincial) financial development, measured by branch density. We will start from a simple specification that includes also firms' size and industry dummies. We then add regional dummies and provincial GDP to this specification. We finally include provincial dummies and firm level variables capturing R&D and investment intensity. We experiment both with logit and linear probability models, the latter estimated by OLS and IV, using banking structure variables from 1936 without or with more recent banking development information as instruments. We also present results from conditional logit models that control for both provincial and firm level components of the error term that are constant with time. Finally, we will estimate simple investment and R&D equations in which we will allow for a direct effect of financial development on spending and for interaction of financial development with balance sheets variables such as cash flow.

4.1 Probability models

We will first estimate a simple linear probability model by OLS and a logit model separately for product innovations (see Table 5) and process innovations (see Table 6) on the pooled firm level data. Initially we control only for firm size and sector and a time (wave) dummy (see column 1 and 2 of Table 5 and 6). In this specification we cannot distinguish whether banking development affects the quantity or the effectiveness of firm level inputs into the innovative process and we can only capture its total effect. Firm size is measured as the log of the capital stock (fixed capital plus R&D capital at the beginning of the first year of each wave). Our measure of banking development is branch density and it is measured as the average number of branches per capita over the three year period covered by each wave. In the calculation of the standard errors we allow for heteroskedasticity and for spatial correlation between the error term for firms within the same province. This correlation may reflect the presence of province level unobservables that may affect the probability of introducing an innovation.

The results for both the linear probability model and for the logit model suggest that the probability of introducing a product innovation is significantly and positively associated both with firm size and with the degree of banking development. The branch density variable remains significant in the logit specification at approximately the 5% level even after we control for regional dummies (see columns 3) or for regional dummies and the provincial level of GDP per capita (see column 7). These variables control for provincial and regional characteristics different from the degree of financial development that may affect the probability of introducing an innovation. For instance, there may be important geographical differences in the availability of human or social capital, in the quality of the court system, and the presence of tax or other incentives, all relevant determinants of firms' innovative activity. The effect of banking development is non trivial. For instance, going from the first quartile (0.305) to the third quartile (0.533) of branches per capita in 1991-2000 period, the logit model generates an approximate increase in the probability of introducing a product innovation between 3 and 4 percentage points. The effect of banking development is not robust, however, to the introduction of provincial dummies in the equation (see columns 5 and 6). This may reflect the fact that the between provinces variation in branch density is more important than the within province variation over time, so that the variation in branch density controlling for province dummies is not enough to pin down its coefficient precisely.

The results for the introduction of process innovation confirm a positive and significant positive association with size (see Table 6). The coefficient of branch density is significant only when the regional dummies are included. This, at first sight is somewhat puzzling, because regional dummies proxy for the level of social and human structure, the quality of institutions, and infrastructures, all of which are likely to increase the probability of introducing a process innovation and are likely to be positively associated with financial development. Their exclusion, therefore should lead to an upward bias in the coefficient of branch density. However, as Parisi et al (2002) show and as we will see shortly, the introduction of a process innovation is closely related to firms' investment in fixed capital, which was receiving tax and other incentives in the less developed regions of the South in this period. Indeed, the coefficient of the dummies for the southern regions are on average larger than those for the northern and central regions, which is consistent with the presence of tax and other incentives playing a role even more important than other factors that may hinder investment in the southern regions. Also in this case, the effect of banking development is sizeable. Going from the first quartile to the third quartile of branches per capita in 1991-2000, the increase in the probability of introducing a process innovation is between 4 and 7 percentage points in the logit model and between 5 and 9 percentage points in the linear probability model. Again the introduction of province dummies, makes the effect insignificant. However, in this case the point estimate of its coefficient increases both in the logit and in the linear probability model.

The positive association between branch density and the probability of an innovation in some specification is interesting, but it would be premature to give it a causal interpretation, particularly since the association is not significant when controlling for unobserved province effects. An interesting experiment is to see what happens when we instrument the branch density variable with its past values. One possibility is to follow the strategy in Guiso et al (2003a, 2003b) and instrument bank branches with variables that reflect the nature of the banking system in 1936, the year in which a fundamental reorganization of the banking system occurred and a set of rules and regulations were set in place that determined the structure of the banking system until the beginning of deregulation in the second half of the 80's. More specifically the instruments used are the 1936 values of branches per inhabitant, the share of bank branches owned by local branches over total branches, the number of saving banks, and the number of cooperative banks per capita. Guiso et al. explain in details why these variables have predictive power for the level of banking development in the more recent past, but the basic idea is that different types of banks faced different constraints in opening new branches (national banks were more tightly regulated, and within local banks, cooperative banks faced tighter constraints). Moreover they argue that the way regions vary in their banking structure in 1936 is unrelated to the level of economic development at that time and that the differential treatment of different types of banks in the 1936 law were not driven by different regional economic factors, as opposed to political factors. Note that we use the provincial value of these variables, while Guiso et al (2003a, b), given the nature of their dependent variables use their regional values.[10] Moreover, the use of these instruments captures fundamentally the cross sectional heterogeneity in degrees of financial development, but cannot capture the effect of its evolution over time.[11] This means that they cannot be used in conjunction with province dummies. Finally, whereas the use of the 1936 instruments addresses the issue of the correlation between branch density and both the firm and province specific component of the error term and the idiosyncratic component, biases may derive from the correlation of firm specific variables with these components.

Be as it may, the results of IV estimation of the linear probability model are reported in Table 7 for both product and process innovation, for the specification without firm level R&D and investment intensity variables and in Table 8

[10] Italy is currently divided in 20 regions (similar to US States) and in 103 provinces (similar to US counties). In our empirical analysis we used only 91 provinces since this is the number of existing provinces in 1936.

[11] We have experimented by allowing the coefficient of the first stage regression to vary by wave. The results are qualitatively similar to the ones presented below.

for the specification that includes them. In this tables we also include results obtained when the 1936 instruments are augmented by the lagged value of the density variable (1991 for the 1992-94 wave, 1994 for the 1995-97 wave and 1997 for the 1998-2000 wave). In Table 7, the size of the coefficient of branch density remains similar to OLS for product innovation, but its significance disappears. The size of the branch density coefficient in the process innovation equation is similar to OLS, but it is only significant at approximately the 10% level. If we also use the (recent) lag of branch density as an additional instrument, the coefficient is significant at the 6% level for product and at the 1% level for process. In both cases, the tests of overidentifying restrictions do not suggest serious misspecifications of the model for product innovation, while for process innovation the test of overidentifying restriction is more marginal. When we include province level dummies the coefficient of banking development is not significant either for product or process innovation. The point estimate is actually negative for product innovation, while it is positive for process innovation.

In Table 8 we introduce in addition to wave, industry and region dummy, provincial GDP, branch density and firm size, other firm level variables, in particular fixed investment intensity measured as the average value of fixed investment over total fixed and R&D capital *(I/K)*, the average value of R&D expenditure relative to total capital, and their interaction. These variables can be thought as firm level inputs in the innovation production function. We have included fixed investment intensity, in addition to R&D intensity because, particularly for process innovation new process innovation may be embodied in new machines. Their interaction is meant to capture the effect that internal R&D has in identifying and facilitating the absorption of new technologies embodied in new investment goods. Both variables are highly significant both for product and process innovation, although, as in Parisi et al. (2002), the relative importance of fixed investment intensity is greater for process innovation. The interaction between fixed investment and R&D intensity is instead not significant. The results for the linear probability model estimated by IV suggest that the coefficient of branch density is significant at least at the 5% level with either the narrow or the more extended instrument set, both for product and process innovation, provided one does not include province dummies. Its size is even bigger than in the case in which the firm level variables are not included. This is somewhat puzzling since by including firm level inputs one would expect that the branch density variable should capture only the increase in the quality/effectiveness of these firm level inputs in generating an innovation. The Sargan test suggests that no major mispecifications are present neither in the product or process equation. With province dummies, the coefficient of branch density is never significant.

In Table 9 and 10 (still using IV, with 1936 instruments, but the results of OLS are similar) we perform a set of important experiments. In Table 9 we allow the effect of banking development to differ across high tech and low tech firms. The idea is to assess whether more informationally challenging activities to evaluate, presumably located in the high tech sectors, benefit differentially from a higher degree of banking development. In the more general specification containing region dummies, provincial GDP, size and investment and R&D intensity (columns 1 and 4), it appears that the branch density coefficient for firms in high tech sectors is larger and significant both for product and process innovation, while for firms in the low tech sectors is lower and not significant. In addition differences are statistically significant for process innovation. So a higher degree of banking development is particularly beneficial for firms in the more innovative sectors of the economy.

In Table 10 we interact the branch density dummy with a size dummy (employment greater or smaller than 250 workers). The expectation would be that small firms, since they are more dependent on local sources of finance, should respond more to local financial development. The results for product innovation (column 1) and process innovation (column 4) suggest that the coefficient of branch density for small firms is indeed larger and more significant than for large firms. The difference is statistically significant for process innovation.

Finally, in the remaining columns of Table 9 and 10, we also include as additional explanatory variable the provincial concentration level, as measured by the Herfindhal index with the purpose of capturing the toughness of competition in the banking sector at the provincial level. Existing theories point out that competition might have both a positive and a negative effect. We also include the rate of change in the bank branches density variable. Given a level of financial development, this variable is likely to be positively associated with the extent of entry of new players in the local market. As we have discussed previously, this will have varied effects, some positive (cost and efficiency effects), other potentially negative for more opaque firms (disruption of relationships). However, we find no support for any significant effect of concentration and only a marginally significant effect of the percentage change in branches on either product or process innovation.

A different estimation strategy to the one pursued so far is to control for unobserved firm and province characteristics that are relatively constant through time by using an appropriate transformation that eliminates the time invariant effects. Conditional logit models do so but only switchers contribute to the likelihood function. This is potentially a serious problem not only because a sizeable proportion of our panel is made by firms that are observed only at one point in time but also because product innovation has been found (see Parisi et al., 2002) to be a fairly persistent phenomenon. Another problem is that endogeneity can arise not only because of the presence of a firm specific time invariant effect but also because there is an idiosyncratic shock to the technological frontier that leads to an increase in both the probability of observing an innovation and in the incentive for banks to open new branches. With this caveat in mind results are presented in Table 11 for product innovation and in Table 12 for process innovation. For product innovation the parameter on branch density is always estimated very imprecisely, whether or not one includes R&D and fixed investment intensity. The same occurs when this parameter is allowed to vary between high tech and low tech firms or between large and small firms. The story for process innovation is different. The coefficient on branch density is positive and significant at approximately the 5% level when the intensity variables are not included and the same coefficient is imposed across size classes and sectors. The size of the coefficient decreases when the intensity variables are included (as one would expect) and it is now significant only at around the 10% level. Interestingly, whether or not one includes the intensity variables, the coefficient of banking development for firms in the high tech sector is larger than for those in the low tech sector and it is always significant at least at the 5% significance level, although the difference is not statistically significant.

4.2 Investment equations

In many of the models estimated in the previous equation we have included R&D and fixed investment intensity as controls. In this case one gets closer to estimating the effect of banking development that goes beyond its effect on the quantity of R&D and on fixed investment. Obviously, in order to assess the total effect of banking development on the probability of introducing an innovation, one must investigate whether financial development has an effect on R&D and fixed investment spending, and this is the issue we will discuss in this section. Banking development may have an effect on spending mainly through a cost of capital effect or through a relaxation of financing constraints effect, or both. For this reason we will include directly our branch density variable in a simple investment or R&D equation containing also the lagged dependent variable, output divided by total capital and cash flow divided by total capital. To control for macro effects common to all firms we will include also year dummies, so that we will be able to pick up an effect of banking development only if the evolution over time of the cost of capital varies across provinces. In the more general specification, the cash flow sensitivity of investment will be allowed to vary by size or by technological intensity of the sector. Moreover, the coefficient for each firm type will also depend upon the degree of banking development.

Since we now can rely on yearly observations on balance sheet variables, we will be able to control for firm (and province) time invariant effects. Moreover, we will recognize that our regressors will be correlated with the idiosyncratic component of the error term. We will use the GMM system estimator proposed by Blundell and Bond (2000) in which values lagged two or three times of output, cash flow, and branch density (or of the appropriate interactions) are used as instruments for the equation in differences and once lagged differences of the same variables as instruments for the equation in levels. In all cases, we will limit ourselves to firms that have at least six consecutive observations.

The results for fixed investment are reported in Table 13 and for R&D in Table 14. For R&D the branch density variable does not seem to play an important role, either directly or in affecting the cash flow sensitivity. For fixed investment the situation is different. Also here one cannot find evidence of a positive and significant direct effect of bank branches on investment. However, in this case the interaction between cash flow and branch density is negative and significant, suggesting that local financial development reduces the cash flow sensitivity of investment (see column 4 of Table 13). Moreover, if we allow the cash flow coefficient and its interaction with branch density to differ across firm size, we now see that the cash flow coefficient is larger and more significant for small firms. More importantly, financial development reduces significantly its size only for small firms, as one would expect, since these firms are more dependent on local sources of finance (see column 6).

5 Conclusions

What is the final verdict on the effect of local (provincial) banking development on growth? There is clear evidence that banking development has lessened the severity of financing constraints faced by small firms when they invest in fixed capital. Small firms are indeed those that are likely to rely more heavily on local banks for their financing needs. However, there is no such evidence for R&D spending. To the extent that investment in fixed capital is an internal input of the innovation production function, the relaxation of financing constraints will have a positive effect on the introduction of product and process innovation.

There is also evidence of a positive effect of banking development on the probability of introducing an innovation, controlling for regional unobserved heterogenity and provincial level GDP. This result is robust, particularly for process innovation, to instrumenting financial development with variables that capture the banking structure in 1936 and to the introduction of R&D and fixed investment intensity as determinants of the probability of introducing an innovation. The effect is larger for firms in high tech sectors and for small firms.

However, these results are not robust to the inclusion of provincial dummies in the specification. Yet, in a conditional logit model that controls both for province and firm level time invariant components of the error term, process innovation is significantly and positively related to local banking development. The significance at conventional levels remains for high tech firms, even after controlling for R&D and fixed investment intensity. On balance, there is some evidence from the probability models that local banking development plays a role, especially for process innovation. Such role, for certain types of firms, goes beyond the effect on the quantity of R&D and fixed investment spending, suggesting that a more developed financial system with the ability to select and monitor projects and entrepreneurs exercises a direct positive effect on firms' innovative activity.

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Table 1: Branches to Population Ratio

	(1) 1936	(2) 1991	(3) 1992-94	(4) 1995-97	(5) 1998-00	(6) 1991-00	(7) Δ%00-91
Observations	91	91	91	91	91	910	91
Mean	0.204	0.346	0.391	0.444	0.489	0.432	47.1
Standard Deviation	0.109	0.123	0.131	0.155	0.164	0.156	34.5
- within	..	..	..	..	..	0.058	..
- between	..	..	..	..	..	0.146	..
First Quartile	0.130	0.255	0.291	0.308	0.345	0.305	29.1
Median	0.182	0.361	0.408	0.470	0.509	0.432	42.1
Third Quartile	0.256	0.419	0.469	0.533	0.591	0.533	55.7
Correlation with 1936	..	0.679 (0.00)	0.664 (0.00)	0.641 (0.00)	0.628 (0.00)	..	-0.168 (0.11)
Correlation with 1991	..	..	..	..	..	..	-0.310 (0.00)

Note: The ratio is constructed by dividing the number of branches in each province by population in thousands. Columns (3) to (5) refer to the three year period average ratio ; column (6) refers to the pooled sample over the 1991-2000 period; column (7) refers to the percentage variation in the 1991-2000 period. Pvalues of the null hypothesis that the correlation coefficient is 0 in round brackets.

Table 2: Herfindhal Index

	1991	1992-94	1995-97	1998-00
Observations	91	91	91	91
Mean	0.148	0.143	0.139	0.141
Standard Deviation	0.066	0.063	0.058	0.078
First Quartile	0.100	0.094	0.096	0.095
Median	0.135	0.132	0.131	0.129
Third Quartile	0.178	0.170	0.160	0.162

Note: The Herfindhal Index ranges from 0 (atomistic market) to 1 (fully concentrated market)

Table 3: Share of Innovative Firms by Type of Innovation (%)

	1992-94	**1995-97**	**1998-00**	**Total**
Observations	2055	2088	1882	6025
Process	64.23	68.49	39.64	58.02
Product	49.00	34.34	25.72	36.65
Process or Product	75.67	75.72	48.72	67.27
Process and Product	35.57	27.11	16.63	27.40
Process | Product	76.66	78.94	64.67	74.77
Product | Process	58.48	39.58	41.96	47.23
Process | R&D average > 0	78.90	83.20	56.21	73.33
Product | R&D average > 0	68.06	52.49	43.92	56.22

Note: the last four rows refer to conditional frequencies

Table 4: Descriptive Statistics (mean and standard deviation)

	1992-94	**1995-97**	**1998-00**	**Total**
Observations	2055	2088	1882	6025
Fixed investment intensity	0.147(0.135)	0.207(0.197)	0.186(0.192)	0.180(0.178)
R&D intensity	0.028(0.046)	0.018(0.038)	0.022(0.042)	0.023(0.043)
Share of Observations (R&D av. > 0)	51.19	36.49	41.50	43.07
R&D intensity | R&D av. > 0	0.055(0.052)	0.049(0.050)	0.053(0.052)	0.053(0.052)
Total Capital	11.5(35.7)	8.7(26.6)	5.5(27.0)	8.6(30.2)

Note: Intensities are investment ratios with respect to total capital. Intensities and total capital are averaged over three-year periods. Total Capital is in million Euros at 2000 prices.
(R&D av. > 0) counts all firms which invested in R&D in at least one year in the observed period.

Table 5: Basic Product Innovation Probability Equations

Number of firms	6025	6025	6025	6025	5997	6025	6025	6025
Estimation method	Logit	Lin. Pr.	Logit	Lin. Pr.	Logit	Lin. Pr.	Logit	Lin. Pr.
Dependent variable	Product	Product	Product	Product	Product	Product	Product	Product
$(\text{Firm Size})_{it}$	0.276	0.058	0.283	0.059	0.285	0.059	0.282	0.059
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$(\text{N. of Branches})_{jt}$	0.900	0.175	0.826	0.150	−1.355	−0.396	0.836	0.152
	(0.001)	(0.001)	(0.057)	(0.100)	(0.335)	(0.167)	(0.052)	(0.092)
$(\text{GDP})_{jt}$	..	..	..	..	..	..	0.003	0.001
							(0.718)	(0.636)
Marginal effect, branches	0.205	..	0.188	..	−0.308	..	0.190	..
(Pseudo) R^2	0.084	0.105	0.087	0.109	0.093	0.118	0.087	0.109
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummies	No	No	Yes	Yes	No	No	Yes	Yes
Provincial dummies	No	No	No	No	Yes	Yes	No	No

Note: All regressions include a constant and two wave dummies. Standard errors in all columns but 5 and 6 are robust to within province heteroskedasticity and correlation. Pvalues of the null that each coefficient is equal to 0 in round brackets. Marginal effects are computed at the sample means of the explanatory variables.

Table 6: Basic Process Innovation Probability Equations

Number of firms	6025	6025	6025	6025	6008	6025	6025	6025
Estimation method	Logit	Lin. Pr.	Logit	Lin. Pr.	Logit	Lin. Pr.	Logit	Lin. Pr.
Dependent variable	Process	Process	Process	Process	Process	Process	Process	Process
$(\text{Firm Size})_{it}$	0.252	0.055	0.256	0.055	0.253	0.054	0.255	0.055
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$(\text{N. of Branches})_{jt}$	−0.063	−0.011	1.073	0.242	2.008	0.403	1.108	0.250
	(0.810)	(0.852)	(0.005)	(0.005)	(0.149)	(0.183)	(0.003)	(0.003)
$(\text{GDP})_{jt}$	..	..	..	..	..	..	0.013	0.003
							(0.200)	(0.227)
Marginal effect, branches	−0.015	..	0.260	..	0.486	..	0.268	..
(Pseudo) R^2	0.078	0.103	0.080	0.105	0.088	0.117	0.080	0.106
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummies	No	No	Yes	Yes	No	No	Yes	Yes
Provincial dummies	No	No	No	No	Yes	Yes	No	No

Note: as in Table 5

Table 7: IV Linear Probability Models

Number of firms	6025	6025	6025	6025	6025	6025
Estimation method	IV Lin Pr.	IV Lin Pr.	IV Lin Pr.	IV Lin Pr.	IV Lin Pr.	IV Lin Pr.
Dependent variable	Product	Product	Product	Process	Process	Process
$(\text{Firm Size})_{it}$	0.059	0.059	0.059	0.055	0.055	0.054
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$(\text{N. of branches})_{jt}$	0.221	0.166	-0.573	0.268	0.256	0.500
	(0.147)	(0.061)	(0.177)	(0.103)	(0.002)	(0.250)
$(\text{GDP})_{jt}$	0.001	0.001	..	0.003	0.003	..
	(0.596)	(0.624)		(0.208)	(0.218)	
Industry dum.	Yes	Yes	Yes	Yes	Yes	Yes
Regional dum.	Yes	Yes	No	Yes	Yes	No
Provincial dum.	No	No	Yes	No	No	Yes
Sargan	[0.124]	[0.196]	..	[0.045]	[0.086]	..
Difference Sargan	..	[0.592]	..	..	[0.103]	..

Note: In columns 1-2 and 4-5 the number of branches is instrumented with the number of saving banks per capita, the share of branches from local (non national) banks, the number of branches per capita, the number of cooperative banks per capita, all at provincial level and dated 1936. Instrument sets in columns 2 and 5 also include the branches to population ratio dated the year before the beginning of the wave. Instrument set in columns 3 and 6 only includes the braches to population ratio dated the year before the beginning of the wave. All regressions include a constant and two wave dummies. Standard errors in all columns but 3 and 6 are robust to within province heteroskedasticity and correlation. Pvalues of the null that each coefficient is equal to 0 in round brackets. Sargan is a Sargan test of the validity of the overidentifying restrictions and Difference Sargan is a test of the additional overidentifying restriction in columns 2 and 5 with respect to columns 1 and 4. Pvalues of the Sargan and Difference Sargan tests in square brackets.

Table 8: IV Linear Probability Models with Firm-Level Variables

Number of firms	6025	6025	6025	6025	6025	6025
Estimation method	IV Lin Pr.	IV Lin Pr.	IV Lin Pr.	IV Lin Pr.	IV Lin Pr.	IV Lin Pr.
Dependent variable	Product	Product	Product	Process	Process	Process
$(\text{Firm Size})_{it}$	0.058	0.058	0.058	0.068	0.068	0.066
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$(\text{N. of Branches})_{jt}$	0.337	0.224	−0.434	0.336	0.308	0.634
	(0.036)	(0.013)	(0.298)	(0.043)	(0.000)	(0.133)
$(\text{GDP})_{jt}$	0.000	0.000	..	0.002	0.002	..
	(0.838)	(0.912)		(0.332)	(0.349)	
$(\text{Inv. Int.})_{it}$	0.115	0.115	0.103	0.561	0.561	0.551
	(0.001)	(0.001)	(0.006)	(0.000)	(0.000)	(0.000)
$(\text{R\&D Int.})_{it}$	2.077	2.073	2.071	1.827	1.826	1.877
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$(\text{Inv. Int.})_{it}(\text{R\&D Int.})_{it}$	0.253	0.235	0.333	−0.648	−0.653	−0.618
	(0.744)	(0.762)	(0.634)	(0.383)	(0.381)	(0.381)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	No	Yes	Yes	No
Provincial dummies	No	No	Yes	No	No	Yes
Sargan	[0.159]	[0.213]	..	[0.089]	[0.166]	..
Difference Sargan	..	[0.425]	..	..	[1.000]	..

Note: As in Table 7

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Table 9: Parameter Constancy Tests: Technological Level

Number of firms	6025	6025	6025	6025	6025	6025
Estimation method	IV Lin Pr.	IV Lin Pr.	IV Lin Pr.	IV Lin Pr.	IV Lin Pr.	IV Lin Pr.
Dependent variable	Product	Product	Product	Process	Process	Process
$(\text{Firm Size})_{it}$	0.058	0.058	0.057	0.068	0.068	0.068
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$(\text{High Tech})_{it}(\text{N. of Branches})_{jt}$	0.444	0.422	0.379	0.566	0.565	0.499
	(0.024)	(0.060)	(0.084)	(0.001)	(0.002)	(0.003)
$(\text{Low Tech})_{it}(\text{N. of Branches})_{jt}$	0.269	0.274	0.191	0.241	0.253	0.165
	(0.106)	(0.115)	(0.305)	(0.181)	(0.157)	(0.315)
$(\text{High Tech})_{it}(\text{Herfindhal})_{jt}$	..	0.002	..	..	0.486	..
		(0.999)			(0.617)	
$(\text{Low Tech})_{it}(\text{Herfindhal})_{jt}$	..	0.811	..	..	0.983	..
		(0.256)			(0.215)	
$(\text{High Tech})_{it}(\Delta\text{ branches})_{jt}$	..	..	0.011	..	..	0.009
			(0.112)			(0.112)
$(\text{Low Tech})_{it}(\Delta\text{ branches})_{jt}$	..	..	0.007	..	..	0.000
			(0.289)			(0.968)
$(\text{GDP})_{jt}$	0.000	0.004	−0.002	0.002	0.008	0.001
	(0.843)	(0.401)	(0.343)	(0.332)	(0.126)	(0.575)
$(\text{Inv. Int.})_{it}$	0.115	0.117	0.117	0.562	0.564	0.564
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
$(\text{R\&D Int.})_{it}$	2.074	2.075	2.090	1.822	1.835	1.795
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$(\text{Inv. Int.})_{it}(\text{R\&D Int.})_{it}$	0.270	0.271	0.204	−0.613	−0.619	−0.544
	(0.731)	(0.734)	(0.795)	(0.412)	(0.407)	(0.453)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Sargan test	[0.341]	[0.170]	[0.400]	[0.092]	[0.066]	[0.162]
Parameter Constancy test (Branches)	[0.291]	[0.460]	[0.274]	[0.001]	[0.021]	[0.012]
Parameter Constancy test (Herfindhal)	..	[0.644]	..	..	[0.684]	..
Parameter Constancy test (Δ branches)	..	..	[0.422]	..	..	[0.734]

Note: The level and the growth of branches as well as the Herfindhal index (interacted with the high tech dummy) are instrumented with the number of saving banks per capita, the share of branches from local (non national) banks, the number of branches per capita, the number of cooperative banks per capita, all at provincial level, dated 1936 and interacted with the high tech dummy. All regressions include a constant and two wave dummies. Standard errors robust to within province heteroskedasticity and correlation. Pvalues of the null that each coefficient is equal to 0 in round brackets. Sargan is a Sargan test of the validity of the overidentifying restrictions. Pvalues of the Sargan test in square brackets. Parameter constancy test is a Wald test of the equality of the effect of number of branches, Δ branches and Herfindhal in high and in low tech sectors.

Table 10: Parameter Constancy Tests: Size

Number of firms	6025	6025	6025	6025	6025	6025
Estimation method	IV Lin Pr.	IV Lin Pr.	IV Lin Pr.	IV Lin Pr.	IV Lin Pr.	IV Lin Pr.
Dependent variable	Product	Product	Product	Process	Process	Process
$(\text{Firm Size})_{it}$	0.062	0.062	0.062	0.073	0.073	0.072
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$(\text{Large Firm})_{it}(\text{N. of Branches})_{jt}$	0.281	0.150	−0.005	0.273	0.549	−0.003
	(0.119)	(0.850)	(0.985)	(0.128)	(0.344)	(0.992)
$(\text{Small Firm})_{it}(\text{N. of Branches})_{jt}$	0.350	0.395	0.338	0.351	0.309	0.364
	(0.030)	(0.080)	(0.073)	(0.035)	(0.105)	(0.035)
$(\text{Large Firm})_{it}(\text{Herfindhal})_{jt}$	..	1.291	..	..	−0.624	..
		(0.748)			(0.813)	
$(\text{Small Firm})_{it}(\text{Herfindhal})_{jt}$	..	0.468	..	..	0.857	..
		(0.413)			(0.251)	
$(\text{Large Firm})_{it}(\Delta\text{ branches})_{jt}$	..	..	0.015	..	..	0.010
			(0.099)			(0.164)
$(\text{Small Firm})_{it}(\Delta\text{ branches})_{jt}$	..	..	0.008	..	..	0.004
			(0.193)			(0.451)
$(\text{GDP})_{jt}$	0.001	0.005	−0.002	0.002	0.001	0.001
	(0.748)	(0.290)	(0.336)	(0.277)	(0.163)	(0.720)
$(\text{Inv. Int.})_{it}$	0.121	0.120	0.122	0.568	0.574	0.569
	(0.001)	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)
$(\text{R\&D Int.})_{it}$	2.073	2.089	2.094	1.822	1.833	1.820
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$(\text{Inv. Int.})_{it}(\text{R\&D Int.})_{it}$	0.273	0.268	0.183	−0.626	−0.644	−0.640
	(0.725)	(0.733)	(0.821)	(0.402)	(0.378)	(0.406)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Sargan test	[0.212]	[0.174]	[0.527]	[0.218]	[0.106]	[0.169]
Parameter Constancy test (Branches)	[0.217]	[0.791]	[0.218]	[0.034]	[0.715]	[0.141]
Parameter Constancy test (Herfindhal)	..	[0.850]	..	..	[0.624]	..
Parameter Constancy test (Δ branches)	..	..	[0.287]	..	..	[0.248]

Note: The level and the growth of branches as well as the Herfindhal index (interacted with the size dummy) are instrumented with the number of saving banks per capita, the share of branches from local (non national) banks, the number of branches per capita, the number of cooperative banks per capita, all at provincial level, dated 1936 and interacted with the size dummy. All regressions include a constant and two wave dummies. Standard errors are robust to within province heteroskedasticity and correlation. Pvalues of the null that each coefficient is equal to 0 in round brackets. Sargan is a Sargan test of the validity of the overidentifying restrictions. Pvalues of the Sargan test in square brackets. Parameter constancy test is Wald test of the equality of the effect of number of branches, Δ branches and Herfindhal for small and large firms.

Table 11: Conditional Logit Models: Product Innovation

Number of firms	398	398	398	398	398	398
Number of observations	867	867	867	867	867	867
Estimation method	Con. Logit	Con. Logit	Con. Logit	Con. Logit	Con. Logit	Con. Logit
Dependent variable	Product	Product	Product	Product	Product	Product
$(\text{Firm Size})_{it}$	−0.197 (0.368)	−0.211 (0.338)	−0.181 (0.411)	0.489 (0.120)	0.484 (0.126)	0.506 (0.110)
$(\text{N. of Branches})_{jt}$	0.826 (0.812)	..	..	0.486 (0.891)	..	..
$(\text{High Tech})_{it}(\text{N. of Branches})_{jt}$	..	−1.075 (0.780)	..	..	−1.466 (0.708)	..
$(\text{Low Tech})_{it}(\text{N. of Branches})_{jt}$	..	1.713 (0.631)	..	..	1.444 (0.691)	..
$(\text{Large Firm})_{it}(\text{N. of Branches})_{jt}$	..	..	3.134 (0.475)	..	..	2.991 (0.500)
$(\text{Small Firm})_{it}(\text{N. of Branches})_{jt}$	..	..	0.561 (0.872)	..	..	0.162 (0.964)
$(\text{GDP})_{jt}$	−0.072 (0.758)	−0.074 (0.752)	−0.072 (0.760)	−0.082 (0.732)	−0.083 (0.726)	−0.081 (0.735)
$(\text{Inv. Int.})_{it}$	..	..	..	2.632 (0.002)	2.658 (0.002)	2.629 (0.002)
$(\text{R\&D Int.})_{it}$	..	..	..	6.593 (0.038)	6.522 (0.040)	6.789 (0.034)
$(\text{Inv. Int.})_{it}(\text{R\&D Int.})_{it}$	..	..	..	−16.429 (0.177)	−16.309 (0.182)	−16.864 (0.167)
Parameter Constancy test (Branches)	..	[0.246]	[0.386]	..	[0.234]	[0.346]

Note: All regressions include two wave dummies. Pvalues of the null that each coefficient is equal to 0 in round brackets.

Table 12: Conditional Logit Models: Process Innovation

Number of firms	469	469	469	469	469	469
Number of observations	1017	1017	1017	1017	1017	1017
Estimation method	Con. Logit	Con. Logit	Con. Logit	Con. Logit	Con. Logit	Con. Logit
Dependent variable	Process	Process	Process	Process	Process	Process
$(\text{Firm Size})_{it}$	−0.489 (0.046)	−0.469 (0.056)	−0.489 (0.047)	−0.048 (0.883)	−0.037 (0.911)	−0.042 (0.898)
$(\text{N. of Branches})_{jt}$	6.842 (0.053)	..	..	5.925 (0.103)	..	..
$(\text{High Tech})_{it}(\text{N. of Branches})_{jt}$	..	8.562 (0.025)	..	..	7.895 (0.044)	..
$(\text{Low Tech})_{it}(\text{N. of Branches})_{jt}$	..	5.569 (0.133)	..	..	4.448 (0.244)	..
$(\text{Large Firm})_{it}(\text{N. of Branches})_{jt}$	..	..	7.343 (0.122)	..	..	7.341 (0.131)
$(\text{Small Firm})_{it}(\text{N. of Branches})_{jt}$	..	..	6.783 (0.057)	..	..	5.751 (0.116)
$(\text{GDP})_{jt}$	0.108 (0.647)	0.109 (0.643)	0.135 (0.572)	0.132 (0.580)	0.136 (0.573)	0.135 (0.572)
$(\text{Inv. Int.})_{it}$	..	..	..	1.275 (0.100)	1.224 (0.115)	1.282 (0.098)
$(\text{R\&D Int.})_{it}$	..	..	..	7.370 (0.052)	7.633 (0.043)	7.385 (0.052)
$(\text{Inv. Int.})_{it}(\text{R\&D Int.})_{it}$	..	..	..	17.538 (0.295)	17.333 (0.295)	17.803 (0.288)
Parameter Constancy test (Branches)	..	[0.224]	[0.874]	..	[0.172]	[0.660]

Note: As in Table 11.

Table 13: Fixed Investments equations

Number of firms	899	899	899	899	899	899
Number of observations	4903	4903	4903	4903	4903	4903
Estimation method	GMM Sys	GMM Sys	GMM Sys	GMM Sys	GMM Sys	GMM Sys
Dependent variable	$(I/K)_{it}$	$(I/K)_{it}$	$(I/K)_{it}$	$(I/K)_{it}$	$(I/K)_{it}$	$(I/K)_{it}$
$(I/K)_{it-1}$	0.357 (0.000)	0.373 (0.000)	0.320 (0.000)	0.293 (0.000)	0.336 (0.000)	0.288 (0.000)
$(Y/K)_{it-1}$	0.004 (0.175)	0.003 (0.170)	0.005 (0.103)	0.004 (0.095)	0.003 (0.134)	0.004 (0.080)
$(CF/K)_{it}$	0.057 (0.027)	..	..	0.232 (0.003)	..	..
$(\text{branches})_{jt}$	−0.169 (0.090)	..	..	0.002 (0.985)	..	..
$(CF/K)_{it}(\text{branches})_{jt}$	..	..	..	−0.359 (0.013)	..	..
$(\text{High Tech})_{it}(\text{N. of Branches})_{jt}$	..	−0.146 (0.135)	..	..	−0.060 (0.577)	..
$(\text{Low Tech})_{it}(\text{N. of Branches})_{jt}$	..	−0.152 (0.128)	..	..	−0.026 (0.805)	..
$(\text{High Tech})_{it}(CF/K)_{it}$	..	0.034 (0.260)	..	..	0.116 (0.261)	..
$(\text{Low Tech})_{it}(CF/K)_{it}$	..	0.044 (0.146)	..	..	0.131 (0.156)	..
$(\text{Large Firm})_{it}(\text{N. of Branches})_{jt}$	..	..	−0.195 (0.053)	..	..	−0.054 (0.575)
$(\text{Small Firm})_{it}(\text{N. of Branches})_{jt}$	..	..	−0.182 (0.065)	..	..	−0.030 (0.744)
$(\text{Large Firm})_{it}(CF/K)_{it}$	..	..	0.084 (0.032)	..	..	0.185 (0.177)
$(\text{Small Firm})_{it}(CF/K)_{it}$	..	..	0.052 (0.054)	..	..	0.205 (0.006)
$(\text{High Tech})_{it}(CF/K)_{it}(\text{branches})_{jt}$	..	..	..	..	−0.120 (0.530)	..
$(\text{LowTech})_{it}(CF/K)_{it}(\text{branches})_{jt}$	..	..	..	..	−0.194 (0.246)	..
$(\text{Large Firm})_{it}(CF/K)_{it}(\text{branches})_{jt}$	..	..	..	..	..	−0.188 (0.422)
$(\text{Small Firm})_{it}(CF/K)_{it}(\text{branches})_{jt}$	..	..	..	..	..	−0.318 (0.021)
Sargan test	[0.231]	[0.495]	[0.112]	[0.326]	[0.073]	[0.152]
AR(1)	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
AR(2)	[0.089]	[0.047]	[0.125]	[0.186]	[0.080]	[0.164]
Parameter Constancy test (Branches)	..	[0.931]	[0.478]	..	[0.739]	[0.316]
Parameter Constancy test (CF/K)	..	[0.796]	[0.610]	..	[0.914]	[0.887]
Parameter Constancy test (Branches)(CF/K)	..	..	..	..	[0.774]	[0.594]

Note: Results are obtained with the one step GMM System estimator with robust standard errors. The estimation sample is restricted to firms with at least 6 contiguous observations. The instrument set includes the regressors dated $t-2$. All equations include year and industry dummies as regressors and instruments. Sargan is a Sargan test of the validity of the overidentifying restrictions. AR(1) and AR(2) test that the errors in the differenced equations follow an AR(1) and an AR(2) process.

Table 14: R&D Investments equations

Number of firms	225	225	225	225	225	225
Number of observations	1218	1218	1218	1218	1218	1218
Estimation method	GMM Sys	GMM Sys	GMM Sys	GMM Sys	GMM Sys	GMM Sys
Dependent variable	$(RD/K)_{it}$	$(RD/K)_{it}$	$(RD/K)_{it}$	$(RD/K)_{it}$	$(RD/K)_{it}$	$(RD/K)_{it}$
$(RD/K)_{it-1}$	0.534 (0.000)	0.570 (0.000)	0.443 (0.000)	0.553 (0.000)	0.535 (0.000)	0.503 (0.000)
$(Y/K)_{it-1}$	−0.001 (0.176)	−0.000 (0.086)	−0.001 (0.319)	−0.001 (0.191)	−0.001 (0.151)	−0.000 (0.351)
$(CF/K)_{it}$	0.013 (0.126)	..	..	0.013 (0.578)	..	..
$(\text{branches})_{jt}$	−0.051 (0.137)	..	..	−0.039 (0.203)	..	..
$(CF/K)_{it}(\text{branches})_{jt}$	..	..	..	−0.003 (0.940)	..	..
$(\text{High Tech})_{it}(\text{N. of Branches})_{jt}$	..	−0.048 (0.005)	..	..	−0.055 (0.103)	..
$(\text{Low Tech})_{it}(\text{N. of Branches})_{jt}$	..	−0.021 (0.072)	..	..	0.022 (0.471)	..
$(\text{High Tech})_{it}(CF/K)_{it}$	..	0.009 (0.048)	..	..	0.010 (0.738)	..
$(\text{Low Tech})_{it}(CF/K)_{it}$	..	0.010 (0.026)	..	..	0.009 (0.632)	..
$(\text{Large Firm})_{it}(\text{N. of Branches})_{jt}$	..	..	−0.071 (0.058)	..	..	−0.046 (0.145)
$(\text{Small Firm})_{it}(\text{N. of Branches})_{jt}$	..	..	−0.066 (0.086)	..	..	−0.037 (0.237)
$(\text{Large Firm})_{it}(CF/K)_{it}$	..	..	0.011 (0.246)	..	..	0.031 (0.423)
$(\text{Small Firm})_{it}(CF/K)_{it}$	..	..	0.015 (0.184)	..	..	0.024 (0.397)
$(\text{High Tech})_{it}(CF/K)_{it}(\text{branches})_{jt}$	..	..	..	..	0.008 (0.879)	..
$(\text{Low Tech})_{it}(CF/K)_{it}(\text{branches})_{jt}$	..	..	..	..	0.002 (0.964)	..
$(\text{Large Firm})_{it}(CF/K)_{it}(\text{branches})_{jt}$	..	..	..	..	..	−0.032 (0.676)
$(\text{Small Firm})_{it}(CF/K)_{it}(\text{branches})_{jt}$	..	..	..	..	..	−0.028 (0.567)
Sargan test	[0.833]	[0.250]	[0.853]	[0.198]	[0.155]	[0.328]
AR(1)	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
AR(2)	[0.091]	[0.025]	[0.138]	[0.082]	[0.086]	[0.100]
Param. Constancy test (Branches)	..	[0.061]	[0.554]	..	[0.013]	[0.272]
Param. Constancy test (CF/K)	..	[0.865]	[0.760]	..	[0.970]	[0.867]
Param. Constancy test (Bran*CF/K)	..	..	..	..	[0.914]	[0.965]

Note: Results are obtained with the one step GMM System estimator with robust standard errors. The estimation sample is restricted to firms with at least 6 contiguous observations and with strictly positive R&D expenses in every year. The instrument set includes the regressors dated $t-2$. All equations include year and industry dummies as regressors and instruments. Sargan is a Sargan test of the validity of the overidentifying restrictions. AR(1) and AR(2) test that the errors in the differenced equations follow an AR(1) and an AR(2) process.

A Appendix 1: Sample Selection

The firm level data data used in this work are obtained by merging the three most recent waves (1995, 1998, 2001) of a comprehensive survey on Italian manufacturing firms carried out by Capitalia's Observatory on Small Firms every three years. Each wave reports standard balance sheet data for the previous three years (1992-94, 1995-97 and 1998-00 respectively) complemented by additional qualitative and quantitative information on several research issues including R&D and innovation. The three surveys include respectively 5415, 4497 and 4680 firms. As already mentioned in Section 2, all firms with more than 500 employees are included in each wave. Most of the firms with less than 500 employees are selected with a stratified sampling method in each wave. However, some of them (at the discretion of Capitalia) are kept in two consecutive waves. Therefore, even after conditioning on survival, the probability of finding a small firm in two separate waves is small.

We removed from the sample firms with missing or non-manufacturing activity codes, as well as firms with no indication of the location of headquarters. As we use provincial level instrument sets dated 1936 we removed firms located in four provinces (Isernia, Pordenone, Oristano and Caserta) created after 1936. Therefore our sample is composed by firms located in one of the remaining 91 provinces existing at the beginning of the '90s. Furthermore, we removed in each wave those with missing values or inconsistencies for the variables used in the econometric estimates or with extreme values for the variables. The first and last percentiles have been used as lower and upper thresholds for the trimming procedure. The following table describes our sample.

Table A.1. Firms distribution by size and technology in each sample, %

	1992-94	1995-97	1998-00	Total
Number of Firms before Cleaning	5415	4497	4680	14592
Number of Firms after Cleaning	2055	2088	1882	6025
of which Small-Medium	84.33	87.64	93.25	88.27
Large	15.67	12.36	6.75	11.73
of which High-Tech	35.47	31.42	29.91	32.33
Low-Tech	64.53	68.58	70.09	67.67

Note: A firm with less than 250 employees is defined as "Small-Medium". It is "Large" otherwise. A firm is defined as "High-Tech" if its main activity is one of the following: Chemicals, Machinery, Computers, Electrical Machinery, TV-Radio, Medical Apparels, Means of Transport. It is "Low-Tech" otherwise.

Some firms are sampled in more than on wave and apper more than once in our final sample. The following table describes the panel structure of the cleaned sample.

Table A.2. Panel structure of the sample

	Total number of firms	of which Small-Medium	of which High-Tech
1992-94 only	1476	1287	486
1995-97 only	1189	1090	341
1998-00 only	1236	1193	353
1992-94 & 1995-97	348	258	146
1992-94 & 1998-00	95	80	41
1995-97 & 1998-00	415	374	113
1992-94, 1995-97 & 1998-00	136	108	56

B Appendix 2: Variables Definition

Innovation dummies: the process (product) innovation dummy takes the value 1 if the firm has declared to have introduced at least one process (product) innovation in the period covered by the survey (1992-94, 1995-97, 1998-00), and zero otherwise.

Fixed Investment (I): yearly investment in plants and machinery as reported in the questionnaire deflated with the aggregate business investment price index.

R&D Investment ($R\&D$)**:** yearly R&D investment as reported in the questionnaire deflated with a weighted average of the consumer price index (0.8) and the aggregate business investment price index (0.2). Firms are provided with a definition of what has to be considered as R&D investment consistent with the Frascati manual.

Fixed Capital (K)**:** real fixed capital stock (at the end of the period), computed by a perpetual inventory method with a constant rate of depreciation ($\delta = 0.05$). The benchmark at the first year is the accounting value as reported in the balance sheet.

R&D Capital (G)**:** real R&D capital stock (at the end of the period) computed by a perpetual inventory method with a constant rate of depreciation ($\delta = 0.15$). The benchmark for the first year is calculated assuming that the rate of growth in R&D investment at the firm level in the years before the first positive observation equals the average growth rate of industry level R&D between 1980 and 1991. The initial stock at historical costs is revalued using the average inflation rate for the R&D deflator during the same period.

Total Capital (TK)**:** computed as the sum of fixed capital (K) and of R&D capital (G).

Industry Dummies: 21 industry dummies have been included in all equations reported in Tables from 5 to 12 (15+16 - food, beverages and tobacco; 17 - textiles; 18 - clothing; 19 - leather; 20 - wood; 21 - paper products; 22 - printing and publishing; 23 - oil refining; 24 - chemicals; 25 - rubber and plastics; 26 - non-metal minerals; 27 - metals; 28 - metal products; 29 - non-electric machinery; 30 - office equipment and computers; 31 - electric machinery; 32 - electronic material, measuring and communication tools, TV and radio; 33 - medical apparels and instruments; 34 - vehicles; 35 - other transportation; 36 - furniture). Each dummy takes the value 1 if the firm main activity is in that industry, and zero otherwise.

Regional Dummies: 18 regional dummies have been included in equations reported in Tables from 5 to 10, 13, and 14. To avoid collinearity with the time invariant instruments dated 1936 two one province regions (Molise and Valle d'Aosta) have been grouped with the nearest region (Piedmont and Abruzzi).