FINANCING INNOVATION: TRODDEN AND UNEXPLORED PATHS*

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* This is a slightly revised version of a paper prepared under the Fifth EU Programme, Key Action, Improving the Socio-economic Knowledge Base. It is the result of an extended Research Program called "Improving the human potential and the socio-economic knowledge base programs" that has been financed by the European Commission-DG Research and is under development since the fall of 2001. Participants in such program include, among others, Professors P. Stoneman, P. C. Padoan, A. Schertler, and other researchers from several European universities as the Kiel Institute of World Economics, the University of Oxford, the University of Rome "La Sapienza", the Institute for New Technologies of the United Nations University and the Warwick Business School of the University of Warwick. Further information can be obtained at the INTECH-UNU site: http://www.intech.unu.edu/publications. El artículo se recibió el 12/03/02 y se aprobó el 23/09/02.

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ABSTRACT

Some specific characteristics of innovation (such as vertical product differentiation, the strategic role of technological standards or the quasi public nature of technological knowledge) introduce additional complexity to the standard problem of the mismatch between investment projects and financial resources needed to realize them. Thus, the situation poses two questions: Is there an optimal design of rules and intermediaries to tackle this problem? Are existing domestic financial systems close to this optimal design? The paper collects and organizes theoretical and empirical results of research on several issues related to this question and suggests some relatively unexplored paths. These issues range from the interaction among market structure, stock market value, and innovation financing to theoretical models and empirical tests of multiple equilibria that explain how country fundamentals evolve into equilibria of high (low) development of financial institutions and high (low) real growth.

Key Words: Financial system, Financial intermediaries, Financial constraints, Innovation, Asymmetric information, Technology-based firms.

RESUMEN

Debido a algunos rasgos específicos de la innovación, por ejemplo, la diferenciación vertical de los productos, el papel estratégico que juegan los estándares tecnológicos y la naturaleza de bien semi-público de la información, el problema de la "coincidencia" entre proyectos de inversión y recursos financieros se hace aún más complejo. Ante tan intrincada situación, cabe preguntarse si existe, por ejemplo, un diseño óptimo de reglas y unos intermediarios que permitan afrontarla y si los sistemas financieros existentes en cada país se aproximan a tal diseño o no. El artículo organiza y examina sistemáticamente la información teórica y empírica disponible gracias a los distintos estudios realizados sobre este argumento y delinea algunas direcciones aún no exploradas suficientemente. Los temas cubiertos abarcan desde la interacción que existe entre la estructura del mercado, el valor de mercado y el financiamiento de las innovaciones hasta los modelos teóricos y las pruebas empíricas de equilibrio múltiple que explican la evolución de los aspectos fundamentales hacia equilibrios de alto (bajo) desarrollo de las instituciones financieras y el alto (bajo) crecimiento real.

Palabras clave: Sistema financiero, intermediarios financieros, restricciones financieras, innovación, información asimétrica, empresas de base tecnológica.

Introduction

An analysis of the relationship among finance, investment and innovation is of great relevance in an "opaque" Schumpeterian world in which innovative goods may be viewed as complex "systemic" products. Such a world is characterized by three distinguishing features: i) the market performance of high-tech sectors is dramatically influenced by the pace of subsequent innovations; ii) asymmetric information does not always ensure a successful matching between innovating entrepreneurs and financial investors; iii) the standards adopted for defining the architecture of complex systemic products created through an integration among different components have crucial effects on the success of innovation beyond their own technological potential.[1]

Even though financial integration is progressively marking differences among domestic financial systems less clear cut than they were before, it may be useful to organize our analysis around "archetypal" financial systems which are useful examples to illustrate some features to which actual financial systems seem to converge.

Policymakers' decisions over the reform of financial institutions may therefore be aided by the evaluation of the performance of four major financial systems (see Table 1) in supporting investment and innovation: i) the "German system" in which major banks, either directly or through managing portfolios for individual savers, dispose of large equity participation in innovating industries;[2] ii) the Anglo-Saxon "atomistic" system in which the role of financing innovation is played, in presence of a relatively lower bank-firm participation, by dispersed shareholders, closed-end funds and venture capitalists in a fully developed financial market (Edwards-Fisher, 1993); iii) the "opaque" "Japanese" system in which large conglomerates determine a high degree of concentration and integration between financial and innovating sectors;[3] iv) the "bank-

[1] Tushman and Anderson (1986) argue that *"It may be fruitful to conceptualize products as systems made up of core technologies and associated linkage technologies."* Becchetti-Paganetto (2001) analyze the behavior of a company with a systemic product developing an optimal contractual design separating component producers' qualities and providing optimal incentives to them. The particular features of the system company generate, however, a static and an intertemporal dilemma in its optimizing behavior. The static dilemma implies these alternatives: i) releasing property rights to component producers to increase their incentives, and ii) maintaining more control on "strategic" components to improve her "systemic" capacity. Empirical results (Tani, 1996; Danelmayer, 1998) seem consistent with these propositions. An EEC project report (Danelmayer, 1998) analyses outsourcing-internalization decisions of 35 System-Companies (SC's) on 120 different component products (CP's). The report shows that about 70% of vertical integration, persistence of vertical integration and partial or complete outsourcing decisions of SC's depend on changes in the systemic role of CP's which tend to be internalized when they have *strategic* influence on the SC's systemic capacity.

[2] Banks often possess a relevant stake of company shares because they add the management of portfolios of individual savers to their own participation. Bank proximity to firms mitigates informational asymmetries and generates "lender of last resort" advantages, though it is not possible to say that it reduces the cost of external financing. Interest rates on bank loans are generally expensive because of monitoring costs and reserve requirement costs implicitly charged on them (Edwards-Fisher, 1993).

[3] Because of historical reasons, the existing organization concerning the relationship between the financial and real sectors in Japan has acquired

dependent" Italian system characterized by a "liquidity-volatility" dilemma and costs of information disclosure that prevent small and medium firms from being listed on the domestic exchange and determine an abnormally small stock market capitalization over GDP. In such a system, bond financing is crowded out by public debt so it is not a substitute of bank financing.

These four models of interaction between financiers and investors originated as endogenous responses to "country fundamentals" (national, social and legal norms)[4] and are now evolving to face new challenges.

Our survey will try to provide some support for policymakers' decisions by taking a close look at the evolution and integration of financial systems on the basis of empirical evidence and theoretical arguments developed in the literature on comparative financial systems and their performance in financing innovation.

The paper is divided into five sections, including introduction and conclusions. The first section is our introduction. In the second section, we analyze the problem from a micro-theoretical perspective. This section presents a vast number of contributions that research the effects of informational asymmetries in the relationship among finance, investment and innovation, highlighting the actual, potential roles of national financial systems in reducing such informational asymmetries. In the third section, we discuss some methodological problems that arise when attempting to measure and compare financial constraints in different institutional frameworks, to evaluate their relative capacity in matching innovative ideas and financial resources. In this section, we examine the most recent micro-empirical results as tests of the relative effectiveness of national financial systems in dealing with investment and innovation. A critical evaluation of the methodological issues involved in comparative empirical analyses is also included. The fourth section tackles the issue from a macroeconomic perspective and focuses on the relationship between finance and growth. The macro-theoretical approach is made up, to a large extent, of endogenous growth models and attempts at estimating macro-theoretical hypotheses through cross-country analyses.

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some particular characteristics (government regulations imposing interest rate ceilings and the impossibility of raising money abroad during the 70's). Many firms are part of groups (keiretsu) in which banks play an important role (Takagi, 1993). With respect to the UK system, the Japanese system presents: i) higher bank-firm participation; ii) lower reliance on internal sources and higher reliance on bank loans to finance investments: iii) a group of stable shareholders including financial and non-financial corporations, if compared to the dispersed ownership structure of the UK (Edwards-Fisher, 1993; Takagi, 1993; Hodder-Tschoegl, 1985).

[4] Landes (2000) finds that cultural factors contribute to explaining differences in human capital accumulation and in rates of economic development. Investigating whether religious beliefs significantly affect financial institutions net of the effect of language, trade openness and the origin of the country's legal system. The author finds that creditors' rights are significantly less protected in Catholic countries than in Protestant countries. Bagella-Becchetti-Caiazza (2001) find that language, legal origin and religious culture generate significant differences in financial institutions across countries.

In the fifth section, conclusions, preliminary policy suggestions are advanced based on the current status of the research. The main conclusion is that *national financial systems play a crucial role in determining the "optimal" interaction between finance and innovation and have spontaneously adapted themselves to the challenge of financing risky innovative ventures*: i) "equity oriented" systems have created a favorable environment for the creation of financial intermediaries (FI's) specialized in financing innovation, such as industry-funded venture capitalists, and have stressed the importance of creating an environment favorable to small shareholders relatively more. Nonetheless, in spite of the relatively higher attention given to transparency, quality of information, and repression of insider trading in these systems, there is still a long way to go to solve dramatic agency problems between managers, consultants, analysts and small shareholders; ii) "bank oriented" systems have tried to reinforce the long-term reputation links between banks and firms. Their agency problems are yet even harsher than those of equity-oriented systems as they have contributed to generate systemic crises and not only crises of individual intermediaries.

Both systems need to reduce existing agency problems and reinforce the systems of penalties and incentives that allow investors to finance themselves directly on the market with a strategy other than the search of a unique specialized FI.

1. The micro-theoretical approach

One of the most important tasks of micro-theoretical studies is to evaluate the effect of different FI's on the magnitude of the cost differential among different financing sources at firm level. These studies are based on some widely acknowledged common premises: i) the link among finance, investment and innovation is crucially affected by the problem of imperfect information (generally ex ante hidden action of ex post hidden information) (Hubbard, 1998); ii) the remuneration of FI's in terms of extra costs arising from external financing is justified by their informational economies of scale (Diamond, 1991; Ramakrishnan-Thakor, 1984).

The advantage of the imperfect information approach as compared to the Modigliani-Miller approach seems to be its capacity of giving consistent explanations to some relevant empirical features of modern corporate finance[5] such as: i) the downward inflexibility of dividend policy in relation to financing requirements; ii) the variations in stock prices occurring when equity, bond or convertible issues are announced; iii) the existence of credit rationing.

[5] Weigand (1999) points out that the existence of asymmetric information creates constraints in corporate finance and drives away from the "irrelevance theorem" of Modigliani and Miller (1958) concerning the financing of investment, because it creates adverse selection (pre-contractual asymmetry) and moral hazard (post-contractual asymmetry) problems. Such problems, in turn, provoke rationing of credit supply. Even though credit rationing problems may be solved by means of screening, monitoring and contract enforcement measures, costs incurred in these activities make the cost of external finance increase as compared to the cost of internally generated funds, so they are imperfect substitutes.

The basic idea is that managers have superior information over firm financial and economic perspectives and that market agents can infer this information from managerial decisions,[6] such as dividend policy and financing strategy. Managers are aware of this and their decisions over firm policies must take into account the indirect "signaling" effects of a given choice that, in some cases, enter into conflict with the perfect information effects of the choice itself (this may occur, for example, in the dilemma between dividend distribution and internal financing).

The effect of imperfect information is that through adverse selection, it creates a positive cost differential between external and internal financing sources and, thus, a kind of "hierarchy of finance", known as the "pecking order" hypothesis, in which internal funds are preferred to external ones ranked based on their costs. Subsequently, if internal funds do not suffice, banking debt will be preferred to new equity[7] (Stiglitz and Weiss, 1981; Myers and Majluf, 1984).

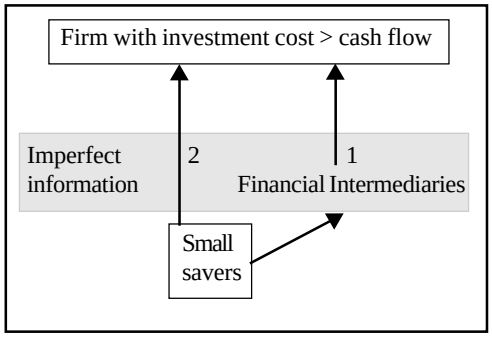
[6] The principal objection to this (Mayer, 1990) is that looking at the firm's publicly disclosed figures is the easiest way to improve information on firm perspectives. The response to this objection is that accounting statistics may be easily manipulated. In fact, they regard past performance more than future firm perspectives and do not provide better information than the "revealed preferences" represented by managers' financing and dividend policies.

[7] Several empirical studies in the nineties identified a series of firm characteristics that may be associated with constrained access to external finance: non-dividend paying firms, small firms, non-mature firms, growing firms, leveraged firms, non-bank affiliated firms, firms without bond rating, and firms with high asset specificity are generally those that suffer the greatest financial constraints (Weigand, 1999).

Given the existence of the "lemon problem", two main solutions are identified in the literature. First, we have a "market oriented" solution that consists in devising a financing strategy that precisely signals firm quality to the market as to avoid extra costs generated by imperfect information. Second, we have an "intermediated" solution that consists in improving the quality of FI's, whose role is to reduce informational asymmetries between lenders and borrowers (Figure. 1) (Giudici and Paleari, 2000).

The first solution assumes that an (equity/bond) issue is a signal of the firm's expected performance. Several authors have examined the potential information revealed and have suggested the existence of a signaling order in the different financing policies of different firms (Brennan and Kraus 1987; Noe, 1998; Costantinides-Grundy, 1989; Stein, 1992).

Figure 1
The role of Financial Intermediaries is that of filling the information gap



Directions for reducing imperfect information
1. Quality improvement of financial intermediaries
2. Optimal "signaling" financing strategy

Source: Bagella and Becchetti (1997)

According to these authors, leverage-increasing issues are generally viewed as positive signals because debt holders seem to monitor investors more closely than shareholders do and also because limited free cash flow reduces the possibility that managers may pursue non-profit rent-seeking activities (Jensen and Meckling, 1976; Ross, 1977; Harris and Raviv, 1991; Short 1994). Consequently, the signaling order of financing strategies, ranking from the strongest to the weakest signal, seems to be approximately the following: debt or equity buy-back, straight bond issue, convertible bond or bond-plus-equity-warrant issue,[8] equity issue. Yet, there is a crucial condition for signaling strategies to be "value-revealing signaling equilibria": mimicking costs must outweigh mimicking benefits. For firm financing policies, this means that, for instance, i) costs of financial distress must be higher than benefits from asset overpricing for a bad firm to choose a signal which is superior to its quality and ii) underpricing costs must be higher than gains for a good firm to choose a signal which is inferior to its quality.[9]

Conditions for the existence of a signaling equilibrium are, however, quite restrictive and several financing strategies are likely to create pooling equilibria if mimicking costs are not relevant. These theoretical findings provide us with some normative suggestions on *how financial systems may play a major role in reducing the asymmetric information problem* and in creating of an institutional framework that may help firms to find their optimal signaling strategy while avoiding adverse selection effects (see Box 1).

The hypotheses on which these models are built clearly indicate that: i) bond rating; ii) the existence of derivatives that ensure against non-diversifiable risk, and iii) the existence of an enforceable system of penalties in case of bankruptcy[10] are all mea-

[8] An optimal financing strategy for innovating firms may be that of bond plus equity warrant issues (BW). These issues are optimal for firms whose research activity approaches achieving results that can be manufactured and marketed. For this type of firms, a BW issue is preferred over a convertible bond issue because of the more time flexible financing profile that avoids excessive increases in leverage at the issue date. If firm research results are not positive, the equity price falls below the exercise price and warrants are not exercised. In this case, the firm finds itself with a lower leverage than it would had it chosen a convertible issue. At the same time, the warrant is a signal that subordinates firm future leverage reductions to future positive results and is, then, implicitly a bet of the firm itself on these results. This interpretation of equity warrants may explain why the warrant financing strategy is so widespread among firms engaged in biotechnology research. The history of the 80's in Japan shows, though, that the weak point of this strategy lies in the assumption that the equity price fully reflects the advancement of firm research and future firm market perspectives. The main problem is, in fact, that the non diversifiable risk component may drive the equity price far below the warrant exercise price at the exercise deadline in spite of good firm performance. The fall of the Nikkei index in the last years of the 80's caused the failure of many high-tech Japanese firm financing strategies because of this reason.

[9] A problem for this literature is that only some and not all the possible financing strategies are considered within the same model. As a consequence, such models provide partial perspectives of firm optimal financing strategy in a high-tech sector. For example, Stein (1992) compares debt, equity and convertibles, Santarelli (1991) venture capital and debt.

[10] Haugen and Senbet (1988) argue that bankruptcy costs, generally overstated in literature, should be

sures that reinforce the system of costs and incentives that makes a signaling equilibrium feasible.

The recent evolution of financial markets, therefore, tends to suggest that the system of penalties needs to be reinforced by particularly increasing managers' penalties in the event of bankruptcy (something which heads in the opposite direction of golden parachutes!) and reducing the "natural" incentives of accountants, analysts and financial advisors to collude with firm managers in order to make their signals more credible to the market.[11] Since financial markets cannot do all the job, the role of FI's in providing external finance to high-tech firms is doubtlessly crucial.

Literature provides a series of FI features that, at the same time, are rational justifications for their existence and for the role they play in financing innovation. Giudici and Paleari (2000) find FI useful to avoid pricing mechanism inefficiencies and IPO cost distortions in the case of financially constrained high-tech firms. Bhattacharya and Thakor (1992) highlight that the two main positive activities of FI are those of brokerage and Quality Asset Transformation (QAT). The first one consists mainly in the ability of FI to interpret signals and to exploit cross-sectional and temporal reusability of information. The second is represented by the capacity of FI to modify term-to-maturity, divisibility, liquidity and credit risk of managed assets.

Separate analyses of the capacity of financial markets and FI to support investment and innovation do not allow, however, direct comparisons of the two systems and cannot provide direct answers regarding their relative efficiency.

However, Allen and Gale (1995) argue that the choice between a "market-oriented system" and an "intermediated system" involves a trade-off between cross-sectional risk sharing (in which the "market oriented" system is relatively more specialised) and intertemporal risk sharing (in which the "intermediated system" is relatively more specialised). Given these broad distinctive features, the relative capacity of the two systems to support investment and innovation depends on: i) the amount and ii) the price of investment and innovation financing provided; iii) the relative capacity of evaluating entrepreneurs and selecting good projects; iv) the relative capacity of monitoring innovating firms'behaviour to avoid waste of resources: v) the relative effectiveness in spreading information about

limited to the lower of: i) costs through formal reorganisation involving the court system; ii) transaction costs of informal reorganisation. What really matters, though, in signalling models of financing strategies, is the individual manager's bankruptcy costs. These costs are particularly high for managers-owners of small-medium firms with non-transferable skills. In certain financial systems these costs are increased by temporary loss of civil and economic rights (voting rights and entrepreneurial rights). Additionally, a fundamental component of these costs, in a world of imperfect information, has to do with the bankruptcy probability of revealing negative information about the manager-entrepreneur.

[11] Lim (2001) shows that systematic over evaluation of firm perspectives is a rational behaviour of analysts who are interested in establishing good, long-run relationships with listed companies in order to have preferential or non discriminatory treatment when new information is released.

firm prospects and research activity in order to create technological spillovers.

In order to check whether general considerations on the effectiveness of financial systems and FIs in supporting physical investment apply to innovation and R&D investment, it is necessary to focus on the specificity of the second type of investment. A main feature of innovation is the production of scientific knowledge which is generally a non excludable, non rivalrous public good that can be made partially excludable when patented. R&D and innovating returns usually manifest themselves with considerably longer lags than physical investment returns so that a delicate problem of interim stages during the investment process arises. In these stages, immaterial intermediate research output can be hardly marketed (unless knowledge is publicly verifiable and then licensed for a fee), but can be appropriated by competitors if some forms of disclosure occur. This is why the traditional pecking order in signaling financing strategies may not hold (Saltari and Travaglini, 2001). Whereas for physical investment, a convertible issue is a stronger signal than an equity issue and may be an optimal strategy for a good firm in order to avoid adverse selection and issue underpricing, the signaling benefit for R&D investment may be outweighed by costs of disclosing knowledge to competitors (Bhattacharya-Ritter, 1983).[12] The other part of the problem lies in the fact that, although interim knowledge disclosure has private costs, it also has social benefits as it generates positive spilllovers and increases the innovating capacity of the system. In addition, given the ex ante uncertainty regarding the outcome of the race, an interim knowledge sharing commitment may be ex ante efficient, increasing R&D incentives for all competitors (Bhattacharya and Chiesa, 1995).

Differences in market structure between high-tech sectors and traditional sectors need also to be taken into account when analyzing optimal financing schemes for innovation. A crucial feature is that, whereas, in traditional sectors with horizontal product differentiation, new entries only reduce market share, in high-tech sectors with "vertical product differentiation", new entries may eliminate some of the incumbents from the market when certain conditions on the quality of products and on the distribution of income are met. The higher risk of exit has obvious consequences in terms of a more prudent leverage structure.

Innovating races also generate particular incentive problems in intrafirm agreements. It is much easier to design efficient incentive schemes for a joint venture that lasts until the final production stage than for a research joint venture which stops at earlier stages before the realization of output profits. Two questions arise, then: How do we avoid knowledge free-riding when research

[12] In the first rudimentary non-stochastic R&D contest models where an R&D race could be won with certainty after a given number of research steps (i.e. experiments) were carried out, the issue of disclosure costs was completely ignored, whereas, in more reasonable stochastic frameworks, knowledge disclosure generated by a market financing strategy may increase the probability of "leapfrogging" from competitors.

joint venture (RJV) members turn into individual runners and competitors at the final stage of the competitive race? How do we compensate intermediate results when profits are still not materialized? A suggested solution is to impose large licensing fees for winners at the final stage if they received information at the earlier stage (Bhattacharya, Glazer, and Sappington, 1992). Another distinguishing feature is that informational asymmetry between financiers and R&D investors may be more relevant than informational asymmetry between financiers and traditional investors given that the more complex technicalities of an R&D investment are more difficultly fully understood by a financier. In this light, the optimal FI for innovation must then develop financial and technological monitoring capacities more effectively than the traditional banking system does. This is particularly true when it has to individuate the potential capacity of small innovators lacking collateral. The direction taken by "equity oriented" systems to solve the issue has been to develop "venture capital" supply of finance; whereas "bank-oriented" systems reinforce the long-term relationship between borrowers and banking lenders.

The greater success of "industrial venture capital" in supporting the most innovative phases of the product cycle (seed and start-up) (Cavallo, 1996) shows that venture capital funds generated by spin-off from industries have an informational advantage over "bank venture capital funds" in terms of technological monitoring capacity and are more competitive in financing innovation when banks are not able to bridge their informational gap in terms of technological knowledge.

This may indicate that a specific dimension of the informational asymmetry in financing innovation is determined by market sector knowledge and by the technological and scientific knowledge needed to evaluate the potential success of an innovation. "Bank-oriented" and "equity-oriented" systems are effective in innovation financing to the extent to which they are able to bridge this specific informational gap.

More recently, the literature on finance, high-tech investment and innovation has directed its research efforts in directions partially unexplored, such as the interaction between market structure and sources of finance for innovating firms.

Blundell, Griffith, and van Reenen (1999) have tried to establish the relationship between innovation and market share, on one hand, and between stock market value and innovative activity, on the other. They argue that "by looking at the relationship between market share and innovation together with the impact of market share on the relationship between innovations and corporate stock market value, it is possible to shed light on the importance of the incentive to innovate."

The starting point is the firm's value function and an innovation equation. The value function has the following form:

$$V_{it} = \Pi(G_{it}, K_{it}, MS_{it}, W_t) + \varphi E_t V_{it+1}$$

where current net cash flow (Π) depends on market share (MS_{it}), fixed capital (K_{it}), and knowledge capital (G_{it}). φ is the firm's discount factor, E_t is the expectations operator-conditioned on the firm's current in-

formation set, and W_t stands for a vector of relative prices on which other inputs that are maximised out of the model and replaced by their optimal values depend.

The innovation equation takes the form:

$$I_{it} = f(x_{it}, u_{it})$$

for i=1,...N and t=1,...T

Where x_{it} is a vector of firm i characteristics (such as market share), industry characteristics and macro-economic conditions. Unobservable are represented by the term unit.

This relationship is the outcome of a firm's optimal search rule for innovation. Two assumptions are made: i) the search process generates innovations in future periods, so the x_{it} term consists of lagged variables, and ii) economically useful knowledge depreciates because of innovation imitation, personnel movement, and machinery wear.

This approach provides a general framework that is useful to empirically test the relationship between market share, innovation and stock market value of an innovating firm.

Blundell *et al.* (1999) take into consideration a number of possible interpretations of the model and predict a positive coefficient on the market share variable included in the innovation equation. Different versions of the market value function are then tried out to test this hypothesis. Final results confirm that firms with large market shares tend to develop and commercialise more innovations although increased product market competition in the industry tends to stimulate innovative activities. Yet, large market share firms tend to benefit most from innovations. This would also imply that higher levels of innovating activity are not due only to higher cash flow availability to finance it, but also to a relatively greater incentive to do so since high market share firms that innovate get a higher valuation on the stock market than those which do not undertake innovation. Other channels through which firms with larger market shares may perpetuate their competitive advantage are the acquisitions paid with their stocks, which are equivalent to overvalued money when they incorporate a market share premium, and the imposition and strategic use of technological standards, when not forbidden by antitrust authorities, which may even lead them to prevail over a better technology with less market power.

An interesting variation is the case of financial rationing in a monopolistic environment, such as the case examined by Maurer (1999). He presents a theoretical model on the influence of financial leverage on investment and/or product market behaviour of both leveraged firms and their rivals. A two-period duopoly model is analysed for two technologically identical firms, one of which is leveraged, while the other counts on internally generated funds. Each firm has an innovation opportunity to develop in each period. Both the firms and the outside rational investor (bank) are risk-neutral.

The success probabilities (θ) of both firms depend on the effort they spend on the project. There is a fixed cost F due to market operation and use of the innovation opportunity; such cost must be paid before the project starts.

The investor makes a *take it or leave it* offer to firm *i* (the leveraged firm) prior to investment. Assuming that profits (Õ) are serially uncorrelated over the two periods, two informational structures are analysed: *i) Simultaneous move game*, in which the finance contract between the leveraged firm and the outside investor is unobservable (*i.e.*, it is not publicly announced by the lender) but can be rationally inferred by competitors; *ii) Stackelberg game*, in which the lender publicly announces the contract and the leveraged firm decides whether to enter into it or not so that predation by competitors is not possible.

The crucial results of this model are listed below.

- The optimal contract between the investor and the leveraged firm resembles a *standard debt contract*, but future finance is provided with probability lower than one, so that the second period project is financially constrained, even though it is profitable.
- In the case of the *simultaneous move game*, the leveraged firm is vulnerable to rival attacks because the competitor increases its effort and tries to take the leveraged firm out of the market.
- In the case of the *Stackelberg game*, there is an optimal no-predation contract, but there is also a further financial constraint in the second period, so the contract is not "renegotiation-proof".

The *predation issue* is especially relevant for young and small innovative firms that cannot rely on collateral or retained earnings nor have easy access to capital markets to finance innovation projects. Also, if patents are not considered effective rent-protective tools, predation by established firms on innovative but undercapitalised start-ups is a certain behaviour. Yet, such a behaviour is not exclusively characteristic of monopolistic environments as shown by Westhead and Storey (1997).

Simply put, in a quasi-monopolistic environment, the competition is won by better funded (though not necessarily more innovative) firms and not by younger, smaller financially constrained firms.

Giudici and Paleari (2000) have listed some other mainstream characteristics and potential problems concerning high-tech SME's. First of all, they point out that the differences in the innovative activity of small and large firms –such as SME's getting benefits from spillovers created by university research as well as informal external sources of information, their stake on product specialisation and on market niches, the importance of dynamic and entrepreneurial management and efficient network co-operation– are more heavily emphasised when dealing with technology-based small firms.

In fact, technology-based (*i.e.*, high-tech) small and medium sized firms' growth is heavily conditioned by access to and costs of finance, particularly during the phase of introduction of a new product in the market because of the need to develop intangible and highly specific resources. Multivariate analysis results (Westhead and Storey, 1997) indicate that, in general, firms that obtain income from manufactured products are far more likely to report a continual constraint, probably because they want to borrow

greater sums than service firms, and technologically sophisticated high-tech firms are more likely to face a continual financial constraint than less technologically sophisticated high-tech firms.

High entry sunk costs of R&D plus advertising and information costs necessary to enhance product demand, low diversification represented by single research projects, little business administration experience of entrepreneurs (also Westhead and Storey, 1997) and other well-known factors combine to restrain the viable financial sources to which high-tech firms may have access, even more than for "traditional" SME's.

Furthermore, the problems associated with each of these sources ranked in the "pecking order" hypothesis are much tougher in the case of innovation financing (Weigand, 1999) because future cash flow from R&D activities is unpredictable and information asymmetries are even greater. In addition, eventual bankruptcy and liquidation costs are heavier due to the high "specificity" of the assets used for innovation.

All this contributes to making high-tech innovating entrepreneurs highly prone to using internal financing sources, even if growth slows down. The case becomes even more complex when additional factors are included, such as the controlling shareholder's fear of losing control over his firm and revealing technological information to outsiders.[13]

Under these conditions, the role of venture capitalists, merchant banks and closed-end funds may be a relevant answer to financial constraints faced by high-tech firms. In fact, Giudici and Paleari (2000) argue that, concerning SME's equity trading in the high-tech sector, the main problem is its "thinness" due to the small number of listed firms and to the investor's longer holding period related to expected higher capital gains.

They add that liquidity shortage creates inefficiency in the pricing mechanism and affects the cost of the IPO because stock market investors demand a "liquidity premium". So the role of market makers in financial markets is necessary, in order to find a way out of the financially constrained regime faced by high-tech firms.

Giudici and Paleari (2000) confirm in their empirical analysis that "half of the sample companies experienced difficulties in funding innovative projects and their development has been sensibly slackened by the scarcity of self-generated profits." As for the ranking of financial sources, the pecking order hypothesis is fully confirmed since start-ups rely

[13] It is worth noting, however, that Saltari and Travaglini (2001) have identified a "failure" in the pecking order hypothesis derived from the scarce importance given to expectations concerning future financial resources. The two authors argue that "liquidity constraints can affect a firm's investment policy even when these constraints are currently slack." In fact, assuming a perfect competition with credit rationing, optimal investment decisions depend, among other things, on market demand because demand shocks translate into internal liquidity. Assuming the existence of floor and ceiling prices, investment is feasible as long as the price lies between the upper and the lower barrier. Yet, as the price goes up, "internal liquidity will approach its maximum possible level, increasing the probability of liquidity constraints in the future."

on internally-generated profits, short-term credit, and equity capital from existing shareholders as preferred over venture capitalists, merchant banks and new shareholders respectively. Firms'preferences do not change over time and only a wider range of feasible financing sources becomes available.

Furthermore, these empirical results indicate that "high technology services" (IT firms) have different financial needs regarding "high technology manufacturing" (electronics and mechanical firms) which support hardening processes, the pecking order hypothesis is based on control and ownership considerations, and external investors are accepted conditionally to the contribution of complementary competencies (lacking in the firm). In this framework, facilitated public credit offered to high-tech firms may be inadequate because of "the long procedures to access it regarding the fast obsolescence of high-tech products", specially when firms do not rely on patents but on market dynamism (temporary monopolistic rights) to protect innovation.

Hubbard (1998) and Himmelberg and Petersen (1994) investigate further financial constraints of high-tech firms and claim that "the financing of physical investment for R&D-intensive firms is more prone to moral hazard and adverse selection problems [than is the case with other firms.]" More specifically, adverse selection and incentive problems are compounded by the absence of collateral value for investments such as R&D because small, high-tech firms hold most of their value in growth opportunities and scientific knowledge. These factors greatly enhance the role of internal finance for such firms. Moreover, the existences of informational asymmetries in these firms prevents outsiders from making accurate appraisals of firm market value and augment the strategic importance of internally generated funds. Information asymmetries are hardly random; in fact, they are often necessary because most industries view patents as an ineffective way to protect their proprietary rights and often prefer secrecy. Alternative sources of finance are also ineffective for various reasons: venture capital is expensive because potential investors may have to hire a scientific team to appraise the potential value of R&D projects; debt issuance is complicated by moral hazard problems too, as R&D project output "can never be predicted perfectly from the inputs." Furthermore, as Westhead and Storey (1997) remark, a high-tech firm's product is novel so it is difficult to assess the market-place, it tends to have a shorter life than conventional sector products, and financing is often required to conduct research and development at the pre-product stage, so that another source of uncertainty arises with the eventual results of research and the timescale of such delivery. Again, from these considerations, it is clear that another factor that makes credit hard to find for high-tech firms has to do with the financial sector's weak expertise in assessing this type of projects.

Moreover, the existence of high adjustment costs in high-tech firms implies that, in order to minimise present and future adjustment costs, firms set the R&D investment level in accordance with the "permanent" level of internal finance. This means that "R&D is relatively unresponsive to transi-

tory movements, [so] the full impact of the financing constraint is revealed by the relationship between R&D and permanent cash flow." This is confirmed by Westhead and Storey (1997), who examine a sample of 179 high-tech firms that allocated slightly more funding to R&D than to physical investment and none of which paid dividends (as a proof of financial constraint). The authors find evidence that firms "smooth" R&D investment because of the cost of responding to transitory movements in cash flow and conclude that "the principal determinant of investment for small, high-tech firms is internal finance.

2. The micro-empirical approach: comparative results and methodological problems

A first major direction of research of the "imperfect information"-based empirical analysis on finance, investment and innovation pursues proving the existence of a positive cost differential between internal and external finance predicated by the theories covered in the previous section.

Empirical analyses provide interesting results for the evaluation of costs of informational asymmetries between financiers and investors. They may provide a benchmark for comparing the performance of national financing systems in supporting investments and innovation. The two main tests surveyed here are the analyses of: i) liquidity constraints on firms' investments and; ii) average announcement effects of issues of firm market value. The first test aims at measuring the incidence of liquidity measures on firm investment plans to demonstrate that, in the presence of cash constraints, the access to external finance is rationed or relatively more costly and, therefore, negatively affects investment perspectives.

The empirical literature on financial constraints on investment follows three main methods:[14]

i) a direct estimate of an investment demand function obtained from first order conditions of the basic model where the shadow value of capital (marginal Tobin's Q) should be one of the regressors and is proxied by the average Tobin's Q (Fazzari, Hubbard and Petersen 1988, for the US; and Hoshi, Kashyap and Sharfstein (1992) for Japan; Devereux and Schiantarelli (1989) and Schiantarelli and Georgoutsos (1990) for the UK);
ii) an Euler equation test for financial market imperfections whose empirical specification does not include the marginal Tobin's Q among regressors (Bond and Meghir (1994), Withed (1992), Hubbard, Kashyap and Withed (1995), and Bagella-Becchetti-Caggese, (2001);
iii) a direct estimate of the investment demand function where the shadow value of capital is proxied by a VAR forecast of firm fundamentals observable to the econometrician (Gilchrist-Himmelberg (1995)).

A first empirical problem common to the three methods is the valuation of capital, for which replacement costs and not book value has to be considered. The standard proce-

[14] See mathematical appendix.

dure for the evaluation of the replacement cost of capital ("perpetual inventory method") requires only the initial book value of the capital stock, to which subsequent inflation-corrected yearly investments are added. This procedure presents two main problems: it requires long time series to operate the iterating method and it implies the arbitrary choice of an average depreciation rate to apply to capital book values.

A second problem occurs if a "separating equilibrium" between bad and good firms exists. Investment in some firms may be more sensitive to internal liquidity just because these firms face worse investment perspectives (bad firms) and are recognized as such by well-informed financiers who increase their cost of external financing. It is then necessary to introduce additional controls for firm investment perspectives and this can be done in several ways.[15]

A more controversial problem, typical of the second method, is the valuation of Tobin's Q. Average Q is the proxy usually adopted for marginal Q, though the two variables coincide only under rather restrictive conditions (constant returns of scale, perfect competition and a single quasi-fixed factor). So, the estimated Q variable is likely to be seriously biased (Chirinko, 1993).[16] A solution proposed by Hoshi et al. (1991) is the division of the sample into subgroups. The differences in liquidity coefficients -and in sensitivity to cash flow- for firms belonging to different subgroups should be unbiased given that the Q bias is the same for the two groups of estimates.[17] Yet, in this case an important caveat is required. The assumption that Q mismeasurement is equally severe in both subgroups is debatable given that future profits of firms less integrated in the financial system tend to be more misvalued by the market (Gilchrist-Himmelberg, 1995). Another problem for these firms is the excess sensitivity of investment to cash flow that may reflect the fact that cash flow itself partially becomes a proxy for future investment opportunities when Tobin's Q cannot be correctly evaluated.[18-19]

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[15] The approach followed by Fazzari *et al.* (1988) is that of carrying out the estimate on a sample composed only of firms with positive net sales performance (good firms) at the beginning of the period considered in the analysis.

[16] Chirinko (1993) identifies three main sources of bias: i) the divergence between market sentiments and fundamentals creates distortions when marginal *Q* is influenced by excess volatility giving a biased measure of firm fundamentals which determine investments decisions; ii) the generalization of applying fixed depreciation rates in the perpetual inventory method adopted for measuring capital stock may not be appropriate in times of rapid technological revolution with time changing rates of capital depreciation; iii) tax and non tax components of the price of capital may also distort the evaluation of capital stock.

[17] Hoshi-Kashyap and Scharfstein (1991) support their approach by saying that "the advantage of this approach is that, even though the individual estimate of the liquidity coefficients may be biased (say because Tobin's Q is mismeasured), provided that the bias is the same for two sets of firms, the estimated difference in the coefficients will be an unbiased estimate of the true difference" and again that "this approach is useful even if the estimated coefficients on liquidity are biased. This is because the difference in the estimated coefficients is an unbiased estimate of the true difference as long as the biases are the same for the two sets of firms".

[18] The simple advice of dividing into subsamples to solve the Q problem is implicitly followed by all

As for the first and third methods, these try to circumvent Tobin's Q puzzle, but they lead to criticism as Euler's equation has some drawbacks, such as poor small sample properties and the failure to detect the presence of financial constraints for agents whose degree of financial constraint remains unchanged in two successive periods (Zeldes, 1989; Attanasio, 1995).

Yet, the VAR methodology seems more effective than the financial constraint test in isolating the role of investment sensitivity to cash flow as a proxy for future investment opportunities in firms where Tobin's Q is less easily measurable. A disadvantage exists though because such a sophisticated proxy seems to have a negligible marginal performance with respect to the average Q (Abel-Blanchard, 1986; Gilchrist-Himmelberg, 1995).

Concerning the second type of analysis, the announcement effect of firm issues, it is possible to draw some preliminary comparative conclusions based on recent literature. With regard to the US, empirical results seem to confirm the existence of a "signaling order" for firm financial issues as: i) equity reaction to the announcement of convertible bond offering is around -1,5% (Dann-Mikkelson, 1984; Eckbo, 1986); ii) equity reactions to the announcement of stock offering, calculated using the same methodology, is around -3,5% (Asquith-Mullins, 1986; Masulis - Korwar, 1986; Mikkelson-Partch, 1986). With regard to Japan, recent results (Kato & Schallheim, 1985) contradict Myers-Majluf (1984) conclusions and show that announcement effects of equity issues may even generate positive changes in the issuers' market value.[20] Is this another consequence of the "short-termist" hypothesis and of the Japanese system's better capacity to bridge the informational gap between investors and financiers?

Several methodological problems prevent us from giving a definite response. Mainly, equity effects mature in two different moments: the announcement date and the issue date. On the announcement date, agents receive the "revealed" signal about firm fi-

other authors in previous contributions without additional control for the relevance of the measurement error. Hoshi *et al.* (1991) opt for a "*keiretsu*/*non keiretsu*" division, trying to test if Japanese firms participating in a group that includes banks, may in this way mitigate agency costs. Hubbard *et al.* (1988) adopt a dividend payout and firm size split criteria, while Devereaux-Schiantarelli (1989) use firm size, firm age, investment perspectives (proxied with Tobin's Q) and firm industry. What is interesting in these results is the difference in the modifications of the basic model tested, in the criteria adopted to split samples, and in the interpretations of the findings obtained.

[19] Some authors counter-argue that no empirical evidence of first order relevance of this bias has been found so far (Blanchard, Ree, and Summers, 1993, Hoshi and Kashyap, 1991), and that a comparison of first and longer differences of investment equations often shows the irrelevance of the Q measurement error.

[20] A theoretical rationale for this empirical finding is provided by the Cooney-Kalay (1993) version of the Myers-Majluf model allowing for the existence of negative NPV projects. The two authors demonstrate that, if several negative NPV projects in the "no issue-no invest" region exist, the "issue and invest" decision may result to be good news for new shareholders. This model might explain why equity issue announcement effects are anticyclical (Ercoli, 1995).

nancial conditions and react to it, but the signal and the reaction are not complete given that full information about issue details will be known only on the issue date.

In fact, abnormally high common stock returns before and after the announcement date may be justified by the same signaling models in the presence of insider trading and multiple announcements, respectively.

A rigorous control must be exerted on the presence of other important firm events in correspondence to the announcement date and the issue date. Moreover, the empirical analysis ought to be able to discriminate between the downward sloped demand rationale (Loderer *et al.*, 1991) and the imperfect information rationale (Stein, 1992). In this respect, an estimate of equity changes in correspondence to the announcement date and not to the issue date seems more advisable.

In the light of these considerations, a test of ex post cumulative abnormal common stock returns may circumvent insider trading, multiple announcements and announcement/issue date problems and may be the best way to check if ex post common stock performance corresponds to firm quality as revealed through the financing strategy adopted.

To sum up, the contributions of the empirical literature seem to show that *equity and bank oriented financial systems have different performances when measured through liquidity constraint and announcement effect tests*. Both tests need to improve their accuracy to solve some important methodological problems. It is, therefore, important to develop comparative empirical studies aimed at directly comparing group results among different countries once reasonably uniform data collection methods and estimating procedures are established.[21]

3. The macro-theoretical and the macro-empirical approaches

Within macro-theoretical and macro-empirical approaches to finance, investment and innovation, we consider models that, though micro founded, place particular emphasis on the aggregate consequences of agency costs in the relationship between financiers and investors.

On the macro-theoretical side, a seminal contribution from Bernanke-Gertler (1987) presents a "market-oriented" model where coa-

[21] Additional methodological problems occur because of different accounting procedures. For instance, Japanese firms appear more indebted than UK firms. This is because, due to differences in accounting conventions, land and securities in Japan are registered in the balance at their original value and assets of associated companies are not consolidated. Moreover, intercountry differences in leverage may sensibly vary, reflecting the effect of bearish or bullish stock exchange behaviour (Hodder-Tschoegl, 1993).

Another problem is that many items (mainly all those related to technology measures) are not available and also that a different proxy for liquidity has to be found. For this reason, among many others, it is not entirely correct to make direct comparisons of coefficient magnitudes between countries, while some comparative insights may be provided confronting intra-country subgroup estimates when homogeneous split criteria are adopted.

litions of internal and external financiers are endogenously determined. In this model, the conditions that establish whether intermediated finance is optimum or not in Diamond (1991) are reversed because auditing results are public information and external lenders can commit in advance to sharing auditing costs. The equilibrium level of investment profitability and interest rate in the model is a function of auditing costs, the hazard rate and the marginal cost of becoming an internal financier. In such a model, changes in interest rates and in per capita saving may generate business cycle fluctuations that affect the ratio between inside and outside finance, and, subsequently, bankruptcy costs via changes in the hazard rate. An important insight of the model is that the "informational paradox" of financial systems is represented in a new original way. If information is costly, its costs can never be completely eliminated as gains from information gathering (gains from becoming an "informed trader" in the Grossman-Stiglitz (1980) model and gains from becoming an internal financier in the Bernanke-Gertler (1987) model) decrease when it is less costly to gather information.

These models show that the interaction between agents with more and less information may create robust fluctuations with serious real effects in "market-oriented" systems. The fragility of "intermediated systems", in times of business cycle fluctuations, has been clearly evidenced by the "credit view" literature. Credit crunches in times of restrictive monetary policies have strong real effects (Kashyap-Lamont-Stein, 1993) in "intermediated" systems with: i) weak substitutability of bonds with bank debt as external financing; ii) real or nominal price rigidities; and iii) scarce autonomy of commercial banks from the Central Bank. These crunches are likely to have asymmetric effects on firms when informational asymmetries are a negative function of firm size and age (Gertler-Gilchrist, 1993).

Credit view models implicitly suggest which positive effects may derive from the integration of "market-oriented" and "intermediated" systems, if we consider that the development of financial markets might increase substitutability between bank debt and other forms of external financing for firms and might increase the capacity of banks to issue reserve-free liabilities.

All these models focus on cyclical effects of the relationship between finance and innovation without directly addressing the growth issue.

Other contributions follow this path and adopt the exogenous technological progress with a self-sustaining growth, relying on Marshallian externalities or on non-decreasing returns in the accumulated production factor. With endogenous growth, financial intermediation may be shown to have not only level effects but also growth effects. In the King-Levine (1992) model, for example, FI have four crucial roles: i) pooling funds, ii) evaluating entrepreneurs, iii) diversifying risk and iv) rating expected profits from innovative activities. In this manner, they affect not only the level of saving, but also the rate of growth. In Saint-Paul's model (1992), the existence of strategic complementarity between financial markets and technology (both are instruments that can be used for diversification) allows en-

trepreneurs to spread risk through financial diversification and to choose riskier and more profitable technologies. Without financial markets, entrepreneurs can limit risk only by choosing less specialised and less productive technologies.

On the macro-empirical side, tests on the asymmetric effects of restrictive monetary policies under the credit view hypothesis showed that firms with more financial constraints seem to be more affected by credit crunches (Gertler-Gilchrist, 1993). The problem, however, is that the division between financially constrained and unconstrained firms is exogenously determined by using the dimensional variable and is not estimated in the sample.

The first attempts to test for the positive relationship between growth and finance postulated by King-Levine (1992) and Saint-Paul (1992) among others, come from Goldsmith, Edward (1969), McKinnon (1973) and Shaw and Leet (1973) who find a positive correlation between the rate of growth and the degree of financial intermediation. These early contributions leave two questions unsolved: the causality direction of the relationship and the effects of financial development on the efficiency or merely on the rate of investment. Even here, the endogeneity problem makes it difficult to establish whether the contemporaneous correlation between financial and real variables has to be interpreted in the sense of a positive role of FI in stimulating investment and growth or, according to the real business cycle explanation (Long-Plosser, 1983), in the sense of the financial system's endogenous response which "catches up" to the development of the real sector of the economy. The endogeneity problem is particularly serious when we consider forward-looking based measures of financial development, such as stock market capitalisation, which obviously incorporate expectations of future real growth.

The other main problem of the macro-empirical literature is that it considers a largely passive role of financial institutions and treats them generally as perfect competitors. In reality financial markets are imperfectly competitive and ridden with agency costs, as Stiglitz (1993) clearly points out while focusing on the public good features of information and monitoring and providing several examples of externalities, moral hazard and adverse selection existing in these markets. Given these considerations, the relevant issue for the relationship between finance and growth is whether financial repression and directed market credit may reduce market failures and increase growth (even if the price paid is a reduction of the total amount of credit available) or this result is obtained simply through financial deepening and reliance on market mechanisms.

The rationale always for not considering financial repression a negative phenomenon is that -in a perfectly competitive framework- low interest rates may reduce savings and inhibit economic growth, though they may reduce adverse selection and moral hazard effects, thereby increasing the quality of borrowers in an imperfectly competitive environment with information costs.

Directed credit may, on the other hand, allocate more resources to high-tech sectors where social returns of the projects, which

include knowledge accumulation, are higher than private returns. This way, it can reduce underinvestment in these sectors resulting from unregulated financial markets. The problem with government intervention, however, lies on the fact that regulatory standards are based on subjective assessments of crucial variables (such as risk and premiums), while market pricing mechanisms provide a more "objective" assessment of them. Even though government intervention may be beneficial in redressing market failures affecting the relationship between finance and growth, it always involves the risk of misjudgement and corruption.

The most recent literature investigating the macroeconomic relationship between finance and growth has attempted to detect in empirical data the existence of a non-linear relationship between finance and growth evidenced by many theoretical models which end up with multiple equilibria (Saint Paul, 1992). An almost observationally equivalent result of biunivocal finance-growth relationship after a given threshold is found by Harrison-Sussman *et al.*, (1999) and Deidda (2001). The former find that economic growth increases banks activity and promotes new entries. Entries reduce costs of financial intermediation and, in turn, boost investment and growth. The latter argues that, in an economy with risk-adverse savers and learning by lending, transition from financial repression to full financial repression may initially lead to a recession, while, with the increasing level of expertise and institutional quality, it guarantees a growth-inducing allocation of financial resources.

From the empirical point of view, recent empirical papers find support for the multiple equilibria hypothesis and try to identify the threshold of financial development over which the virtuous circle between finance and growth operates (Rousseau-Watchel, 2000; Bagella, Becchetti Caiazza, 2001).

We believe that these results provide a contribution to the empirics of growth in several respects and reconcile empirical findings with most recent theories on finance and growth. An example of multiple equilibria in the relationship between country fundamentals, financial systems and growth consistent with these results may be sketched as follows. In countries with cultural backgrounds unfavourable to the development of financial institutions, fixed costs of accessing debt and equity markets are high and sources of external finance are costly. These countries do not possess enough instruments to diversify risk and therefore reduce the capacity of entrepreneurs to invest in risky activities. Thus, they are trapped in a low growth equilibrium in which financial institutions are underdeveloped. In countries in which cultural backgrounds do not prevent the development of financial institutions, intertemporal and cross-sectional risk sharing induce easier access to external finance and allow entrepreneurs to invest in risky activities. In these countries, there is a virtuous, positive relationship between financial development and growth.

Conclusions and normative suggestions

This paper provides a critical evaluation of the literature on finance, investment and innovation and suggests insights towards a

new comparative research method for evaluating the comparative performance of financial systems in supporting innovation.

The survey on micro-theoretical contributions describes the asymmetric information problem between investors and financiers and the role of FI in reducing this asymmetry. It also shows that country-specific features of financial systems in terms of investment and innovation financing are not neutral with respect to solving the problem.

Opinions on the relative effectiveness of the two "archetypal structures" of financial systems (the "market oriented" and the "intermediated" ones) are mixed. Intermediaries may reduce monitoring of free-riding problems of individual lenders, they may avoid "short-termism" by creating long-term relationships with borrowers, and they may guarantee secrecy of information on interim values of high-tech projects, thus increasing incentives for long-term investment in innovation (Bhattacharya-Chiesa, 1995). On the other hand close integration between intermediaries and firms may generate severe agency costs which have partially been the root of the crises of Asian economies in the last decade.

On the other hand, the effectiveness of "market-oriented systems", may be understated. The market for corporate control not only provides alternative forms of monitoring and control on managers' activities, but it is also an important source of internal funds for managers. In addition, even though it is argued that multilateral banking may promote information sharing (and technological spillover) among firms, it seems that dissemination of information and better opportunities for mergers and acquisitions are a comparative advantage of "market-oriented" systems.

The micro-empirical survey analyses the results of liquidity constraints and average announcement effects of equity/bond issues as tests of the relative performance of national financial systems. These results seem to confirm that "bank-oriented" systems have an informational comparative advantage over "equity-oriented" systems. The survey also stresses which methodological problems have to be solved in order to improve the quality of comparative analyses.

The survey on macro empirical papers shows that this type of contribution does not seem to solve interpretational ambiguities related to the endogeneity problem and to the direction of the causality links between finance and innovation, nor between the monetary sector and the real sector. With regard to the comparative evaluation of financial systems, it seems that both of them possess inherent causes of fragility ("market-oriented" systems are more exposed to financial crises generated by the interaction of agents having different informational sets, while "intermediated systems" amplify the real effects of monetary restrictions through the "credit view"). An implicit suggestion of these models is that the integration of the two systems may partially solve at least the "credit view" problem.

As a conclusion, this survey individuates four main paths among those less explored in the literature on finance, investment and innovation. These paths are represented by:

i) theoretical analyses of informational asymmetries and coordination failures between investors and financiers in the event of venture capital financing (the problem of informational asymmetries between investors and financiers in case of bank and stock market financing is widely explored by the existing literature); ii) comparative empirical analyses of financial constraints on firm investments (an opportunity to compare the relative efficiency of different country systems of innovation and investment financing); iii) direct tests of firm financial constraints based on qualitative data which may be used to check traditional results from traditional indirect tests of financial constraints (based on balance sheet data); iv) the effect of particular forms of market financing that may be greatly helpful for supporting innovation.

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Appendix

Table 1
Summary features of corporate governance and industrial structure in selected OECD countries

	Italy	USA	Japan	Germany
Corporate governance				
Ownership and control patterns				
Ownership concentration	High	Low	Low	High
Separation ownership/control	Weak	Strong	Weak	Weak
Constraints on bank ownership	Strong	Strong	Weak	Very Weak
Dominant control model				
Cross-shareholdings	Large	Small	Large	Medium
Inter-group	Large	-	Small	Medium
Intra-group	Large	-	Large	Small
Corporate monitoring				
Board composition	Insider	Mixed	Insider	Insider
Large shareholders	Yes	No	Yes	Yes
Other stakeholders	No	No	Yes	Yes
Board power over management	High	Low	Medium	High
Independence of management	Low	High	Low	Low
Public disclosure requirements	Medium		Medium	Low
Role of financial intermediaries	Low	Low	High	High
Role of stock market	Low	High	Low	Low
Corporate Financial Patterns				
Self-finance	Medium	High	Low	Medium
Leverage	High	Low	High	Medium

	Italy	USA	Japan	Germany
Industrial Structure				
Sectors of Specialization	Cap. Int. Labour Int.	R&D Int. Cap. Int.	R&D Int. Cap. Int.	Cap. Int. R&D Int.
Average firm size	Small	Large	Small	Large
Diffusion of business groups	High	Low	High	Medium
Producer/supplier relationship				
Employer/employee relationship	Medium-term	Short-term	Long-term	Long-term
R&D Intensity	Low	High	High	Medium
Internationalization of firms	Low	High	Medium	Medium

The USA are nearer to the "abstract" model of a "market oriented" system (strong separation between firm ownership and control, low ownership concentration, high independence of management, low role of financial intermediaries and high role of financial markets), while the German system is nearer to the "abstract" model of a "bank oriented" system (weak separation between firm ownership and control, high ownership concentration, low independence of management, high role of financial intermediaries and low role of financial markets in corporate monitoring, very weak constraints on bank ownership of firm equity). The Japanese system is close to the German model, but has some crucial differences in terms of larger cross-shareholding and stronger intra-group relationship. The Italian system, instead, shares the US strong constraints on firm equity ownership by banks and most characteristics of the German system, even though the role of financial intermediaries in corporate monitoring is much lower and the system of cross-shareholdings, inter and intra group participation is much more widespread for large firms listed in the stock exchange.

Source: Bagella and Becchetti (1997) and OECD Country Profiles: various years.

Box 1
Signaling models' and FI's roles compared

In “market oriented” systems, mergers and acquisitions are a channel for an informal market of internal funds. Enhancing the provision of internal funds is an implicit advantage in the presence of imperfect information as it implies a reduction in the proportion between external and internal financing sources for innovating firms and, therefore, a reduction in financing costs. The relative weight of market issues and the existence of a significant residual between individual firm internal financing and total financing in “market oriented systems” seem to suggest that this advantage exists. Furthermore, the main function of the market in corporate control is that of disciplining management. This should offset “free-riding” inefficiencies *à la Diamond* in those systems in which dispersed shareholding reduces shareholders incentives to monitor innovating firms' activities.

In “intermediated systems”, concentrated shareholdings and bank-firm participation are assumed to provide more incentives for monitoring, though Stiglitz (1993) emphasises the simple argument that relevant agency costs are induced by bank-firm participation (“the bank may have an incentive to lend the firm funds to tide it over a short run shortage of funds”).

With regard to the ability of spreading technological information and fostering technological spillovers, Dewatripont and Maskin (1995) argue that centralised lenders have a higher relative ability in gathering information concerning their borrowers. Bhattacharya and Chiesa (1995) show, instead, that it is the structure of the financial agreement, irrespective of the financial system in which it is determined, that may support or not technological knowledge sharing. The authors show that, in an environment where information is not verifiable so that interim knowledge cannot be licensed for a fee, an interim knowledge sharing commitment by innovating firms is time inconsistent even though it should be *ex ante* efficient. In this framework, multilateral financing (one bank lending to multiple firms competing with each other) may be the appropriate commitment mechanism for promoting interim knowledge sharing which occurs in the lender's interest. The model does not ignore, however, that multilateral financing implies a trade-off between the described advantage and the free-rider problem generated by disclosure of property knowledge to a borrower’s competitor.

Other direct comparisons concerning the relative capacity of the two systems to provide means for financing innovation are implicitly present in papers that analyse the borrowers' choice between bank loans and direct debt financing on the market.

Chan *et al.* (1990) suggest that, in the presence of unestablished management skills, Venture Capital (VC) is an option to be preferred to both bank loans and bond financing. According to other authors, bond financing (bank loans) should be preferred in case of good (bad) prospects for future profits (Rajan, 1992), low (high) credit risk (Berlin and Mester, 1992), established (unestablished) credit reputation (Diamond, 1991), severe (not severe) intrafirm incentive problems (Wilson, 1992).

Most of these considerations, together with the lack of reputation of the banking system, should explain why direct market financing, as a percentage of total sources of investment financing, is so much higher in rapidly developing countries (between 20 percent and 30 percent in Thailand, Korea and Taiwan) (Stiglitz, 1993) than in industrialised countries (not higher than 5 percent in France, Germany, Japan, the UK and the US).

Mathematical Appendix

In the case of the *first method*, taking the standard neoclassical model, the maximization problem of the firm is described by:

$$V_t(K_{t-1}) = \max_{L_t, I_t} \left\{ \Pi_t(K_t, L_t, I_t) + \beta_{t+1}^t E_t \left[V_{t+1}(K_t) \right] \right\} \tag{1}$$

where $\beta_{t+1}^t = 1/1 + r_t$ is the maximiser's discount factor, $\beta_{t+1}^t = 1/1 + r_t$ is the net profit function whose arguments are the capital stock K_t, the labor input factor L_t, and gross capital investment I_t, which has strictly convex adjustment costs. The constraint given by the stock of capital law of motion is:

$$K_t = (1-\delta)K_{t-1} + I \tag{2}$$

where d is the depreciation rate of capital stock. Using the envelope theorem and following Bond & Meghir (1994), Euler's equation is:

$$\frac{\partial V_t}{\partial \mathrm{K}_{t-1}} = (1-\delta)\left(\frac{\partial \Pi}{\partial \mathrm{K}}\right)_t + (1-\delta)\beta_{t+1}^t E_t\left[\lambda_{t+1}\right] \tag{3}$$

$$(1-\delta)\left(\frac{\partial \Pi}{\partial I}\right)_t + \frac{\partial V_t}{\partial \mathrm{K}_{t-1}} = 0 \tag{4}$$

where $\frac{\partial V_t}{\partial \mathrm{K}_{t-1}} = \mathrm{l}_t$ is the first derivative of the maximizing function with respect to the constraint (shadow value of capital). Replacing (4) in (3) we obtain Euler's equation without Tobin's Q:

$$-(1-\delta)\beta_{t+1}^t E_t\left[\left(\frac{\partial \Pi}{\partial I}\right)_{t+1}\right] = -\left(\frac{\partial \Pi}{\partial \mathrm{K}}\right)_t - \left(\frac{\partial \Pi}{\partial I}\right)_t \tag{5}$$

Bond & Meghir (1994), instead, start from the following arbitrage condition:

$$(1+(1-m_{t+1})\imath_t)(V_t - (1-m_t)\vartheta_t D_t N_t) = E_t\left[V_{t+1}\right] - \zeta_{t+1}(E_t\left[V_{t+1}\right] - V_t - N \tag{6}$$

where m_t is the rate of personal income tax, i_t is the interest rate on the riskless asset, θ_t is the dividend received on one unit of firm earnings distributed after corporate tax, D_t is dividends paid in period t, N_t is new share issues in period t, z_t is the effective capital gain tax and ζ_t is the value of that tax in period t+1. Under the arbitrage condition, the firm's value may be rewritten as:

$$V = E_t\left[\sum_{i=0}^{\infty} \beta_{t+i}^{t} \Pi_t (\gamma_{t+i} D_{t+i} - N_{t+i})\right] \tag{7}$$

where $\gamma_t = (1-m_t)\theta_t /(1-z_t)$ is an expression for the relative tax advantage of dividend income over capital gains.

Another constraint comes from the sources and uses of funds:

$$D_t = \Pi_t + (1-\Omega_t)N_t + B_t - (1+(1-\tau_t)i_{t-1})B_{t-1} \tag{8}$$

where B_t is the volume of debt and Ω_t is transaction costs of external finance.

Given the non-negativity constraints on dividend payments and new share issues (whose associated Kuhn-Tucker multipliers are respectively λ_t^D and λ_t^N) and the existence of non-zero bankruptcy costs, Euler's equation for the "financial hierarchy" model is:

$$-(1-\delta)\beta_{t+1}^{t} E_t\left[\left(\gamma_{t+1} + \lambda_{t+1}^{D}\right)\left(\frac{\partial \Pi}{\partial I}\right)_{t+1}\right] = -\left(\gamma_t + \lambda_t^D\right)\left(\frac{\partial \Pi}{\partial K}\right)_t - v_t\left(\frac{\partial B_t^2}{p_t^I K_t^2}\right) \tag{9}$$

where

$$v_T = E_t\left[\beta_{t+1}^{t}\left(\gamma_{t+1} + \lambda_{t+1}^{D}\right)\left(q_{t+1}^{'}\left(\frac{X_{t+1}}{B_t}\right) + q_{t+1}^{'} i_t - i_t^{'}(1-q_{t+1}^{t}))(\tau_{t+1} - m_{t+1}^{B})\right)\right] \tag{10}$$

where $q_{t+1}^{'}$ and $i_{t+1}^{'}$ are derivatives of q_{t+1}^{t} and i_{t+1} with respect to $\left(B_t / p_t^I K_t\right)$.

Concerning the *second method*, the corresponding F.O.C. is:

$$(1-\lambda_t^D)((1-\tau)p_t(1-1/\varepsilon_t)(F_{K_t} - \varphi_{I_t} - \varphi_{K_t}) - p_t^k) + \beta_{t+1} E_t\left[\frac{\partial V_{t+1}}{\partial K_t}\right] = 0 \tag{11}$$

where ε_t is price demand elasticity. Equation (11) is rearranged in the familiar Q investment equation where the shadow value of capital formula is:

$$\frac{\partial V_t}{\partial K_{t-1}} = \frac{V_t - A_t + H_t - C_t}{K_{t-1}} \tag{12}$$