Research in Economics (2001) **55**, 219–254
doi:10.1006/reec.2000.0249
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Financial constraints on investments: A three-pillar approach

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(*Received 29 January 1998, accepted 7 June 2000*)

Summary

Recent theoretical analyses demonstrate how informational asymmetries between financiers and investors may generate credit rationing and positive cost differentials between external and internal financing sources. The traditional empirical approach used to test for the presence of financing constraints at firm level is based on two pillars: *a priori* identification of relatively more financially constrained firms and econometric estimation of an investment demand function. This approach has been seriously questioned due to several methodological problems. This paper intends to amend it by adding a third pillar: the informational content of direct revelation through qualitative data. The paper estimates a reduced form investment equation following the Euler equation approach, and combines *a priori* information and direct qualitative information to consistently estimate for each firm the probability of being financially constrained. Our main finding is that when financially constrained firms are properly identified, the neoclassical model is rejected only for unconstrained firms. This indirectly rescues the validity of the Euler equation approach. Moreover, financially constrained firms show a positive correlation between investment and lagged cash flow.

J.E.L. Classification: D92, G31
Keywords: Financing constraints, firm investment.

1. Introduction

Financial sector neutrality, at firm level, is a result of the Modigliani-Miller theorem, which demonstrates the equivalence

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1090–9443/01/020219 + 36 $35.00/0

of internal and external firm financing sources. This theorem cannot be reconciled with some stylized facts of economic reality such as: i) abnormal common stock returns at the announcement date for firms issuing equities, convertibles or bonds; ii) changes in a firm's market value after changes in its dividend policy; iii) cost differentials between internal and external financing sources and credit rationing. A microfoundation for these phenomena is provided by the asymmetric information literature, which postulates the existence of informational advantage of managers over financiers about the quality of investment projects. Asymmetric information models predict the existence of a cost differential and even rationing when external finance is represented by bank debt (Stiglitz & Weiss, 1981; Besanko & Thakor, 1986; Milde & Riley, 1988) and new equity issues (Myers & Majluf, 1984 & Fazzari, Hubbard & Petersen, 1988).

Several empirical papers confirm the existence of financing constraints suggested by these theoretical models. In order to do so, they test for the additional power of the availability of internal finance in explaining firm investment decisions. Their approach is based on two pillars: i) *a priori* information on the relevance of financing constraints for subgroups of firms selected according to size, age and access to financial markets; ii) econometric estimates of an Euler equation or of an investment demand function derived from the solution of a standard neoclassical investment model.

These contributions find that constrained firms reject the neoclassical model because of investment's excess sensitivity to cash flow, as predicted by the presence of financing constraints. However, these analyses are riddled with unsolved methodological problems (Chirinko, 1993; Gilchrist & Himmelberg, 1995; Schiantarelli, 1996). As a consequence, this finding is not conclusive, because the financing constraints hypothesis cannot be distinguished from the alternative hypothesis which states that *a priori* information is not related to financing constraints and that cash flow is just a proxy for unobservable future investment opportunities.

Given the abundance of contributions that nevertheless adopt the cash flow-investment empirical approach, it seems evident that adding information from a third pillar—direct revelation of financial problems from qualitative data—may be decisive in increasing the reliability of firm level tests of financing constraints. This will be done by using the "Mediocredito" dataset containing qualitative and three-year balance sheet data for 3852 Italian firms, and a restricted sample, which merges "Mediocredito" and "Centrale dei Bilanci" datasets, containing qualitative and 13-year balance sheet data for a subset of 891 firms.

We think that the application of this methodology to our data is of particular interest given the nature of the sample used and the specific features of the Italian industrial and financial system.

This sample is unique because it focuses on small and medium firms not quoted on the stock market, starting from firms with more that 10 employees and one billion lira of turnover (less than 700 000 U.S. dollars). These very small firms are more likely to face financing constraints, like credit rationing or very high cost of non-collateralized debt, but are almost never considered in firm level studies which, as Gertler and Gilchrist (1994) note, focus exclusively on publicly traded companies. We have access not only to detailed balance sheet data of these firms for 13 years, but also to direct information about their problems in financing investments. Hence, this paper is one of the few† that try to verify directly whether or not higher investment-cash flow sensitivity is really related to financing problems.

The Italian industrial system, in a comparison with some benchmark OECD countries, appears heavily downsized,‡ with a high ownership concentration. Many firms are family owned and when they are not, management independence is low. Firms' leverage is high as bank loans are the main, if not the only, source of external finance. This is due to: i) the heavily biased fiscal distortion toward debt financing (a combination of interest payment allowances and double taxation on firm profits); ii) the relatively modest role of the stock market which can be inferred from the low stock market capitalisation (1/10 of that in the U.K. in 1995); and iii) the almost non existent private bond market crowded out by the more liquid market of Treasury bonds (the market value of bonds listed by domestic private sector was in 1995 less than 1/60 of that in the U.K.).§

This general framework is necessary for understanding why also the relationship between finance and innovation in Italy may be quite different from that of the main OECD countries. There are no innovating firms in high cash flow sectors such as

† For example Kaplan and Zingales (1998) carry out a more detailed analysis of the 49 low dividend firms identified as constrained by Fazzari Hubbard and Petersen (1988), and show how in 85% of firm-years direct data exclude the presence of financial constraints for them.

‡ The main rationales for this phenomenon are that upsizing is prevented by several costs such as i) the need for more transparency in a system where tax evasion is widely spread and ii) problems of coordination and control that new equity partners would generate in small family controlled firms. Downsizing is also recognised to have relevant private and public costs for the Italian industrial system such as more financial constraints and higher difficulty in transmission of human capital across generations. (De Cecco-Ferri, 1997; Bagella-Becchetti-Caggese, 1996)

§ This makes the Italian system a perfect case of credit view where all of the three Kashyap-Stein (1993) requirements are met (price and wage rigidities, firm dependence from bank loans as the unique source of external finance and reduced independence of bank financing sources, all subject to strong reserve requirements, from movements in policy rates decided by the Central Bank).

pharmaceuticals and chemicals. Most innovating firms are either niche pharmaceutical, niche chemical or mechanical equipment firms. In both cases they are generally much smaller in size and invest in product and process innovation. Italian innovating firms therefore have a comparatively higher external finance requirement than innovating firms in Japan or in the U.K.†

From a theoretical point of view, the need for more sector specific knowledge in innovating sectors is supposed to increase the gap between the cost of internal and external finance when unspecialized financiers provide the latter. This stimulates the birth of internal (venture capital) financiers à la Bernanke & Gertler (1990) which develop sector specific knowledge and help to eliminate the financial constraint differential between innovating sectors and other sectors in equilibrium. This does not occur in Italy because: i) the "equity dilution syndrome" in family owned firms is a strong barrier to equity participation from external financiers (see Tables A1.1 and A1.2 in Appendix 1); ii) the creation of a market for venture capital financiers is not encouraged by the tax system which was heavily biased (at least until the October 1997 fiscal reform) toward debt financing.

This paper aims to measure the consequences of these features of the Italian financial and industrial system on firms' financing constraints and is organised as follows: Section 2 justifies our (three-pillar) methodological choice compared to the traditional two-pillar empirical approach used for estimating financial constraints at firm level. Section 3 explains the methodology adopted in identifying financially constrained firms using direct qualitative information and comments on the empirical findings. Section 4 presents the estimates of the dynamic model of investment for constrained and unconstrained firms.

2. The choice of methodology

The empirical literature on the two-pillar approach to financial constraints on investment is based on a joint test of two distinct hypotheses (henceforth H1 and H2):

- H1) Some observable characteristics of firms (size, age, affiliation to group, etc.) are related to how likely they are to be financially constrained.
- H2) Financially constrained firms, selected according to these characteristics, reject the neoclassical model of investment

† This explains why the *a priori* identification of R&D firms as more financially constrained firms is a particular consequence of Italian financial system imperfections (Bagella and Becchetti, 1996).

because their limited access to external finance prevents them from investing optimally when internal finance is not available.

To perform such a joint test, this literature follows three main methods: 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 & Petersen, 1988, for the U.S.A., Hoshi, Kashyap & Sharfstein, 1992 for Japan, Devereux-Schiantarelli, 1989, Becchetti, 1994 and Schiantarelli & Georgoutsos, 1992 for the U.K.); ii) a Euler equation test for financial market imperfections whose empirical specification does not include the marginal Tobin's *Q* among regressors (Bond & Meghir, 1994; Withed, 1992; Hubbard, Kashyap & Withed, 1995); iii) a direct estimate of the investment demand function where the future expected marginal productivity of capital is proxied by a VAR forecast of firm fundamentals observable to the econometrician (Gilchrist & Himmelberg, 1995 & 1998).

These empirical analyses suffer from several problems. The most relevant of them are: i) Tobin's average *Q* can replace marginal *q* only under very restrictive assumptions (Hayashi, 1982); ii) measurement errors in the future expected marginal productivity of capital generate biases in the measurement of the investment-cash flow relationship; iii) problems in the estimation of the replacement cost of capital (Chirinko, 1993; Schiantarelli, 1996); iv) the ambiguous informational content of the cash flow variable which may be a proxy for both financial constraints and future investment opportunities when firms and markets are still learning how to extract the latter from Tobin's *Q* (Gilchrist & Himmelberg, 1995).

Given these problems, the Euler equation approach has a main advantage with respect to the other two: it solves the investment equation backwards, and hence it does not require the estimation of the future expected marginal productivity of capital, nor of average *Q*. Instead, expectations can be evaluated at realized values.

Despite this great advantage, this approach is now less popular in empirical literature because of one major shortcoming: if the model is rejected, all assumptions fall together, and it is impossible to interpret the reason for the rejection. In other words, the result that financially constrained firms reject the model because of an excess sensitivity of investment to cash flow is useless if the model is rejected also for unconstrained firms. As a consequence, it is impossible to distinguish financing constraints result from a joint alternative hypothesis: observable characteristics of firms are not a proxy for financing constraints and investment is excessively sensitive to cash flow because the latter is a proxy for unobservable future investment opportunities.

For this reason we propose to follow the Euler equation combined with a three-pillar approach. The third pillar is an independent direct sorting criterion, because we extract from the qualitative survey not only information on firms' characteristics, which may be indirectly related to financing constraints, but also a direct declaration of firms on their problems in obtaining external funds to finance new investment.

This constitutes an independent source of information that enables us to consistently estimate the probability of each firm to be financially constrained, and to separately test the two hypotheses. In fact, the consistency between direct information and *a priori* firm characteristics related to financial constraints tests H1, while econometric estimation, given the reliability of our method to identify constrained firms, tests H2.

TABLE 1 *Sample statistics—cut points for 10 equal groups*

Enlarged sample of 3852 firms.					
Percentile	Age	Avg. Total Sales	Avg N. of empl.	Sales Growth*	Avg. R.O.E.*
10.00	9	1786	16	−19·2%	−5·1%
20.00	12	3396	24	−8·8%	0·7%
30.00	16	5980	36	−0·9%	2·7%
40.00	18	9789	56	5·8%	5·0%
50.00	22	15 030	81	12·2%	7·6%
60.00	26	22 091	112	18·4%	10·7%
70.00	31	33 463	155	26·1%	14·6%
80.00	37	57 711	244	38·5%	19·9%
90.00	51	128 623	537	63·3%	32·0%
Restricted sample of 891 firms**					
Percentile	Age	Avg. Total Sales	Avg N. of empl.	Sales Growth	Avg. R.O.E.
10.00	16	8514	47	−17·8%	−2·4%
20.00	18	12 086	67	−7·8%	1·2%
30.00	22	16 463	88	−0·8%	3·0%
40.00	25	20 515	110	4·6%	5·2%
50.00	29	25 820	132	9·4%	7·2%
60.00	33	33 551	162	14·8%	9·3%
70.00	37	45 927	200	21·3%	11·9%
80.00	46	63 345	269	30·4%	15·8%
90.00	62	105 439	484	44·8%	21·7%

Sales in million of liras at 1992 prices.
*Values computed only for firms that have balance sheet data for all the three years, for a Total of 3275 firms.
**Values computed using only the three years of data in common with the enlarged sample.

The validity of the third pillar is confirmed by the main result of the paper: when financially constrained firms are properly identified, the neoclassical model is rejected only for unconstrained firms. This indirectly rescues the validity of the Euler equation approach.

3. The empirical results from the direct revelation approach

The Mediocredito dataset is a sample of more than 4000 firms drawn from the whole set of Italian manufacturing firms (64 463 firms at 1992 according to Cerved database). For a subsample of 3852 firms both qualitative and balance sheet data† for the period 1989–1991 are available. The sample is randomly stratified (it reflects the sector's geographical and dimensional distribution of Italian firms) for 3433 firms from 11 to 500 employees. It is by census for firms with more than 500 employees.‡

This dataset is limited in that balance sheet data are available only for three years. We solve this problem by merging the Mediocredito sample with another dataset, extracted from Centrale dei Bilanci, which is a balanced panel of 5485 firms with 13 years of balance sheet data, from 1982 to 1994. The result is a subsample of 891 firms with complete balance sheet data from 1982 to 1994 plus qualitative data. The main features of the two samples are reported in Table 1. The restricted sample does not include the younger and smaller firms of the enlarged sample. Nonetheless, it is still mainly composed of small firms, with half of them below 26 billion lira of average total sales (approx. 15 million U.S. dollars).

Qualitative information is used to divide the sample into subgroups of financially constrained and non-financially constrained firms. The survey asks if the firm undertook new investment projects in the years 1989–1991. In case of a positive answer, the firm is requested to answer if it had difficulties in financing investments because of: i) "lack of medium-long term financing"; ii) "excessive cost of debt" or iii) "lack of guarantees" (questions 17.2, 17.3 and 17.4 in the questionnaire).§ For each problem it can

† Only 3275 firms have quantitative data for all the three years.

‡ Qualitative data provide, among other things, information on firm property, degree of internationalisation, entitlement to state subsidies and conclusion of agreements with partners and competitors.

§ The three questions about financial problems are addressed in the "new investment projects" section of the questionnaire. Hence, only firms with new investment projects (82% in the enlarged sample and 89% in the restricted sample) were supposed to answer those questions. However, a small share of firms without new projects also filled out that section of the questionnaire. All these firms replied that they had financial difficulties. This may indicate the reason why they were unable to undertake the new investment in the first place. Therefore, the remaining firms without new projects that did not fill out that section of the questionnaire could either be unconstrained firms with low financing needs or constrained firms that, as intended, went on to the next part optionally assess a degree of intensity ranging from 1 (low intensity) to 3 (high intensity).†

The financial constraints indicator, constructed as the sum of the three answers, ranges from a minimum of zero (no financial constraints) to a maximum of 9.‡ Using the financial constraints indicator we preliminary define two groups of firms: i) firms with high financial constraints (HFC), with a value of the indicator from 3 to 9; ii) firms with medium financial constraints (MFC), with a value of the indicator from 1 to 9.

A possible objection to these criteria concerns the unweighted aggregation in a composite index of different causes of financing constraints. For this reason we propose some additional criteria considering the following alternatives as financial constraint indicators: DGAR (if lack of guarantees>0), DUCODEB (if excess cost of debt >0), DUSCFIN (if scarcity of long term financing >0) and GARSCFIN (if DUSCFIN >0 or DGAR >0). The rationale for additional criteria, in which each cause of financial constraints is separately considered, is that several theoretical models show that the three causes considered in question 17 may be mutually incompatible. For example, in Stiglitz-Weiss (1981) the maximizing behaviour of banks implies quantity rationing (scarcity of financing) and not higher cost of debt to avoid moral hazard and adverse selection. When projects are not ordered according to mean preserving spreads, as in Stiglitz & Weiss (1981), however, raising the cost of debt may have “cleansing effects” ruling out bad firms (De Meza & Webb, 1987). If the dimension of informational imperfection matches the number of instruments which the firm may use to signal its quality (and if the only available instrument is collateral) then only firms without collateral will not be able to signal their quality and will be rationed (Bester, 1987). In addition, moral hazard can be caused also by the imperfect enforceability problem (Hart and Moore, 1998). Also in this case, a firm’s borrowing capacity will depend on the collateral value of its assets. Grossly simplifying we may state that DUSCFIN is a Stiglitz & Weiss (1981), DUCODEB is a De Meza & Webb (1987), DGAR is a

of the questionnaire. By not including firms without new projects we could have a serious sample selection bias. This is because the decision to undertake new projects is highly correlated to the presence of profitable investment opportunities and of available funds. Therefore we decided to estimate the whole sample.

† An average value of 2 is assigned to a positive answer without the indication of intensity.

‡ Questionnaire responses are often likely to be distorted because, for instance, the interviewer may have the interest to enhance or minimise problems in order to give a desired signal to the interviewer. Hence we eliminated *ex-ante* from both samples “non credible” firms that: i) declare a problem of scarce medium-long term financing (question 17.3) and, at the same time, the availability of grants and soft loans to finance investments (questions 16.4.2 and 16.5).

Bester (1987) and GARSCFIN is a Hart & Moore (1997) indicator of financial constraints.

Table 2 illustrates the distribution of firms according to the alternative selection criteria. Tables A1.3 and A1.4 in Appendix 1 provide descriptive evidence of the consistency between *a priori* identification and direct revelation of financially constrained firms. Variables in rows are the six measures of directly revealed financial constraints (HFC, MFC, DGAR, DUSCFIN, DUCODEB, and GARSCFIN). Variables in columns are the traditionally adopted discriminants for financial constraints. R&D "participation" is the share of firms that invest in R&D; R&D intensity is the average ratio of R&D capitalized investment over total assets; loss of control is the share of firms participated by more than 50%. Table 3 refers to the enlarged sample (3852 firms of the whole Mediocredito dataset), Table 4 refers to the restricted sample (891 firms from merging Mediocredito and Centrale dei Bilanci detests).

Descriptive statistics from these tables show at first the strong significance of firm size and leverage, which is consistent with previous results from Italy (Becchetti, 1994), and the U.S. (Fazzari-Hubbard-Petersen, 1988). Firms with financial constraints, on average, have half the ratio of net assets over liabilities and are half the sizes of the complementary set (150–180 employees for financially constrained groups against 310–350 for non-financially constrained groups). The result is robust across simple and composite financial constraint indicators.

TABLE 2 *Intensity of financing constraints (% values)*

F. Constraints Index	Enlarged sample	Restricted sample
0	78·0	76·8
1	1·6	1·8
2	11·0	11·4
3	3·9	4·3
4	2·9	2·8
5	1·0	1·3
6	1·1	1·3
7	0·3	0
8	0·2	0·1
9	0·1	0·1
N. observed	3852	891
% of MFC firms over total	22	23·2
% of HFC firms over total	9·4	10
% of DUCODEB firms over total	17·6	15·1
% of DUSCFIN firms over total	13	14·6
% of DGAR firms over total	2·6	2·5
% of GARSCFIN firms over total	14·8	15·6

TABLE 3 *Multivariate probit results—enlarged sample of 3852 firms*

	MFC	HFC	DUCODEB	DUSCFIN	DGAR	GARSCFIN
Intercept	−2·53	−2·91***	−2·14***	−2·56***	−6·14***	−2·67
	(2·32)	(0·30)	(0·22)	(0·26)	(1·04)	(2·78)
Small firms	1·29***	0·65**	1·01***	0·96***	2·70**	1·02***
	(0·23)	(0·29)	(0·22)	(0·25)	(1·03)	(0·25)
Medium firms	0·84***	0·21	0·63***	0·75***	2·24**	0·80***
	(0·21)	(0·27)	(0·21)	(0·24)	(1·02)	(0·23)
Firm's year of birth	0·33**	0·12	0·11	−0·23*	0·25	0·000
	(0·12)	(0·19)	(0·13)	(0·16)	(0·29)	(0·003)
Leverage	−0·03**	−0·07***	−0·04***	−0·07***	−0·08*	−0·07***
	(0·01)	(0·02)	(0·01)	(0·02)	(0·05)	(0·019)
R&D participation	0·36**	0·53***	0·16	0·43***	0·88***	0·43**
	(0·10)	(0·15)	(0·10)	(0·11)	(0·25)	(0·15)
R&D intensity	7·89*	5·09	11·20**	7·75	13·67*	10·00*
	(5·53)	(7·62)	(5·48)	(5·97)	(8·21)	(5·66)
Loss of control	−0·16	−0·25*	−0·31**	−0·24**	−0·09*	−0·25**
	(0·12)	(0·18)	(0·12)	(0·13)	(0·05)	(0·13)
Chi square	84·41	40·37	78·61	68·13	40·06	75·33
Probability	0·00	0·00	0·00	0·00	0·00	0·00

*Coefficient significant at 90% confidence level.
**Coefficient significant at 95% confidence level.
***Coefficient significant at 99% confidence level.
HFC: firms with index of financial constraints >2; MFC: firms with index of financial constraints >0; DUCODEB: firms with financial constraints under the form of excessive cost of debt; DUSCFIN: firms with financial constraints under the form of scarcity of medium-long term financing; DGAR: firms with financial constraints due to lack of guarantees; GARSCFIN = DGAR ∪ DUSCFIN; Small firms: 1 if firms with less than 50 employees; Medium firms: 1 if firms from 50 to 500 employees; Leverage: net assets/liabilities; R&D participation: 1 if the firm has positive R&D expenditures; R&D intensity: R&D expenditures/total assets; Loss of control: firms controlled (more than 50% of capital) by other companies.
The table reports multivariate probit coefficients with standard errors in parenthesis. Chi square is the value of a joint significance test of coefficients.

The expected age result (firms with financial constraints are on average younger) is significant in the enlarged sample but not in the restricted sample. A plausible explanation is that the restricted sample collects firms that transmitted at least 13 years of balance sheets to the Centrale dei Bilanci database ruling out newly established firms. This shows that the need to combine qualitative information with panel data analysis entails some costs as it excludes part of the richer information contained in the enlarged Mediocredito Survey, including a wider set of less homogeneous firms, from the restricted analysis. The result on R&D participation seems more robust than R&D intensity across different specifications of financing constraints. These two variables do not always significantly discriminate among subsamples, even though they both go in the right direction. As a result R&D, participating firms are in Italy more financially constrained than non-R&D firms, in contrast with empirical

TABLE 4 *Multivariate probit results—restricted sample of 891 firms*

	MFC	HFC	DUCODEB	DSCFIN	GARSCFIN
Intercept	0·35	−5·77	−6·80	2·27	0·45
	(5·01)	(6·78)	(5·92)	(5·52)	(5·51)
Small firms	0·51**	0·18	0·70**	0·10	0·21
	(0·25)	(0·29)	(0·29)	(0·28)	(0·28)
Medium firms	0·47**	0·12	0·45**	0·36	0·39*
	(0·21)	(0·24)	(0·25)	(0·23)	(0·22)
Firm age	−0·000	0·002	0·002	−0·002	−0·001
	(0·002)	(0·003)	(0·002)	(0·003)	(0·003)
Leverage	−0·007**	−0·005	−0·005*	−0·007**	−0·008**
	(0·003)	(0·003)	(0·003)	(0·004)	(0·003)
R&D participation	0·12	0·16	−0·07	0·26*	0·28**
	(0·14)	(0·16)	(0·16)	(0·15)	(0·15)
R&D intensity	7·07	4·39	34·13*	−22·27	−23·26
	(18·3)	(20·8)	(19·88)	(21·84)	(21·38)
Loss of control	−0·28**	−0·30**	−0·36***	−0·13	−0·14
	(0·11)	(0·14)	(0·12)	(0·12)	(0·12)
Chi square	24·92	12·55	26·33	13·63	14·65
Probability	0·00	0·08	0·00	0·05	0·04

*Coefficient significant at 90% confidence level.
**Coefficient significant at 95% confidence level.
***Coefficient significant at 99% confidence level.
HFC: firms with index of financial constraints >2; MFC: firms with index of financial constraints >0; DUCODEB: firms with financial constraints under the form of excessive cost of debt; DUSCFIN: firms with financial constraints under the form of scarcity of medium-long term financing; DGAR: firms with financial constraints due to lack of guarantees; GARSCFIN = DGAR ∪ DUSCFIN; Small firms: 1 if firms with less than 50 employees; Medium firms: 1 if firms from 50 to 500 employees; Leverage: net assets/liabilities; R&D participation: 1 if the firm has positive R&D expenditures; R&D intensity: R&D expenditures/total assets; Loss of control: firms controlled (more than 50% of capital) by other companies. The table reports multivariate probit coefficients with standard errors in parenthesis. Chi square is the value of a joint significance test of coefficients.

findings from several other countries† (Becchetti, 1995). Also firms that belong to a group‡ are significantly less financially constrained, especially in the enlarged sample.

† This result may be explained by the weaknesses of the Italian financial system where firms heavily rely upon financing from state owned banks that cannot own shares of firms. Bagella-Becchetti (1996) show how the contemporary presence in Italy of scarce monitoring capacity, small medium firm "dilution syndrome" and the highest debt favourable tax shield among OECD countries strongly penalises R&D intensive firms vis-à-vis other firms.

‡ In a sophisticated financial system, with a less concentrated ownership of shares, it is obviously possible to control a firm with much less than 50% of its shares. In an unsophisticated system with small-medium firms (90% in the "Mediocredito" sample) the 50% threshold is a good proxy for firm control. The variable is considered as a significant discriminant in other papers. Results from previous analyses on Japanese (Hoshi-Kahyap-Scharfstein, 1992) and Italian

Finally, it is important to note that these findings seem to be internally consistent (questionnaire responses seem to be sincere), for at least two reasons: i) firms declaring difficulties in financing investment for lack of guarantees (DGAR) have a significantly lower net asset/liabilities ratio (Tables A1.3 and A1.4); ii) all subgroups of firms declaring to be financially constrained find higher advantages in terms of financial solidity and easier access to credit from equity dilution and have a relatively higher preference for policy instruments directed at solving financial problems (see Tables A1.1 & A1.2).

Multivariate probit results confirm the relative strength of the net effect of size, group affiliation and R&D participation on financial constraints and the relative weakness of the other effects (Tables 3 & 4).

The size effect (measured by the two dummy variables SMALL FIRMS and MEDIUM FIRMS) is significant in all of the six specifications for the enlarged sample and in three out of five in the restricted section.† Also, R&D participation seems to be very robust across different specifications, especially in the enlarged sample, while the marginal effect of age is not significant.

4. The econometric estimates: methodology and results

This section will consider the econometric estimation of a dynamic model of investment. Using the qualitative information of the survey, we are able to directly identify financially constrained firms, and separately test H2. This hypothesis is not rejected if the neoclassical model holds for unconstrained firms, while constrained firms reject it because of excess sensitivity of investment to cash flow. We will also show how the estimation results are robust to the sample selection bias problem, due to the combined use of (endogenous) direct and (exogenous) indirect information.

Following Bond & Meghir (1994), we consider the dynamic investment problem of a firm in the context of tax advantage for borrowing and for retained earnings against new shares issues, and for bankruptcy costs. We believe that these features are at least as important as financial constraints in explaining the hierarchy of finance for Italian manufacturing firms, as other studies confirm.‡

(Becchetti, 1994b) balance sheet data showed that intragroup participation (affiliation to keiretsus in the Japanese case) may ease a firm's access to credit.

† DGAR is not estimated for the restricted sample because of too few observations of firms with this problem.

‡ See for example Bonato, Hamaui and Ratti (1993). Moreover model predictions are consistent with the presence of financial constraints, in the sense that a firm facing credit rationing behaves like the "liquidity constrained regime" firm in the model.

We consider the problem of a firm at the beginning of period t, which maximises the value of its shares for the marginal shareholder. Capital stock K_t follows the law of motion

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

where δ is the depreciation rate and I_t is the investment. The value of the firm for the marginal shareholder is given by:

$$V = E_t \left| \sum_{j=0}^{\infty} \beta_{t+j}^{t} (\gamma_{t+j} D_{t+j} - N_{t+j}) \right| \tag{2}$$

D_t is dividends paid in period t and N_t is new share issues in period t.† The budget constraint is the following:

$$D_t = \Pi_t + (1-\Omega)N_t + B_t - (1 + (1-\tau_t)i_{t-1})B_{t-1} \tag{3}$$

where Π_t is net revenues, B_t is volume of debt, Ω is transaction costs of external finance, i_{t-1} is interest rate on debt, and τ_t is the corporate tax rate.

The problem has also two non-negativity constraints on dividend payments and new share issues, whose associated Kuhn-Tucker multipliers are respectively λ_t^D and λ_t^N. Moreover, it is assumed that in case of bankruptcy, ownership is transferred from shareholders to creditors, with positive bankruptcy costs. Interest rate on debt and bankruptcy probability is linear in the ratio $\dfrac{B_t}{p_t^l K_t}$, where p_t^l is the price of a unit of capital goods in period t, while bankruptcy costs are linear in B_t.

The Euler equation characterizing the optimal investment path and the first order condition for new shares issues can be written, using the first order condition for investments to eliminate the shadow value of capital (Tobin's Q), in the following way:

$$-(1-\delta)\beta_{t+1}^{t} E_t \left[(\gamma_{t+l} + \lambda_{t+1}^{D}) \left(\frac{\partial \Pi}{\partial I} \right)_{t+l} \right] = -(\gamma_t + \lambda_t^D) \left(\frac{\partial \Pi}{\partial I} \right)_t - (\gamma_t + \lambda_t^D) \left(\frac{\partial \Pi}{\partial K} \right)_t - \nu_t \left(\frac{\partial B_t^2}{p_t^l K_t^2} \right) \tag{4}$$

$$\lambda_t^N = -(\gamma_t + \lambda_t^D)(1-\Omega) + 1 \tag{5}$$

† $\gamma_t = (1-m_t)\theta_t/(1-z_t)$ is an expression for the relative tax advantage of dividend income over capital gains, and the discount factor for j periods is $\beta_{t+j}^{t} = \prod_{i=l}^{f}(1+r_{t+i-l})^{-1}$, where. $r_t = [(1-m_{t+l})l_t]/1-\zeta_{t+l}.m_t$ is the rate of personal income tax, ι_t is the interest rate on the riskless asset, θ_t is the dividend received on one unit of firm's earnings distributed after corporate tax., z_t is the effective capital gain tax and ζ_t is the value of that tax in period $t+1$.

The coefficient v_t is positive under the imperfections stated before, because the cost of debt increases with leverage, and is zero otherwise (see Bond & Meghir, 1994). In order to perform a GMM estimation of equation (4), the following assumptions are made: i) the net revenue function is specified with quadratic adjustment costs: $\Pi_t = p_t F(K_t, L_t) - p_t G(K_t, L_t) - w_t L_t - p_t^l I_t (6)$, where $G(K_t, L_t) = 1/2bK_t[I/K)_t - c]^2$; ii) $F(K_t, L_t)$ is a CRS production function; iii) $Y_t = F(K_t, L_t) - G(K_t, L_t)$ is linearly homogeneous in (K, L); iv) the marginal product of variable factors $(\partial F/\partial L)$ can be replaced† by $w/\alpha p$. p_t^l is the price of investment goods, p_t is the price of the firm's output and w_t is the vector of prices of variable inputs L_t. $\alpha = 1 - 1/\varepsilon > 0$ since ε, the price elasticity of demand is assumed to be greater than 1. By replacing the derivatives with respect to capital stock and investment in the Euler equation (4) we obtain:

$$\left(\frac{I}{K}\right)_{t+1} = \alpha_{0,t+1} + (1+c)\phi_{t+1}\left(\frac{I}{K}\right)_t - \phi_{t+1}\left(\frac{I}{K}\right)_{t+1}^2 - \frac{\phi_{t+1}}{\alpha b}\left(\frac{C}{K}\right)_t + \frac{\phi_{t+1}}{\alpha b(\varepsilon - 1)}\left(\frac{Y}{K}\right)_t - \frac{v_t}{\alpha b \beta_{t+1} p_{t+1}(\gamma_{t+1} + \lambda_{t+1})}\left(\frac{B}{K}\right)_t^2 + \upsilon_{t+1} \qquad (7)$$

Where‡ $\phi_{t+1} = \dfrac{1}{1-\delta}\dfrac{p_t}{p_{t+1}}\dfrac{\lambda_t^D + \gamma_t}{\beta_{t+1}(\lambda_{t+1}^D + \gamma_{t+1})}$. Equation (7) may be subsequently specified for the empirical estimate as:

$$\left(\frac{I}{K}\right)_{i,t} = \alpha_{i,t} + \beta_{l,t}\left(\frac{I}{K}\right)_{i,t-1} + \beta_{2,t}\left(\frac{I}{K}\right)_{i,t-1}^2 + \beta_{3,t}\left(\frac{C}{K}\right)_{i,t-1}$$

† Assumptions iii) and iv) are necessary to derive an empirically tractable investment equation (see Bond and Meghir, 1994), as they imply the following simple linear relation between marginal productivity of capital and cash flow and output: $\left(\frac{\partial H}{\partial K}\right)_t = \frac{\alpha p_t Y_t - w_t L_t}{K_t} + b\alpha p_t \left(\frac{I}{K}\right)_{t+l}^2 - bc\alpha p_t \left(\frac{I}{K}\right)_{t+l}$ (6 bis) If there is perfect competition, then $\alpha = 1$ and the numerator of the first term of the RHS in equation 6bis is equal to the cash flow: $C_t = \alpha p_t Y_t - w_t L_t$. In general $\alpha < 1$, and the first term of the right hand side can be decomposed to: $\frac{\alpha p_t Y_t - w_t L_t}{K_t} = \frac{C_t}{K_t} - (1-\alpha)\frac{p_t Y_t}{K_t}$. This means that, when cash flow is used to proxy for the marginal productivity of capital, output has a residual negative correlation with the latter.

‡ $(B/K)_t^2 = (p_t^l/p_{t+1})[B_t/(p_t^i K_t)]^2$, $(C/K)_t = (p_t Y_t - w_t L_t)/(p_t K_t)$ and $\alpha_{0,t+l} = \phi_{t+l}\left(\frac{1}{\alpha b}\frac{p_t^l}{p_t} - c\right) + \left(\frac{1}{\alpha b}\frac{p_{t+l}^l}{p_{t+1}} - c\right) \cdot \upsilon_{t+1}$ is an iid error under rational expectations.

$$+\beta_{4,t}\left(\frac{Y}{K}\right)_{i,t-1}+\beta_{5,t}\left(\frac{B}{K}\right)_t^2+d_t+\upsilon_{it} \quad (8)$$

The crucial point is that the coefficient ϕ_{t+1} includes the unobservable multipliers λ_t^D and λ_{t+1}^D. The interpretation of this is straightforward. If the firm is not constrained today (and expects not to be in the future), because it is able to finance all profitable investment, then it will borrow in order to exploit the tax advantage of debt and will distribute dividends. In this case λ_t^D is zero for any t. Assuming that γ is constant over time then we have that $\phi_{t+1}=\frac{1}{1-\delta}\frac{p_t}{p_{t+1}}\frac{1}{\beta_{t+1}}$, that means a value roughly constant over time, greater than one.† Then $\alpha_{i,t}=\alpha_i$ and $\beta_{i,t}=\beta_i$, for $i=1,\ldots,5$, and it is possible to consistently estimate parameters of equation (8), where the individual effects $\alpha_{i,t}$ and the time specific effects d_t should capture variations of $\alpha_{0,t+1}$ that includes the unobservable user cost of capital. β_1 should be positive and greater than one; β_2 negative and greater than one in absolute value;‡ β_3 and β_4 are respectively§ $-\frac{\phi_{t+1}}{\alpha b}<0$ and $\frac{\phi_{t+1}}{\alpha b(\varepsilon-1)}>0$. Their magnitude depends on ϕ_{t+1}/b, while the ratio between the two depends on $\varepsilon-1$;¶ β_5 is expected to be negative under costly bankruptcy and financing costs increasing in the amount borrowed, not significant otherwise.

A similar result is obtained when λ_t^D is positive but the firm is able to finance investment issuing new shares. In this case,

† The inflation rate has been fairly stable in Italy during the 1987–1994 period used for the estimation, hence p_t/p_{t+l} is stable as well. Given that plausible intervals for structural parameters are $\delta\in[0{\cdot}1, 0{\cdot}2]$, $1/\beta_{t+1}\in[1{\cdot}1, 1{\cdot}2]$ and $p_t/p_{t+l}\in[0{\cdot}9, 0{\cdot}95]$, then $(\phi_{t+l}|\lambda_t=0, \gamma_t=\gamma_{t+l}, \forall t)\in[1{\cdot}1, 1{\cdot}425]$.

‡ If the adjustment cost function is correctly specified c should be roughly equal to δ, then $(1+c)\phi_{t+l}=\beta_1\in[1{\cdot}21, 1{\cdot}71]$ and $-\phi_{t+l}=\beta_2\in[-1{\cdot}425, -1{\cdot}1]$.

§ Previously, we noted that cash flow and output correlations with marginal productivity of capital are respectively positive and negative. If the Euler equation (4) is solved forward, we have the classic Q-model where investment is positively correlated to future expected marginal productivity of capital. Therefore it is also positively related to cash flow and negatively related to output. Instead the coefficients in equation 8 have opposite signs, because we derive the investment equation by solving the Euler equation backwards. The intuition is that an increase in productivity of capital at time $t-1$ increases investment at time $t-1$, cash flow at time $t-1$ and expected investment at time t. Given the investment smoothing effect of the convex adjustment costs, the net effect of cash flow on future investment is negative.

¶ Hence to find a cash flow coefficient bigger than the output coefficient is a fact consistent with a high price elasticity of demand. This would not imply the rejection of the model, as the sample is focused on small and medium firms.

using equation (5) with $\lambda_t^N = 0$ we have that $(\gamma_t + \lambda_t^D) = constant$, allowing us to consistently estimate equation (8).†

When the firm is constrained and unable to efficiently finance investments, then both λ_t^D (dividends are not distributed) and λ_t^N (dilution costs prevent from issuing new shares) are positive. More importantly λ_t^D changes over time, and hence equation (8) is misspecified, because coefficients are not constant.

An example will clarify what is likely to happen. Let us suppose that at time t the firm's optimal level of investment increases because of a positive technological shock, but the firm has no available internal finance. If debt finance is available but at an increasing cost, then the firm will borrow and invest at a lower level with respect to the same firm with available cash flow, because external finance is more costly than internal one. λ_t^D will be positive, with a magnitude proportional to the cost differential between external and internal finance.‡ If debt finance is not available because the firm is credit constrained, λ_t^D will be positive again, proportional to the difference between marginal return of investment and marginal cost of internal finance.§

Now suppose that at time $t+1$ investment needs are still high but an increase in internal resources from previous period (C/K_t is high) reduces the intensity of financial constraints. Then in this case I/K_{t+1} goes up because λ_{t+1}^D goes down, but since β_i coefficients are constant (that is equivalent to say that λ_{t+1}^D is an omitted variable), the effect is captured by a positive coefficient of C/K_t, which is negatively correlated to λ_{t+1}^D for a financially constrained firm. This is the reason why we expect that under financial constraints the coefficients of I/K_{t+1} equation are biased, and that in particular the coefficient of C/K_t is positive and strongly significant instead of being negative.

The model (8) is estimated, following Bond-Meghir, by selecting firms in two groups of constrained and unconstrained firms, and by allowing coefficients $\beta_i (i = 1 \ldots 5)$ to vary across the groups. This is equivalent to a nested test of two hypotheses, the null of the neoclassical investment model and the alternative of financing constraints: i) if both groups reject the neoclassical model, then the rejection is in favour of an unknown alternative; ii) if the unconstrained group does not reject the neoclassical model, and the constrained one rejects it because of an excess sensitivity of investment to cash flow, then the rejection is in favour of the alternative of financial imperfections.

† Given the described features of the Italian system, (equity dilution syndrome of Italian entrepreneurs and downsizing adequately represented in our sample), this regime should include very few of the observed firms.

‡ These firms are detected by the DUCODEB variable.

§ These firms are detected by the DUSCFIN and GARSCFIN variables.

The robustness of the second point depends crucially on the criteria used to split the groups. The main contribution of this paper is to provide additional information essential to increase the reliability of such criteria.

The dynamic model is estimated† by eliminating the unobservable α_i with the following orthogonal forward transformation (Arellano and Bover, 1995):

$$x^*_{i,t} = \left(\frac{T-t+1}{T-t+2}\right)^{1/2}\left[x_{i,t-1} - \frac{1}{T-t+1}(x_{i,t} + x_{i,t+1} + \cdots + x_{i,T})\right]. \tag{9}$$

The property of the transformation is that, if $x_{i,t}$ is serially uncorrelated, then $x_{i,t-s}$ will be uncorrelated with the transformed error term $\nu^*_{i,t}$, for $s \geq 2+q$ [with $q=0$ if $\nu_{i,t}$ is serially uncorrelated, and $q>0$ if $\nu_{i,t}$ is $MA(q)$]. Therefore, lagged values of right hand side variables will be valid instruments in the transformed model. The estimation technique used is the GMM method with fixed yearly effects. In Tables 5 and 6, parameters obtained using three-period and four-period lagged instruments are reported. Two-period lagged instruments are not included because their validity is rejected by the Sargan statistic in almost all the regressions. The sample period of panel data estimates is 1987−1994,‡ and 842 firms were included§ in the estimation, for 6735 observations.

The first columns of Tables 5 and 6 show the GMM estimate results for the whole sample. Other columns show the results when the coefficients are allowed to vary for a subset of firms, with five additional $S_{it}X_{i,t-1}$ regressors. These are products of dummies

† The variables used for the estimation are the following: pY = Total sales; $p^i I$ = Total new fixed assets; pC = cash flow: is operating profit before taxes plus depreciation; B = total debt repayable in more than one year; $p^i K$ = net capital stock at replacement cost (plant-machinery plus land and buildings). $p^i K$ is computed using the usual perpetual inventory formula: $p_{t+1}K_{t+1} = p_t K_t(1+\delta_t)(p_{t+1}/p_t)^+ p_{t+1} I_{t+1}$ where depreciation rate δ_t is a weighted average of the depreciation rate of plant and machinery (8%) and the rate of land and buildings (2,5%): $\delta_t = PMac_t{}^* 0{\cdot}08 + LBuil_t{}^* 0{\cdot}025$, where $Pmac_t$ and $Lbuil_t$ are the shares of plant and machinery and of land and buildings on total fixed assets in the year t. The same method is used to compute price index variations p_{t+1}/p_t that are the weighted average of price variations of the same assets.

‡ We do not use the first 5 years of the sample to avoid distortions caused by the perpetual inventory method used to compute the replacement cost of capital.

§ We applied a filter to control for outliers to the original 891 firms. Outliers are found in the sample because of two main reasons: i) presence of mergers and acquisitions, for which we cannot control for; ii) some errors in data transmissions, for the smallest firms in the series. We computed the mean and standard deviation for each series in each year, excluding from the computation the 1% left and right tail, and filtered out all firms with a difference from the mean bigger than ten times the standard deviation. Information about the series is reported in appendix 3.

TABLE 5 *GMM estimates—Dependent variable: $(I/K)_{i,t}$, sample period 1987–1994, 842 firms, 6735 observations—firms selected according to* "a priori" *dummies*

	Whole sample	Small firms	Young firms	R&D participation	Independent firms	No dividends
$\left(\frac{I}{K}\right)_{i,t-1}$	0·665***	0·709***	−0·276**	1·295***	0·912***	1·539***
	(0·084)	(0·184)	(0·120)	(0·207)	(0·261)	(0·219)
$\left(\frac{I}{K}\right)^2_{i,t-1}$	−1·404***	−1·230***	0·262	−3·307***	−0·076	−2·285***
	(0·168)	(0·423)	(0·197)	(0·368)	(0·471)	(0·434)
$\left(\frac{C}{K}\right)_{i,t-1}$	0·047***	0·028	0·133***	−0·048	0·056	0·074***
	(0·009)	(0·023)	(0·019)	(0·047)	(0·037)	(0·027)
$\left(\frac{Y}{K}\right)_{i,t-1}$	0·010***	0·022***	0·010***	0·024***	0·007*	−0·014***
	(0·001)	(0·004)	(0·002)	(0·004)	(0·004)	(0·004)
$\left(\frac{B}{K}\right)^2_{i,t-1}$	0·007	−0·034***	0·069***	−0·048**	−0·177***	−0·015
	(0·005)	(0·012)	(0·015)	(0·021)	(0·035)	(0·017)
$S_{it}\left(\frac{I}{K}\right)_{i,t-1}$		−0·735***	2·298***	−0·351***	−1·487***	−1·923***
		(0·230)	(0·513)	(0·133)	(0·350)	(0·239)
$S_{it}\left(\frac{I}{K}\right)^2_{i,t-1}$		0·796	−3·800***	1·296***	0·747	2·593***
		(0·521)	(1·013)	(0·221)	(0·578)	(0·434)

$S_{it}\left(\frac{C}{K}\right)_{i,t-1}$		0·119**	−0·232***	0·072*	−0·017	0·050
		(0·049)	(0·065)	(0·039)	(0·059)	(0·053)
$S_{it}\left(\frac{Y}{K}\right)_{i,t-1}$		−0·034***	−0·018	−0·014***	0·002	0·057***
		(0·006)	(0·013)	(0·003)	(0·006)	(0·006)
$S_{it}\left(\frac{B}{K}\right)^2_{i,t-1}$		0·046	−0·232***	0·033*	0·277***	0·087**
		(0·032)	(0·055)	(0·017)	(0·049)	(0·041)
Sargan Test	76·86	70·74	75·51	74·38	63·53	69·83
P-value	19·19%	20·89%	11·62%	13·47%	42·22%	23·13%

*Coefficient significant at 90% confidence level.
**Coefficient significant at 95% confidence level.
***Coefficient significant at 99% confidence level.
S_{it} is a dummy variable which takes values of 1 for firms in the following categories and zero otherwise. Small firms: smaller 50% of firms according to total sales. Young Firms: first quartile of firms according to age. R&D participation: firms with positive R&D expenditures. Independent firms: firms not controlled by other companies; No dividends: firms not distributing dividends for at least 6 years of the 1987−1994 period. I = total new fixed assets. C = cash flow (operating profit before taxes plus depreciation); B: total debt repayable in more than one year; K: net capital at replacement cost; Y: total sales.
Standard errors are in parenthesis, and are computed from heteroskedastic and autoregressive consistent matrix; Sargan is the test of overidentifying restrictions.

TABLE 6 *GMM estimates—Dependent variable: $(I/K)_{it}$, sample period 1987–1994, 842 firms, 6735 observations—firms selected according to exogenous direct revelation dummies*

	Total sample	Fitted DUCODEB	Fitted DUSCFIN	Fitted GARSCFIN	Fitted MFC
$\left(\frac{I}{K}\right)_{i,t-1}$	0·665*** (0·084)	0·972*** (0·235)	1·099*** (0·215)	0·780*** (0·210)	0·883*** (0·247)
$\left(\frac{I}{K}\right)^2_{i,t-1}$	−1·404*** (0·168)	−0·702 (0·456)	−1·368*** (0·383)	−0·576 (0·372)	−0·845* (0·442)
$\left(\frac{C}{K}\right)_{i,t-1}$	0·047*** (0·009)	−0·057*** (0·022)	−0·022 (0·019)	−0·054** (0·021)	−0·062*** (0·020)
$\left(\frac{Y}{K}\right)_{i,t-1}$	0·010*** (0·001)	−0·002 (0·002)	−0·002 (0·002)	0·001 (0·002)	0·004** (0·002)
$\left(\frac{B}{K}\right)^2_{i,t-1}$	0·007 (0·005)	0·067*** (0·021)	0·011 (0·011)	0·006 (0·011)	0·014 (0·013)
$S_{it}\left(\frac{I}{K}\right)_{i,t-1}$		1·945*** (0·350)	−1·113*** (0·268)	−0·778** (0·254)	−0·654** (0·290)
$S_{it}\left(\frac{I}{K}\right)^2_{i,t-1}$		2·300*** (0·643)	1·243*** (0·480)	0·334 (0·450)	0·095 (0·514)
$S_{it}\left(\frac{C}{K}\right)_{i,t-1}$		0·337*** (0·072)	0·243*** (0·060)	0·362*** (0·064)	0·458*** (0·069)
$S_{it}\left(\frac{Y}{K}\right)_{i,t-1}$		0·011* (0·006)	0·027*** (0·006)	0·019*** (0·006)	0·000 (0·006)
$S_{it}\left(\frac{B}{K}\right)^2_{i,t-1}$		−0·281*** (0·062)	−0·082* (0·042)	−0·030 (0·042)	−0·038 (0·044)
Sargan Test	76·86	61·07	66·67	65·91	65·13
P-value	19·19%	50·96%	31·92%	34·30%	36·84%

*Coefficient significant at 90% confidence level.
**Coefficient significant at 95% confidence level.
***Coefficient significant at 99% confidence level.
For each of the dichotomous direct revelation variables (MFC, DUCODEB, DUSCFIT, GARSCFIN), fitted values from a probit regression are obtained. S_{it} is equal to 1 if the fitted value is greater than a threshold, and zero otherwise. The threshold is chosen to utilize all the predictive power of the probit estimation to screen financially constrained firm out of the unconstrained group.
I = total new fixed assets. C = cash flow (operating profit before taxes plus depreciation); B: total debt repayable in more than one year; K: net capital at replacement cost; Y: total sales.
Standard errors are in parenthesis, and are computed from heteroskedastic and autoregressive consistent matrix; Sargan is the test of overidentifying restrictions.
MFC: firms that declared any kind of financing constraint. DUCODEB: firms that declared excessive cost of debt. DUSCFIN: firms that declared lack of medium long term financing. GARSCFIN = firms that declared lack of medium and long term financing or lack of guarantees.

S_{it} (taking value of one for the subgroups of financially constrained firms and zero for the other subgroups) and the original regressors. Hence the first five coefficients are relative to the unconstrained subgroup, while the additional five coefficients are the deviation for the coefficients of the constrained subgroup. Each column shows results relative to a different criterion used to identify constrained firms. An important requirement for such criteria is to be exogenous with respect to the probability to be constrained; otherwise we have a sample selection bias problem, because the probability to be selected in the group is correlated to the dependent variable. This means that the conditional probability density function used is not correct and that the estimated coefficients are biased.

Table 5 shows results using the *a priori* indirect criteria employed by past literature. Age, size, R&D participation and group affiliation can be considered to be exogenous,† while dividend policy is surely endogenous. Table 6 considers four direct revelation criteria: MFC, DUCODEB, DUSCFIN and GARSCFIN.‡ The assumption we make is that λ_t^D and/or λ_t^N are equal to zero for any t for the subgroup of firms that did not declare financing constraints.§ Such variables are obviously endogenous and correlated to the dependent variable. We avoid the sample selection bias problem by using instrumental variables in the following way: each dichotomous variable of financial constraints is the dependent variable of a probit regression where independent variables are exogenous *a priori* criteria plus other exogenous variables (i.e. sectorial and regional dummies).¶ The fitted values of the regressions are the exogenous probabilities to be financially constrained. By construction they are independent with respect to the actual level of financial constraints. Firms are selected in the constrained group if the exogenous probability is greater than a threshold, and zero otherwise.

In choosing the threshold we face a trade-off: if we increase it the probability of including an unconstrained firm in the constrained group is reduced, but it is more likely that the unconstrained group will include also constrained firms. Since we are interested in testing whether or not the neoclassical model holds for unconstrained firms, the threshold chosen is the one that uses all the predictive power of the probit estimation to screen

† We assume that such characteristics are "weakly exogenous", in the sense that, even though they can be correlated with past constraints, they are not correlated with the probability to be financially constrained in the sample period.

‡ We do not use DGAR, because of too few observations in the restricted sample. Also we do not use HFC, as preliminary probit estimation (Table 4, column 2) reveals this is not an effective selection criteria for the restricted sample (probably because it leaves too many constrained firms in the complementary group).

§ See previous footnotes on pages 233 and 234.

¶ Details about these regressions are reported in appendix 2.

financially constrained firms out of the unconstrained group, given that the constrained group randomly includes constrained and unconstrained firms.

Now we can turn to estimation results. Whole sample regression, in the first columns of Tables 5 and 6, show that the neoclassical model is rejected. Coefficients of I/K_{t-1}, $(I/K)^2_{t-1}$ and Y/K_{t-1} are significant and have the expected signs, and the $(B/K)^2{}_{t-1}$ coefficient is not significant, consistently to debt irrelevance. Also their magnitude is consistent with structural parameters, with the exception of the I/K_{t-1} coefficient, whose 95% confidence interval is [83·3−50·7]. Hence it is much lower than expected.† The validity of instruments is not rejected, although the p-value is quite low. The main violation of the structural model is, however, the C/K_{t-1} coefficient, that is positive and strongly significant instead of being negative.

Does this prove that λ_t^D is positive and is time variant, thus confirming the relevance of financing constraints in affecting investment? We argue that the remaining columns of Table 5, which present results using "traditional" indirect criteria to select constrained firms, hint in that direction, without providing any conclusive evidence, while our exogenous direct criteria in Table 6 provide a positive and very consistent answer to the question.

In fact, Table 5 shows that among indirect criteria to identify financially constrained firms, a firm's size and R&D investment seem the most effective. This is consistent with results presented in the previous paragraph. The coefficient of C/K_{t-1} is positive and significant only for smaller and R&D firms. Large firms' coefficients are closer to the neoclassical model, even though they still reject it. This is because the C/K_{t-1} coefficient is not significant and the $(B/K)^2{}_{t-1}$ coefficient is negative and significant, while the perfect market assumption predicts the opposite.

Table 6 shows that direct revelation criteria (columns 2, 3 and 4) are more effective in selecting constrained firms. The coefficients of the unconstrained subgroup are closer to the neoclassical model, and the C/K_{t-1} coefficient especially has opposite signs in the two subgroups according to the financing constraints hypothesis.‡ Given that all three criteria seem successful, it is natural to expect that the best way to identify constrained firms is to pool the information and use the MFC variable in the probit estimation. The last column of Table 6 confirms this. We see that firms selected as unconstrained do not reject the neoclassical model. I/K_{t-1} and

† See previous footnote on page 233.

‡ The consistency of estimation results with theoretical assumptions is confirmed by the fact that $(B/K)^2{}_{t-1}$ coefficient is negative and strongly significant only for firms selected as constrained using the DUCODEB variable. In fact the model predicts a negative coefficient only if firms face a cost of debt that increases in leverage rather than equilibrium credit rationing.

$(I/K)^2{}_{t-1}$ coefficients are close to 1 in absolute value, and their 95% confidence interval includes range of values consistent with structural parameters. More importantly, the C/K_{t-1} coefficient is negative and strongly significant. This is a key result in support of the neoclassical model as it implies, as mentioned earlier, a positive relation between expected productivity of capital and investment. This coefficient is also bigger in absolute value with respect to Y/K_{t-1}'s coefficient, which is significant as well. This is consistent with a price elasticity of demand greater than one.† The $(B/K)^2{}_{t-1}$ coefficient is not significant, which is consistent with the neoclassical model with debt irrelevance. Moreover, we see that financially constrained firms reject the model because the cash flow variable is positive and strongly significant, with a value of 0·40, While I/K_{t-1} coefficient is reduced to 0·13.‡ This is exactly the effect predicted by our financing constraints hypothesis. According to this, the model omits the λ_t^D variable that is significant and negatively correlated to I/K_t for constrained firms. Because of this misspecification problem, the C/K_{t-1} coefficient is positive and very large instead of negative, because of its negative correlation to λ_t^D.

These considerations are supported by the fact that the Sargan test's p-value is greater in Table 6. This means that instruments are less correlated to the error, which is likely to happen when misspecification problems are reduced.

5. Conclusions

Recent theoretical analyses demonstrate how informational asymmetries between financiers and investors may generate financial constraints under the form of financial rationing and positive cost differentials between external sources (bank, stock market and venture capital financing) and internal sources.

"Indirect" attempts (two pillar methods) to verify financial constraints at firm level based on *a priori* identification and econometric estimation have recently been seriously questioned because of methodological problems concerning balance sheet panel data analysis. These papers claim to test for the presence of financing constraints, while in fact they perform a joint test of two distinct hypotheses:

$H1_a$) Some observable characteristics of firms (size, age, affiliation to group, etc.) are related to their probability to be financially constrained; $H2_a$) Financially constrained firms reject the neoclassical model of investment because the limited access to external

† See previous footnote on page 233.

‡ Coefficients for the constrained subgroup are obtained adding the deviations (the last 5 coefficients), when significant, to the basic coefficients.

finance prevents them from investing optimally when internal finance is not available.

As a consequence their findings are not robust, because it is impossible to distinguish this joint hypothesis from the joint null: $H1_0$) Observable characteristics are not related to financing constraints; $H2_0$) Investment is excessively sensitive to cash flow because the latter proxies for future investment opportunities. This paper is the first one to be able to overcome this problem by integrating the traditional approach with an independent and direct source of qualitative information about financing constraints.

As a result we are able to separately test the two hypotheses. On the one hand the consistency between direct information and *a priori* firms characteristics related to financial constraints, shown in Section 3, tests and rejects $H1_0$ in favour of $H1_a$. On the other hand, the econometric estimation in Section 4 rejects the neoclassical model only for constrained firms. This result not only rejects $H2_0$ in favour of $H2_a$, but more importantly it confirms the validity of the Euler equation approach in estimating reduced form investment equations, when financial constraints are properly identified.

The other findings are the following: i) age matters a lot in the enlarged sample of 3852 firms which contains richer information, but its effect is more ambiguous in the restricted sample demonstrating the existence of a difference in the composition of the two samples; ii) size and R&D participation matter both in the restricted and in the enlarged sample and represent the most relevant *a priori* discriminant between financially constrained and non financially constrained firms; iii) the composite indicator of financial constraints outperforms simpler indicators in the Euler equation test; iv) probit results from “Mediocredito” are strongly consistent with probit results from “Centrale dei Bilanci”.

Acknowledgements

Even though the paper is fruit of a common work Section 2 can be attributed to M. Bagella, Section 3 to L. Becchetti and Section 4 to A. Caggese. The authors thank D. Archibugi, P. Ardeni, S. Bhattacharya, W. Brown, M. Ceccagnoli, G. Chiesa, C.P. Himmelberg, M. Messori, G. Nicodamo, S. Nickell, G. Orosel, A. Pasetto, A. Riti, G. Rotino, A. Santomero, G. Scanagatta, and other participants to the Conference of the EAEPE (Rome, October 1995), to the IV Financial Conference of Tor Vergata (November 1995), to the Financial Market Group Conference at LSE (June 1996), to the 1996 Annual Conference of the Royal Economic Society in Swansea and to the 1998 Annual Conference of the EARIE in Copenhagen for their precious comments and suggestions. Grant from Mediocredito is acknowledged. The usual disclaimer applies.

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Appendix 1. Consistency between a *priori* identification and direct revelation of financial constraints

TABLE A1.1 *Firm availability to equity dilution**

Response	NHFC (%)	HFC (%)	NMFC (%)	MFC (%)
Is the firm ready to accept financing under the form of soft loans plus equity participation?				
No answer	78·04	67·37	77·41	61·73
Yes	14·81	23·75	15·10	32·17
No	7·14	8·86	7·48	6·08
Is the firm ready to accept equity financing under the form of acquisition of minority stakes by merchant banks or venture capitalists?				
No answer	78·13	67·73	77·49	62·60
Yes	12·01	21·80	12·72	24·78
No	9·85	10·46	9·77	12·60
Is the firm ready to accept equity financing under the form acquisition of minority stakes by closed end investment funds?				
No answer	78·16	67·73	77·52	62·60
Yes	5·56	8·15	5·71	9·56
No	16·27	24·11	16·75	27·82
Availability to "equity dilution"				
No "equity dilution"	85·94	73·91	86·55	77·48
Dilution up to 10%	4·11	3·47	4·16	3·54
Dilution between 10% and 30%	6·79	16·08	6·23	13·82
Dilution between 30% and 49%	2·42	6·08	2·34	4·43
Dilution beyond 50%	0·71	0·43	0·69	0·70

(*Continued overleaf*)

TABLE A1.1 *(Continued)*

Response	NHFC (%)	HFC (%)	NMFC (%)	MFC (%)
Advantages in term of higher financial "solidity" from equity dilution				
No advantages	61·01	39·56	62·25	45·03
Relative advantages	4·74	9·13	4·10	10·28
Advantages (no indication of intensity)	12·20	13·04	10·97	19·68
High advantages	10·13	12·60	10·21	10·63
Very high advantages	11·89	25·65	12·43	14·36
Advantages in terms of easier access to credit from equity dilution				
No advantages	77·00	60·43	77·70	66·13
Relative advantages	3·89	6·086	3·58	6·56
Advantages (no indication of intensity)	4·66	6·08	4·10	8·51
High advantages	8·64	13·47	8·30	12·58
Very high advantages	5·79	13·91	6·29	6·20
Risk of loss of control from equity dilution				
No risk	46·32	37·39	47·90	33·51
Relative risk	16·15	22·17	16·24	18·08
Risk (non indication of intensity)	27·36	26·08	25·97	34·92
High risk	3·83	4·34	3·64	5·14
Very high risk	6·32	10	6·23	8·33
Risk of management coordination problems from equity dilution				
No risk	69·46	62·17	69·79	64·53
Relative risk	10·57	18·69	10·67	13·29
Risk (non indication of intensity)	10·38	7·39	10·18	10·28
High risk	6·26	7·82	5·86	9·21
Very high risk	3·31	3·91	3·46	2·65

*Answers from the other discriminating variables (DGAR, DUCODEB, DSCFIN, GARSCFIN) go in the same direction and are available from the author upon request.

TABLE A1.2 *Usefulness of different policy instruments for firms with and without financial constraints**

Response	NHFC (%)	HFC (%)	NMFC (%)	MFC (%)
Are soft loans useful for small medium firm development?				
Useless	34·29	18·26	35·37	21·45
Quite useful	5·65	11·3	5·2	10·63
Useful (with no indication of intensity)	15·04	16·52	14·78	17·19
Very useful	26·06	42·17	26·82	28·19
Extremely useful	18·93	11·73	17·82	3·86
Are grants useful for small medium firm development?				
Useless	46·63	30·86	46·62	40·24
Quite useful	6·12	8·69	5·93	8·33
Useful (with no indication of intensity)	11·34	13·47	11·43	11·7
Very useful	21·83	37·39	22·32	25·35
Extremely useful	14·05	9·56	13·68	14·36
Are tax incentives useful for small medium firm development?				
Useless	36·53	22·61	37·80	23·40
Quite useful	5·72	9·57	5·38	9·22
Useful (with no indication of intensity)	18·25	9·57	17·15	21·10
Very useful	15·32	22·17	15·09	19·50
Extremely useful	24·19	36·09	24·57	26·77
Are accelerated depreciation schemes useful for small medium firm development?				
Useless	72·61	62·61	37·80	23·40
Quite useful	4·64	7·83	5·38	9·22
Useful (with no indication of intensity)	4·83	3·48	17·15	21·10
Very useful	8·83	12·61	15·09	19·50
Extremely useful	9·08	13·48	24·57	26·77
Are tax incentives on profits useful for small medium firm development?				
Useless	53·51	39·13	54·35	42·73
Quite useful	4·25	3·91	3·95	5·85
Useful (with no indication of intensity)	13·56	12·17	12·65	18·26
Very useful	10·05	12·61	9·85	12·23
Extremely useful	18·64	32·17	19·19	20·92
Is merchant bank or closed end funds equity participation useful for small medium firms development?				
Useless	87·22	70·00	87·44	78·90
Quite useful	3·78	8·70	3·86	5·32
Useful (with no indication of intensity)	2·10	0·43	1·64	4·08
Very useful	3·84	11·30	3·89	6·56
Extremely useful	3·06	9·57	3·16	5·14

(*Continued overleaf*)

TABLE A1.2 *(Continued)*

Response	NHFC (%)	HFC (%)	NMFC (%)	MFC (%)
Are fondi di garanzia useful for the development of small and medium firms?				
Useless	91·99	77·83	91·85	87·06
Quite useful	3·23	10·00	3·32	5·50
Useful (with no indication of intensity)	0·77	0·87	0·67	1·42
Very useful	2·82	6·52	2·98	3·37
Extremely useful	1·19	4·78	1·19	2·66

*Answers from the other discriminating variables (DGAR, DUCODEB, DUSCFIN, GARSCFIN) go in the same direction and are available from the author upon request.

TABLE A1.3 *Consistency between a priori identification and direct revelation of financial constraints. Overall Mediocredito sample 3852 firms*

	Firm size	Firm age	R&D participation	R&D intensity	Leverage	Loss of control
MFC	148**	1972**	48%*	0·0019*	1·56**	33%**
Compl. set	343**	1967**	44%*	0·0011*	3·37**	25%**
HFC	182**	1972**	54%**	0·0022*	2·08**	33%**
Compl. set	319**	1967**	44%**	0·0012*	3·49**	25%**
DUCODEB	238	1970**	44%	0·0021*	1·83**	34%**
Compl. set	324	1967**	45%	0·0011*	3·54**	23%**
DUSCFIN	153**	1969*	51%**	0·0020*	1·60**	33%**
Compl. set	332**	1967*	44%**	0·0011*	3·48**	25%**
DGAR	89**	1972**	59%**	0·0037*	1·42**	32%**
Compl. set	314**	1967**	44%**	0·0012*	3·28**	22%**
GARSCFIN	149**	1971*	51%	0·0021**	1·61**	33%**
Compl. set	335**	1969*	44%	0·0011**	3·51**	25%**

Variable legend: HFC-: firms with index of financial constraints >2; MFC-: firms with index of financial constraints >0; DUCODEB-: firms with financial constraints under the form of excessive cost of debt; DUSCFIN-: firms with financial constraints under the form of scarcity of medium-long term financing; DGAR-: firms with financial constraints due to lack of guarantees; GARSCFIN = DGAR ∪ DUSCFIN; Firm size: average number of employees (1989–91); Firm age: year of foundation; R&D participation: percentage of firms with nonzero R&D expenditures; R&D intensity: R&D expenditures/total assets; Leverage: net assets/liabilities; Loss of control: firms participated for more than 50%.
*: Subgroup means are significantly different at 90%.
**: Subgroup means are significantly different at 95%.

TABLE A1.4 *Consistency between a priori identification and direct revelation of financial constraints. Restricted sample of 891 firms*

	Firm size	Firm age	R&D participation	R&D intensity	Lever-age	Loss of control
MFC (1)	164**	1961	59%**	0·0014	1·76**	36%**
Compl. set	256**	1961	45%**	0·0009	4·29**	25%**
HFC (1)	175**	1962	60%**	0·0016	1·59**	35%
Compl. set	242**	1961	47%**	0·0009	3·93**	27%
DUCODEB (1)	146**	1963	57%*	0·0016	1·50**	36%**
Compl. set	251**	1961	47%*	0·0009	4·08**	22%**
DUSCFIN (1)	188*	1960	60%**	0·0011	1·85**	35%
Compl. set	243*	1962	46%**	0·0010	4·01**	29%
DGAR (1)	138**	1965	85%**	0·0024	1·88	34%
Compl. set	238**	1961	47%**	0·0010	3·74	23%
GARSCFIN (1)	185*	1961	61%**	0·0011	1·87**	35%
Compl. set	244*	1961	46%**	0·0010	4·03**	29%

Variable legend: HFC-: firms with index of financial constraints >2; MFC-: firms with index of financial constraints >0; DUCODEB-: firms with financial constraints under the form of excessive cost of debt; DUSCFIN-: firms with financial constraints under the form of scarcity of medium-long term financing; DGAR-: firms with financial constraints due to lack of guarantees; GARSCFIN = DGAR ∪ DUSCFIN; Firm size: average number of employees (1989–91); Firm age: year of foundation; R&D participation: percentage of firms with nonzero R&D expenditures; R&D intensity: R&D expenditures/total assets; Leverage: net assets/liabilities; Loss of control: firms participated for more than 50%.

*: Subgroup means are significantly different at 90%.

**: Subgroup means are significantly different at 95%.

Appendix 2. Probit regression used for sample selection in the GMM estimation

TABLE A2.1 *Dependent Variable: MFC; Method: ML - Binary Probit; Convergence achieved after four iterations; Covariance matrix computed using second derivatives*

Variable	Coefficient	Std. Error	z-Statistic	Prob.
PERCEXP	−0·330102	0·191561	−1·723219	0·0848
LTOTAT	−0·129987	0·016951	−7·668471	0·0000
IMM_TOTA	1·290228	0·332272	3·883048	0·0001
RSGRP	0·168745	0·079284	2·128377	0·0333
DUGRP	−0·199461	0·111899	−1·782498	0·0747
YOUNG	−0·213264	0·123196	−1·731101	0·0834
AGEVOL	0·240591	0·109164	2·203947	0·0275
DUSET11	0·619819	0·386539	1·603510	0·1088
Mean dependent variation	0·229762	S.D. dependent variation		0·420930
S.E. of regression	0·410225	Akaike info criterion		1·036222
Sum squared residual	140·0130	Schwarz criterion		1·081302
Log likelihood	−427·2132	Hannan-Quinn criterion		1·053500
Avg. log likelihood	−0·508587			
Obs with Dep = 0	649	Total observations	842	
Obs with Dep = 1	193			

TABLE A2.2 *Dependent Variable: DUCODEB; Method: ML - Binary Probit; Convergence achieved after four iterations; Covariance matrix computed using second derivatives*

Variable	Coefficient	Std. Error	z-Statistic	Prob.
LTOTAT	−0·160331	0·018427	−8·700782	0·0000
IMM_TOTA	1·299992	0·373924	3·476619	0·0005
RSGRP	0·089967	0·087382	1·029585	0·3032
DUGRP	−0·297566	0·128758	−2·311048	0·0208
D7_1	0·488956	0·187675	2·605335	0·0092
DUSET18	0·554874	0·193853	2·862345	0·0042
DUSET21	1·771314	0·984942	1·798394	0·0721
DUREG8	0·189421	0·116137	1·631016	0·1029
DUREG17	0·643706	0·378272	1·701700	0·0888
Mean dependent variation	0·147619	S.D. dependent variation		0·354933
S.E. of regression	0·343424	Akaike info criterion		0·792945
Sum squared residual	98·00807	Schwarz criterion		0·843660
Log likelihood	−324·0370	Hannan-Quinn criterion		0·812383
Avg. log likelihood	−0·385758			
Obs with Dep = 0	718	Total observations	842	
Obs with Dep = 1	124			

TABLE A2.3 *Dependent Variable: GARSCFIN; Method: ML - Binary Probit; Convergence achieved after four iterations; Covariance matrix computed using second derivatives*

Variable	Coefficient	Std. Error	z-Statistic	Prob.
LTOTAT	−0·162076	0·017981	−9·013906	0·0000
IMM_TOTA	0·851090	0·363069	2·344157	0·0191
RSGRP	0·123528	0·084278	1·465721	0·1427
AGEVOL	0·381590	0·124389	3·067708	0·0022
DUSET11	0·684112	0·390823	1·750440	0·0800
DUSET21	1·492652	0·954983	1·563014	0·1180
Mean dependent variation	0·147619	S.D. dependent variation		0·354933
S.E. of regression	0·350267	Akaike info criterion		0·820594
Sum squared residual	102·3210	Schwarz criterion		0·854404
Log likelihood	−338·6493	Hannan-Quinn criterion		0·833552
Avg. log likelihood	−0·403154			
Obs with Dep = 0	718	Total observations	842	
Obs with Dep = 1	124			

TABLE A2.4 *Dependent Variable: DUSCFIN; Method: ML - Binary Probit; Convergence achieved after four iterations; Covariance matrix computed using second derivatives*

Variable	Coefficient	Std. Error	z-Statistic	Prob.
LTOTAT	−0·168151	0·018439	−9·119148	0·0000
IMM_TOTA	0·967663	0·369864	2·616265	0·0089
RSGRP	0·104051	0·086176	1·207424	0·2273
AGEVOL	0·384252	0·126842	3·029380	0·0025
DUSET11	0·724927	0·392137	1·848660	0·0645
DUSET21	1·554655	0·960266	1·618984	0·1055
Mean dependent variation	0·139286	S.D. dependent variation		0·346451
S.E. of regression	0·341542	Akaike info criterion		0·789896
Sum squared residual	97·28707	Schwarz criterion		0·823706
Log likelihood	−325·7565	Hannan-Quinn criterion		0·802855
Avg. log likelihood	−0·387805			
Obs with Dep = 0	725	Total observations	842	
Obs with Dep = 1	117			

Variable legend: PERCEXP = % of income from export; LTOTAT = log of total assets; IMM_TOTA = ratio of fixed assets over total assets; RSGRP = dummy equal to 1 for firms that invest in R&D and 0 otherwise; DUGRP = dummy equal to 1 for firms that belong to a group and 0 otherwise; YOUNG = dummy equal to 1 for the youngest 25% of firms and 0 otherwise; AGEVOL = dummy equal to 1 for subsidized firms and 0 otherwise; D7_1 = dummy equal to 1 for firms belonging to "consorzio fidi" and 0 otherwise; DUSETNN = industrial sector dummies; DUREGNN = regional dummies.

Appendix 3. Statistics about the series used in the gmm regressions

TABLE A3.1 *B/K series*

Year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
					Pre-filtering sample statistics—891 observations							
Mean	0·38	0·36	0·29	0·26	0·25	0·23	0·26	0·25	0·25	0·26	0·25	0·51
Median	0·24	0·22	0·21	0·20	0·19	0·17	0·18	0·18	0·17	0·18	0·15	0·16
Maximum	20·94	12·53	11·02	6·09	4·94	3·83	5·14	3·93	3·72	3·23	6·71	230·13
Minimum	−7·07	0·00	−0·53	−0·82	−0·36	−3·10	−0·72	−0·13	−0·14	−1·32	−0·74	−0·51
Std. Dev.	0·92	0·70	0·50	0·34	0·30	0·33	0·36	0·35	0·33	0·34	0·41	7·71
Skewness	13·10	9·94	12·32	6·84	5·55	2·76	5·66	4·54	3·80	3·03	6·60	29·67
Kurtosis	290·70	141·79	244·60	102·84	73·84	46·89	57·75	36·82	26·69	18·39	80·61	883·95
					Post filtering sample statistics (without outliers)—842 observations							
Mean	0·33	0·29	0·26	0·24	0·23	0·22	0·24	0·23	0·23	0·25	0·23	0·21
Median	0·24	0·22	0·21	0·19	0·19	0·16	0·18	0·17	0·17	0·18	0·15	0·15
Maximum	3·25	2·33	2·34	1·59	1·90	1·98	2·33	2·54	2·38	2·47	2·75	2·37
Minimum	0·00	0·00	0·00	−0·82	−0·36	−0·49	−0·72	−0·13	−0·14	−0·13	−0·32	−0·27
Std. Dev.	0·36	0·31	0·28	0·25	0·24	0·23	0·25	0·27	0·28	0·29	0·29	0·26
Skewness	2·65	2·08	2·28	1·54	1·90	1·94	2·11	2·88	3·07	2·87	3·34	2·72
Kurtosis	15·15	9·72	11·60	7·07	9·32	10·05	12·09	16·55	17·48	15·12	21·96	15·89

TABLE A3.2 *C/K series*

Year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
					Pre-filtering sample statistics—891 observations							
Mean	0·53	0·49	0·47	0·49	0·46	0·44	0·38	0·34	0·29	0·27	0·23	0·27
Median	0·34	0·34	0·34	0·34	0·34	0·32	0·27	0·24	0·21	0·19	0·16	0·18
Maximum	18·44	18·82	7·45	5·61	8·19	9·64	5·05	5·28	6·51	6·96	5·97	14·14
Minimum	−3·30	−6·92	−1·74	−1·60	−1·95	−2·02	−4·80	−3·27	−1·83	−2·01	−5·26	−2·48
Std. Dev.	1·20	1·03	0·60	0·56	0·60	0·58	0·53	0·46	0·42	0·46	0·50	0·72
Skewness	7·81	7·59	4·34	3·39	5·87	6·97	1·83	3·70	4·89	5·29	3·70	13·06
Kurtosis	93·77	136·20	37·20	22·96	60·44	92·43	33·69	40·12	60·37	67·01	70·63	220·87
					Post filtering sample statistics (without outliers)—842 observations							
Mean	0·44	0·44	0·43	0·45	0·42	0·40	0·36	0·31	0·28	0·25	0·21	0·22
Median	0·33	0·33	0·34	0·34	0·33	0·31	0·27	0·24	0·20	0·19	0·16	0·18
Maximum	4·94	3·57	3·21	3·46	2·65	2·78	2·97	2·56	2·60	2·73	2·41	1·96
Minimum	−2·26	−1·44	−1·13	−1·52	−0·64	−2·02	−2·38	−0·66	−1·83	−1·32	−1·14	−1·02
Std. Dev.	0·63	0·48	0·44	0·44	0·38	0·39	0·39	0·33	0·34	0·33	0·30	0·25
Skewness	2·45	2·00	2·21	2·25	1·98	1·64	2·00	2·32	1·88	2·24	1·96	0·99
Kurtosis	16·11	12·64	10·81	12·15	9·71	12·65	19·75	14·19	14·76	15·21	15·07	9·83

TABLE A3.3 *I/K series*

Year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Pre-filtering sample statistics—891 observations												
Mean	0·23	0·21	0·19	0·18	0·18	0·18	0·19	0·16	0·14	0·12	0·10	0·11
Median	0·17	0·16	0·15	0·15	0·15	0·15	0·15	0·14	0·12	0·10	0·08	0·08
Maximum	14·92	4·33	1·78	0·92	0·89	0·93	2·36	0·92	0·88	0·96	0·93	1·19
Minimum	−10·72	−1·25	−0·47	−0·50	−0·07	−0·06	−0·08	−0·02	−0·03	−0·26	−0·38	−0·17
Std. Dev.	0·68	0·24	0·15	0·14	0·13	0·12	0·15	0·11	0·11	0·10	0·10	0·10
Skewness	6·56	7·24	2·37	1·23	1·39	1·54	4·64	1·76	2·01	1·99	2·72	3·21
Kurtosis	316·33	112·17	18·37	6·23	5·85	7·51	56·82	8·70	10·71	11·22	17·58	25·01
Post filtering sample statistics (without outliers)—842 observations												
Mean	0·21	0·19	0·18	0·17	0·18	0·18	0·18	0·16	0·14	0·12	0·10	0·11
Median	0·17	0·16	0·15	0·15	0·15	0·15	0·15	0·14	0·12	0·10	0·08	0·08
Maximum	1·34	1·04	0·92	0·72	0·80	0·91	0·97	0·92	0·88	0·60	0·78	0·62
Minimum	0·00	0·00	0·00	−0·50	−0·04	−0·06	−0·02	−0·02	−0·03	−0·09	−0·38	−0·17
Std. Dev.	0·18	0·15	0·13	0·13	0·12	0·12	0·12	0·11	0·10	0·09	0·09	0·09
Skewness	1·74	1·63	1·35	1·05	1·18	1·28	1·61	1·60	1·75	1·69	2·21	1·70
Kurtosis	7·54	6·52	5·59	5·76	4·72	6·01	7·42	8·14	9·13	7·00	13·58	7·44

TABLE A3.4 *Y/K series*

Year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
					Pre-filtering sample statistics—891 observations							
Mean	6·99	7·27	6·53	5·83	5·35	5·05	4·91	4·59	4·14	4·00	3·78	3·86
Median	4·93	4·62	4·39	4·05	3·81	3·68	3·53	3·26	3·02	2·81	2·63	2·68
Maximum	260·91	144·61	134·76	83·69	79·10	96·08	112·06	86·60	71·35	139·29	78·52	55·62
Minimum	−416·68	−151·33	−14·79	−8·76	−5·21	−56·12	−4·54	−3·10	−1·83	−22·10	−23·06	−27·97
Std. Dev.	20·07	12·66	8·89	7·46	6·08	6·16	6·11	5·84	4·57	6·34	5·38	4·96
Skewness	−8·05	2·83	6·54	5·99	5·55	4·55	8·73	7·87	6·61	12·83	7·46	5·05
Kurtosis	259·44	69·69	67·48	50·23	49·06	74·55	124·66	93·91	74·03	247·69	86·73	45·54
					Post filtering sample statistics (without outliers)—842 observations							
Mean	6·53	6·05	5·50	5·00	4·69	4·55	4·26	3·98	3·69	3·49	3·25	3·35
Median	4·83	4·51	4·28	3·97	3·67	3·56	3·43	3·19	2·93	2·75	2·57	2·60
Maximum	64·20	49·22	58·22	51·06	33·22	41·63	28·63	25·60	23·83	28·78	20·56	28·89
Minimum	0·00	0·01	0·33	−8·76	−2·49	−2·29	−0·89	−0·55	−0·51	−10·69	−10·06	−9·88
Std. Dev.	6·11	5·45	4·79	4·11	3·61	3·70	3·07	2·97	2·79	2·82	2·64	2·77
Skewness	3·44	3·20	4·04	3·63	2·67	3·78	2·38	2·49	2·59	2·85	2·48	3·07
Kurtosis	21·56	17·62	32·61	28·25	14·01	28·75	11·94	12·05	13·01	18·32	14·10	21·11