Management & Marketing (2009) Vol. 4, No. 2, pp. 3-18.

FINANCING OF INNOVATION – THRESHOLDS AND OPTIONS

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Abstract. *The paper investigates thresholds and options for financing innovation activities in manufacturing and services using data from the German Community Innovation Survey (CIS) 2007. We analyze the significance of financing restrictions, especially the role of internal financing, external capital, and public funding, and discuss applicable management options to cope with challenges in markets and technology. We find that most firms rely mainly on self-financing means to start an innovation project. As a consequence of information asymmetries, private investors, e.g. banks, are uneager to invest in risky innovative ventures. Public funding might complement internal financing in order to balance shortcomings in private capital provision, but these sources have to be identified and convinced. In sum, the empirical work states that financing innovation is an entrepreneurial task, and the management of innovation needs strategic thinking as well as a well defined capital portfolio policy.*

Keywords: Financial management, innovation and entrepreneurship, business policies and strategies.

1. Funding as an obstacle to innovation

It is generally accepted that growth in modern economies is based on efforts to increase productivity by innovation (BMBF, 2007). Innovation is an essential precondition for technological and structural changes, contributing to growth and competitiveness. At the firm level, innovation is a form of entrepreneurial risk-taking (Drucker, 1985; Tidd et al., 2005). Introducing new products, entering new markets, increasing efficiency, or improving quality involves investments in research infrastructure and people. Innovation management means not only the operational control of processes, but also the strategic management of the firm. A fundamental component of strategic innovation management is the long-term decision to innovate, which is accompanied by the need to establish structures and to provide resources for the acquisition of technology.

Factors hampering innovation curtail the profitability of innovative projects, and are an indication that framework conditions are acting to reduce the extent of innovation activities in the national economy. They may lead firms not to start innovation activities at all, or be reasons for a delay of or even an unsuccessful end to

innovation projects. Generally, factors which constitute barriers to innovative success can be put into the following categories:

- Costs, economic risks and profit opportunities;
- Lack of internal and external funds;
- Knowledge and human capital;
- Legal and bureaucratic burdens;
- Intra-firm restrictions and resistance.

Reviewing the obstacles to innovation activities that firms in manufacturing and services in Germany experienced as a hampering factor of relevance and importance a number of interesting results occur (Rammer and Weißenfeld, 2008; Aschhoff et al., 2007): Firstly, *excessive risks and substantial costs of innovation projects can be regarded as the main barriers to innovation*. A large amount of capital must be invested in the innovation process, yet it is difficult to estimate at the beginning of the innovative activity whether and when it will pay off and what economic effects it may have. Secondly, *sourcing, allocating and funding the necessary resources, such as equipment, personnel and know-how can often present considerable difficulties carrying out innovation activities*. Firms in manufacturing and services may be affected by a lack of an appropriate internal source of finance. At third, *unsurprisingly, the importance of innovation obstacles, especially the challenges of funding goes hand in hand with the size of the firm*. Small and medium-seized firms (SMEs) find it harder to overcome the financial limitations, particularly because of high fixed costs, minimum investments needed to start innovation projects and high information asymmetries at the side of external financers. As a consequence, the likelihood that SMEs extend, abort, or do not initiate an innovation project is higher in comparison to larger firms.

Getting access to sufficient financial sources is one of the main challenges in innovation. In general, firms have more ideas for technically feasible and customer demanded innovation than they can fund with the resources at hand (Peeters and van Pottelsberghe, 2003). Financing restrictions thus reduce the volume of innovation activities of firms. On the one hand, such financing restrictions are unavoidable and serve as a way to allocate scarce resources to those projects that promise the highest returns. On the other hand, there are indications that firms invest less into innovation than would be necessary to maximize social returns (Hall, 2005).

From the financing side, two factors contribute to underinvestment in innovation: First, many innovation projects show an *unfavorable ratio between earnings and costs* due to a low exclusive appropriability of innovation returns (Arrow, 1962). From a firm perspective, such risky projects show too high innovation costs. Intellectual property rights (IPRs) are the main government instrument to ensure full appropriability for the innovator and thus improve the cost-earning-ratio of innovation, though for a number of innovative activities, no effective IPRs exist.

Secondly, suppliers on financial markets, especially banks, are reluctant to finance innovative activities of firms, resulting in a *low supply of loans for innovation financing*. There are many reasons for this reluctance (Hall, 2005), such as information asymmetries, moral hazard, adverse selection and lack of collaterals.

As a consequence, innovative firms are often forced to rely on internal funding sources for innovation (cash flow financing). Other sources of private capital are offered outside the firm (external equity financing) such as private equity, venture capital, and stock markets. Due to the specific terms of the agreement these financial means are of minor attractiveness, especially for SMEs. As an alternative to private funds, firms can receive public support for R&D and innovation. Public financial sponsorship of innovation projects is given as grants, loans, subsidies, or credit guarantees.

When firms are asked to state which sources of funding were employed to finance innovation projects, data on German firms for the time period 2004 to 2006 reveal the following picture (Annex, Table 1)(Community Innovation Survey, 2007):

- Firstly, the huge majority of firms (87%) finance innovation projects out of funds generate by ongoing business operations, such as profits, sales, working capital, or extended payment terms (cash flow financing). Some 95 percent of enterprises in high-tech production and almost 80 percent in knowledge-intensive services utilize internally generated financial means for innovation activities;
- Secondly, debt financing by using credit lines and current account advances is the second important means of funding for enterprises in manufacturing and services. Almost 20 percent of firms in high-tech production, especially SMEs, and 19 percent in knowledge-intensive services utilize these relatively unprofitable financing instruments. Standard bank loans are ranked on place number three. Credit financing implies a couple of disadvantages for firms, e.g. dependency on lender, high interest rates, and concerns about the securities;
- Thirdly, other private funding sources that are external to a firm are stock markets and private equity funds are sought. The empirical data reveal that the admission of new shareholders, participation of other enterprises, shareholders' loans, dormant equities, and/ or participation certificates have a similar importance as bank loans but play a minor role compared to internal funding;
- Finally, in addition to internal and private external capital, firms may obtain public money either through loans or allowances and grants to develop and launch innovations. On average, 11 percent of all firms utilize public subsidies for financing innovation projects, and 5 percent absorb public loans.

The data clearly show that firms first of all rely on their self-financing power and use sources such as profits or reserves out of ongoing business operations. External funding sources are of minor importance and in most cases complementary to cash flow. Neither bank loans or current account advance (credit lines) nor public loans or subsidies are utilized to finance innovation projects to the same extent as cash

flow financing. Internal financial means are thus an absolutely essential precondition to finance innovation projects. Without cash flow or other reserves it is often impossible to acquire additional financial sources outside the firm.

2. Empirical analysis of financing of innovation

2.1. Theoretical Framework and Considerations

The challenge of financing innovation is very much associated with the type of innovation being performed in a sector. Innovation financing will become the more difficult the larger a project, the higher the risks of technology, market, and implementation, the longer the project duration, and the lower the volume of available collaterals (Hall 2005). With respect to loan funding - which is in general the most important external funding source for investment in firms - risk exposure and collaterals are the two most important factors: A high risk increases the asymmetry between lender and borrower since high-risk projects are more likely to fail, threatening the lender with a total loss of money. Low collaterals in innovation projects occur in case of predominating intangible investment, such as expenditure for R&D, skill formation and design while a high share of gross fixed capital formation (i.e. capital expenditure) in total innovation expenditure indicates high collaterals available for securing loans.

Another important determinant for choosing funding sources for innovation is the type of innovation project pursued, particularly with respect to its risk exposure. Risk in innovation has basically two dimensions: On the one hand, an innovation may fail because of technological problems. These are likely to increase with the degree of technological novelty and sophistication. In case a completely new technological path is taken, firms can not rest on past experiences and may be confronted with unanticipated challenges which may increase costs, prolong project durations or even call for a termination of the project. On the other hand, market acceptance is another source of innovation risk, particularly if firms enter markets they are not familiar with. With regard to product innovation, one may distinguish four types of risk exposure, as can be seen in Overview 1:

– *Incremental innovations*, i.e. innovations that are linked to existing products and serve to improve, extend or complete them. They are neither new to the market nor new to the firm's range of products and/or business area;

– *Market novelties* (without a previous version on the market, but a comparable product within a firm's product range) are innovations that are new to the market and represent an expansion of or a complement to an existing product line, but do not increase the breadth of a firm's range of products and/or business area meaning that they are introduced on a market the firm is familiar with;

– *Product range novelties* (without a previous version within the firm, but a comparable product on the market) are innovations that are new to the firm in that they expand the firm's range of products and/or business area. This is typically associated with entering a market that is new to the firm. The innovation need not be new to this market, however, since other firms may already offer comparable products with the same intended use;

– *Radical product innovations* combine market novelties and product range novelties, i.e. with these innovations a firm both enters a new market and introduces a product on this market which has not been offered by any other firm before.

The idea behind this typology according to the level of innovation is that a firm has certain „thresholds" in its innovation process. These thresholds affect the way innovation is planned, organised, operated, and financed, because they imply different forms of uncertainty and risk.

Overview 1

Categories of product innovation by degree of innovativeness

The innovation is new to the market and/or sector	Yes	Market novelty in established market	Radical product innovation
	No	Incremental product innovation	Product range novelty
		No	Yes
		The innovation widens the firm's range of products and/or business area	

It can be assumed that in order to bring out innovations that are new to the market and/or sector (market novelties and radical product innovations), firms have to go beyond a „technological threshold", while in the case of innovations, which expand a firm's range of product and/or business areas (product range novelties), they are confronted with a „market threshold".

Radical innovations promise suitably lucrative returns. Since this type of innovation involves pushing technology beyond its current boundaries and developing a marketing concept for a new target group. Firms that demonstrate this kind of product innovation are venturing into undiscovered territory in terms of technology and the target market and tend to be confronted with the highest costs and levels of uncertainty. Not only the adoption but also the application of technology is a challenging task in the product development process. In association with the generation of technical competence marketing concepts and strategies for the successful entry and penetration onto a market must be developed.

The introduction of product range novelties involves less uncertainty, since the firm can – as a follower in the market – refer back to the experiences of other firms. The difficulties in building up a new product line lie in passing the market threshold

since the firm must catch up with its competitors and establish itself in a market that is new to it. Product range novelties involve less technological risk since the technology has typically been tested to some extent and that the market for the product already exists. Still, in this situation some risks remain: within the firm due to a likely internal resistance and the need to reorganise routines, and related to competition when dealing with market entry barriers.

Summing up, it is to be expected that overstepping the technology threshold (market novelties and radical innovations) will involve more technological and market risk than is the case for product range novelties and incremental innovation, the main requirement of which lies in marketing efforts and organisational adaptation. Additionally, it is obvious that financing projects within the range of incremental and radical product innovation requires strategic thinking, a decision which degree of innovativeness should be achieved, and a target-oriented financial policy.

The degree of novelty and risk that is captured by this classification of new products may be extend by another dimension which is related to research and development (R&D) efforts. Firms that introduce new products based on own R&D efforts may indicate a higher level of sophistication with respect to the technology involved in new products, and thus experience higher (technological) uncertainty.

Not all innovation activities refer to product innovation. A significant fraction of firms focus their innovative efforts on new or improved processes. For process innovation, the level of market risk and technological uncertainty is generally lower. On the one hand, firms may rest on technology suppliers and their experience when implementing new processes. On the other hand, process innovation often affects the way an already existing product which is well established on the market is produced. The role of market uncertainty is thus significantly smaller. Nevertheless it is worthwhile to distinguish two types of process innovation: efficiency innovations (intended to decrease unit costs of production) and quality innovations (intended to increase a product's quality or performance characteristics). With regard to efficiency innovation, their might be a higher degree of technological uncertainty since it raising efficiency of processes will involve new production methods or technological changes in existing ones. Positive effects of quality innovation have to be gained on the market through raising sales of profit margins which naturally is associated with some market risks, e.g. whether customers are willing to pay more for higher product quality. Combining both types constitute a "radical" process innovation while new processes that neither result in higher efficiency nor improved quality may constitute „incremental" process innovations.

2.2. Empirical analysis

The following part investigates the interdependence between the characteristics of innovations as described above and the financial sources used to fund these innovations. The points of interest are the driving factors that determine a

firm's decision to use a certain source given the risk exposure of the innovation project. In the course of the examination, a better understanding of a firm's financial portfolio policy with regard to innovation activities should be achieved. The following hypotheses guide our analysis:

– The higher the risk exposure of an innovation due to technology, market, or implementation (organization) the higher is the probability that innovation projects are predominantly financed by self-financing means (cash flow);

– The higher the risks of innovation due to technology, market, or implementation (organization) the less external private capital in terms of bank loans is utilized;

– The higher the technological risks of innovation projects the higher is the probability that public money can be acquired to finance innovation.

In order to test these hypotheses, we conduct multivariate analyses. Our dependent variable which should be explained is the information whether a firm has made use of a certain type of financial source to fund its innovation projects. This information is binominal, i.e. we only know whether a source has been used or not during a certain period of time, but we do not know the amount of money that has been allocated. Given this data quality we apply a probity model approach (Maddala, 1983). The decision of a firm *i* to use a financing source *F* of type *j* for funding innovation activities is modelled as a function of a vector *I* of innovation characteristics and a vector *X* of control variables (such as size, age, sector, location). The latent model is given by

$$\Phi^*_{\iota\varphi} = \alpha + \beta\, \mathrm{I}_\iota + \chi\, \Xi_\iota + \mu_\iota \qquad [1]$$

with α being a constant term, β and χ vectors of parameters and μ a firm-specific error term which is assumed to be iid $N(0;\sigma_\mu)$. The probability to use a finance source of type *j* (F^*_{ij}) cannot be observed completely but only as a binary choice

$$F_{ij} = \begin{cases} 1 \text{ if } F^*_{ij} > 0 \\ 0 \text{ if } F^*_{ij} \leq 0 \end{cases} \qquad [2]$$

We thus use F_{ij} as dependent variable in out model. In order to simplify the analysis, we only look at three financing sources out of the eight shown in Annex, Table 1: cash flow, bank loans and public subsidies since these represent three clearly distinguished types of financing.

A multitude of factors may influence a firm's decision of how to finance an innovation project. Some factors are directly related to the innovation process and management behavior. Other determinants are straightforwardly linked to the financial

opportunities and resources of the firm, the economic and technological resources at hand, and the legal scope. The following groups of indicators are distinguished:

– Innovation activities are characterized by the *type of product innovation and the type of process innovation* according to the classification discussed in the previous section, as well as by a dummy variable whether a firm conducts in-house R&D on a continuous base (as an indicator for the efforts to generate new technology). Furthermore, we calculate the share of capital expenditure in total innovation expenditure as a proxy for the amount of collaterals available to secure external capital. Capital expenditure includes fixed investment and investment in intangibles such as patents, trade marks or software;

– Another set of indicators represent *the capabilities of internal financing and liquidity and capital resources*. The equity ratio (equity as a share of total assets) informs about the ability of a firm to back external capital by own funds. We also use dummy variables on the direction of change of the equity ratio between 2004 and 2006 since a decrease (increase) may signal external capital providers a worsened (improved) internal financing situation. The profit margin indicates the amount of internal funds available for financing future investment and enters the model as a lagged variable;

– Furthermore, we include *firm characteristics* such as size, age, sector affiliation and location (differentiating between East and West German firms). Since financing opportunities of firms may depend on their legal status, we add dummy variables on the legal form and whether a firm is predominantly owned by private individuals or a family (which may enable the firm to profit from the personal wealth of these individuals). We also control for a firms affiliation to an enterprise group, differentiating by domestic and foreign ownership.

Altogether, these factors are assumed to influence a firm's decision making process and consequently the budgeting policies of innovation projects. Not only persons in charge inside a firm who run the management of innovation take these indicators into account, but also external executives, experts in banks and public institutions value their decision on base of these elements.

All variables are taken from the German CIS conducted in 2007. The dependent variables refer to innovations projects conducted between 2004 and 2006, though the actual information provided by firms on the funding source used to finance these innovative efforts is rather biased to the most recent activities. Innovation characteristics refer to the same reference period, while equity ratio is available for 2006 only. Profit margins are for 2005, while all control variables present the situation of the year 2006. A total of 2,013 observations with full information on all model variables are available. Note that only firms with innovation activities conducted during 2004 and 2006 enter the model. While most of them successfully introduced either product or process innovation, there is a small fraction of firms with innovation activities, but no successful innovation (e.g. having introduced a new product on the market or a new process within the firm) were implemented by the end of 2006.

2.3. Results of the Analysis

The estimation results of three separate probity models are reported in Annex, Table 2. They reveal that the financing of radical product innovations and product range novelties show a higher impact on the probability to use self-financing opportunities (cash flow) while financing through bank loans is rarely considered by firms conducting in-house R&D on a permanent base or introducing radical product innovations. The explanation for this result is twofold: first, *external investors have only little interest to put money in risky and uncertain innovation projects*. R&D activities as well as innovation projects that are characterized by a high degree of novelty (radical product innovations) imply technical, economical, and organisational risks that are difficult to assess from outside the firm. Secondly, *the utilisation of internal financial resources is the easiest and fastest way to allocate funds to innovation projects*. There is no dependency of the lender, no duty to repay interest, no participating of others in the decision making process, no divulgement of relevant data and information. Due to these reasons self-financing is the natural and entrepreneurial way of financing innovation projects. The higher the degree of innovativeness, the more important is this source, as long as product innovation in concerned.

The negative impact of in-house R&D on the probability to use bank loans may be related to different concerns on the lenders side of the transaction. The negative attitude of banks has clearly to do with the above mentioned high uncertainty over the outcome of R&D activities. Banks typically have problems to assess the technological and organisational operations associated with in-house R&D. Not only the adoption but also the application of technology is a challenging and risky task in the product development process. Furthermore, collaterals are missing which are demanded by internal controlling mechanism of banks and/or regulation authorities. Finally, there is an implicit suspiciousness against the ability and competence of the borrower.

However, process innovations are more attractive investments for commercial banks. Banks fund different types of process innovation in a similar way, i.e. not discriminating between incremental, efficiency-oriented or quality-oriented process innovations. One obvious reason is that process innovations are less subject to information asymmetries since it is easier for a bank to assess the involved risk and the likely outcome since many process innovations are similar among firms and rely on standard technologies. It is thus easier to calculate the likely returns of such innovation projects and their periods of amortisation. Investors seek for facts and figures that are reliable and on which they can proof the economic benefits of the innovation project. A comprehensible outline of the whole innovation process, a precise description of the purpose of the new product, the unique selling proposition,

and the advantages for the customers, together with the planned actions to reach a targeted position in competition are necessary requirements in convincing external investors. What is more, process innovations are more likely to offer collaterals for loans.

The use of public subsidies for financing innovation is highly correlated with R&D activities and market novelties that open up a new market (radical innovation). Firms conducting in-house R&D on a permanent base show an 8 percentage points higher probability to finance innovation through public money, and introducing radical product innovation increases the probability of using public subsidies by 5 percentage points. This result reflects the government's goal to use public funding for generating radical innovations that contribute to growth and employment. This is most likely the case with market novelties. Since generating market novelties most often involves the development of new technology as a prerequisite, there is also a strong effect of R&D. With regard to process innovation, quality innovations tend to be financed more likely through public subsidies. This reinforces the finding for product innovations, since quality innovations are that type of new processes that are most likely associated with employment growth (through an increase in sales due to the improved product quality).

The financial variables basically show the expected signs. Profit margin exerts a strong positive impact on the use of cash flow, as does a high equity ratio and an increase in the equity ratio over the past years. A firm's past profitability has almost no effect on using bank loans for funding innovation, however. Interestingly, firms with a low equity ratio are more likely to use bank loans. This result may reflect that firms with a high equity ratio have sufficient self-financing means and thus refrain from asking for credit financing. Credit financing does not only imply concerns on side of the lender (see above), it is a source of innovation financing that contains also a couple of disadvantages for the borrower. There is the dependency on lender, the payment of potentially high interest rates, the concerns about the possible disclosure of critical firm data, and doubts about the securities to be provided. Firms with high profit margins are less likely to finance innovation through public subsidies. An explanation for this finding may be the government's tendency to focus public funding on those firms that need it most. On the other hand, firms with high profits will have sufficient in-house funds and do not need to apply for public funding, which is associated with significant transaction costs due to complex application procedures and rather long decision making processes at public agencies.

There are also some effects of firm characteristics on financing decisions. Large firms are more likely to use cash flow or public subsidies, while family-owned firms tend to use bank loans more often and show a lower propensity to use public money. Firms that are part of an enterprise group are less likely to receive public funding (or refrain from applying for it). The legal status of a firm as well as its age

both exert little effects on innovation financing decisions, except from a lower propensity of corporate enterprises to use bank loans.

3. Conclusion: managing thresholds and finance

Summing up, for the majority of firms financing innovation activities is an undertaking during which a number of problems arise. The specific economic characteristics of innovation projects (risk and uncertainty, information asymmetries, moral hazard, lack of collateral) discourage institutional investors from investing in innovative projects.

Firms thus have to rely on their own financial means to start innovation projects. Financing innovation by allocating a part of current operation profits to activities is fraught with risks. If successful, cash flow financing will not create revenue until later periods. Since most of this investment is in current expenditure (salaries, material, external services), financing of innovation projects drains the current operating profit and can severely restrict an enterprise's liquidity. The negative cash-flow effects tend to affect firms seriously and might lead to an underinvestment in innovation that would be necessary to fulfill the challenges in highly competitive markets.

A firm, especially a small or medium-sized one, needs to consider available sources of finance very carefully. The choice of debt or equity financing depends on a variety of factors, because all financial means have advantages and disadvantages. In the innovation process a firm's financial ability - in particular the internal financing capacity – is of uppermost importance. A firm that receives private equity or bank loans has to accept some loss of control, strong financial discipline, and sharing the profits respectively paying interest. The primary purpose of every lender is the creation of value and profit, i.e. sustained growth and a satisfactory return on the investment. Firms can sometimes obtain public money to develop and launch an innovative idea. Public money cannot remove risk from the innovation activities at the firm level, but it can endeavor to make the innovation scenario more attractive. Governments put schemes in place to encourage banks and other private investors to award loans to what they might otherwise consider undesirable customers, especially high risk ventures in small firms. Going beyond technology and marketing thresholds at the same time the empirical work suggests a mix of sources, especially cash flow, and public funds.

Management has to understand the economics of valuation of innovation activities in order to attract potential investors, such as banks, venture capitalists, and public authorities. Managers have to think entrepreneurial, primarily to check market opportunities and technology trends. They are responsible for the innovation strategy and set the goals of the product development process. Aiming to cross thresholds in

technology and marketing needs furthermore an appropriate portfolio management of financial resources. The willingness to take risks in the development of new products and technologies are core business characteristics which can not substituted by any outside action or governmental encouragement.

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Annex

Table 1

Financial sources used for financing innovation by innovative enterprises in Germany (2004-2006, %)

	A	B	C	D	E	F	G	H
Sector (Nace rev. 1.2)								
10-14	88	0	0	0	27	19	2	6
15-16	92	1	14	0	37	20	8	9
17-19	96	1	10	0	11	9	7	17
20-22	91	8	15	3	21	9	7	8
23-24	95	8	16	0	20	7	7	14
25	94	6	10	1	24	14	5	19
26	77	13	12	0	12	16	17	11
27-28	94	3	10	0	21	20	14	15
29	96	2	8	0	18	18	9	15
30-32	98	9	12	0	25	8	3	19
33	91	12	15	1	34	10	8	20
34-35	84	6	16	1	16	14	9	12
36-37	82	12	22	0	25	18	17	6
40-41	90	2	7	0	13	14	7	3
51	87	4	23	0	39	35	1	7
60-63, 64.1	86	1	8	1	30	17	5	3
65-67	95	5	3	0	4	0	0	0
72, 64.3	96	5	20	1	25	2	1	17
73, 74.2-74.3	78	15	17	0	20	4	9	32
74.1, 74.4	75	18	28	0	17	17	3	3
74.5-74.8, 90	96	5	13	0	16	16	4	4
92.1, 92.2	88	3	19	0	14	4	11	11
Sector group								
High-tech production	95	6	12	0	22	13	7	16
Low-tech production	91	5	13	1	22	15	10	12
Knowledge-intensive services	81	14	22	0	19	10	4	13
Other services	89	3	16	0	30	25	3	5
Size class (# employees)								
5 to 49	85	9	19	0	24	16	5	10
50 to 99	92	6	11	1	20	20	7	16
100 to 499	93	5	9	1	21	13	8	12
500 and more	92	4	4	1	12	11	7	13
Region								

	A	B	C	D	E	F	G	H
West Germany	87	8	17	0	24	16	5	10
East Germany	89	8	18	0	21	14	7	17
Total	87	8	17	0	23	16	5	11

Note: based on all enterprises with any type of innovation activity during 2004 and 2006. A: Cash flow B: New equity C: Shareholder's loan D: Bonds, notes E: Overdraft credit F: Bank loan G: Public loan H: Public subsidy

Source: *ZEW: German Innovation Survey 2007*, weighted data.

Table 2

Determinants of financing innovation through cash flow, bank loans and public subsidies: results of probity models for German enterprises

	Cash Flow			Bank Loans			Public Subsidies		
	m.E.	t value		m.E.	t value		m.E.	t value	
Innovation characteristics									
Continuous R&D activities	-0.010	-0.74		-0.070	-3.83	***	0.082	4.46	***
Incremental product innovation	0.028	1.69	*	-0.037	-1.65	*	0.060	2.07	**
Product range novelty	0.028	1.77	*	-0.014	-0.63		0.030	1.12	
Market novelty in establ. market	-0.009	-0.36		-0.035	-1.13		0.039	1.13	
Radical product innovation	0.034	2.18	**	-0.044	-2.14	**	0.050	2.17	**
Incremental process innovation	0.033	1.42		0.029	0.82		0.015	0.46	
Quality process innovation	-0.017	-0.96		0.003	0.13		0.058	2.38	**
Efficiency process innovation	0.022	0.91		-0.045	-1.57		-0.020	-0.59	
Radical process innovation	-0.004	-0.29		0.021	1.05		0.018	0.87	
Capital exp. f. innovation (share)	-0.008	-0.68		0.016	0.91		0.161	1.38	
Financial resources									
Equity ratio (share)	0.055	2.34	**	-0.124	-3.90	***	-0.042	-1.27	
Increase of equity ratio 2004-06	0.033	2.64	***	0.034	1.99	**	-0.005	-0.30	
Decrease of equity ratio 2004-06	0.005	0.31		0.056	2.01	**	0.024	0.91	
Profit margin 0% - <4%, lagged	0.022	1.26		0.025	0.84		-0.031	-1.24	

	Cash Flow			Bank Loans			Public Subsidies		
	m.E.	t value		m.E.	t value		m.E.	t value	
Profit margin 4% - <10%, lagged	0.043	2.38	***	0.053	1.71	*	-0.023	-0.92	
Profit margin ≥10%, lagged	0.056	3.06	***	0.008	0.25		-0.051	-1.90	*
Profit margin: missing value	0.055	2.83	***	0.049	1.23		-0.029	-0.87	
Firm characteristics									
ln(no. of employees)	0.020	4.47	***	0.006	1.12		0.017	2.98	***
ln(age of the firm)	0.004	0.57		-0.015	-1.79	*	-0.030	-3.47	***
Family firm	0.004	0.30		0.036	1.99	**	-0.065	-3.66	***
Part of group, German-based	0.029	1.89	*	-0.056	-2.94	***	-0.060	-3.02	***
Part of group, foreign	0.041	1.85	*	-0.104	-3.62	***	-0.103	-4.35	***
Limited partnership	0.021	1.02		-0.061	-2.28	**	-0.033	-0.96	
Limited liability company	0.027	1.43		-0.071	-2.67	***	0.014	0.47	
Incorporation	0.015	0.52		-0.012	-0.33		0.017	0.41	
East German firm	0.017	1.32		0.006	0.37		0.153	7.96	***
No. of observations	2,013			2,013			2,013		
Share of positive observations	0.90			0.16			0.18		
Pseudo R^2	0.12			0.11			0.18		

Note: All models contain a set of industry dummies which are not shown due to space restrictions, coefficients of industry dummies are jointly significant. m.E.: marginal effect.

Source: *ZEW: German Innovation Survey 2007, calculations based on net sample.*