

Financial constraints and innovation

AN EMPIRICAL STUDY

Abstract

The purpose of this paper is to find the factors that influence the financial constraints in innovation activity and how these factors vary across different types of innovation strategies or different firm types. Therefore, we will analyse the effect of cutting-edge research, age and firm size, innovation demand and internal funding on financial constraints. In order to test these relationships, we will set up an empirical model and execute these tests using STATA on German innovation survey data. Afterwards, we will analyse the results and make a conclusion based on these outcomes. The most important things we can conclude from our research are: First, firms with cutting-edge R&D launch market novelties and are more likely to be financially constrained than routine innovations. Second, bigger firms will be less financially constrained. Lastly, firms with large expenditures are also large firms, and thus less constrained.

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Introduction

The aim of this paper is to examine the impact of different relevant variables on the financial constraints of a firm. We will study how these constraints vary across different types of firms or types of innovation strategies by using several surveys on the one hand and our empirical test on the other hand. In the empirical test, we will regress the constraint variables on possible determinants.

First of all, it is important to notice that financial constraints do not only depend on the availability of internal funds but also on innovation capacity. Therefore, we can divide the constraints in two major categories: the internal constraints and the external ones.

In this paper we will first investigate whether cutting-edge R&D is more likely to be constrained than routine R&D. Second, we will analyse how the financial situation with respect to their innovation activities is affected by a firm's age and size. Then we will examine whether innovation demand affects the financial constraints of a firm. Finally, we will take a closer look at the influence of a firm's internal funding.

Before we test these relationships in the empirical model, we will discuss the relevant effects on financial constraints in the theoretical approach. We selected these relevant effects based on earlier studies.

Theoretical approach

1. The effect of cutting-edge research on financial constraints

In our research, we take the heterogeneity of R&D into account. First of all, we distinguish cutting-edge from routine R&D. These 2 forms of R&D have a different degree of uncertainty. Cutting-edge innovation is typically more radical compared to routine R&D, which is more imitative. Firms with routine R&D introduce products that strengthen their product lines and that may be new to the firm but not to the market. Therefore, they have lower resource requirements which cause lower default risk and better predictable and sooner results. For routine innovations, returns from initial products are often used as a source for finance. On the contrary, firms with cutting-edge R&D launch market novelties which involve basic research and intensive resources. As a result, the risk of default and returns is more uncertain. Moreover, cutting-edge firms have more secrecy issues.¹ All these properties make cutting-edge R&D more likely to be financially constrained than routine innovations.

In order to examine the impact of cutting-edge R&D compared to routine R&D, we insert the variables 'mneu' and 'confi' in the regression. 'mneu' represents whether a firm has introduced market novelties (cutting-edge R&D) or not (routine R&D) and 'confi' gives information about the importance of secrecy in the firm.

2. The effect of age / firm size on financial constraints

The influence of external constraints for R&D investment is more salient for small companies than for large companies. This is not the case for internal constraints. When the conditions for the access to external funds become worse, the levels of R&D investment of smaller firms decrease. Larger firms are not as sensitive. Furthermore, the level of constriction increases in a monotonous way with decreasing firm size. Larger firms will discard fewer R&D investment projects. We include the variable 'pa' in our regression analysis to test this relationship. Lastly, larger firms are capable to fund most of their projects internally. These firms can offer sufficient collateral to their investors.¹

Czarnitzki et al (2011) could not find a relationship between age of the firm and financial constraints.

3. The effect of innovation demand on financial constraints

The subcomponents of innovation demand will be explained briefly using a simple model by Howe et al (2000).

The model (see figure 1) shows that the demand function for innovation is equal to the marginal rate of return of innovative activities. It depends on three different components: firstly, the level of innovation expenditure which is the amount spent on innovation. Secondly, the innovative capability, which represents the competence to produce and pursue new ideas. The last factor represents other firm-specific characteristics such as the education level of the employees.

Furthermore, to find profit-maximizing setting for the amount of investment for innovation, the model states that the downwards sloping demand function should be equal to the upwards sloping marginal cost of capital. The marginal cost of capital is determined by the expected returns of investment, innovation expenditure, internal funds of a firm and its creditworthiness.

All these factors have an effect on the optimal amount of innovation investment for a firm. The firm is considered financially constrained if it would use exogenously received funds for an investment in innovation, i.e. if its optimal investment would change if the marginal cost of capital would shift. This is something we can't test easily empirically.

However, from the model we can already expect some results.

According to the model, firms with fewer funds but with the same level of innovative capability are more likely to be constrained as can be shown in this figure. One of the reasons is assumed to be the higher cost of external capital for firms with less liquidity because these firms have to get their funding from investors who mostly won't have certainty of success.

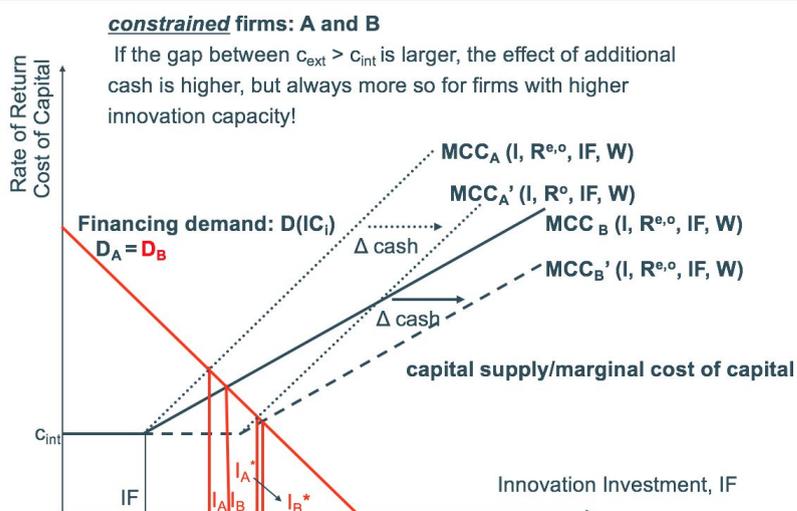


Figure 1: subcomponents of innovation demand

To test the effect of innovation capacity, we will insert the variable 'pa', which could have an effect on the demand function, in our regression. This variable gives information about innovation projects that are not completed yet or did not make it.

Second, we introduce the variable 'lniexp' in our model. This variable gives information about the natural logarithm of the total innovation expenditure of a firm.

From the theory, we expect firms with large expenditures to also be large firms, and thus less constrained in line with the observations from the previous section.

4. The effect of internal funding on financial constraints

At last, we discuss the effect of internal funds on financial constraints. Internal financing of a firm represents the use of a firm's financial resources and profits as a source of capital for R&D. If a firm doesn't have enough internal funds to finance the investments and projects, the owners will have to use external funds. External funds are resources from outside the corporation, e.g. bond offering and bank loans.

An important difference between internal and external funds is the cost of capital. If a firm decides to finance research and development with bank loans, it has to pay an interest rate. This interest rate is the cost of debt. It's evident that a firm prefers internal financing to external funds, because a decrease of the profits due to the extra cost of capital is imminent.

In the paper of Czarnitzki et al (2011), we see that when a firm is financially constrained, its investment spending is set at the constrained optimal level of spending. This optimal level is determined by the marginal cost of external funds and the marginal benefit of investment. Moreover, if firms prefer using internal over external funds, higher cash flows will be associated with a decline in the use of external financing for a given level of investment. This decline of external financing decreases the marginal cost of external funds and thus, the constrained optimal level of spending increase.

To test the effect of internal funding, the variable 'finconint2' is introduced in our model as it represents the lack of suitable sources of internal funding.

Empirical research

In this part of our research we use data from the survey of 2005. First we present some descriptive statistics of the most important variables we will use. Then we implement this data in the regression. Based on our results we make conclusions about the impact of these factors on the financial constraints for R&D investment. The used dataset contains 1635 observations.

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|------------|-------|----------|-----------|-----|----------|
| fincon2 | 1,635 | .3663609 | .4819571 | 0 | 1 |
| finconint2 | 1,635 | .4116208 | .4922777 | 0 | 1 |
| mneu | 1,548 | .24677 | .4312711 | 0 | 1 |
| confi | 1,595 | .2275862 | .4194055 | 0 | 1 |
| lniexp | 1,432 | .3647129 | .7380722 | 0 | 6.500597 |
| lninv | 1,313 | .4326267 | .8068705 | 0 | 5.683875 |
| lnemp | 1,635 | 3.794006 | 1.643377 | 0 | 10.82743 |
| pa | 1,635 | .0929664 | .2904741 | 0 | 1 |
| unideg50 | 1,467 | .1874574 | .3904113 | 0 | 1 |

Figure 1: summary of our most important variables

The ordinal variable *hemm4* represents the importance of external financial constraints. We recoded *hemm4* to the dummy variable *fincon2* in order to make the regression coefficients easily interpretable. If the importance of financial constraints was designated none (0) or low (0), the firm has a *fincon2* of 0. Otherwise, if it was noted as middle (2), or high (3), *fincon2* will be 1.

Hemm4 contained a total of 1406 observations. For *fincon2*, we filled in the missing ones as 'not constrained' because skipping the question would mean that it is not relevant for the firm, and that the firm is thus not constrained.

| RECODE of hemm4 (Innovation obstacle: lack of external funding sources) | Innovation obstacle: lack of external funding sources | | | | Total |
|--|--|--------|--------|------|-------|
| | nein | gering | mittel | hoch | |
| 0 | 460 | 347 | 0 | 0 | 807 |
| 1 | 0 | 0 | 292 | 307 | 599 |
| Total | 460 | 347 | 292 | 307 | 1,406 |

Figure 2: example of a recoding

We did similar recodings with the variables hemm3 (internal financial/funding constraints, → finconint2), schutzb6 (importance of secrecy, → conf). Details can be found in the descriptions in our STATA do-file.

```
. regress fincon2 finconint2 mneu conf lnixp lninv lnemp pa unideg50 ost ind*, robust
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```
Linear regression                               Number of obs   =    1,022
                                                F(20, 1001)    =    106.49
                                                Prob > F       =    0.0000
                                                R-squared     =    0.5836
                                                Root MSE     =    .3181
```

| fincon2 | Coef. | Robust Std. Err. | t | P> t | [95% Conf. Interval] | |
|------------|-----------|------------------|-------|-------|----------------------|-----------|
| finconint2 | .7149484 | .0232656 | 30.73 | 0.000 | .6692934 | .7606034 |
| mneu | .0725056 | .0258552 | 2.80 | 0.005 | .0217689 | .1232423 |
| confi | .0391701 | .0260981 | 1.50 | 0.134 | -.0120432 | .0903834 |
| lnixp | .011789 | .0188628 | 0.62 | 0.532 | -.0252262 | .0488042 |
| lninv | -.0183255 | .0210379 | -0.87 | 0.384 | -.059609 | .0229579 |
| lnemp | -.0370736 | .0090761 | -4.08 | 0.000 | -.054884 | -.0192632 |
| pa | -.0717987 | .0408681 | -1.76 | 0.079 | -.1519956 | .0083983 |
| unideg50 | -.021534 | .0369907 | -0.58 | 0.561 | -.0941221 | .0510542 |
| ost | .0100105 | .0215617 | 0.46 | 0.643 | -.0323008 | .0523217 |
| ind2 | -.0945421 | .0528951 | -1.79 | 0.074 | -.1983402 | .009256 |
| ind3 | -.0666066 | .0469439 | -1.42 | 0.156 | -.1587263 | .025513 |
| ind4 | -.0734388 | .0452779 | -1.62 | 0.105 | -.1622893 | .0154116 |
| ind5 | -.0816763 | .0510498 | -1.60 | 0.110 | -.1818531 | .0185005 |
| ind6 | -.097425 | .0506278 | -1.92 | 0.055 | -.1967738 | .0019237 |
| ind7 | -.0088076 | .0500586 | -0.18 | 0.860 | -.1070394 | .0894242 |
| ind8 | -.1105042 | .0461052 | -2.40 | 0.017 | -.2009781 | -.0200304 |
| ind9 | -.1079034 | .0497041 | -2.17 | 0.030 | -.2054395 | -.0103673 |
| ind10 | -.0305963 | .0535338 | -0.57 | 0.568 | -.1356476 | .074455 |
| ind11 | .019737 | .0859829 | 0.23 | 0.818 | -.1489904 | .1884644 |
| ind12 | -.0005667 | .0646641 | -0.01 | 0.993 | -.1274594 | .1263259 |
| _cons | .2781761 | .0522757 | 5.32 | 0.000 | .1755937 | .3807585 |

Figure 3: regression of variables fincon2 finconint2 mneu conf lnixp lninv lnemp pa unideg50 ost and indicators

We use the regression to predict the factors that influence the financial constraints in innovation activity.

The next five independent variables that will be discussed, can be considered as 'statistically significant'. These conclusions are based on the reference value of 0.05.

The first independent variable of the regression is finconint2 (see table 1), which represents the internal funding constraints. This variable is statistically significant. We expect a positive effect of internal constraints on external constrained firms. Thus when a firm has low suitable sources for internal funding or she is internal financially internal constrained, the is firm is

also external constrained. The coefficient (0.7149) is comparatively large, which means that the firm will be 71,49% more likely to have external financial constraints if the lack of internal funding raised with 1%. This variable explains most of the variance found in the R^2 statistic.

The parameter 'mneu' represents whether market novelties are introduced or not. As can be seen in the table, it has a p-value (0.005) that is smaller than the reference value. As a result, we can assume that this parameter is statistically significant. Based on the theoretical approach, we expect an increase in the financial constraint of the firm, due to market novelties. When we take a look at the regression, we see that the coefficient of 'mneu' is 0.072 which means that the firm will be 7.2% more external financially constrained if market novelties are introduced, compared to the situation where there are no introduced market novelties.

The variable 'lnemp' is a control variable that stands for the natural logarithm of employees and is significant with a p-value of 0. Its coefficient is -0,037 so if the number of employees increases with 1%, the firm will be about 4% less likely to have external financial constraints. This observation is in line with our theoretical expectation that larger firm have less constraints.

Finally, the parameters 'ind8' and 'ind9' are also statistically significant due to their p-value that is lower than 0.05. These parameters are control variables for respectively the metal processing and electronic industries. The firm will have respectively 12% and 11% less external financial constraints if it belongs to these sectors. This could be because it they are capital intensive and technically complex sectors.

All the other variables in the table are not statistically significant because of their high p-value. We expected a significant relation for these variables and the external constraints but at this point, we can make no empirical statement about them.

The R^2 is 58,36% which means that 58,36% of the variance is explained by our model. We can say that 58,36% of the variance of financial constraint is explained by our seven independent variables. The higher R^2 , the better our model fits the data.

Conclusion

In this paper the purpose was to find the factors that influence the financial constraints in innovation activity. In the empirical test we used the data of the survey of 2005, to study how these constraints vary across different types of firms or types of innovation strategies.

We divided the constraints in two major groups: the internal and the external constraints because financial constraints do not only depend on the availability of internal funds, also on innovation capacity.

The empirical test shows that only five out of the twenty variables are statistically significant because of a p-value smaller than 0.05. We discussed these variables in the empirical research.

We conclude that firms will be more external financially constrained if market novelties increase or if they do not belong to high-capital and high R&D sectors. Firms will be less external financially constrained if the number of employees decreases.

The studies we described in the theoretical approach support our findings. Researchers state that firms with cutting-edge R&D launch market novelties and are more likely to be financially constrained than routine innovations². The results of the empirical test confirm this. From the theory, we also expected large firms to be less constrained.¹ This was confirmed by the results of the regression.

References

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