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Are innovation barriers really hampering innovation? The ability to recognize barriers as  
a driver of survival for innovative firms

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## **Abstract**

Innovative firms are likely to face barriers when taking new offerings to market. In line with previous research, we confirm that more innovative firms face more barriers. Using novel survey data coupled with register data, we extend previous models of innovation barriers by showing that the likelihood of firms experiencing barriers increases with novelty of the innovation. The effect appears to be driven by increased external orientation in the form of external search, market analysis and application for external funding. We show that the more barriers firms report to have experienced during the introduction of their most recent innovation, the less likely to survive. Our research adds to the literature on barriers to innovation and provide insight for managers in showing that the ability to identify and acknowledge the importance of the barriers to innovation is a significant driver firm performance. For policy makers, this study indicates that the barriers firms report are not an indication of impediments to be removed through policies, rather firms should be supported in recognizing the barriers in their environment in order deal with and learn from them.

Keywords: Innovation barriers, external search, firm survival

## 1. Introduction

Innovation is the ability of firms to create new and useful solutions and is, thus, closely linked to firm competitiveness, growth and survival. In this light, it is not surprising that the drivers and barriers of innovation have received great attention. Research on drivers (e.g. Damanpour, 1991) and barriers (e.g. Piatier, 1984) are exploring heterogeneity in innovation performance across firms. Though seemingly similar, the implications yielded by the two bodies of literature are different. Studies on factors associated with successful innovation provide best-practice insights on what firms can do to improve their chances of innovative outcome. Studies on barriers identifies bottlenecks (Hölzl and Janger, 2013) of innovation, e.g. regulation and lack of funding, which is relevant for policy makers seeking to foster a good environment for innovation. While the drivers of innovation has received extensive scholarly attention, barriers have been comparatively neglected. Items on barriers regularly appear in surveys intended to inform policy makers, because a major aim of business policy is to stimulate the innovative environment for firms.. Yet relatively little is known about how the barriers which firms correlate with innovation and firm performance.

We build on significant contributions to literature on innovation barriers by Galia and Legros (2004), Segarra-Blasco, Garcia-Quevedo and Teruel-Carrizosa (2008), D'Este *et al.* (2012), Blanchard *et al.* (2013), Garriga, Von Krogh and Spaeth (2013), and Pellegrino and Savona (2017) in developing our hypotheses. The objectives of these studies has been to look at the determinants of facing barriers as well as how these barriers affect performance. The objectives of the current study are the following: 1) examining the model by D'Este *et al.* (2012) in a new setting, 2) extending the model by considering potential drivers of barrier recognition, 3) establishing correlation between barrier recognition and firm survival. In the previous literature, the presence of barriers are assumed to

hamper innovation. In this study, we challenge the conventional wisdom and argue the barriers reported by firms should be seen as opportunities for learning and that the ability of firms to recognize potential impediments is positively linked to performance.

Our first contribution lies in replicating the previous finding that more innovative firms experience more barriers on a novel dataset. Secondly, we provide new insight by measuring the impact of these barriers specifically in the rare end of the innovation process; the stage of development and testing leading up to market launch. Hence, the setting of our research is the stage leading up to the final step of the innovation process: successful exploitation as defined by Schumpeter (1934). In the later stages of the innovation process a great amount of resources has been tied to the innovation (Cooper, 1990). Therefore, this phase is particularly interesting to policy makers. The Danish Business Authority has identified the rare end of the innovation process as a key impediment for the growth and survival of innovative firms. Getting past the testing phase is often critical to getting access to funding needed to scale the innovation. External funding is expensive prior to the stage at which the invention has been tested and gained some market traction, because lack of concept proof induces a risk premium. Getting past this stage, makes innovative much more likely to succeed and it is therefore a particularly interesting research setting. We hypothesize that firms with more innovative activities in the past three years, are more likely to report barriers related to costs, human resources, market and regulation for their most recent innovation introduced to the market.

Our second contribution is to include previously unexplored information in predicting the likelihood of assessing barriers. Firms which search for funding and knowledge external of the firms boundaries are more likely to be aware of barriers arising from their environment. Especially external knowledge sourcing has been shown as a significant driver of innovation performance (e.g. Laursen and Salter, 2006; Foss, Lyngsie and Zahra, 2013; Arora, Cohen and Walsh, 2016; Colombo *et al.*, 2018). We

suggest that external orientation increases the likelihood of reported barriers because moving beyond the firm's boundaries increases complexity and thereby the likelihood of experiencing challenges. External orientation may also increase the firms awareness of barriers in their environment. Using a combination of survey data and observational data, multivariate probit results grants support for our hypotheses. Lastly, we show that the broader range of barriers firms' report in relation to their most recent innovation, the less likely they are to exit the market in years following the market introduction. This finding lends support to our argument that innovation barriers reported by firms are not hampering their performance. We suggest two potential mechanism behind the counterintuitive result of barriers being positively related to performance. Firstly, barriers may be seen as learning opportunities which stimulates organizational capabilities. Secondly, identifying barriers and recognizing their importance may be an important capability in realizing innovative potential.

The paper is structured as follows. Section 2 provides a review of literature on barriers to innovation and drivers of innovation. Section 3 explains how we deduct our hypotheses while section 4 describes how the hypotheses are tested including a description of the data sources, measures, and econometric method. Section 5 present our results along with some robustness checks, Finally, section 6 discusses implications and limitations before summing the paper up in a conclusion.

## **2. Theory and hypotheses**

### **2.1 Barriers to innovation**

Research on barriers to innovation has mainly focused on financial constraints, i.e. lack of internal and external funding. For example, Hall (2002) examine the 'funding gap' and find evidence that small and young firms suffer from high costs of capital for R&D, while this evidence is mixed for large firms. Hottenrott and Peters (2012) show with experimental evidence that firms with higher

innovative capability are less likely to have unrealized innovation projects due to lack of funding than their less innovative counterparts. This result indicate that for highly capable firms there is indeed a funding gap. Savignac (2008) uses CIS data to show that financial constraints significantly decreases the likelihood of firms engaging in innovative activities.

Lack of funding is just one out of many barriers that innovators face. Firms ability to innovate is not only dependent on their capacity to access finance but also on a range of other skills including, identifying and understanding market needs, recruiting skilled staff, and establish interaction with others also determines firms' innovative ability (D'Este *et al.*, 2012). Therefore, it is necessary to include other barriers in addition to financial barriers in the study of what hampers innovation. Such contributions are largely based on the Community Innovation Survey (CIS) or similar surveys. These studies can be divided into two groups: 1) papers with innovation barriers as the dependent variables and 2) papers with barriers as independent variables.

Studies with barriers as the dependent variable aim to predict the likelihood of firms facing barriers based on a number of firm characteristics including level of technology used in the production process Baldwin and Lin (2002), engagement in innovative activities (D'Este *et al.*, 2012), human capital (D'Este, Rentocchini and Vega-Jurado, 2014), firm located in country-groups based on distance to technological frontier (Hölzl and Janger, 2014), high firm growth (Hölzl and Janger, 2013), and young or mature firms (Pellegrino, 2018).

Baldwin and Lin (2002) conclude, based on a sample of Canadian firms, that the more technologically innovative firms are, as measured by using advanced technology in the production process, the more frequently cost-related, institution-related, labor-related, organization-related and information-related barriers are faced. They argue that innovation entails a learning process in which the higher the firm sets the bare, the more obstacles and, thus, opportunities for learning the firm faces. In a

similar line, D'Este *et al.* (2012) suggest that a distinction between deterring barriers and revealed barriers is necessary to obtain meaningful results in research on innovation barriers. Deterring barriers prevents firms from committing to innovative activities, while revealed barriers are those obstacles that firms face along the innovation process. Using UK CIS data the authors show that cost and market barriers have deterring effects, i.e. prevents firms from engaging in innovation activity, while cost and knowledge barriers are revealed barriers, i.e. the more innovation activities the firm is engaged in, the more likely they are to experience these barriers. The findings of these studies highlight that more innovative firms face more barriers. Accordingly, we hypothesize the following:

*H1 firms with higher innovation intensity, as measured as number different innovations introduced to the market in a three year period, are more likely to experience barriers in the market introduction of their most recent innovation*

Novelty is a central element in innovation. Uncertainty is a central element in novelty. In a more uncertain environment firms are more likely to experience barriers, because their existing resources have to be adopted or they need to acquire new resources. Thus, we hypothesize the following:

*H2 The more novel the firms most recent innovation, as measured by the new market offering being new to the firm, new to the market or new to the world, the more likely the firm is to experience barriers in the introduction of the innovation*

## **2.2 External orientation**

Building on the resource-based view of the firm (Wernerfelt, 1984 & Barney, 1991) and organizational learning (Levitt and March, 1988 & Huber, 1991) and following Chesbrough's (2003) work on open innovation, external knowledge has received great attention and is consistently shown as a significant driver of innovative performance (e.g. Laursen and Salter, 2006; Foss, Lyngsie and

Zahra, 2013; Arora, Cohen and Walsh, 2016). Garriga, Von Krogh and Spaeth (2013) deploys Swiss CIS data to extend the (Laursen and Salter, 2006) model by including information from the barrier items included in the CIS survey and, to the best of our knowledge, is the only paper which integrates barriers and external knowledge. They show that barriers reported in firms' general innovation activities over a three year period decrease innovative performance measured as fraction of turnover pertaining to new products and improved products respectively. Barriers increases the breadth of knowledge search, i.e. number of external knowledge sources used in the firms innovation processes, while the likelihood of searching deeply, that is using an external knowledge source to a high extent, decreases. The authors argue that constraints firm resources shape their search strategy. We use a reverse argument and say that sourcing knowledge externally are more likely to report barriers due to increased complexity and increased awareness of the external environment. Due to the cross-sectional nature of our survey data we can seek to replicate the correlation, but we cannot establish the direction of argument. Our expectation is that firms which search more broadly are more likely to report lack of human resources as barrier, because the search for external knowledge may compensate for lack of internal knowledge, but that the involvement of externals may also increase awareness of barriers in the market.

Performing a market analysis for the innovation is another act of external awareness. Similarly to involving externals in the process, market analysis is about obtaining knowledge but the market analysis is specifically targeted at obtaining knowledge regarding the external environment in which the innovation is going to be introduced. This variable is, thus, expected to be a predictor of reporting market barriers. Whether or not the firm performances market analysis for its innovation may also be a sign of innovation management, which to the best of our knowledge has been absent from previous innovation models.

Our final construct of external orientation is whether the firm applies for external funding. Naturally, applying for external funding should be a good predictor of having experienced financial constraints, but the process of applying for external funding may also increase awareness of barriers in general because it most often requires the preparation of a business model as well as interaction with external investors which provide feedback including potential challenges. We hypothesize the following,

*H3 Firms with external orientation, as measured by search breadth, market analysis, and external funding, are more likely to experience barriers*

### **2.3 Barriers and firm performance**

Another stream of literature looks at how barriers affect dependent variables related to innovation outcome or firm performance. Blanchard *et al.* (2013) looks at deterring barriers as defined by D'Este *et al.* (2012) and show that in measuring the impact of barriers on French firms' propensity to innovate, it is important to distinguish between firms who intend to innovate and firms with no intention to innovate. In the former sample they find a negative impact of barriers to innovation on firms' propensity to innovate, that is, firms experiencing barriers are less likely to introduce new or significantly improved products or processes. Coad, Pellegrino and Savona (2016) uses a UK CIS panel to look at the effect of barriers related to finance, knowledge, demand, market structure and regulation on firms' productivity measures as the sales-employee ratio. Financial barriers and lack of skilled personnel are the only barriers exerting significant and positive effect on firm productivity. While controlling for firm productivity, we look at another performance variable; survival. Survival is an interesting performance variable because being innovative implies engaging in risky activity which is especially relevant given that the vast majority of Danish firms are micro-small firms which are more vulnerable to risk.

Whether or not experiencing barriers is positively or negatively related to firm survival is not clear cut. The Coad, Pellegrino and Savona (2016) study suggest a negative relationship between firm performance and barriers related to lack of finance and human resources. Similarly, Garriga, Von Krogh and Spaeth (2013) finds constraints to negatively increase innovation performance as measured by fraction of turnover pertaining to innovation. A potential bias in these studies is that respondents are asked to report barriers for the firms innovation activity in general over a period of three years. With a substantial risk recall bias, respondents may rationalize current suboptimal performance with past barriers. Because we seek to test our argument that barriers are positive in the sense of being either a learning opportunity or being a sign of the firms' ability to effectively evaluate risk we propose the following hypothesis,

*H4 The breadth of the barriers experienced by firms is positively related to firm survival*

## **2.4 Firm characteristic and the phase of the innovation process**

Some studies look at how specific firm characteristics affect the barriers firms face. D'Este, Rentocchini and Vega-Jurado (2014) use Spanish CIS data to show that human capital, measured as the proportion of employees with a higher education degree, reduces how important managers perceive deterring barriers related to knowledge shortages and market uncertainties to be. Bruneel, D'Este and Salter (2010) find that inter-organizational trust, collaboration experience, and interaction breadth diminish the likelihood of facing barriers in industry-university collaboration. Hölzl and Janger (2014) draw on CIS data from 18 countries to conclude that firms located in countries close to the technological frontier are more likely to report barriers related to lack of skilled labor, innovation partners, and technological knowledge, while firms in countries further away from the technological frontier suffer from lack of external finance. Finally, Pellegrino (2018) looks at the role of firm age in firms' assessment of barriers. In line with the innovation funding literature, the

author find that mature firms are less likely to experience constraints in financial resources. Mature firms are deterred from engaging in innovation due to lack of qualified personnel, while young firms mainly report this obstacle as a revealed barrier, i.e. a hindrance that come up while engaging in innovation. Older firms report barriers related to market structure and demand more often than their younger counterparts. The richness of our dataset allows for a more extensive controls related to characteristics both on the firm level and on the level of a specific innovation, i.e. characteristics of the most recent innovation and the process of its market introduction.

The papers mentioned in this sections looks at barriers perceived by managers in the firms innovative activities in general. In their systematic review on barriers to radical innovation, Sandberg and Aarikka-Stenroos (2014) note that the majority of research on barriers looks at the innovation process as a whole, while 19% specifically considers the R&D phase. The R&D phase is prior to the adjustment and testing phase which us context of our study. García-Quevedo, Pellegrino and Savona (2017) show that barriers related to lack of demand negatively influences firms propensity to conduct R&D activities and also the amount invested in R&D, while demand uncertainty actually increased R&D spending in low-tech sectors. In the earlier phases of innovation, barriers may be a good thing, because they sought out bad innovation projects (Hölzl and Janger, 2014). Whereas, barriers faced towards market introduction of the innovation may have severe consequences for the firm, because a substantial amount of resources has been devoted to the innovation. Therefore, the lack of research on barriers specifically towards the end of the innovation process is a significant gap that we seek to address with the current study.

## 4. Data and method

### 4.1 Data

To test our hypotheses we use a novel dataset with survey data sampled from the population of Danish firms in sectors which are subject to international competition and with a minimum of two employees. In Denmark, there are approximately  $N=40,000$  firms fitting these criteria. The sample is stratified to ensure representation across nine industries and six size groups. The samples firms are almost the sample closely resemble the grouping across the 54 strata as all firms in the population. The data was collected in 2013 via structured phone interviews conducted by professional interviewers and with a response rate of 59 percent providing a total sample of  $n=5,186$ . Mean comparison tests between respondent and non-respondent in terms of age, number of employees, industry, and geographical location shows now significant differences which speaks to the representativeness of our sample. Survey respondents are firm representatives holding positions corresponding to CEO, CFO, or Head of R&D. Main questions of the survey concerns the process of developing new market introductions. These questions were asked to firms reporting to have been introducing a new product, service and concept to the market in 2010-2012 which is 1,651 firms in total.

The survey design is inspired by the Oslo manual which makes items comparable to those of the Community Innovation Survey, CIS. Our survey data is distinct from CIS in four important dimension. Firstly, questions related to the development and testing phase of the innovation process, that is when invention has occurred, as opposed to the entire innovation process. Secondly, main questions on, e.g. barriers and external knowledge sources relate to the firms' most recent innovation. Asking about a specific innovation as supposed to the general innovation activity in a three years period may yields a more precise measure of the barriers faced in an innovation process, as it is easier to more precisely recall recent and specific events rather than general activity, i.e. recued respondents'

recall bias (Arora, Cohen and Walsh, 2016), and asking about the most recent innovation decreases respondents' recall bias. Furthermore, survey items provides information both on the firms general innovation activity level for a three years period, and information at the level of the most recent innovation, which is a great advantages in testing the hypothesis of whether for innovative firms recognize more barriers.

Thirdly, the data collection method is phone interviews as opposed to a written survey completed by the respondent with no supervision. The data collection method increases the quality because the respondents tendency to provide satisficing answers is less prevalent in a conversation with another person, than filling in a survey due to social mechanisms . Furthermore, the professional interviewer have the possibility to provide clarification along the executing of the survey and assess the respondents ability to provide valid answers (Krosnick, 1999).

Fourthly, the sample is representative of a broader population of firms. The CIS samples firms with 10 or more employees, while our sample includes firms down to two employees. Previous research has shown that small firm are especially fragile to barriers because of restrained resources, so the inclusion of micro firms is highly relevant when studies barriers.

The survey data has been merged with register data from two different databases, the Danish Business Authority's CVR register and Experian's KOB database, to obtain objective measures of firm characteristics including age, size, industry, ownership, and financial data such turnover, share of exports, and potential exit. The data has been merged on a unique firm key which identifies the firm as a legal entity. The longitudinal nature of the register data provides some opportunity to address concerns of simultaneity given the cross-sectional server data and also reduce concerns of common method bias.

## 4.2 Variables

### *Dependent variables*

The dependent variables are constructed based on 12 barriers item<sup>1</sup> for which the respondent are asked whether the barrier was of no, little, some or high importance to the market introduction of their most recent innovation<sup>2</sup>. A factor analysis was performed to check if the barrier items loaded into meaningful factors. The factor analysis resulted in the following categories, *cost barriers*, *human resource barriers*, *market barriers*, and *regulation barriers*. Following the approach of D'Este et al 2012, we code each barrier factor with 1 if the firm has reported at least one of the items in the factor to be highly important, and 0 otherwise.

For the survival analysis, the dependent variable is *exit* coded 1 if the firm is determined as a legal entity prior to the introduction of its most recent innovation as reported in the survey. The duration is coded as 2017, which is the final year we observe the firm, minus the year of introduction<sup>3</sup> of its most recent innovation.

### *Independent variables*

The main independent variables reflects the innovative activity of the firm in the period of 2010-2012. We focus strictly on product innovation<sup>4</sup>, that is new offerings introduced to the market. We construct 3 dummies representing *innovation activity low*, *innovation activity medium*, and *innovation activity* based on the quantiles for the number of different innovations introduced the market in the reference period<sup>5</sup>. Firms with low innovation activity includes those who introduced only one type of

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<sup>1</sup> See appendix 2 for a list of the barrier items

<sup>2</sup> Respondent can also say 'not relevant' or 'do not know'

<sup>3</sup> Year of introduction of most recent innovation is either 2010, 2011, or 2012

<sup>4</sup> Following the definition of the Oslo manual, product innovation new offerings introduced to the market, i.e. not process, marketing, or organization innovation

<sup>5</sup> See appendix 4 for a list of innovation activities

innovation to the market, those with medium activity have introduced 2-3, and 4-6 for highly innovative. We also include a categorical variable reflecting the novelty of the most recent innovation. Following the approach of previous innovation studies, we measure novelty as the innovation being either new to the firm, new to the market, or new to the world.

The second set of independent variables of interest are those pertaining to the firms external orientation. The first construct is search breadth which has been operationalized by Ahuja and Katila (2004), Laursen and Salter (2006), and followers reflecting the number of external sources firms' draw upon in their innovation process. In our setting, search breadth is measured as the number of external sources included in the testing and adjustment of the invention. The variable takes the value of 0-5<sup>6</sup>. The second variable of external orientation is a dummy taking the value of one if the firm has conducted market analysis for the most recent innovation. Finally, we employ a dummy for whether the firm has applied for external funding to finance their most recent innovation.

### *Control variables*

How much importance the firms attach to barriers is likely to depend on the significance of the innovation. Therefore, we control for the *fraction of turnover* pertaining to the innovation in 2012. To make the fraction of turnover variable meaningful we also control for the year in which the innovation was introduced. We also include a set of controls from observational data representing firm characteristics which are likely to affect how firms evaluate barriers. Research on innovation barriers has shown that the perception of barriers are associated with *size* and *industry* of the firm (Hölzl and Janger, 2013). We include industry dummies and measure size as the logarithm of the number of employees in the firm in 2013<sup>7</sup>. *Firm age* and whether the firm is a *startup*<sup>8</sup> is controlled

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<sup>6</sup> See appendix 4 for a list of external knowledge sources

<sup>7</sup> Robustness checks with the averages number of employees over a number of years prior to the survey

<sup>8</sup> A startup is defined as a firm which has been established within 3 years of the survey (2013)

for as younger firms may be more likely to face barriers due to lack of experience and established brand both in relation to external funders, potential employees and customers. Firms located in the capital region may be less likely to face barriers related to sourcing finance and human resource due to higher density of both in capital regions. Therefore, we include the dummy *capital* taking the value of one if the firm is located in the capital area. Following previous studies such as D'Este *et al* (2012) and Garriga, Von Krogh and Spaeth (2013), we control for the firms export intensity. Export intensity may both be a sign of firm quality, but exporting firms may also be more likely to face barriers especially when it comes to financing and regulation. Export is measured with a dummy reflecting whether the turnover share from export is above the mean. Finally, we control for the firms' labor-productivity ratio by dividing firm profit with number of employees. This is again an attempt to control for firm quality, to circumvent the concern that either better firms face less barriers or, as we argue to be the case, better firms face more barriers or at least are better at recognizing these barriers.

### 4.3 Sample and descriptive statistics

While our full sample consists of 5,186 Danish firms, our unit of analysis are only those firms which have introduced a least one innovation to the market in the reference period, that is 1,651 firms. This implies that the results based on this sample should only be inferred to firms who are innovation active. This also means that within the framework suggested by D'Este *et al* 2012, we are strictly dealing with revealed barriers, i.e. barriers firms encounter along their innovation process, and not with barriers deterring firms from engaging in innovative activities. As can be seen from the descriptive statistics table, the innovative sample are on average larger than their non-innovative counterparts. This is not surprising given that our sample comprise firms all the way down to two employees, and thereby kiosk owners and local carpenters which are less likely to innovate are included. Firm age does not differ notably between the two groups, while innovating firms higher

export intensity and productivity. Around 10 pct. of out sample exit the market post to the survey, and interestingly, this does not differ between innovators and non-innovators.

**Table 1**

Descriptive statistics

Sample	Full					Innovative firms				
Variables	Obs.	Mean	St. Dev.	Min	Max	Obs.	Mean	St. Dev.	Min	Max
<b><i>Dependent variables</i></b>										
Cost barriers						1,651	0.025	0.156	0	1
HR barriers						1,651	0.018	0.134	0	1
Market barriers						1,651	0.104	0.306	0	1
Regulation barriers						1,651	0.050	0.217	0	1
<b><i>Independent variables</i></b>										
Innovation activity low						1,651	0.570	0.495	0	1
Innovation activity med.						1,651	0.273	0.445	0	1
Innovation activity high						1,651	0.171	0.376	0	1
Novelty						1,651	2.008	0.736	1	3
Search breadth						1,651	0.657	0.756	0	5
Market analysis						1,651	0.240	0.427	0	1
External funding						1,651	0.151	0.359	0	1
Fraction of turnover						1651	2.240	1.388	1	7
Year of introduction						1,651	2011.4	0.794	2010	2012
Firm size	5,186	21.515	266.429	2	18,049	1,651	30.292	447.919	2	18,049
Firm age	5,186	20.650	23.055	0	473	1,651	20.164	25.064	0	473
Startup	5,186	0.0864	0.281	0	1	1,651	0.107	0.301	0	1
Export	4,450	8.031	21.967	0	100	1,482	11.306	25.747	0	100
Productivity	3,805	553	1,161	-9,179	41,700	1,338	659	1,668	-1,745	41,700
Exit	5,186	0.102	0.303	0	1	1,651	0.102	0.302	0	1

Productivity has been divided by 1,000

Looking at our dependent variables, it can be seen that market and regulation barriers are the most frequently sided. The majority of firms only introduce one innovation to the market in 2010-2012. 24% of the innovative firms conducted a market analysis for their most recent innovation, while 15% applied for external finance to fund their innovation.

#### 4.4 Estimation method

To estimate the likelihood of reporting barriers, we use a multivariate probit model. This technique allows for simultaneous estimation of the likelihood of experiencing each barrier factor which is important because the likelihood of facing one barrier factor may not be independent of facing another. Standard errors are clustered at the industry level. For the second model, a Weibull model is used to estimate the proportional hazard function for firm leaving the sample post innovation introduction. For robustness, a simple probit model provides consistent conclusions.

### 5. Results

The results from the multivariate probit estimation is displayed below. Moving from low to medium innovation activity increases the likelihood of reporting barriers across all barrier type with the exception of cost barriers. Also when moving from low to high innovation activity the likelihood of reporting barriers increase, and with a larger effect size than from low to medium as would be expected. Highly innovative firms does not exhibit significantly higher probability of facing human resource barriers. This result may, however, be due to scarcity of observations as HR barriers is the factor with fewest observations. Overall, hypothesis 1 is supported. In a restricted version of the model<sup>9</sup> in which the variables related to external orientation were not included, novelty was positive and significant across all barriers, i.e. as hypothesized the likelihood of experiencing barriers increase with novelty of the innovation. Interestingly, when the variables of external orientation are added, novelty inly remains significant for market barriers. This indicates that external orientation are drivers of novelty or vice versa. Hence, hypothesis 2 is only partially supported. In line with hypothesis 3, search breadth, market analysis, and external funding significantly increases the likelihood of

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<sup>9</sup> The restricted model is not displayed in the paper for reasons of space restriction

reporting barriers. As has been shown by prior research, one would expect that highly innovative firms are also more externally oriented. Our results show that both high innovation activity and external orientation are significant drivers of barriers recognition and, hence, these are distinctive effects.

**Table 2**

Multivariate probit. Dependent variables: whether the firm assesses at least 1 barrier-item as highly important for each barrier factor

Explanatory variables	Cost barriers		HR barriers		Market barriers		Regulation barriers	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
<i>Innovation activity</i>								
Low	Reference		Reference		Reference		Reference	
Medium	0.197	0.180	0.350***	0.119	0.262**	0.141	0.150***	0.055
High	0.627***	0.198	0.225	0.150	0.280**	0.119	0.257**	0.122
<i>Most recent innovation</i>								
Novelty	0.084	0.151	0.009	0.141	0.124**	0.061	0.166	0.150
Fraction of turnover	0.148***	0.043	-0.027	0.063	0.104***	0.019	0.150***	0.019
Year of introduction	0.013	0.060	-0.113	0.119	-0.042	0.045	-0.038	0.048
Search breadth	-0.014	0.101	0.122	0.122	0.102**	0.044	0.146**	0.058
Market analysis	0.349***	0.126	-0.163	0.201	0.285***	0.092	0.270***	0.064
External funding	1.113***	0.106	0.087	0.153	0.068	0.097	0.226	0.181
<i>Firm characteristics</i>								
Logemp	-0.124	0.105	0.053	0.066	-0.002	0.045	0.093	0.068
Logage	0.142	0.110	-0.188***	0.053	-0.016	0.044	-0.070	0.078
Starup	-0.067	0.361	-0.213	0.145	-0.196	0.190	-0.681***	0.215
Export	0.217***	0.042	-0.143	0.162	-0.001	0.014	-0.034	0.087
Logproductivity	-1.533	1.354	-2.426**	1.072	-1.448*	0.755	-0.659	0.890
Capital region	-0.181*	0.093	0.111	0.098	0.142	0.101	-0.036	0.089
Industry dummies	Included		Included		Included		Included	
Constant	-4.987	107.850	264.940	230.526	106.342	97.180	83.582	108.154
	Rho 1		Rho 2		Rho 3		Rho 4	
Rho 1	1.000							
Rho 2	0.257**		1.000					
Rho 3	0.441***		0.479***		1.000			
Rho 4	0.280***		0.288***		0.548***		1.000	
Observations	1,337							
Log Likelihood	-837.644							
Wald $\chi^2_{296}$	128.807							

Two tailed tests \* p&lt;0.10 \*\*p&lt;0.05 \*\*\*p&lt;0.01

With respect to the control variables, we see that, interestingly, firm size and age does not exhibit significant influence on barrier perception with exception of HR barriers. We observe that startups are less likely to report regulation barriers, while firms with higher export intensity are more likely to face cost constraints. This is not surprising as a market introduction including foreign market is likely to be substantially more costly than introduction at the local market. Being located in a capital region does not have a notable effect.

Table 3 reports the result of the duration model, and as a highly interesting finding, the extent of the barriers reported by innovative firms for their most recent innovation significantly decrease the firms probability of exiting the market. Thereby, granting support for hypothesis 4.

**Table 3**

Proportional hazard model. Dependent variable: firm exiting the market post innovation

	Explanatory variables	Coefficient	S.E.
<i>Innovation activity</i>	Medium	0.598	0.386
	High	0.934***	0.294
<i>Most recent innovation</i>	Barrier breadth	-0.131**	0.058
	Novelty	0.285**	0.124
	Fraction of turnover	-0.090*	0.051
	Search breadth	0.033	0.302
	Market analysis	-0.561	0.425
	External funding	1.036***	0.191
<i>Firm characteristics</i>	Logemp	0.045	0.097
	Logage	-0.591**	0.273
	Startup	-0.116	0.400
	Export	-0.225	0.331
	Logproductivity	-4.224	2660
	Capital region	0.375***	0.132
	Industry dummies	-0.190**	0.095
	Constant	52.305	43.097
	Observations	1,337	
	Log Likelihood	-188.061	
	Non-censored observations	169	

Two tailed tests \* p<0.10 \*\*p<0.05 \*\*\*p<0.01

## **6. Conclusions and implications**

### **6.1 Contributions**

With this study, we have contributed to the literature on barriers to innovation and more broadly to the innovation literature in exploring potential determinants of innovation performance. We confirm what has been previously shown by the literature, that more innovative firms are facing more barriers. In this regard, our distinct contribution lies in the ability to separate the measure of innovation activity at the general firm level, and the measure of barriers to a specific innovation. Thereby, we can show that firms which are more innovative either become better at recognizing barriers in general, or manage to set the bar higher for each of their individual innovations which then leads to more barriers. We theorize that firm with high innovation intensity develop the capability of identifying barriers which makes them significantly more likely to succeed with their current market introduction, but which also provides learning experience increasing future performance.

We show that the ability to recognize barriers is significantly related to firm survival. This somewhat counterintuitive finding draws parallel to the notion within the literature, that firms with challenging homes markets becomes better and more competitive. Our results indicate that facing more barriers improves firms survival which is an important survival measure especially for the many small and young firms in the economy. The finding hold important implications for future research, managers, and policy makers. For research on innovation barriers, the assumption that self-reported barriers to innovation hampers innovation is not valid. For managers, awareness of impediments to successful market introduction of innovation shall be viewed as a strategic capability. For policy-makers, the barriers which firms report are not necessarily impediments which policy should seek to remove. Rather, firms should be supported in recognizing barriers in order to proactively adjust and learn from them.

## 6.2 Limitations and future research

This study is limited by the cross-sectional nature of our survey data, which makes us unable to establish the directionality of the effects. Future research should further explore the dynamics behind the notion that better firms face more barriers. Is it because better firms are better at recognizing barriers, is it because barriers are opportunities for learning, or is it simply because more innovative firms set the bar higher?

## 6.3 Conclusion

We have utilized novel survey data in combination with register data to show that firms with higher innovation intensity and external orientation are more likely to report barriers in the market introduction of their innovation. Contrary to conventional wisdom, we find indication that the breadth of barriers experienced by firms improves their likelihood of survival.

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## Appendices

**Appendix 1**

## Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
Cost barriers	1.00																		
HR barriers	0.12	1.00																	
Market barriers	0.29	0.27	1.00																
Regulation barriers	0.18	0.16	0.31	1.00															
Innovation activity low	-0.04	-0.05	-0.06	-0.05	1.00														
Innovation activity med.	-0.02	0.02	0.03	-0.01	-0.69	1.00													
Innovation activity high	0.07	0.05	0.05	0.07	-0.51	-0.28	1.00												
Novelty	0.05	0.00	0.07	0.09	-0.04	-0.01	0.06	1.00											
Search breadth	0.04	0.05	0.09	0.10	-0.10	0.07	0.05	0.25	1.00										
Market analysis	0.08	-0.00	0.09	0.09	-0.09	0.01	0.11	0.16	0.20	1.00									
External funding	0.24	0.03	0.05	0.07	-0.05	0.02	0.05	0.07	0.06	0.06	1.00								
Fraction of turnover	0.10	0.00	0.10	0.13	-0.02	-0.02	0.05	0.01	-0.01	0.05	0.12	1.00							
Year of introduction	-0.03	-0.02	-0.02	-0.02	-0.09	0.05	0.06	0.00	0.04	-0.03	-0.03	-0.14	1.00						
Firm size	-0.00	-0.00	-0.01	0.00	-0.04	-0.01	0.06	0.04	0.02	0.06	-0.02	-0.01	-0.04	1.00					
Firm age	-0.04	-0.03	-0.03	-0.01	0.02	-0.02	0.00	-0.01	0.03	0.02	-0.06	-0.14	0.01	0.27	1.00				
Startup	0.02	-0.00	0.01	-0.03	-0.04	-0.01	0.05	-0.00	-0.04	-0.03	0.04	0.17	-0.01	-0.02	-0.24	1.00			
Export	0.01	-0.01	-0.03	-0.00	0.00	-0.00	-0.00	0.11	0.07	0.04	-0.01	-0.07	-0.02	0.02	0.18	-0.11	1.00		
Logproductivity	-0.02	-0.02	-0.03	-0.02	-0.06	0.07	-0.01	0.02	-0.00	0.05	-0.04	-0.02	0.04	0.00	-0.00	0.03	0.02	1.00	
Exit	0.04	-0.03	0.00	-0.02	-0.04	0.01	0.04	0.00	-0.01	-0.01	0.09	0.02	0.01	-0.01	-0.07	0.09	-0.03	-0.03	1.00

**Appendix 2**

## Barrier items

*Cost barriers* Lack of funding

*HR barriers* The firm cannot source employees with relevant sales experience

The firm cannot source employees with relevant competencies to further develop the most recent innovation

*Market barriers* The most recent innovation is not thoroughly tested and therefore difficult to sell

The most recent innovation requires changes in the customers' systems or organizations and is therefore difficult to sell

The most recent innovation is not protected against imitation from competitors

The industry has taken longer time to mature as expected which delays the sales

The market is dominated by a few firms

The firm cannot establish sufficient sales and distribution channels

It is a challenge to train the customers in using our most recent innovation

*Regulation barriers* Legislation and regulation on the Danish market

Legislation and regulation on the export market

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**Appendix 3**

Innovation activity: types of innovation introduced to the market in 2010-2012

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New product

Significantly improved product

New service

Significantly improved service

New concept

Significantly improved concept

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**Appendix 4**

Sources of external knowledge used in the testing and adjustment phase

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Suppliers

Sales force

Customers who are user

Customers who are purchasers

Users who are not responsible for the purchase

Universities

Other sources

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