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A discrete choice experiment to explain knowledge acquisition strategies of SMEs

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Abstract

This study predicts the conditions under which firms that engage in an innovation project choose for one of three knowledge acquisition strategies (KASs): internal R&D, buy and collaborate. This is done by linking the KASs to a series of attributes using a discrete choice experiment that is conducted on 427 SMEs. We find that risk and finance models have a large influence on the choice for a KAS. Moreover, we identify four latent classes of firms that have distinctive choice patterns. We demonstrate that the choices for a KAS are related to the past behavior of the firm and that a limited number of firms are likely to change their KAS.

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Keywords: Internal R&D, External R&D, Knowledge acquisition strategy, Discrete choice experiment.

1. Introduction

When engaging in innovation projects firms need to choose if they develop new knowledge through internal or external R&D (Love and Roper, 2002). In case of external R&D, the firm can decide to *buy* the knowledge from another party or to jointly develop the knowledge in *collaboration* with the other party (Fey and Birkinshaw, 2005). As such, the firm has three broad knowledge acquisition strategies (KASs) from which it can choose.

Each of these strategies has implications that can influence the success of the project and thereby the competitive position of the firm. For example, innovations that are developed through internal R&D are more likely to benefit from a first mover advantage (Lieberman and Montgomery, 1988; Kessler et al., 2000; Suarez and Lanzolla, 2007), and the firm can gain full intellectual property (IP) rights. However, internal R&D also implies that the firm alone carries the costs and risks of the project. A buy strategy does not lead to a first mover advantage or full IP rights, but if the firm buys existing knowledge the risk of failure is also lower. Finally, collaborate allows the firm to connect its knowledge base to other knowledge bases which can lead to new innovations (Nelson and Winter, 1982) that give the firm a first mover advantage. Moreover collaboration allows for sharing the costs and risks of large projects (Powell et al., 1996), but the benefits also need to shared.

Earlier studies have attempted to predict the choice for these KASs. Attributes of the innovation project that are of influence include the strategic components mentioned above: speed to market (first mover advantage), IP and risk. Moreover, potential partners types that serve as knowledge source (Kleinknecht and Reijnen, 1992; Miotti and Sachwald, 2003), finance models (Kleinknecht and Reijnen, 1992; Piga and Vivarelli, 2004), and resources to be gained (Miotti and Sachwald, 2003) can affect the choice. Finally, firm characteristics, such as size (Love and Roper, 2002; Cassiman and Veugelers, 2006), sector (Love and Roper, 2002), internal resource (Jones et al., 2001) or knowledge stocks (Grant, 1996), and existing routines (Levitt and March, 1988) may play a role.

Despite these insights, a number of knowledge gaps remain. First, studies have only looked at how KASs are used at the firm level. Although existing routines can be of influence (see Becker, 2004), the choice for a KAS is ultimately made at the level of the different innovation projects that operate within the firm. Until now, no studies have systematically attempted to understand these choices at the level of innovation projects. Second, most studies rely on self-reported survey data. This data is often is often

associated with a low internal validity (Campbell and Stanley, 1966) and common method bias (Podsakoff et al., 2003), which makes it impossible to separate cause from effect, and to exclude confounding influences. As such the relative importance of the different factors that influence choice has never been assessed. Third, firms are heterogeneous, which explains why they pursue different KASs. Until now, studies have only attempted to capture heterogeneity that comes from observed variables, such as the firm characteristics mentioned above. However, current insights from latent class analysis also allow for utilizing unobserved sources of heterogeneity (Vermunt and Magidson, 2002; Masyn, 2013). This can greatly improve our understanding of the choice for a KAS.

Therefore this study aims *to compare the influence of attributes of an innovation project on the choice for a knowledge acquisition strategy for different latent classes of firms*. We conducted a Discrete Choice Experiment (DCEs: Louviere and Woodworth, 1983) on a sample of 427 SMEs from the United Kingdom and Germany. DCEs are a well-established method to elicit stated preferences in marketing, transportation research and health economics. They are particularly useful in situations where reliable data about revealed preferences is lacking (Baltas and Doyle, 2001), such as the choice for a KAS. Using an experimental design, DCEs can incorporate all relevant attributes in a series of systematically varying choice tasks that respondents can use to indicate their preferred option (Ben-Akiva et al., 1991). Since the level of the independent variables (attributes) is given by the experimental design, the results have a high internal validity. Using data from this DCE we identify latent classes of firms that pursue similar strategies. In addition, we demonstrate the effectiveness of different resource endowments to accomplish a change in KAS for the different latent classes. Thereby our results provide opportunities for policy makers that wish to influence the choice for a KAS, for example to promote collaboration.

In the next section we discuss the different KASs and identify the attributes of innovation projects that influence the choice for a KAS. In the methods section we give more information about DCE and our empirical approach. After this our results are presented, followed by a conclusion and discussion.

2. Theory

To derive the KASs and the attributes influencing choice we make use of the Resource Based View (RBV: Wernerfelt, 1984; Barney, 1991). According to the RBV firms obtain a sustained competitive advantage by acquiring a bundle of valuable, rare

and non-imitable resources (Barney, 1991). These resources can be tangible, such as physical or financial capital, or intangible, such as knowledge or social capital (Del Canto and Gonzalez, 1999). Within the RBV knowledge is regarded as a key-resource that provides a strong basis for a competitive advantage (Conner and Prahalad, 1996; Grant, 1996). Acquiring this key-resource means that firms need to engage in a KAS.

The choice for a KAS depends on how the firm values the attributes that are associated with an innovation project. All attributes in this paper are nominal variables, in which different levels represent the values the attribute can take. We consider nine attributes. The first four attributes are properties of the KASs themselves, while the second five are related to the resource endowments that come out of the R&D process. The main outcomes of the R&D process are innovations. However, during the R&D process firms can acquire other beneficial resources, such as network contacts or specialized equipment. We identified these attributes primarily using the literature. However, as is recommended in choice modelling (see Kløjgaard et al., 2012) we also conducted seven qualitative interviews with SMEs about which attributes where deemed important in the choice for a KAS. Insights from these interviews were taken into account while selecting the attributes.

2.1. Knowledge Acquisition Strategies (KASs)

Huber (1991) claims that firms can learn from their own experience or from other sources. This distinction theoretically grounds the difference between internal and external R&D and forms the basis for the three KASs: internal R&D, buy and collaboration.

- *Internal R&D* means that the firm invests its own resources to generate the required knowledge for an innovation internally. Since the firm does not consult external sources, the outcome of the R&D process is more likely to be new and unique (Van Rijnsoever et al., 2013), which can lead to a first mover advantage. However, the result of the internal R&D process is not necessary superior to existing alternatives. Further, internal learning processes involve a lot of trial-and-error (Bandura, 1977; Carbonara, 2004), which makes them rather inefficient, risky and lengthy.

Firms can also consult external sources to acquire knowledge required for an innovation project, which means that they conduct external R&D. The literature makes a distinction between buy and collaboration as primary governance modes of external R&D (Veugelers and Cassiman, 1999; Fey and Birkinshaw, 2005).

- *Buy* refers to the acquisition of knowledge by a firm from the market (see Mangematin and Nesta, 1999; Fey and Birkinshaw, 2005). Instead of producing

knowledge internally, a firm can procure a license from an external party that allows it use an existing stock of knowledge. It is also possible that the firm outsources the development of required knowledge to an external party, or that the firm simply copies knowledge without intellectual property protection. A distinct feature of buy is that the firm itself has not (co-)developed the knowledge, and the knowledge is thus not new. Moreover, the transfer of knowledge is a one-way-stream from the external source to the firm. Being a form of social learning (Bandura, 1977), buy is more efficient, less risky and faster than conducting internal R&D. However, the knowledge procured using the buy strategy manner is not unique, and therefore less likely to lead to a first mover advantage.

- *Collaboration* refers to the joint development of knowledge by the firm and external parties (Powell et al., 1996; Schilling and Phelps, 2007). Examples are joint ventures, alliances (Grant and Baden-Fuller, 2004), but also subsidized collaborative innovation projects (Van Rijnsoever et al., 2013). Collaboration implies that the firm has co-developed the knowledge while interacting with external parties during the R&D process. Partners combine parts of their knowledge bases, to make novel combinations that can leads new knowledge and radical innovations. Moreover, partners can share the costs and risks that are associated with innovation (Powell et al., 1996). Collaboration is not necessarily a more efficient or faster strategy than internal R&D, but it is less risky and also likely to result in unique knowledge that can help with gaining a first mover advantage. However, the benefits from this advantage likely need to be shared between the collaborating parties.

These are three fundamentally different strategies, that go beyond the degree of interaction. A key difference between internal R&D and collaboration on the one hand and buy on the other hand, is that latter does not lead to new knowledge. Buy can lead to innovations new to the firm, but it does not lead to innovations that are radically new to market. This makes the buy strategy different from the other two when it comes to innovation. Moreover, as will be shown in the discussion below, some attribute levels are nested in a KAS, which means that for a KAS they are fixed. An example is that the buy strategy does not give a first mover advantage. Finally, it is important to note that the choice for a strategy like a KAS is also likely the result of accumulated organizational practices (Levitt and March, 1988; Greve, 2003) of which the successful one are stored in routines (Becker, 2004; Van Rijnsoever et al., 2012). These routines limit the firm's degrees of freedom to change their existing strategy, because firms have to unlearn one strategy and relearn another (Betsch et al., 2004).

2.2. Attributes that are properties of the KAS

2.2.1. Speed to market

Speed to market refers to gaining a first mover advantage. This means that the firm is the first to bring the innovation to the market (Lieberman and Montgomery, 1988; Kessler et al., 2000; Suarez and Lanzolla, 2007). Thereby it acquires an initial monopoly position for a (short) period of time (Grant and Baden-Fuller, 2004). The initial monopoly allows the firm to set the price, to acquire an initial market share, go down the learning curve and receive costumers feedback earlier than competitors. However, first movers need to invest in maintaining their position, otherwise competitors can overtake the first mover with relative ease by using a buy strategy (Teece, 1986). This is called a second mover advantage (Hoppe, 2000). Hence, the attribute has two levels: *first mover* and *second mover*. For the internal R&D and collaboration strategies this attribute is fixed to first mover, for the buy strategy this attribute is fixed to second mover.

2.2.2. Risk

The attribute *risk* refers to the certainty that the innovation project will achieve the expected results (see Sitkin and Pablo, 1992). Risk has consistently shown to be important in organizational decision making (Sitkin and Pablo, 1992; Greve, 1998). The choice for engaging in innovation is to a large extent determined by the risks associated with a project (Slevin, 1971; Bloom and Milkovich, 1998; Rosenkopf and McGrath, 2011; Van Rijnsoever et al., 2012), which is why we include it in our model. The attribute has two levels: *low risk* and *high risk*. For internal R&D the level is fixed at high, for buy and collaboration the level is fixed at low.

2.2.3. Development time

The *development time* of a new innovation varies greatly by sector. For small software applications it can be as short as a couple of weeks to a few months (Boudreau, 2012). In contrast, the development time in biotechnology is around ten to twelve years (Pisano, 2006). Longer development times imply more costs without returns, and larger risks that a competitor will launch a similar product. This jeopardizes the chances of gaining a first mover advantage. Being able to develop innovations faster can thus be a source of a competitive advantage. The attribute has two levels: *short development time* and *long development time*. For internal R&D and collaboration the level is fixed at long development time, for buy it is fixed at short development time.

2.2.4. Knowledge source

An external R&D strategy requires an external party that serves as *knowledge source* from which the firm can buy, or with which it can collaborate. Over the years a number of potential knowledge sources relevant to innovation development have been identified in the open innovation literature (Chesbrough, 2003), examples are universities, users or other firms (Nieto and Santamaría, 2007; Van Rijnsoever et al., 2013). These sources operate in different institutional environments (Etzkowitz and Leydesdorff, 2000; Van Looy et al., 2006). Universities for example are pressured to develop knowledge that is publishable in scientific journals, while firms need to develop knowledge that is commercially exploitable. For this reason universities are more likely to possess basic knowledge, while firms are likely to have more applied knowledge (Laursen and Salter, 2004). The knowledge source is an important part in the choice for a KAS (Kleinknecht and Reijnen, 1992; Miotti and Sachwald, 2003) as it influences the performance of R&D (Fey and Birkinshaw, 2005; Laursen and Salter, 2006). We distinguish the following six levels for this attribute: *supplier, competing firm, non-competing firm, buyer, university or public research institute, private research institute*. By definition, internal R&D has no level at all. For buy and collaboration these levels are not fixed.

2.3. Resource endowment attributes

2.3.1. Intellectual property

Intellectual property (IP) can be a key resource for the firm as outcome of the innovation process. IP provides the legal protection that prevents other parties from using or imitating the innovation (David, 1993; Hagedoorn, 2003; Verspagen, 2006). This in turn enables the patent holder to increase commercial benefits from the innovation. IP rights can be fully owned by a single firm, but collaboration partners can also share IP rights, for example through joint patenting (Hagedoorn, 2003). Moreover, the IP holders can set the terms under which others can make use of the knowledge that is covered by the IP, for example through licensing (Braga et al., 2000). However, IP is not always important (see Cohen et al., 2000), in some sectors firms rely on alternative ways to protect their knowledge, such as secrecy. This can be because of the high costs associated with applying and defending a patent, or because the knowledge is simply not patentable. Consequently, the attribute has four levels: *full ownership, licensed IP, shared IP and free IP*. For internal R&D the level is fixed at full ownership. For both external R&D strategies the exact IP rights have to be negotiated (Hagedoorn, 2003), therefore they are not fixed.

2.3.2. Office & specialized equipment

When firms collaborate with other parties, they can, in some instances, get access to physical resources (Lin et al., 2009). For example, incubators or science parks can facilitate collaboration, by providing firms with office space in the vicinity of potential collaboration partners (Lindelöf and Löfsten, 2003). Another benefit from collaboration can be access to specialized equipment that is necessary to develop the innovation, but that the firm would otherwise not be able to use (Chan and Lau, 2005), examples are laboratory space (Mian, 1997) or main frame computers (Hisrich and Smilor, 1988). Thereby this attribute has four levels: *none, office, specialized equipment* and *office & specialized equipment*. Since these benefits can only result from collaboration, the levels for internal R&D and buy are fixed to none for this attribute.

2.3.3. Social network

Social networks are often considered to be a key resource that explains the success of the firm and the innovation process (Adler and Kwon, 2002). A large and heterogeneous social network allows the firm access to resources it does not have internally (Davidsson and Honig, 2003). Building up a social network requires frequent interaction with other actors, which makes it the exclusive product of collaboration. Following Laursen and Salter (2004), we make a distinction between scientific actors (universities, public or private knowledge institutes) and business actors (suppliers, competitors or non-competing firms) with which firms can collaborate. Consequently, the attribute has four levels: *none*, *scientific network, business network, scientific and business network*. The levels for internal R&D and buy are fixed to none for this attribute.

2.3.4. Training & coaching

Human capital is the stock of employee skills within the firm (Wright et al., 2001). Educational level, experience with management, entrepreneurship, and work are important human capital factors that influence the success of entrepreneurs (Robinson and Sexton, 1994; Davidsson and Honig, 2003) and established firms (Hitt et al., 2001). To strengthen their human capital, firms can choose to hire additional employees. However, smaller firms often have limited resources, which often excludes hiring as option. Alternatively, firms can invest in strengthening the human capital of their existing workforce through *training and coaching* (Kutzhanova et al., 2009). Training refers to collective learning processes via workshops and master classes. Coaching takes place on an individual basis. As such this attribute has four levels: *none, training, coaching, training & coaching*. Since these human capital investments require interaction between the firm and another actor, the levels for internal R&D and buy are fixed to none for this attribute.

2.3.5. Funding model

The financial costs of R&D can be between zero up to around a billion Euros (Pisano, 2006). There are several funding models to cover these expenses. First, the firm can invest its own resources in the project. However, it can be attractive to attract external capital as well, for example when internal funds are insufficient, to reduce risks or because of favorable regulations. A second finance model that can thus be attractive for smaller firms and entrepreneurs is to gather investments from 'friends, family and fools' (Kotha and George, 2012). However, this funding source is often limited in size and the entrepreneur places the wellbeing of those who are close to him at risk. A third alternative is borrowing money from a bank against interest. A well-known problem with loans is that banks are often risk averse and prefer physical assets to secure the loan in case of bankruptcy (Hall, 2002); not all firms have these assets. A fourth mode is turning to external investors like venture capitalists or angel investors. Such investors are often willing to take more risks than banks and they can offer the firm valuable advice (see Sapienza and Gupta, 1994). However, investors ask for high returns on their investment, and often demand shares of the company or some form of control (Hellmann, 1998). Fifth, many governments invest in R&D by providing subsidies or tax-benefits to innovating firms (Nooteboom and Stam, 2008). Examples are the European Framework Programs, or the SBIR program in the United States. Although governments often ask little in return, firms can experience a high administrative burden to obtain these funds (Barajas et al., 2012). A sixth and relatively new form to finance R&D is crowd funding. Crowd funding is 'an initiative undertaken to raise money for a new project proposed by someone, by collecting small to medium-size investments from several other people (Ordanini et al., 2011, p.444)'. These donations are usually raised through the internet. Thereby crowd funding enables a broad audience to make certain innovation possible. A downside of crowd funding is that the project has to compete with other ideas, which makes the outcomes uncertain. Moreover the firm has to disclose part of the innovative idea publicly to obtain funds. Overall, this attribute thus has six levels: *Own investment, friends and family, bank loans, investor, government subsidy, crowd funding*. None of the attributes levels is nested in a strategy.

3. Methods

We model the influence of the attributes on the choice for a KAS in a Random Utility Theory (RUT) framework (McFadden, 1974; Manski, 1977). According to RUT each individual *i* attaches a certain amount of utility U_{ij} to each of *j* alternatives, in our case the KAS. This utility consists of an observed component V_{ij} and an unobserved random component part ε_{ij}:

(1) $U_{ij} = V_{ij} + \varepsilon_{ij}$

The observed component V_{ij} is comprised of the attributes that are associated with alternative *j* and respondent characteristics that explain the choice. The error component ε_{ij} captures the unobserved factors that influence the choice, such as latent classes. Since ε_{ij} is stochastic by nature the final choice for alternative *j* is represented as a probability.

This model was tested through a Discrete Choice Experiment (DCE: see Louviere and Woodworth, 1983). In a DCE respondents receive a questionnaire that contains a series of choice tasks. Each choice task has a number of alternatives from which respondents can select their preferred option. Respondents base their choices on the levels of the attributes that are associated with each alternative. These attribute levels vary systematically over the choice tasks and different questionnaire versions, in such a manner that the overall DCE contains an experimental design in which the correlations between the attributes are minimized.

As research design, DCEs have a number of advantages over conventional cross-sectional surveys. First, DCEs have a high internal validity. The experimental design ensures that attribute levels have little to no correlation with each other, which makes it possible to assess the relative influence of each attribute on the choice for an alternative without any confounding factors. Thereby DCEs give the researcher direct insight into how attributes can be manipulated to influence choice. Second, since the levels of the independent variables (the attributes) are given by the experimental design, DCEs do not suffer from common method bias (see Podsakoff et al., 2003). Third, since each respondent receives multiple choice tasks, DCEs allow identification of unobserved latent classes of respondents with similar choice patterns (see Vermunt and Magidson, 2002). Thereby DCEs can capture an additional source of heterogeneity, next to the observed respondent characteristics that are usually measured in cross-sectional surveys. A downside of DCEs is that they measure stated preferences or intended behavior instead of revealed preferences or actual behavior. However, research has shown that they can be used to successfully forecast revealed preferences (Adamowicz et al., 1994; Ben-Akiva et al., 1994) or strategic decisions for innovation (Van Rijnsoever et al., 2012).

It should be noted that DCEs were originally designed to elicit preferences from consumers. However, they have also been applied to understand organizational behavior, like retail strategies from managers (Oppewal et al., 2000), or the preferences for alternative fuel vehicles by local governments (van Rijnsoever et al., 2013). However, when applying DCEs to organizations it is important to take into account that respondents are part of an organization in which decisions are the results of negotiation

processes and power play (Cyert and March, 1963; March, 1994). As such respondents need to be considered as informants that are able to accurately predict the behavior of their organization (Oppewal et al., 2000). To obtain reliable results it is thus important that these informants have sufficient insight into how the organizational decision process works. For this reason it is often better to survey respondents that are involved in making strategic decisions. Moreover, reliability increases as the influence a respondent has over an organizational decision process becomes larger, because the respondent becomes more an informant about his or her own behavior instead of the organization. Finally, reliability is likely to increase as the organization becomes smaller (Van Rijnsoever et al., 2012). Smaller organizations are less inert than large organizations (Hannan and Freeman, 1984), which means that they are better able to implement changes that follow from strategic decisions stated by management.

3.1. Data collection

We collected data among entrepreneurs or former entrepreneurs that founded or owned innovating small- or medium sized manufacturing firms. Data was collected via an online business-to-business panel of a large European marketing agency. The selection of sectors was made according to the Eurostat classification based on NACE codes (Eurostat, 2009). Respondents were surveyed in the United Kingdom (n=284) and Germany (n=143). These are two of the major economies in the European Union, but they operate under different institutional regimes[1], which leads to differences in how the innovation process operates (Hall and Soskice, 2001). By sampling from two different countries we increase the external validity of our results. However, the response per country was limited by the number of potential respondents in its panel. To correct for this, the firms in our sample were weighed according to the occurrence in the population of manufacturing firms in their respective countries in 2011 (see Eurostat, 2013). As such, the weight ratio between UK and German firms was set at 0.565 to 1.864 with a mean of 1.

The average age of the respondents ranged between 22 and 70 years (mean=51.0), a large majority (89.5%) was male. The average firm age ranged between 1 and 42 years (mean=10.24), while the size ranged between 0 and 400 full time employees (mean=29.70). However, this distribution was negatively skewed due to outliers. The 5% trimmed mean of size was 18.19 full time employee. Filling in the questionnaire took

[1] In political economy, the United Kingdom is often characterized as a 'liberal market' economy, while Germany is often seen as a 'coordinated market' (Hall and Soskice, 2001).

approximately 20 minutes. For their participation, respondents received a small monetary reward.

3.2. Experimental design

The first part of the questionnaire consisted of the DCE. Respondents were asked to imagine that their enterprise needed to acquire knowledge for research and development to bring a new innovative idea to a proof of concept for their market. Respondents received a series of choice tasks containing three alternatives with systematically varying attribute levels. Prior to the giving the choice tasks, respondents received instructions about how the DCE works, the attributes and the associated levels. This information is given in appendix A. For each choice task the following question was posed:

"Given the following conditions, which of the following strategies would your enterprise most likely pursue to acquire knowledge to research a new innovative idea to proof of concept in your current market?"

After reading the instructions respondents proceeded to the choice tasks. Because of the complexity, each task contained a link to a pop-up screen in which the attributes were again explained. Appendix B shows an example choice task. To make the risk attribute more realistic to the respondents we operationalized low risk as a more than 50% chance that the project would succeed. High risk implied a less than 50% chance of success. We made development time sector specific by enquiring about the average time to develop in innovation in the respondents specific sector. A short development time was operationalized as completing the project in half that time. A long development time meant the industry average.

An important topic to consider when constructing a DCE is the effect of labelling alternatives (Hensher et al., 2005; De Bekker-Grob et al., 2010). Alternatives in a choice task can be labeled with, for example, a brand, product or technology name. In case of a labeled task, respondents do not only base their choice on the attributes levels given in the task. They can also infer (accurately or not) attributes from the label or they can experience certain emotions that influence their decision state (Loewenstein et al., 2001). Thereby the label can greatly influence choice. In our case it is possible that respondents are influenced by the name of the KAS, as it makes an alternative more realistic to them. Although realism is clearly a desirable feature of a choice task, the downside of labelling alternatives is that certain attribute levels are nested in their associated KAS, as has been described in the theory section. Without independence between the label and the attribute levels, it is impossible to separate the effect of individual attribute levels from that of the label.

To control for this problem, respondents were randomly assigned to an unlabeled and a labeled condition. The alternatives in the choice tasks of the unlabeled condition contained all nine attributes, but the name of the KAS was omitted. In the labelled condition the name of the KAS was given for each alternative. As indicated in the theory, some attributes were fixed to the level associated with the KAS.

Both conditions contained 72 choice tasks that were blocked over 8 questionnaire versions to which respondents were randomly assigned. The attribute levels varied in such a manner that all choice tasks and questionnaire versions added up to fractional orthogonal design (e.g. attributes were uncorrelated). Respondents in the unlabeled condition received 8 or 10 choice tasks, while in the labeled condition respondents received 9 choice tasks.

We measured the time it took a respondent to complete each choice task. Deeming them unrealistic, we removed 10 observations from the data (0.1%) that took longer than 1500 seconds (25 minutes)[2] to complete. After removing these observations, the average time to complete a task was 31.02 seconds (S.D=48.67). Respondents in the labelled condition needed on average 27.51 seconds, which made them significantly faster ($p<0.001$) than respondents in the unlabeled condition where the average was 34.55 seconds. This is because the label could serve as heuristic cue. In addition, there were less varying attributes since some were nested in the KAS.

3.3. Measurement of firm characteristics

In addition to the DCE, respondents were asked to report a series of firm characteristics about past R&D activities, patents stock, product innovations, past use a KAS with various knowledge sources, and firm size. These characteristics measure the firm's past behavior and can thus indicate if the firm has already developed routines for a strategy. The measures and their frequencies are reported in table 1. It should be noted that we also tested the effects of factors external to the firm, like industry, but these did not give any significant results. To save degrees of freedom, these external factors were not included in our models.

Firm characteristic	**Item (response categories)**	**Frequencies**
R&D	Did your enterprise engage in R&D activities to develop knowledge in the past three years? *(No, Yes)*	No: 186 (43.3%), Yes: 242 (56.7%)
Patent stock	How many patents does your firm own? *(0, 1-2, 3-10, >10)*	0: 287 (67.2%), 1-2: 76 (17.8%), 3-10: 42 (9.8%), >10: 22 (5.2%)

[2] This cut-off point was determined after examining the distribution of the time to complete variable. Observations under 1500 seconds were quite frequent and distributed evenly, above 1500 seconds observations were scarce and unevenly distributed.

Product innovations	how many new or significantly improved products has your enterprise introduced in the last three years? *(0, 1, 2, 3, >3)*	0: 159 (37,2%), 1: 102 (23.9%), 2: 81 (19.0%), 3: 42 (9.8%), >3: 43 (10.1%)
Past use of KAS with knowledge source	Please indicate the strategies your company used on the following external technological knowledge sources in the last three years? *(Buy, Collaborate, Not used)*	
	• Suppliers of equipment, materials, components, or software	Buy: 155 (36.3%), Collaborate: 205 (48.0%), Not used: 67 (15.7%)
	• Competing firms inside your sector	Buy: 28 (6.6%), Collaborate: 164 (38.4%), Not used: 235 (55.0%)
	• Non-competing firms outside your sector	Buy: 22 (5.2%), Collaborate: 179 (41.9%), Not used: 226 (52.9%)
	• Prospective customers or users of your product	Buy: 40 (9.4%), Collaborate: 305 (71.4%), Not used: 82 (19.2%)
	• University, other higher education institutes or public research institutes	Buy: 31 (7.3%), Collaborate: 153 (35.8%), Not used: 243 (56.9%)
	• Private research institutes that primarily conducts applied contract research, such as Frauenhofer	Buy: 31 (7.3%), Collaborate: 119 (27.9%), Not used: 277 (64.9%)
Size	How many Full-Time Equivalents* (FTEs) does your enterprise employ? *(recoded to micro (0-10), small (11-50), medium (51-250), medium-large (251-400))*	Micro: 269: (63.0%), Small: 100 (23.4%), Medium: 50 (11.7%), Medium-large: 8 (1.9%)

Table 1: Indicators and frequencies of firm characteristics.

3.4.Analysis

We analyzed our data via a latent class analysis using the Latent Gold program. This software is specifically designed to analyze choice models and has demonstrated to outperform other programs when it comes to identifying latent classes (Haughton et al., 2009). Prior to our analyses, we pooled the observations from both conditions together in one dataset. The total number of observations in the data was 12804; 6390 (49.9%) observations were from the unlabeled condition.

The dependent variable in the latent class model was the choice a respondent made for an alternative in a choice task. Since the choice tasks elicited respondents to give a most likely and least likely alternative, we were able to construct a full ranking per task (see Flynn, Louviere, Peters, & Coast, 2007). This ranking was predicted by the attribute levels of the alternatives. In the labeled condition, some attributes levels were nested in the KAS, therefore we included alternative specific constants for each KAS that capture the variance from the label (Hensher et al., 2005; De Bekker-Grob et al., 2010).

Through the attributes and alternative specific constants we model the observed component V_{ij} from RUT.

The unobserved heterogeneity in the sample comes from ε_{ij}, which was modeled by identifying latent classes. Respondents are assigned to these latent classes based on the extent to which they make similar choices (see Vermunt and Magidson, 2002). Each latent class has its own set of estimators to predict the choice for a KAS. To aid in the identification of latent classes we added the labeling condition and country (UK or Germany) as covariates to the model. Thereby we control for possible differences that result from the experimental conditions or sampling. We used the Bayesian Information Criterion (BIC: Schwarz, 1978) as heuristic to tool determine number of scale classes (Roeder et al., 1999; Greene and Hensher, 2003; Nylund et al., 2007), were a lower BIC implies a better solution. Since the BIC penalizes the inclusion of additional parameters, a parsimonious solution is most likely favored. We explored solutions between one and five latent classes

Moreover, we explored if scale classes could be identified. The idea behind scale classes is that respondents exhibit different degrees of consistency when making their choices. This consistency is based on the variance in responses (Magidson and Vermunt, 2007). Not taking into account scale can lead to a bias in model estimates (Swait and Louviere, 1993; Sælensminde, 2001). By clustering respondents that display a similar degree of consistency into one scale class it is possible to add a correction for this bias. We explored solutions between one and four scale classes. We plotted the BIC against the number of scale classes. Using a 'scree-type' analysis we determined the optimal number of classes at the point where the curve leveled off (see Masyn, 2013).

Finally, we estimated a multi-nominal regression model in which we use the observed firm characteristics to predict latent class membership of the previous model. In this way we can identify firms in the latent classes by their observed characteristics.

We report the McFadden pseudo-R^2 (McFadden, 1974) as model performance indicator. The Wald χ^2 indicates the relative importance of the attributes. The coefficients for each level are effects coded, which means that the effects are uncorrelated with the intercept, and that the estimators add up to one (Bech and Gyrd-Hansen, 2005).

4. Results

Table 2 presents the outcomes of the latent class analysis. The BIC indicators revealed that a solution with four latent classes and two scale classes fitted the data best. The McFadden pseudo-R^2 is 0.27, which indicates a good fit. Moreover, it is a major improvement over the fit of a simple one-class model which has a pseudo-R^2 of only

0.03. This confirms the notion that unobserved variables help to explain the heterogeneity in choices by firms.

All attributes are significant, but the Wald χ^2 shows that largest influence on choice comes from the funding model, followed by risk, knowledge source and IP. Moreover, experimental condition significantly influenced class membership, while country did not.

Attribute	Wald χ2	Sig.	Wald χ2 (=)	Sig.	Level	β class 1	Sig.	β class 2	Sig.	β class 3	Sig.	β class 4	Sig.
Knowledge acquisition strategy	53,66	***	30,59	***	Internal R&D	-8,08	**	16,93	***	-1,61		0,75	***
					Buy	3,95	**	-17,61	***	-8,16	***	-0,15	
					Collaborate	4,12	**	0,68		9,77	***	-0,60	***
Speed to market	76,85	***	76,40	***	First mover	-0,33	***	0,03		2,23	***	0,23	
					Second mover	0,33	***	-0,03		-2,23	***	-0,23	
Risk	133,85	***	79,15	***	Small	0,82	***	0,13		2,24	***	-0,05	
					Large	-0,82	***	-0,13		-2,24	***	0,05	
Development time	32,38	***	30,20	***	Short	0,00		-0,12		0,85	***	0,51	**
					Long	0,00		0,12		-0,85	***	-0,51	**
Knowledge source	96,24	***	63,71	***	Buyer	0,16		-0,26		0,28		0,15	
					Competing firm	-0,80	***	0,08		-0,93	**	0,04	
					Private research institute	-0,23		0,22		0,62	*	-0,46	*
					Non-competing firm	0,77	***	0,44	**	1,30	***	-0,27	
					Supplier	0,17		0,11		-0,43		0,33	*
					University or public research institute	-0,08		-0,59	**	-0,84	*	0,22	
IP	86,06	***	76,48	***	No IP	-0,16		-0,20		0,35		0,18	
					Full ownership	0,01		0,96	***	1,53	***	-0,33	*
					License IP	0,15		-0,38	**	-1,54	***	0,25	
					Shared IP	0,00		-0,38	**	-0,35		-0,10	
Network	48,37	***	42,87	***	None	-0,14		-0,10		0,96	**	-0,36	
					Business	0,38	**	0,19		-1,82	***	0,39	
					Scientific	-0,23		0,10		-0,31		-0,05	
					Scientific & business	-0,01		-0,19		1,18	***	0,01	
Office & specialized equipment	49,10	***	46,02	***	None	0,00		0,22		-0,17		-0,50	**
					Office	0,34	**	0,12		-0,40		0,07	
					Specialized equipment	0,02		-0,30	*	0,93	***	-0,24	
					Office & specialized equipment	-0,36	**	-0,04		-0,36		0,66	***
Training & coach	49,91	***	40,57	***	None	0,33	**	-0,25	*	-0,97	**	-0,20	
					Training	-0,28	*	0,16		1,43	***	-0,19	
					Coach	0,12		0,32	*	-0,26		0,47	**
					Training & coach	-0,17		-0,22		-0,21		-0,09	
Funding model	207,07	***	181,68	***	Own investment	0,71	***	3,02	***	0,66	*	-0,27	
					Family & friends	-0,84	***	0,09		0,90	*	-0,06	
					Investor	0,44	**	-0,47	**	0,43		-0,19	
					Loan (bank)	0,37		-1,16	***	-2,06	***	-0,42	**
					Crowd funding	-0,77	***	-0,97	***	-2,51	***	0,72	***
					Subsidy (government)	0,09		-0,51	**	2,59	***	0,22	

Task position	48,75	***	35,45	***	Left	0,06		0,21	*	0,29	0,63	***
					Middle	0,06		-0,14		-0,13	0,77	***
					Right	-0,12		-0,08		-0,16	-1,40	***
Intercept	9,50	*				-0,19		0,35	**	-0,10	-0,06	
Label	34,54	***			Labeled	-0,66	***	-0,12		-0,04	0,83	***
					Unlabeled	0,66	***	0,12		0,04	-0,83	***
Country	5,55				UK	-0,09		0,24	*	-0,13	-0,03	
					Germany	0,09		-0,24	*	0,13	0,03	
N (Class)						102		121		92	112	
McFadden R2	0,27											
Number of parameters	126											
Log-likelihood (LL)	-5890,9201											
BIC (based on LL)	12545,00											

Table 2: Latent class model. Wald χ2 indicates attribute importance, Wald χ2 (=) indicates attribute differences between classes. *: p<0.05, **:p<0.01, ***:p<0.001.

Firm characteristic	Wald χ2	Sig.	Category	β class 1	Sig.	β class 2	Sig.	β class 3	Sig.	β class 4	Sig.
Intercept	12,12	**		1,48	**	-0,55		-1,28	*	0,35	
R&D	16,61	***	Yes	-0,80	***	0,40	*	0,07		0,33	a
Patent stock	20,07	*	0	0,21		-0,23		0,51	*	-0,49	**
			1-2	0,16		0,32		-0,42		-0,06	
			3-10	0,52	*	-0,53	a	-0,04		0,04	
			>10	-0,90	*	0,44		-0,05		0,51	
Product innovations	20,31	a	0	-0,11		0,12		0,10		-0,11	
			1	-0,06		-0,31	a	0,02		0,35	*
			2	-0,35		0,36	a	-0,27		0,27	
			3	0,37		-0,60	*	0,50	*	-0,27	
			>3	0,15		0,42	a	-0,35		-0,23	
Past use of KAS: suppliers	16,41	*	Buy	-0,17		0,14		-0,05		0,08	
			Collaborate	0,41	**	-0,01		0,09		-0,49	***
			Not used	-0,25		-0,13		-0,04		0,42	*
Past use of KAS: competing firm	14,50	*	Buy	0,68	*	0,22		-0,92		0,01	
			Collaborate	-0,23		-0,41	*	0,48		0,15	
			Not used	-0,46	*	0,18		0,44		-0,16	
Past use of KAS: non-competing firm	14,21	*	Buy	0,34		0,43		-0,55		-0,23	
			Collaborate	-0,26		-0,48	*	0,50	a	0,23	
			Not used	-0,08		0,04		0,04		0,00	
Past use of KAS: customers	11,27	a	Buy	0,05		0,01		-0,61		0,55	*
			Collaborate	-0,09		0,14		0,43	a	-0,48	**
			Not used	0,03		-0,14		0,17		-0,07	
Past use of KAS: Universities & Public knowledge institutes	8,71		Buy	0,17		-0,47		0,17		0,12	
			Collaborate	-0,01		-0,09		0,10		0,00	
			Not used	-0,16		0,56	**	-0,27		-0,13	
Past use of KAS: Private knowledge institutes	6,88		Buy	0,23		-0,11		0,05		-0,17	
			Collaborate	-0,28		0,31		-0,23		0,20	
			Not used	0,05		-0,20		0,18		-0,03	
Size	24,13	**	Micro	-0,27		0,31		-0,12		0,08	
			Small	0,47		-0,08		0,04		-0,43	a
			Medium	0,62	a	-0,04		-0,91	**	0,33	
			Medium-large	-0,82		-0,20		0,99	a	0,03	
McFadden R2	0,15										
Number of parameters	72										
Log-likelihood (LL)	-502,21										
BIC (based on LL)	1440,51										

Table 3: Multinomial logit model. *: p<0.05, **:p<0.01, ***:p<0.001.

Table 3 presents the results of the multinomial regression to predict class member ship using the firm characteristics. The pseudo R^2 is 0.15, which is an acceptable fit. Using tables 2 and 3 we describe the four latent classes by the attribute levels and firm characteristics that are significant.

- Class 1 - *externally oriented*: This class values the external R&D strategies over internal R&D, and collaboration slightly over buy. This is the only class that finds a second mover position more attractive than a first mover position. Consistent with their preference for external R&D and being a second mover, this class prefers to take small risks only. Class 1 prefers to work with non-competing firms as external knowledge source, while competitors are least preferred. To the other knowledge sources class members are indifferent. In line with their external orientation, this class is sensitive to resources that come from collaboration. Of the resource endowments, class members find a business network and getting access to an office space attractive. However, they have no interest in combining office space with specialized equipment, nor are they interested in the human capital resources. Finally, they prefer to finance innovation through own investments. Investors are seen as the most likely external alternative. Family & friends and crowd funding are unlikely sources of funding. The firms characteristics show that this class is least likely to conduct R&D itself and that relatively little firms hold more than 10 patents. Firms do collaborate with suppliers, and buy knowledge from competitors and non-competitors. Thereby the choice for a KAS is largely consistent with the firm's current behavior. Finally, firms in class 1 are most likely medium sized.
- Class 2 - *internally oriented*: This class has a strong preference for internal R&D and a strong preference against buy. If a class 2 firm consults an external knowledge source, it is most likely a non-competing firm. Universities and public research institutes are seen as the least likely sources. In line with their internal orientation these firms find full IP ownership important. None of the resource endowments positively influence their choice for a KAS, except for gaining access to a coach on an individual basis. Of all classes this group has the strongest preference for using own funds to finance innovation. Consistent with the choice for internal R&D, firms in this class are most likely to already conduct R&D themselves. As a result this class has a large share of firms that introduced more than 3 innovations on the market. The estimators that are significant for past use of KAS, indicate that firms in this class made the least use of external knowledge sources.
- Class 3 - *collaborators*: This class has a strong preference for collaboration, and against buy. Consistent with this, they prefer a first mover advantage and like to

small risks. They prefer a shorter development time over a longer one, which is consistent with their preference to be a first mover. In line with other classes, non-competing firms are preferred knowledge sources, while competitors and universities are least preferred. If possible, this class wants to have full IP ownership. Consistent with their aversion against the buy strategy, firms in this class do not want to license IP. The network preferences for this class are difficult to interpret. Either firms prefer a network consisting of both scientists and business or no network at all, which indicates that only integrated networks are of added value to class 3. This seems inconsistent with the preference for collaboration and aversion against using universities as knowledge source. Further, access to specialized equipment and collective training can positively influence the choice for a KAS. The most attractive funding model is government subsidies, since many subsidy instruments aim to promote collaboration this is an expected finding. Alternative finance models are family & friends or own investment. Loans from banks and crowd funding are deemed unlikely. Many firms in this class hold no patents and have brought about 3 new products to the market. In line with their KAS choice, these firms have collaborated in the past, mostly with non-competing firms and customers. Finally, this class contains the largest firms, but relatively little medium sized firms.

- Class 4 - *flexible*: This class is least pronounced in its preference for a KAS. There is a slight preference for internal R&D, and small aversion against collaborate. Members prefer a short development time over a long one. Suppliers are the most preferred knowledge source, while private research institutes are least preferred. This group is not interested in gaining full IP, although the differences between estimators are modest here as well. When it comes to resource endowments, class 3 attaches a lot of value to office & specialized equipment and individual coaching. Moreover, this class is the only one that finds crowd funding the most interesting funding model, while loans from a bank a least valued. Firms in this class do conduct R&D themselves and a relatively large share of class members has more than 10 patents. A large share has introduced only 1 new product to the market. Consistent with their KAS choice these firms collaborated less in the past, but they did acquire knowledge from customers using a buy strategy.

Notable for all classes is that the preferences for attributes within the classes are mostly consistent with each other. Moreover, there is also consistency with the associated firm characteristics. It is specifically noteworthy that the choice for a strategy is related to past behavior. Firms thus seem wish to exploit to routines they developed in the past for a future KAS. Only firms in class 4 are willing or able to break with their existing pattern.

Based on these results it is possible to estimate if the resource endowments can bring about a change in KAS. This is the case when the difference between two KAS estimators (βs) in a class is smaller than the sum of estimators from a set of resource endowments. For example, in class 1 the difference in estimators between buy and collaborate is 0.17. This means that giving access to an office (β=0.34) can change the most likely strategy from collaborate to buy. Also in class 4 is the difference in KAS estimators is small enough (β=1.35); a combination of giving access to an office & specialized equipment (β=0.66), coach (β=0.47) and crowd funding (β=0.72) can shift the focus from internal R&D towards collaborate in this class. In the other classes the differences in KAS estimators are too large to bring about a change in KAS, which implies that the developed knowledge acquisition routines are too strong to be changed.

5. Conclusion & discussion

The aim of this study was *to compare the influence of attributes of an innovation project on the choice for a knowledge acquisition strategy for different latent classes of firms*. This was done by conducting a DCE on a sample of 427 SMEs from the United Kingdom and Germany. Thereby we gained systematic insights in how these strategic choices are made at the level of individual innovation projects.

We identified four latent classes with distinct choice profiles. Moreover, we demonstrated that the choice for a KAS is related to the past behavior of the firm and that resource endowments are likely to change the KAS for only a specific group of firms.

Theoretically, our results confirm earlier observations that risk is very important in organizational decision making. The finding that past behavior has a large influence on future choice and causes inertia, is in line with theories claims about routinization from Evolutionary Economics and Organizational Learning. Moreover, since behavior appears to be quite stable the findings lend credibility to studies investigated this topic at the firm level using conventional survey data. Our study adds that different latent classes of firms have different propensities to change their KAS. By including resources endowments, we have investigated a limited number of ways of how to change a KAS. Future research should investigate the effects of alternative strategies.

This study is one of the first to use DCEs to understand these types of organizational decisions. The experimental design used ensures that our results are internally valid. Thereby we are able to claim that a change in attribute levels is causally related to choice, without confounding influences or common method bias. This is an improvement over traditional survey data, and a methodological contribution to the literature. We

encourage scholars to apply this method to other strategic decisions in organizations, like the balance between exploration and exploitation or the trade-off between corporate social responsible behavior and profitability. However, it should be noted however that DCEs only elicit stated preference data. Despite favorable evidence from consumers and individuals, and the fact that our results are theoretically plausible, it is still unknown how these findings translate into actual firm behavior. For this more research is needed.

We finish with practical recommendations. To promote innovation, policy makers often aim to stimulate collaboration between firms and other knowledge sources. This is done by using various policy instruments, like building science parks, or granting innovation subsidies. Our results demonstrate that firms are mostly interested in working with other parties on the market, while institutional sources like universities are deemed unattractive. Second, these measures are only effective to change the behavior of a limited group of firms (class 4). This class is interesting to involve in collaboration, since it has a relatively large share of patents and it is relatively innovative. Firms in class 1 already prefer to collaborate, but their R&D activities and patent stock suggests that their knowledge base is limited. Moreover, since they prefer to be second mover, it is unlikely that this class will bring ground breaking innovations to market. Firms in this class are thus less interesting collaboration partners for innovation. Firms in class 3 are already collaborating, but policy measures, like subsidies can be effective in stimulating collaboration with other knowledge sources, such as universities. Finally, firms in class 2 are relatively innovative, and potentially interesting collaboration partners. However, given their strong preference for internal R&D, it is very unlikely that this class will open-up their innovation process.

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Appendix 1: The explanation of the KAS and the attributes

Strategy	*Explanation*
Internal R&D	**(Creative) work undertaken *within* your enterprise** to increase the stock of knowledge and its use to devise new and improved products and processes (including software development). Research and Development (R&D) is an example of internal knowledge creation. *Advantages of internal R&D:* *1) First mover advantage* *2) Full IP ownership* *Disadvantages of internal R&D:* *1) High risk* *2) Long development time*
Buy	***Copy, purchase or license* know-how, patents and non-patented inventions from other organizations.** Think of advanced machinery, equipment and computer hardware or software you buy from other organizations to devise new or significantly improved products and processes. ***Apart from the possible sale, no interaction*** between you and the other organization takes place. *Advantages of buy:* *1) Low risk* *2) Short development time* *Disadvantages of buy:* *1) Second mover* *2) IP ownership needs to be negotiated*
Collaboration	**(Creative) work undertaken *between* your enterprise and other organizations** to increase the stock of knowledge and its use to devise new and improved products and processes (including software development). Your enterprise and other organizations interact frequently in this joint project. Not all partners need to commercially benefit from this collaboration. Think of partnerships, alliances, collaborative projects and so on. *Advantages of collaboration:* *1) Shared first mover advantage* *2) Low risk* *Disadvantages of collaboration:* *1) Long development time* *2) IP ownership needs to be negotiated*

Characteristic	Explanation	Level
Speed to market	Are you ahead of your competitors?	1. First mover: your product is the first on the market. 2. Second mover: other firms have a similar product on the market
Risk	The likeliness the project will fail, does not yield the expected results in the end.	1. Low risk: more than 50% chance the project will yield the expected results 2. High risk: less than 50% chance the project will yield the expected results
Development time	The timescale of the project.	1. Short time: the development time is two times as fast as normal 2. Long time: the development time is normal
Knowledge source	Where do you get the knowledge to develop your idea to a proof of concept from?	1. None: no external knowledge source is present. You only use the knowledge available within your company. 2. Supplier: supplier of equipment, materials, components, or software 3. Competing firm: competing firm inside your sector 4. Non-competing firm: non-competing firm outside your sector 5. Buyer: prospective costumer or user of your product 6. University or public research institute: University, other higher education institutes or public research institutes 7. Private research institute: research organization that primarily conducts applied contract research, such as Frauenhofer or a commercial laboratory
Your intellectual property (IP)	How is your IP ownership arranged?	1. Free IP: no patents are available for this product 2. Shared IP: patents are shared with knowledge source 3. License IP: patents are licensed from knowledge source 4. Full ownership: all patents are available to your firm
Access to a network	Access to new contacts you gain by choosing a specific strategy to other partners.	1. No: no access available 2. Scientific: access to a scientific network 3. Business: Access to a business/market network 4. Scientific & Business: access to both a scientific and a business/market network
Access to Office/Specialized equipment	Free access to an office and/or specialized equipment (e.g. laboratory, field test facilities)	1. No: no access available 2. Office: access to an office 3. Specialized equipment: access to specialized equipment 4. Office & Specialized equipment: access to an office and specialized equipment
Access to Training/Coach	Free access to a coach and/or training such as master classes and workshops. Coaching includes advisory boards, mentors and other coaches.	1. No: no access available 2. Coach: Access to a coach 3. Training: Access to master classes, workshops and other training programmes 4. Coach & Training: Access to a coach, master classes, workshops and other

		training programmes
Funding model	The way the project is financed.	1. Subsidy: subsidy from government 2. Loan: loan from a bank 3. Crowd funding: use the internet to find individuals that want to invest a small amount of money in your idea. 4. Investor: investor* takes a minority stake in your company 5. Family & Friends: family and/or friends invest in your company 6. Own investment: usage of own assets

* Investor can be an external investor (e.g. venture capital or angel investor) as well as the organizations in the knowledge source

Appendix B: Example choice task.

Given the following conditions, which of the following strategies would your enterprise most likely pursue to acquire knowledge to research a new innovative idea to proof of concept in your current market?
Tick the appropriate boxes under the task to indicate the most likely and least likely strategies.
Click here to see table with choice set characteristics

Characteristics	Internal R&D	Buy	Collaboration
Strategy characteristics	First mover High risk 4 years	Second mover Low risk 2 years	First mover Low risk 4 years
Knowledge Source	None	Supplier	Supplier
Intellectual property	Full ownership	Free IP	Free IP
Access to a network	No	No	No
Access to office/specialized equipment	No	No	No
Access to training/coaching	No	No	No
Funding model	Subsidy	Investor	Crowdfunding
Most likely to choose strategy:	○	○	○
Least likely to choose strategy:	○	○	○